

BUSINESS SAMPLE SURVEY MEASUREMENT ON STATISTICAL THINKING AND METHODS ADOPTION: THE CASE OF CROATIAN SMALL ENTERPRISES

Berislav Žmuk*

Department of Statistics, Faculty of Economics and Business – Zagreb, University of Zagreb
Zagreb, Croatia

DOI: 10.7906/indecs.13.1.14
Regular article

Received: 19 September 2014.
Accepted: 12 January 2015.

ABSTRACT

The objective of this research is to investigate attitudes of management in Croatian small enterprises that use statistical methods towards statistical thinking in order to gain an insight into related issues. The research was conducted in 2013 using a web survey with a random sample of 631 Croatian small enterprises, but this paper focuses only on those enterprises that use statistical methods. In order to get detailed information, a complex stratified sample survey design was used. In the analysis, chi-square tests of independence were used. In the statistical tests of proportion, the nonresponse adjustment factors as weights and weighted proportions were used. It has been shown that the vast majority of Croatian small enterprises (65,93 %) do not even use statistical methods in their business. On the other hand, the enterprises which use statistical methods have recognized the value and capabilities of statistical methods use. The research has shown that the vast majority of enterprises do not use statistical methods due to administrative reasons. In spite of using statistical methods as a supporting tool in the decision-making process in very important and key business cases, Croatian small enterprises admitted the lack of statistical methods use in their business. Also, investments into the statistical methods use are very scarce. This has led to employees' low statistical methods use knowledge level. The statistical methods use led to better business results in more than 90 % of small enterprises. It has been shown that statistical methods use effects on business results have on average a 6-12 months lag. This research leads to the conclusion that more efforts should be put into development of statistical thinking in these enterprises and familiarizing them with statistical methods use, with the aim of increasing their use and improving business results.

KEY WORDS

statistical thinking, business survey, complex sample survey design, weighted stratified proportion estimator, chi-square tests of independence

CLASSIFICATION

JEL: C12, C42, M21

*Corresponding author, η : bzmuk@efzg.hr; +385 1 2383372;
Faculty of Economics and Business – Zagreb, Trg J.F.Kennedyja 6, HR – 10000 Zagreb, Croatia

INTRODUCTION

Statistical thinking is a philosophy of learning and action based on the following principles: all work occurs in a system of interconnected processes; variation exists in all processes, and understanding and reducing variation are keys to success [1]. The development of statistical thinking, which began in the 1990s, is the next step in the evolution of the statistics discipline [2]. According to Moore [3; p.134] statistical thinking has become the most important part of inquiry. Box [4] agrees with that and emphasizes the need to develop a statistical way of thinking and to change the approach to problems. According to him, these developments and changes are needed because of the intensive computer use in dealing with different business problems. Despite the increased need for statistical knowledge, which resulted in an increased number of statistical subjects and students who are interested in statistics [5-7], statistics has been viewed by students as difficult and unpleasant to learn, and by instructors as frustrating and unrewarding to teach [8; p.4]. An inadequate level of computers use due to insufficient institutions' funds and a general aversion of students to statistics and statistical thinking are seen by Cobanovic [9] as the main barriers to the further development and improvement of education in the application of statistical methods.

Presented situation in statistics education reflects on statistics use and statistical thinking in enterprises. According to Dransfield, Fisher and Vogel [10] the statistical methods use has an important role in the measurement of enterprises' organizational effectiveness, which is of fundamental importance for achieving business excellence. Montgomery [11] agrees that the statistical methods use in enterprises has become necessary. He also notes that, since the 1980s, a significant progress has been made not only in the use of statistical methods in enterprises, but also in their development. But research from different countries, such as Canada [12], Croatia [13-17], the Czech Republic [18], Finland [19], Germany [20], Great Britain [19, 21, 22], Kosovo [23], Malaysia [24], Portugal [19], South Africa [25-27], Spain [20], Sweden [28-31] and the United States [32], has shown that statistical methods and statistical thinking are used only in a small number of enterprises and that in most cases enterprises use only the simplest statistical methods and approaches.

It is indicative that enterprises slowly accept and implement statistical methods in their business. According to Makrymichalos et al. [33] the main reasons and barriers to further development and increase of the statistical methods usage level in enterprises are: different opinions on statistical methods of enterprises and their employees; inadequate education at universities in the field of statistical methods use; managers' fear of the statistical methods use. Deleryd [34] has formed four groups of reasons for seldom statistical methods application: problems in management; conservative personal employees' attitudes; practical problems; methodological problems. Antony et al. [18] consider that the reasons for scarce statistical methods use are the following: a lack of quality management's awareness of general statistics methods principles; a lack of awareness about the statistical methods use importance and the resulting benefits from their implementation; academic institutions provide inadequate education on the statistical methods use in enterprises; managers' insistence on one-factor approach application to the process optimization; inadequate skills and competence in the advanced statistical methods application field; a negative attitude towards quality improvement and process optimization strategies; a lack of funds to run a pilot study. Another empirical research has shown that the main reasons for a lack of statistical methods use include low managers' commitment and poor statistical background of employees in enterprises [35]. Antony [36] concludes that there is a huge difference between the current level of statistical methods use knowledge, and the level required for successful solving of enterprises' problems.

