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UTILIZATION OF QUALITY TOOLS: DOES SECTOR AND SIZE MATTER?

Abstract: *This research focuses on the influence of company sector and size on the level of utilization of Basic and Advanced Quality Tools. The paper starts with a literature review and then presents the methodology used for the survey. Based on the responses from 202 managers of Portuguese ISO 9001:2008 Quality Management System certified organizations, statistical tests were performed. Results show, with 95% confidence level, that industry and services have a similar proportion of use of Basic and Advanced Quality Tools. Concerning size, bigger companies show a higher trend to use Advanced Quality Tools than smaller ones. For Basic Quality Tools, there was no statistical significant difference at a 95% confidence level for different company sizes. The three basic Quality tools with higher utilization were Check sheets, Flow charts and Histograms (for Services) or Control Charts/ (for Industry), however 22% of the surveyed organizations reported not using Basic Quality Tools, which highlights a major improvement opportunity for these companies.*

Additional studies addressing motivations, benefits and barriers for Quality Tools application should be undertaken for further validation and understanding of these results.

Keywords: *Quality Tools, Quality Management System, Companies Size and Activity Sector*

1. Introduction

The paper starts with the literature review of the use of Quality Tools and its support for an effective Quality Management System.

Following this review and the definition of the research methodology, a survey was prepared. After choosing the sampling frame and a pretest, a short questionnaire (with the purpose of yielding acceptable response rates) was send to managers of Portuguese ISO 9001 Quality Management System certified organizations. Information about the organizations and the use of Basic Quality Tools and Advanced Quality Tools was collected and after hypotheses tests, results were analyzed and discussed.

Concerning article value, it brings new knowledge on the use of Quality Tolls for different company sectors and sizes and it identifies the opportunity for a more intensive use of Quality Tools.

The article ends with suggestions for future research to improve and extend the conclusions of this research.

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2. Literature Review

Due to an increasingly complex and challenging competitive environment, many organizations have adopted Quality Management Systems (QMS) like the ISO 9001: International Standard Series or Business Excellence Models (BEM), such as the EFQM model (Fonseca, 2015).

ISO 9001:2008 International Standard has achieved great international visibility with more than 1 Million Organizations with ISO 9001 certified Management Systems all over the world accordingly to ISO Survey 2013 (ISO, 2014). These International Standards were first published by ISO© (ISO, 2014) in 1987 as a key tool to allow for the growing internationalization of business and the need for common quality management system standards. ISO 9001:2008 is based on a PDCA (Plan-Do-Check-Act) approach and on the eight quality management principles that can be used by top management to lead the organization towards improved performance (ISO 9000:2005 International Standard). A release of the 2015 version of ISO 9001 is under way and the new standard version should be more business and results oriented, take into consideration the organizational context and relevant stakeholders and apply risk-based thinking, making it closer and more in line with the Business Excellence Models (Fonseca, 2015).

Karapetrovic, Casadesus and Heras (2008) identified 115 empirical studies that employ surveys with the purpose of studying the impact of ISO 9000 standards worldwide and more recently studies by Tari et al. (2012) also suggest that ISO 9001 has clear benefits on organizational, operational, people and customer results (the effects on financial performance are not fully conclusive).

Although ISO 9001 International Standard cannot be considered as a TQM or a Business Excellence Model, it is consistent with BEM and be can a step towards that direction within an evolution perspective. There are also a considerable number of studies on the impact of BEMs (Sila and Ebrahimpour, 2005 and Heras, 2006) that point out to increased financial profit (Boulter *et al*., 2013; Jacob *et al*., 2004; Hansson and Eriksson, 2002) and improved non-financial outcomes (Curkovic *et al*., 2000; Powell, 1995) with the adaptation of these models.