On the other hand, enterprises do not use statistical methods because: an enterprise is already considered as successful; a lack of awareness about the benefits of applying these methods; the lack of resources; time constraints; and managers' decisions [21]. More advanced statistical methods are not being used because enterprises are not aware of their existence and potential, or they are not ready and trained for their use [25].

Small enterprises are the base of each economy. The better business results small enterprises in a country have, the better the country's economy and prosperity is. Previous research has shown that statistical methods use and statistical thinking in general can improve enterprises' business results. Because of that, it is very interesting to research what the position of statistical thinking in modern Croatian small enterprise is. The main research hypothesis is: Statistical thinking is widespread in Croatian small enterprises. The research hypothesis implies that the majority of Croatian small enterprises have developed statistical thinking and that statistical methods are used in them.

The aim of the research is to test if statistical thinking is widely accepted by Croatian small enterprises. In order to make a conclusion about the named research hypothesis, an original scientific web survey in Croatian small enterprises has been conducted. The article is organized as follows. Section 2 introduces the statistical population, the survey design and analysis methods. Section 3 presents the analysis taking the complex survey design into account. Section 4 presents the conclusions of the study.

DATA COLLECTION AND RESEARCH METHODS

STATISTICAL POPULATION

The survey target population [37] includes active Croatian small enterprises that use statistical methods. A small enterprise is an enterprise which meets two out of three of the following criteri: the amount of total assets is lower than HRK 32 500 000,00; the amount of revenue is lower than HRK 65 000 000,00; and the average number of employees during the financial year is lower than 50 [38]. In order to be considered a Croatian enterprise an enterprise has to be registered in the Court Register of the Republic of Croatia. The research included only enterprises with the legal form of a corporation [39].

The Croatian Company Directory of the Croatian Chamber of Economy was used as a sampling frame [40]. The sampling frame contained the updated list of all registered small enterprises. On 1 October 2012, there were 87 805 small enterprises in Croatia with the legal form of a corporation. The problem was that the list included inactive enterprises as well as enterprises that on average had no employees during a year. Consequently 30 449 enterprises were excluded from the analysis and thus the target population was reduced to 57 356 small enterprises. In spite of that representative sample, because of complete sampling frame and known nonzero probabilities of selection, can be obtained [41].

SURVEY DESIGN

In order to get information about enterprises' attitude towards statistical thinking, a web survey was made. Another problem was that all enterprises did not provide a valid e-mail address and because of that they were not able to participate in the survey. As a result, the sampling population consisted of 24 618 Croatian small enterprises. It is assumed that there is no statistically significant difference between enterprises that have and those that have not provided a valid e-mail address.

It is known that each enterprise's main activity area has its own special features. In order to examine if the statistical thinking position is the same in different activity areas, a complex

survey design was used and four strata were constructed based on the enterprises' main activities. In that way, an additional in-depth analysis was enabled. In order to split enterprises into four strata The National Classification of Economic Activities (NACE) was used [42]. NACE recognizes overall 21 main activity areas and indicates them with letters from A to U. The first stratum includes industrial enterprises from the activity areas B, C, D, E, and F. The second stratum consists of trade enterprises (the activity area G). The third stratum contains enterprises which are considered as service-oriented enterprises (the activity areas H, I, J, K, L, M, N, O, P, Q, S). The rest of enterprises are placed into the Other stratum. The last stratum includes enterprises the main activity of which, according to NACE, belongs into the activity areas A, R, T, or U.

Most enterprises were in the Services stratum (10 091), in the Trade (7 186) and in the Industrial (6 769) strata. The fewest enterprises were in the Other stratum (572). In order to achieve a margin of error equal to plus or minus 7%, with a confidence level of 95 % 196 eligible enterprises needed to be surveyed. Because the aim of the research is to investigate the position of statistical thinking in Croatian small enterprises it is necessary to observe only those enterprises that use statistical methods. Consequently, only such enterprises are eligible. Taking into account the assumed share of small enterprises that use statistical methods and the expected response rate, it was concluded that 21 000 small enterprises should be contacted. In order to sample enterprises from each strata, proportionate allocation and the simple random sampling method were used.

Within this survey, Croatian small enterprises are considered to be sampling and analysis units while enterprises' employees, primarily managers who represents the enterprise in which they work, are seen as reporting units. Their responses are considered enterprises' responses. They had to fill in the questionnaire that consisted of 6 different groups of questions. Each group had a different number of questions and covered a different area about the position of statistical thinking in an enterprise. The length and clarity of questions were maximally optimized to avoid misunderstandings. It was estimated that an enterprise needed at least 5 minutes and at most 15 minutes to complete the questionnaire. The computer programme used for the web survey prevented enterprises from skipping some questions or giving inappropriate answers. In that way the item nonresponse problem was avoided.

SURVEY RESPONSE RATE

The survey started in October 2012 and lasted 15 weeks. During that period two reminders were sent to the enterprises. At the end, employees from 631 Croatian small enterprises took part in the survey and filled in the questionnaire for their enterprise but only 215 or 34,07 % of them use statistical methods in their business and are considered as eligible for the research. Because there were no partially completed questionnaires, the response rate was calculated as the total number of eligible enterprises responses over the total number of contacted enterprises and it is equal to 1,02 %. This response rate is known as Response Rate 1 or the minimum response rate [43]. The response rates in strata vary from 0,86 % in the Trade stratum and 0,88 % in the Industrial stratum to 1,22 % in the Services stratum and 1,23 % in the Other stratum.

ANALYSIS METHODS

Different statistical methods were used in the analysis. Descriptive statistics methods were used as a base for inference. Selected statistical tests such as chi-square tests of independence and tests of proportion were used in the inferential analysis. In the analysis, only nonresponse adjustments weights were taken into account. The response adjustments weights were calculated as reciprocal to the response rate for each stratum separately.

EMPIRICAL RESULTS AND DISCUSSION

ATTITUDES TOWARDS REASONS FOR STATISTICAL METHODS USE IN SMALL ENTERPRISES

First of all, the enterprises that use statistical methods were additionally asked about the reasons of their application. According to literature review, there are six most influential reasons for statistical methods use. The enterprises could for each reason separately confirm that the reason had an impact on their decision to use statistical methods or they could disagree with that. Naturally, the enterprises could also answer that they did not know or they were not familiar if a certain reason was one of the reasons for the statistical methods use. Such answers were considered in the further analysis. Because of that, the total number of answers for each selected reason is different. Table 1 shows enterprises' estimated weighted population proportions for each reason. The proportions were calculated as:

$$p_{st} = \sum_{h=1}^H W_h p_{sh}, \quad (1)$$

where the weight $W_h = N_h/N$ is the proportion of units in stratum h , N_h is the known number of units in the population in stratum h , N is the known total number of units in the population, and $p_{sh} = (1/n_{sh}) \sum y_{kh}$ is the sample proportion in stratum h , $\sum y_k$ is the total number of units with observed characteristic k in stratum h , n_{sh} is the number of units in the sample in the stratum h . Because only the nonresponse adjustments weights are used in the analysis, all sampled units in the stratum are given the same weights. In that way the "self-weighting" was conducted and there was no need for introducing more complexity in calculating p_{sh} .

The first three reasons in Table 1 may be considered as true reasons for statistical methods use because they are primarily oriented towards improving processes and business results. On the other hand, the last three reasons are considered as wrong reasons for statistical methods use because statistical methods are used only for administrative purposes. The majority of enterprises, 95 % of 215 enterprises that use statistical methods, use them because they facilitate the business decision-making process. Also, 90 % of enterprises agree that the statistical methods use helps them improve business results. Only 28 % of enterprises use statistical methods because their application has been a prerequisite for business certification and because their competition also uses statistical methods (30 %). These results indicate that the enterprises have recognized the true purpose of statistical methods as an additional tool for better management.

In order to make inference about all small Croatian companies that use statistical methods, the hypothesis test of estimated proportion was conducted. It was assumed for each reason for statistical methods application that more than half of the enterprises accept the reason as a reason of statistical methods application in their enterprise. So the test hypotheses are: $H_0: p \leq 0,5$ and $H_1: p > 0,5$. The population sampling variance of the stratified estimator was calculated as:

$$V_{st} = \sum_{h=1}^H W_h^2 \frac{1-f_h}{n_{sh}-1} p_{sh}(1-p_{sh}), \quad (2)$$

where $f_h = n_{sh}/N_h$. The results of the conducted statistical tests are shown in Table 2. According to those results it can be concluded that at the significance level $\alpha = 0,05$ the null hypothesis can be rejected for the following reasons: statistical methods facilitate the business decision-making process; the statistical methods usage improves business results; the statistical methods application leads to achieving cost efficiency. In that way, it is confirmed

that most of the enterprises have right motives for using statistical methods and that they do not use statistical methods only because of administrative reasons.

The χ^2 tests of independence between accepting the reason as a reason for statistical methods application in an enterprise, and enterprises' activity has also been conducted. In the analysis the Other stratum was omitted because of an insignificant number of such enterprises. The test results are given in Table 3. It can be concluded that at the significance level $\alpha = 0,05$ there is no statistically significant dependence between accepting the reason as a reason for statistical methods application in an enterprise and enterprises' activity for all reasons except the reason that the statistical methods application leads to achieving cost efficiency. The reason

Table 1. Attitudes towards reasons for statistical methods use in small enterprises, weighted proportions, $n = 215$. Source: conducted survey.

Reason	The reason for stat. methods use		No. of answers
	Yes	No	
Statistical methods facilitate the business decision-making process	0,9502	0,0498	202
Statistical methods usage improves business results	0,8955	0,1045	194
Statistical methods application leads to cost efficiency	0,8718	0,1282	183
The management demands statistical methods usage	0,4360	0,5640	195
Statistical methods have been used by competitors	0,3048	0,6952	149
Statistical methods use has been a prerequisite for business certification	0,2763	0,7237	183

Table 2. Hypothesis tests of proportions of reasons for statistical methods application in small enterprises, $n = 215$. Source: conducted survey.