According to the literature on TQM, there are two components in a TQM system: the management system (Quality management) and the technical system (Quality engineering), or the 'soft' and 'hard' part. The hard part includes process and production control techniques like process management and the seven basic quality control tools (Evans and Lindsay, 1999; Wilkinson *et al*., 1998). While there is a considerable stream of literature on the implementation of Quality Management Systems, studies addressing the use of Quality Tools are not so frequent, which can be considered as a research opportunity (Saraph *et al*., 1989; Powell 1995; Hendricks and Singhal, 1997; Bayazit and Karpak 2007; Sila 2007; Stock *et al*,. 2007; Chen, 2013).

Researchers (McQuater *et al*., 1995; Bamford and Greatbanks, 2005) have supported the utilization of quality tools and techniques relevance for effective problem solving and continuous improvement. Tarí and Sabater (2004) made a study of 106 ISO certified firms in Spain concluding that techniques and tools can contribute to the improving of TQM level (providing there is adequate management commitment), leading to company superior performance .

Quality tools have a clear function and are applied by themselves, while quality techniques are a set of tools and have a broader application (e.g., statistical process control that uses histograms, process diagrams and control charts)

There are many Quality tools, however, the most well-known and used are the "seven

Basic Quality Tools" identified by Ishikawa (1976): histograms, cause and effect diagrams, check sheets, Pareto charts, flow charts, control charts and scatter diagrams. These tools are adequate for data collection and analysis.

In 1988, a team of Japanese scientist and engineers led by Shigeru Mizuno developed the "New seven Quality Management Tools" or "the Seven Management Tools" to foster innovation, disseminate information and successfully plan large projects (ASQ 2015). These tools are the relation diagram or interrelationships diagram, the KJ method and the affinity diagram, the systematic diagram or tree diagram or story board, the matrix diagram (including QFD), the matrix data analysis, the process decision program chart and the arrow (PERT/CPM) activity network diagram.

Other Quality Tools that are commonly used are the 5 why's, brainstorming, FMEA – failure mode and effects analysis, QFD (Quality Function Development), 6 Sigma, benchmarking and improvement teams. For the purpose of this research, "The new seven Management Tools" and "Other Quality Tools" were merged into "Advanced Quality Tools" as complementary to the "Seven Basic Quality Tools".

Table 1 summarizes the most common used Quality Tools.

Table 1. Quality Tools summary

Designation	**Source**	**Tools**
Basic Quality Tools	Ishikawa (1976)	• Histograms • Cause and effect diagrams • Check sheets • Pareto charts • Flow charts • Control charts • Scatter diagrams
Advanced Quality Tools (Quality Management Tools or New Quality Tools + Other)	Juse (1988); See Dale & McQuater,(1988) and Okes, (2002) for other Quality Tools	• Relation diagram or interrelationships diagram • Affinity diagram(KJ method) • Systematic diagram • Matrix diagram • Matrix data analysis • Process decision program chart (PDPC) • Arrow diagram • 5 why's • Brainstorming • FMEA - failure mode and effects analysis • QFD (Quality Function Development) • 6 Sigma • Benchmarking • Improvement teams

Source: Adapted by Authors.

According to Bamford and Greatbanks (2005), we use daily quality tools like checklists to plan / organize our time although we often do not realize they are quality tools.

Table 2 presents a brief description of the most common Basic and Advanced Quality Tools (source: adapted from ASQ, 2015, based on Tague, 2004).