Reason	Sample size	Estimated proportion	Standard error	z-value	p-value
Statistical methods facilitate the business decision-making process	202	0,9502	0,0157	28,70	0,0000
Statistical methods usage improves business results	194	0,8955	0,0221	17,93	0,0000
Statistical methods application leads to achieving cost efficiency	183	0,8718	0,0233	15,95	0,0000
The management demands statistical methods usage	195	0,4360	0,0364	-1,76	0,9608
Statistical methods have been used by competitors	149	0,3048	0,0398	-4,90	1,0000
Statistical methods usage has been a prerequisite for business certification	183	0,2763	0,0340	-6,59	1,0000

Table 3. χ^2 tests of accepting the mentioned reason as the main reason for statistical methods application in an enterprise and enterprises' activity, without the Other stratum, $n = 209$. Source: conducted survey.

Reason	Sample size	df	Chi-square test statistic	p-value
Statistical methods facilitate the business decision-making process	196	2	0.512	0.7741
Statistical methods usage improves business results	188	2	0.824	0.6625
Statistical methods application leads to achieving cost efficiency	178	2	9.227	0.0099
The management demands statistical methods usage	189	2	1.062	0.5881
Statistical methods have been used by competition	144	2	4.783	0.0915
Statistical methods usage has been a prerequisite for business certification	177	2	3.093	0.2130

reason for such a conclusion is the proportion of Services enterprises that agree that the statistical methods application leads to achieving cost efficiency, which is considerably lower than the proportion of Industrial and Trade enterprises.

STATISTICAL METHODS POSITION IN ENTERPRISES' KEY BUSINESS CASES

An additional proof that the enterprises have recognized the true purpose of statistical methods use is the level of their involvement in enterprises' key business cases. So, 178 enterprises or 83 % of enterprises in the sample that use statistical methods use them as a decision-making support in very important and key business cases. Out of that number, 46 enterprises always use statistical methods in such cases, and 132 enterprises do that occasionally. Only 30 enterprises or 14 % of enterprises in the sample that use statistical methods do not use them as a decision-making support in very important and key business cases. The rest of enterprises were not familiar with the fact whether statistical methods were used in their key business cases.

REASONS FOR LACK OF STATISTICAL METHODS APPLICATION

Croatian small enterprises that use statistical methods have recognized the importance and the role of statistical methods. But according to survey results, only 80 enterprises or 37 % of enterprises that use statistical methods, are satisfied with the level of statistical methods use in their business. On the other hand, 112 enterprises or 52 % of enterprises that use statistical methods think that they should use more statistical methods. The employees in the rest of enterprises (11 %) could not evaluate the level of statistical methods use in their enterprise. Such enterprises are omitted from the analysis in conducting the hypothesis test of proportions on upper limit. It is assumed that the majority of Croatian small enterprises are not satisfied with the level of statistical methods use in their business. According to that, the test hypotheses are $H_0: p \leq 0,5$ and $H_1: p > 0,5$. The test results suggest that, at the significance level of $\alpha = 0,05$, the null hypothesis may be rejected ($n = 192$; $\hat{p} = 0.5982$; $se = 0.0358$; $z = 2.75$; $p = 0.0030$). Consequently, it might be concluded that statistical methods are not used enough in more than 50% of enterprises. The same conclusion can be brought for Industrial ($n = 41$; $\hat{p} = 0.6585$; $se = 0.0781$; $z = 2.03$; $p = 0.0212$), and Trade enterprises ($n = 48$; $\hat{p} = 0.6667$; $se = 0.0722$; $z = 2.31$; $p = 0.0105$). On the other hand, this conclusion cannot be made for Services enterprises at the significance level of $\alpha = 0.05$ ($n = 97$; $\hat{p} = 0.5052$; $se = 0.0508$; $z = 0.10$; $p = 0.4596$).

In total, six reasons for a lack of statistical methods use are identified. Enterprises that use statistical methods could agree or disagree with each of these reasons according to their impact on the level of statistical methods use in their enterprise. According to the results in Table 4

Table 4. Reasons for a lack of statistical methods application in small enterprises, weighted proportions, $n = 215$. Source: conducted survey.

Reason	The reason for lack of stat. methods use		No. of answers
	Yes	No	
The existing overloaded of employees with other jobs and assignments	0,7563	0,2437	200
Statistical methods are not well known in the enterprise	0,7366	0,2634	198
The lack of qualified personnel	0,5827	0,4173	193
Lack of financial resources	0,5583	0,4417	193
The nature of the product / service	0,5185	0,4815	191
The additional statistical methods application would not have an impact on business results	0,2799	0,7201	180

the most important reason for a lack of statistical methods applications is that the employees are already overloaded with the existing jobs and assignments. The second important reason is that statistical methods are not well known in the enterprises. In order to solve these two reasons and the third one, the lack of qualified personnel, an enterprise should employ one or more statisticians. In that way, a highly qualified person would perform statistical analyses and other employees would in that case have more time for other tasks. Of course, an enterprise should employ a new person only if it has enough financial resources for it.

STATISTICAL METHODS USE KNOWLEDGE IN SMALL ENTERPRISES

Before any investments in additional education, the enterprise should be familiar with employees' knowledge about statistical methods application. Croatian small enterprises that uses statistical methods were asked to give an average grade for their employees' knowledge about statistical methods. Out of 182 enterprises, only 8 enterprises or 4 % gave the highest grade, grade A, to their employees for statistical methods use knowledge. Most enterprises, 70 enterprises or 38 %, gave grade C to their employees. The lowest grade, grade E, was given to employees in 19 or in 10,44 % of enterprises.

It is assumed that grades C, D and E present a non-satisfactory statistical knowledge level. In order to determine if the majority of enterprises have a non-satisfactory statistical knowledge level a statistical hypothesis test for proportion on upper limit was conducted. Consequently, the hypotheses are $H_0: p \leq 0,5$ and $H_1: p > 0,5$. At the significance level $\alpha = 0,05$ the null hypothesis can be rejected ($n = 182$; $\hat{p} = 0,7784$; $se = 0,0308$; $z = 9,05$; $p = 0,0000$), which means that in over than 50% of enterprises employees do not have a satisfactory level of statistical methods application knowledge. The same conclusion can be made for Industrial ($n = 41$; $\hat{p} = 0,7805$; $se = 0,0781$; $z = 3,59$; $p = 0,0002$), Trade ($n = 45$; $\hat{p} = 0,8444$; $se = 0,0745$; $z = 4,62$; $p = 0,0000$) and Services ($n = 92$; $\hat{p} = 0,7174$; $se = 0,0521$; $z = 4,17$; $p = 0,0000$) enterprises.

It is obvious that the enterprises should invest more into employees' education in the field of statistical methods use. But the question if they and how much they invest in their employees' education in this field remains. The conducted hypothesis test of proportion on upper limit, with hypotheses $H_0: p \leq 0,5$ and $H_1: p > 0,5$, at the significance level $\alpha = 0,05$ has shown that the majority of Croatian small enterprises do not invest in statistical methods education ($n = 191$; $\hat{p} = 0,6105$; $se = 0,0357$; $z = 3,09$; $p = 0,0010$). It is remarkable that only 18 enterprises out of 191 (9,42 %) invest more than HRK 10 000,00 into statistical education yearly.

No significant progress in statistical methods knowledge in Croatian small enterprises is expected because 161 or 75 % of the sample enterprises that use statistical methods are not familiar with statistical education possibilities available on the Croatian market. It leads to the conclusion that first a lot of effort should be invested into informing enterprises about statistical education possibilities. After that it would be possible to suggest the most appropriate topics for their business. Also it has been shown that 33 or 15 % of enterprises in the sample are not satisfied with statistical methods education offer on the market. On the other hand, 21 or only 10 % of enterprises in the sample are satisfied with statistical methods education offer available on the market.

IMPACT OF STATISTICAL METHODS USE ON BUSINESS RESULTS

The sample includes 56 enterprises that used statistical methods from their founding. There are 113 enterprises that started to use statistical methods at a certain point in time after the enterprise's founding. In 76 or 67 % of such enterprises business situation was better than in the time before statistical methods use. Detailed results grouped based on the main enterprise activity are shown in Table 5.

The results in Table 5 show whether the business situation in enterprises is better, the same or worse after introducing statistical methods application. But these results do not reveal either strength or the level of business results improvement. According to the results in Table 6 in 45 % of enterprises the impact of statistical methods application on the enterprises' business situation is significant. That means that there is a huge gain in business results due to statistical methods use. Significantly less gain or no significant business results improvement is present in 46 % of enterprises. Only 9 % of enterprises stated that the statistical methods use had not led to any business results improvement.

In the process of statistical methods use in enterprises the time lag for positive impacts on business results to be evident appeared to be very important. So, Croatian small enterprises were also asked about the average time needed for the impact of statistical methods use on business results to be noticeable. Detailed results are shown in Table 7.

In most enterprises the results of statistical methods applications are noticeable on average within 6 to 12 months. Overall, in the vast majority of enterprises in the sample (79 %), the statistical methods use shows its impacts on the business results in less than one year. In the rest of the observed enterprises, the statistical methods use impact is reflected on the business results in the period which is longer than one year. In those enterprises it is questionable if the statistical methods are applied in a proper way and if they are applied efficiently.

Table 5. Situation in small enterprises after introducing statistical methods use, $n = 113$. Source: conducted survey.

Activity	Situation in the enterprise						Total	
	Better		The same		Worse			
	No.	%	No.	%	No.	%	No.	%
Industrial	19	79	4	17	1	4	24	100
Trade	24	67	12	33	0	0	36	100
Services	31	62	19	38	0	0	50	100
Other	2	67	1	33	0	0	3	100
Total	76	67	36	32	1	1	113	100

Table 6. Statistical methods application impact on enterprises' business results improvement, $n = 180$. Source: conducted survey.

Activity	Level of impact						Total	
	Significant		Non significant		No impact			
	No.	%	No.	%	No.	%	No.	%
Industrial	24	56	14	33	5	12	43	100
Trade	21	45	25	53	1	2	47	100
Services	34	40	42	49	10	12	86	100
Other	2	50	2	50	0	0	4	100
Total	81	45	83	46	16	9	180	100

Table 7. Average time needed for the impact on business results due to statistical methods use, $n = 149$. Source: conducted survey.