Table 2. Quality Tools Description

Quality Tool	Description
Histograms	A frequency distribution shows how often each different value in a set of data occurs. A histogram is the most commonly used graph to show frequency distributions
Cause and effect diagrams	Also known as, the fishbone diagram, the cause and effect diagrams identify many possible causes for an effect or problem. It sorts ideas into useful categories
Check sheets	A check sheet is a structured, prepared form for collecting and analyzing data
Pareto charts	A Pareto chart is a bar graph that visually highlights which situations are more significant
Flow charts	A flowchart is a picture of the separate steps of a process in sequential order
Control charts	The control chart is a graph used to study how a process changes over time and to identify if a process is statistical control (subject to normal causes or variation) or not (subject to special causes of variation)
Scatter diagrams	The scatter diagram graphs pairs of numerical data, with one variable on each axis, to look for a relationship between them
Relation diagram or interrelationships diagram	The relations diagram shows cause–and–effect relationships. Just as importantly, the process of creating a relations diagram helps a group analyze the natural links between different aspects of a complex situation
Affinity diagram(KJ method)	The affinity diagram organizes a large number of ideas into their natural relationships. This method taps a team's creativity and intuition. It was created in the 1960s by Japanese anthropologist Jiro Kawakita
Systematic diagram, or tree diagram	Breaks down broad categories into finer and finer levels of detail, that help thinking step by step from generalities to specifics.
Matrix diagram	The matrix diagram shows the relationship between two, three or four groups of information. It also can give information about the relationship, such as its strength, the roles played by various individuals or measurements
Matrix data analysis	Six differently shaped matrices are possible: L, T, Y, X, C and roof–shaped, depending on how many groups must be compared
Process decision program chart (PDPC)	The process decision program chart (PDPC) systematically identifies what might go wrong in a plan under development. Countermeasures are developed to prevent or offset those problems
Arrow diagram	The arrow diagram shows the required order of tasks in a project or process, the best schedule for the entire project, and potential scheduling and resource problems and their solutions (also known as PERT if probabilistic or CPM if deterministic)

Quality Tool	Description
5 why's	The five whys constitute a questioning process used for drilling down into a problem (and the five hows is used to develop the details of a solution to a problem)
Brainstorming	Brainstorming is a method for generating a large number of creative ideas in a short period of time
FMEA - failure mode and effects analysis	FMEA is a step-by-step approach for identifying all possible failures in a design, a manufacturing or assembly process, or a product or service
QFD (Quality Function Development)	QFD is a structured method that uses the seven management and planning tools to identify and prioritize customers' expectations quickly and effectively
6 Sigma	Six Sigma is a disciplined approach for dramatically reducing defects and producing measurable financial results (Anand, 2006; Linderman *et al.*, 2003)
Benchmarking	Benchmarking is a technique in which a company measures its performance against that of best in class companies, determines how those companies achieved their performance levels and uses the information to improve its own performance
Improvement teams	A group belonging to any department that chooses to solve a quality/productivity problem and will continue until a reasonable solution is found and implemented

Bunney and Dale (1997) have advanced that the use of tools and techniques is a vital component in any successful improvement of a process. Ahmed and Hassan (2003) reported that the choice of quality tools might be related to the functions and activities of an organization, as presented in Table 3.

Table 3. Quality tool use by function activity

Function activity	Quality tool use
Launch of new products	Brainstorming; cause – effect diagram
Production phase	Pareto chart; flowcharts; Control charts
Evaluation of the process or product	Histogram; scatter diagram
data collection phase	Checklist

Source: Adapted from Ahmed and Hassan (2003).

While the context in which the tools are applied is relevant for the choice of tool or tools to use, the existence of available resources for their proper utilization and the use of quality tools in conjunction with other tools to produce best results, should be considered (Pyo, 2005).

Tari and Sabater (2004) in a study of 106 ISO certified companies in Spain reported that the use of tools/techniques positively correlates with size and TQM level.