Activity	Average time needed to have an impact on business results						Total	
	Less than 1 month	1 - 3 months	3 - 6 months	6 - 12 months	1 - 3 years	More than 3 years		
	%	%	%	%	%	%	No.	%
Industrial	5	30	14	35	16	0	37	100
Trade	0	22	17	39	17	5	41	100
Services	15	12	24	27	19	3	67	100
Other	0	0	50	0	50	0	4	100
Total	8	19	20	32	19	3	149	100

CONCLUSIONS

The article presents the statistical thinking position in Croatian small enterprises. It has been shown that the vast majority of Croatian small enterprises (65,93 %) do not even use statistical methods in their business. This data do not support the main research hypothesis that statistical thinking is widespread in Croatian small enterprises. On the other hand, it has been shown that enterprises that use statistical methods have recognized the value and capabilities of statistical methods use. So, the right reasons for statistical methods use have prevailed over the administrative reasons. This goes in favor of the hypothesis that statistical thinking is developed in Croatian small enterprises. The fact that 83 % of enterprises that use statistical methods use them as a decision-making support in very important and key business cases indicated that statistical methods use has an important place in Croatian small enterprises business. However, half of the enterprises (52 %) admit that there is a lack of statistical methods use in their business. It has been shown that the two main reasons for scarce statistical methods use in small enterprises are the existing overload of employees with other jobs and assignments and the employees' insufficient statistical methods use knowledge. Another problem is that enterprises do not invest or invest almost nothing into employees' statistical methods use knowledge. The main reason for that could be the fact that three quarters of the enterprises are not familiar with statistical education possibilities in Croatia. The survey shows that in only one enterprise the situation in the enterprise has become worse than before introducing statistical methods. In only 9 % of small enterprises statistical methods use have not led to any business results improvement. In most enterprises the statistical methods use impact on business results is noticeable on average in the period from 6 to 12 months from the time their introduction.

The conducted research has shown that statistical thinking is not widespread in Croatian small enterprises. Despite this, it can be concluded that statistical thinking has a very important position and role in enterprises that use statistical methods in their business. Naturally there is a lot of space for improvement. More efforts should be invested into introducing statistical methods use features and benefits to enterprises that do not use them. The future research should investigate the reasons why some enterprises do not use statistical methods. In order to get a better insight into statistical methods use in enterprises, the future research should be able to answer questions about the commonly used statistical methods in enterprises, as well as frequency and quality of their use. The answers to these questions will provide the ground for further improvement and better affirmation of statistical methods in enterprises. All these efforts should lead to even better business results. The main limitation of this research is that it only observes Croatian small enterprises. Future research should also observe medium-sized and large enterprises.

ACKNOWLEDGEMENT

This work has been fully supported by the Croatian Science Foundation within the project STRENGTHS (project no. 9402).

REFERENCES

- [1] Britz, G.: *Statistical Thinking: Using Statistical Thinking in a Plant*.
<http://rube.asq.org/statistics/1999/06/statistical-thinking-in-a-plant.pdf>, accessed 23rd August 2014,
- [2] Snee, R.: *Discussion: Development and use of statistical thinking: A new era*.
International Statistical Review **67**(3), 255-258, 1999,
<http://dx.doi.org/10.1111/j.1751-5823.1999.tb00446.x>,
- [3] Moore, D.: *Uncertainty*.
In Steen, L., ed.: *On the shoulders of giants: New approaches to numeracy*. National Academy Press, Washington, pp.95-137, 1990,

- [4] Box, G.E.P.: *Statistic for discovery*. Report No. 179, The Center for Quality and Productivity Improvement, Madison, 2000,
- [5] Cobb, G.W.: *Reconsidering Statistics Education: A National Science Foundation Conference*. <http://www.amstat.org/publications/jse/v1n1/cobb.html>, accessed 23rd August 2014,
- [6] Lutzer, D.J.; Maxwell, J.W. and Rodi, S.B.: *Statistical Abstract of Undergraduate Programs in the Mathematical Sciences in the United States: Fall 2000 CBMS Survey*. American Mathematical Society, 2002,
- [7] Conference Board of Mathematical Sciences: *Chapter 1: Draft*. <http://www.ams.org/profession/data/cbms-survey/Chapter1DraftTables2.pdf>, accessed 23rd August 2014,
- [8] Ben-Zvi, D. and Garfield, J.: *Statistical Literacy, Reasoning, and Thinking: Goals, Definitions, and Challenges*. In Ben-Zvi, D. and Garfield, J., eds.: *The Challenge of Developing Statistical Literacy, Reasoning, and Thinking*. Kluwer Academic Publishers, Dordrecht, pp.3-16, 2004, <http://dx.doi.org/10.1007/1-4020-2278-6>,
- [9] Cobanovic, K.: *Role of Statistics in the Education of Agricultural Science Students*. http://iase-web.org/documents/papers/icots6/4i2_coba.pdf, accessed 23rd August 2014,
- [10] Dransfield, S.B., Fisher, N.I. and Vogel, N.J.: *Using Statistics and Statistical Thinking to Improve Organisational Performance*. International Statistical Review **67**(2), 99-150, 1999, <http://dx.doi.org/10.1111/j.1751-5823.1999.tb00417.x>,
- [11] Montgomery, D.C.: *The Future of Industrial Statistics*. ORiON **16**(1), 1-22, 2000,
- [12] West, D.C.: *Number of Sales Forecast Methods and Marketing Management*. Journal of Forecasting **13**(4), 395-407, 1994, <http://dx.doi.org/10.1002/for.3980130405>,
- [13] Pejić Bach, M.; Dumičić, K. and Gogala, Z.: *Methods Utilization of Sale Forecasting in Croatian Large Firms*. In Croatian. Ekonomski pregled **50**(7-8), 780-803, 1999,
- [14] Dumičić, K., Lazibat, T. and Matić, B.: *Quality System Implementation and Market Structure: Sample Survey of Croatian Companies*. Ekonomski pregled **56**(9), 615-633, 2005,
- [15] Gogala, Z. and Šimičević, V.: *Usage of Statistical Methods in Croatian Large Firms*. In Croatian. Zbornik Ekonomskog fakulteta u Zagrebu **3**(1), 321-338, 2005,
- [16] Ćurlin, S.: *Application of the method of forecasting in strategic planning of Croatian companies*. M.A. Thesis. In Croatian. Faculty of Business and Economics – University of Zagreb, Zagreb, 2006,
- [17] Šimičević, V.: *Research of Statistical Methods and Application of Statistical Thinking in the Croatian Business Practice*. In Croatian. Ekonomski pregled **58**(7-8), 445-464, 2007,
- [18] Antony, J.; Somasundaram, V.; Fergusson, C. and Blecharz, P.: *Applications of Taguchi Approach to Statistical Design of Experiments in Czech Republican Industries*. International Journal of Productivity and Performance Management **53**(5), 447-457, 2004, <http://dx.doi.org/10.1108/17410400410545914>,
- [19] Mathews, B.P. et al.: *European Quality Management Practices: The Impact of National Culture*. International Journal of Quality & Reliability Management **18**(7), 692-707, 2001, <http://dx.doi.org/10.1108/EUM0000000005776>,
- [20] Tanco, M.; Viles, E.; Ilzarbe, L. and Álvarez, M.J.: *How is Experimentation Carried Out by Companies? A Survey of Three European Regions*. Quality and Reliability Engineering International **24**(8), 973-981, 2008, <http://dx.doi.org/10.1002/qre.947>,

- [21] Rungasamy, S.; Antony, J. and Ghosh, S.: *Critical Success Factors for SPC Implementation in UK Small and Medium Enterprises: Some Key Findings from a Survey.*
The Total Quality Management Magazine **14**(4), 217-224, 2002,
- [22] Grigg, N.P. and Walls, L.: *Developing Statistical Thinking for Performance Improvement in the Food Industry.*
International Journal of Quality & Reliability Management **24**(4), 347-369, 2007,
<http://dx.doi.org/10.1108/02656710710740536>,
- [23] Gjonbalaj, M.; Dema, M. and Miftari, I.: *The Role of Statistics in Kosovo Enterprises.*
Journal of Applied Quantitative Methods **4**(3), 295-305, 2009,
- [24] Ahmed, S. and Hassan, M.: *Survey and Case Investigations on Application of Quality Management Tools and Techniques in SMIs.*
International Journal of Quality & Reliability Management **20**(7), 795-826, 2003,
<http://dx.doi.org/10.1108/02656710310491221>,
- [25] Juritz, J.M.; Money, A.H.; Affleck-Graves, J. and Du Toit, P.: *A Survey of the Statistical Methods Used in Business and Industry in South Africa.*
South African Journal of Business Management **20**(1), 57-64, 1988,
- [26] Moolman, W.H.: *The involvement of statisticians in the application of statistical methods in companies – a study of the Durban-Pinetown region.*
South African Statistical Association, Matieland, 1996,
- [27] Hargreaves, C.A.: *Do Managers Make Decisions Using Statistics?*
http://www.stat.auckland.ac.nz/~iase/publications/1/10_22_ha.pdf, accessed 23rd August 2014,
- [28] Bäcklund, M., Hellsten, U. and Hjertström, E.: *Quality work in Northern Sweden.*
Research report No. 3, University of Technology, Division of Quality Technology & Statistics, Luleå, 1995,
- [29] Deleryd, M.: *Enhancing the industrial use of process capability studies.* Ph.D. Thesis.
University of Technology, Division of Quality Technology & Statistics, Luleå, 1998,
- [30] Gremyr, I.; Arvidsson, M. and Johansson, P.: *Robust Design Methodology: Status in the Swedish Manufacturing Industry.*
Quality and Reliability Engineering International **19**(4), 285-293, 2003,
<http://dx.doi.org/10.1002/qre.584>,
- [31] Bergquist, B. and Albing, M.: *Statistical methods: Does anyone really use them?*
Total Quality Management & Business Excellence **17**(8), 961-972, 2006,
<http://dx.doi.org/10.1080/14783360600747762>,
- [32] Sanders, N.R. and Manrodt, K.B.: *Forecasting Practices in US Corporations: Survey Results.*
Interfaces **24**(2), 92-100, 1994,
<http://dx.doi.org/10.1287/inte.24.2.92>,
- [33] Makrymichalos, M.; Antony, J.; Antony, F. and Kumar, M.: *Statistical Thinking and its Role for Industrial Engineers and Managers in the 21st Century.*
Managerial Auditing Journal **20**(4), 354-363, 2005,
<http://dx.doi.org/10.1108/02686900510592043>,
- [34] Deleryd, M.: *On the gap between theory and practice of process capability studies.*
International Journal of Quality & Reliability Management **15**(2), 178-191, 1998,
<http://dx.doi.org/10.1108/02656719810204892>,
- [35] Tanco, M.; Viles, E.; Alvarez, M.J. and Ilzarbe, L.: *Why is not Design of Experiments Widely Used by Engineers in Europe?*
Journal of Applied Statistics **37**(12), 1961-1977, 2010,
<http://dx.doi.org/10.1080/02664760903207308>,
- [36] Antony, J.: *Improving the Manufacturing Process Quality Using Design of Experiments: A Case Study.*
International Journal of Operations & Production Management **21**(5-6), 812-822, 2001,
<http://dx.doi.org/10.1108/01443570110390499>,