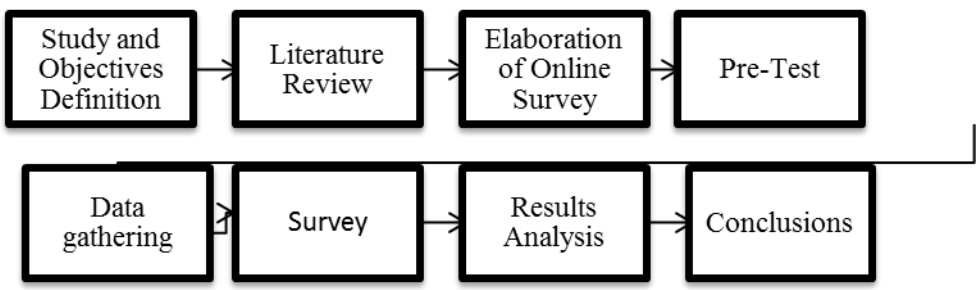
Fotopoulos and Psomas (2009) conducted a study to analyze the level of use of quality tools in ISO 9001 certified organizations in Greece, concluding that there was a low level of use of quality tools and most of the organizations use the tools that are easier to understand and implement. The tools were often not effective because there is not adequate employee training. They also concluded that Flowchart, Data coll., Check sheet, Benchmarking and Graphics were the Quality tools more used and that the use of tools/techniques is positively correlated with size, but found no effect from sector.

A more recent study of 146 Greek ISO 9001:2008 QMS certified companies concluded that that the use of standards and tools/techniques is low when compared with companies from other countries (Ismyrlis and Moschidis, 2015).

Specifically concerning the application of Quality Tools in Portugal, Sousa *et al*. (2005) have concluded by studying a sample of 103 Portuguese Small and Medium Enterprises ISO 9001 certified companies that graphs were almost universally used (98.1%), followed by process flowchart (86.4%) and check sheets (85.4%).

3. Research Methodology

This research followed the methodologies prescribed by Marconi and Lakatos (2003) and comprehended the following six steps (Figure 1).



Source: Authors adaptation.

Figure 1. Research Phases

The first stage was to carry out a comprehensive literature review concerning Quality Tools and the factors affecting their application, within Quality Management and Business Excellence Models frameworks. The sampling frame consisted of quality, environmental and/or safety managers of organizations with ISO 9001:2008 certified Quality Management Systems. Of the 2,906 managers contacted by email (2012), 202 full complete responses were received (7% response rate). A self-administered online questionnaire was used (Lime Survey web-based open software). Subsequent analysis was done with Microsoft Excel 2007 and Statistical Package for the Social Sciences (SPSS) Version 22. Statistical analysis and hypotheses testing were the methods used to draw conclusions in this research.

The questionnaire developed in this study consisted of two main sections. The first section had the purpose of gathering general information about the organization (name of the organization name and function of the person answering the survey, sector of activity and number of employees of the organization, confirming ISO 9001 certification). The second section based on literature review asked whether Basic Quality Tools and Advanced Quality Tools were used by the organization and what were the three Basic and Advanced Quality Tools more commonly used by the organization.

4. Research Results

4.1 Descriptive Statistics

From the 202 responses received, 81 (40%) were from industry and 121 (60%) from Services (and other) as presented in Figure 2.

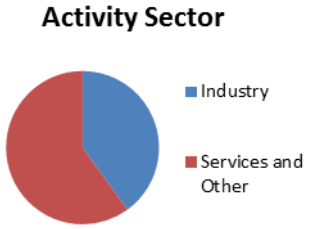


Figure 2. Activity Sectors of the Organization

Concerning size of the organization, in line with some of the criteria of IAPMEI (Portuguese Agency for Competitiveness and Innovation) the number of employees was used to former the following categories: Micro (less than 10 employees), Small and Medium (SME; between 10 and 249) and Other (larger companies with more than 250 employees). Figure 3 summarizes this data.

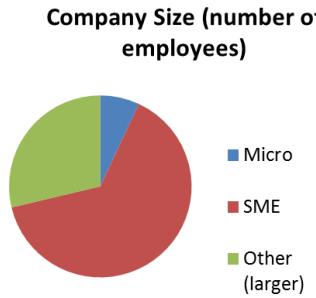


Figure 3. Size of the Organization

The 202 answers received yielded the results presented in Table 4 concerning the numbers and percent of companies applying the Basic and the Advanced Quality Tools.