- [37] Dumičić, K. and Cvetković, B.: *Sampling Designs Applicable in Auditor's Tests*. In Croatian.
Zbornik Ekonomskog fakulteta u Zagrebu **5**(1) 313-330, 2007,
- [38]—: *The Accounting Act*. In Croatian.
Official Gazette **16**(109), Zagreb, 2007,
- [39]—: *The Companies Act*. In Croatian.
Official Gazette **20**(152), Zagreb, 2011,
- [40] Croatian Chamber of Economy: *Croatian Enterprise Directory*.
<http://www1.biznet.hr/HgkWeb/do/extlogon>, accessed 23rd August 2014,
- [41] Dumičić, K.: *Representative Samples*.
In Lovrić, M., ed.: *International Encyclopedia of Statistical Sciences*. Springer, Berlin, **3**, pp.1222-1224, 2011,
http://dx.doi.org/10.1007/978-3-642-04898-2_58,
- [42]—: *Decision on the National Classification of Activities 2007. – NKD 2007*. In Croatian.
Official Gazette **16**(58), Zagreb, 2007,
- [43] American Association for Public Opinion Research: *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys*.
<http://aapor.org/Content/NavigationMenu/AboutAAPOR/StandardsampEthics/StandardDefinitions/StandardDefinitions2011.pdf>, accessed 18th August 2014.

ANKETNO ISTRAŽIVANJE O PRIHVAĆENOSTI STATISTIČKOG NAČINA RAZMIŠLJANJA I METODA U HRVATSKIM MALIM PODUZEĆIMA

B. Žmuk

Katedra za statistiku, Ekonomski fakultet – Zagreb, Sveučilište u Zagrebu
Zagreb, Hrvatska

SAŽETAK

Predmet istraživanja rada jest ispitati stav menadžera u hrvatskim malim poduzećima koja primjenjuju statističke metode prema statističkom načinu razmišljanja kako bi se bolje upoznala problematika povezana s tim područjem. Istraživanje je provedeno 2013. godine primjenom web ankete na slučajnom uzorku od 631 malog hrvatskog poduzeća. kako bi se dobile što detaljnije informacije korišten je složen istraživački dizajn uzorka. U analizi su korišteni hi-kvadrat testovi neovisnosti i statistički testovi proporcija u kojima su proporcije bile vagane temeljem faktora neodgovora. Pokazalo se da većina hrvatskih malih poduzeća (65,93%) ne koristi statističke metode u svojem poslovanju. S druge strane, poduzeća koja primjenjuju statističke metode prepoznala su njihovu važnost i mogućnosti. Istraživanjem je utvrđeno da većina poduzeća ne primjenjuje statističke metode zbog administratorskih razloga. Premda koriste statističke metode kao podršku u procesu donošenja poslovnih odluka u veoma važnim i ključnim poslovnim slučajevima, hrvatska mala poduzeća priznaju da je razina primjene statističkih metoda u njihovom poslovanju na nezadovoljavajućoj razini. Također, investicije u primjenu statističkih metoda su veoma oskudna. Navedeno je dovelo do spoznaje o niskoj razini znanja zaposlenika iz područja primjene statističkih metoda. Primjena statističkih metoda dovila je do boljih poslovnih rezultata u više od 90 % malih poduzeća. Rezultati primjene statističkih metoda se prepoznaju u rezultatima poslovanja u prosjeku s odmakom od 6 do 12 mjeseci. Istraživanjem je zaključeno da bi se trebalo više ulagati u razvoj statističkog načina razmišljanja u poduzećima s ciljem povećanja primjene statističkih metoda te unapređenja rezultata poslovanja.

KLJUČNE RIJEČI

statističko razmišljanje, istraživanje u poduzećima, složeni istraživački dizajn uzorka, vagani stratificirani procjenitelj proporcije, hi-kvadrat testovi neovisnosti