Table 4. Quality tool use by function activity

Description	Number	Number applying Basic Quality Tools	%	Number applying Advanced Quality Tools	%
Industry Sector	81	63	78%	36	44%
Services and Other Sectors	121	95	79%	43	36%
Micro Companies	14	11	79%	5	36%
Small and Medium Companies	130	98	75%	43	33%
Others (large) Companies	58	49	85%	31	53%
Total	202	158	78%	79	39%

Concerning the three main Basic and Advanced Quality Tools more commonly by the organizations, the results are in line with the conclusions of Sousa *et al.* (2005):

- The most frequently used basic Quality Tools (more than 80% reported use) are check sheets, flow charts and histograms (for Service and other sectors) or Control charts (for Industry sector);
- Concerning other (Advanced) Quality tools, Improvement Teams and brainstorming were the ones used more often (higher than 70% utilization).

5. Tests performed and results analysis

As shown by descriptive results analysis, 78% of respondents were applying Basic Quality Tools and 39% Advanced Quality Tools. This difference is in line with the literature since most authors consider that the basic Quality Tools are the first step and solve many of the quality control and improvement issues.

Concerning the activity sectors, the sample results are approximate for the use of Basic Quality Tools and for the use of Advanced Quality Tools. At sample level, there is a higher proportion of use of these tools by industry when compared to services. We will use statistical tests to check if this difference is significant with a 95% confidence level.

This similarity on the proportion of use of Basic Quality Tools between Manufacturing and Service Industry is also consistent with the intensity of certification in the Service sector that has been increasingly and has not surpassed manufacturing in terms of ISO 9001 certificates issued in Portugal (ISO Survey 2013), as shown in Table 5.

Table 5. ISO 9001 certificates Industry versus Services in Portugal

Description	2011	2013
Total Industry	2171	2981
% Industry	48,5%	46,8%
Total Services	2309	3393
% Services	51,5%	53,2%
Total Total	4480	6774

Source: ISO survey 2013

With the purpose to check if the proportion of Basic and Advanced Quality tools use is the same for different sector and company size, the following hypotheses, presented in Table 6, were tested.

Table 6. Hypothesis summary

Hypotheses	H_0	H_a
H1	The proportion of Basic Quality Tools use is the same between the different activity sectors	The proportion of basic Quality Tools use is different between the different activity sectors
H2	The proportion of Advanced Quality Tools use is the same between the different activity sectors	The proportion of Advanced Quality Tools use is different between the different activity sectors
H3	The proportion of Basic Quality Tools use is the same between the different company sizes	The proportion of Basic Quality Tools use is different between the different company sizes
H4	The proportion of Advanced Quality Tools use is the same between the different company sizes	The proportion of Advanced Quality Tools use is different between the different company sectors

Source: authors

We validated with case processing summary test that there was no missing data and proceed with cross tabulation with SPSS. We then performed chi-square tests for "Activity Sector, Basic Quality Tools", "Activity Sector, Advanced Quality Tools", "Company Size, Basic Quality Tools" and "Company Size Advanced Quality Tools". The Tables 7 to 9 present the statistical tests performed with SPSS (version 22) for "Activity Sector, Basic Quality Tools".

Table 7. Case Processing Summary "Activity Sector * Basic Quality Tools"

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Activity sector * Basic Quality Tools	202	100.0%	0	0.0%	202	100.0%

Table 8. Activity Sector * Basic Quality Tools Crosstabulation

			Basic Quality Tools		Total
			N	Y	
Activity sector	IND	Count	18	63	81
		% within Activity sector	22.2%	77.8%	100.0%
	SERV	Count	26	95	121
		% within Activity sector	21.5%	78.5%	100.0%
Total		Count	44	158	202
		% within Activity sector	21.8%	78.2%	100.0%

Tale 9. Chi-Square Tests – Activity Sector * Basic Quality Tools

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.015[a]	1	.901		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.015	1	.901		
Fisher's Exact Test				1.000	.517
Linear-by-Linear Association	.015	1	.902		
N of Valid Cases	202				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 17.64.

b. Computed only for a 2x2 table

Similar statistical tests were made for "Activity Sector, Advance Quality Tools" yielding the following results shown in Tables 10 to 12.

Table 10. Case Processing Summary Activity Sector * Advanced Quality Tools

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Activity sector * Advanced Quality Tools	202	100.0%	0	0.0%	202	100.0%

Table 11. Activity Sector * Advanced Quality Tools Crosstabulation

			Advanced Quality Tools		Total
			N	Y	
Activity sector	IND	Count	45	36	81
		% within Activity sector	55.6%	44.4%	100.0%
	SERV	Count	78	43	121
		% within Activity sector	64.5%	35.5%	100.0%
Total		Count	123	79	202
		% within Activity sector	60.9%	39.1%	100.0%

Table 12. Activity Sector * Advanced Quality Tools Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.617[a]	1	.204		
Continuity Correction[b]	1.264	1	.261		
Likelihood Ratio	1.611	1	.204		
Fisher's Exact Test				.240	.131
Linear-by-Linear Association	1.609	1	.205		
N of Valid Cases	202				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 31.68.
b. Computed only for a 2x2 table

The next statistical tests concerned "Company Size, Basic Quality Tools" with the following results presented in Tables 13, 14 and 15 below.

Table 13. Case Processing Summary Company Size * Basic Quality Tools

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Company size * Basic Quality Tools	202	100.0%	0	0.0%	202	100.0%

Table 14. Company Size * Basic Quality Tools Crosstabulation

			Basic Quality Tools		Total
			N	Y	
Company size	MICRO	Count	3	11	14
		% within Company size	21.4%	78.6%	100.0%
	SME	Count	32	98	130
		% within Company size	24.6%	75.4%	100.0%
	OTHER	Count	9	49	58
		% within Company size	15.5%	84.5%	100.0%
Total		Count	44	158	202
		% within Company size	21.8%	78.2%	100.0%

Table 15. Chi-Square Tests Company Size * Basic Quality Tools

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.950[a]	2	.377
Likelihood Ratio	2.042	2	.360
Linear-by-Linear Association	1.202	1	.273
N of Valid Cases	202		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.05.

The final statistical tests for "Company Size, Advanced Quality Tools" are shown in the following Tables 16 to 18.

Table 16. Case Processing Summary Company Size * Advanced Quality Tools

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Company size * Advanced Quality Tools	202	100.0%	0	0.0%	202	100.0%

Table 17. Company size * Advanced Quality Tools Crosstabulation

			Advanced Quality Tools		Total
			N	Y	
Company size	MICRO	Count	9	5	14
		% within Company size	64.3%	35.7%	100.0%
	SME	Count	87	43	130
		% within Company size	66.9%	33.1%	100.0%
	OTHER	Count	27	31	58
		% within Company size	46.6%	53.4%	100.0%
Total		Count	123	79	202
		% within Company size	60.9%	39.1%	100.0%

Table 18. Chi-Square Tests Company Size * Advanced Quality Tools

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.062[a]	2	.029
Likelihood Ratio	6.964	2	.031
Linear-by-Linear Association	5.175	1	.023
N of Valid Cases	202		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.48.

Table 19 below summarizes the main conclusion reached with the chi-square tests.

Table 19. Chi-square test results

Hypothesis	Chi-square test		Conclusion
	Value	*Sig. (2-sided)*	
H1	0,015	0,901	The proportion of Basic Quality Tools use is **the *same*** between the different activity sectors
H2	1,617	0,204	The proportion of Advanced Quality Tools use is **the *same*** between the different activity sectors
H3	1,950	0,377	The proportion of Basic Quality Tools use is **the *same*** between the different company sizes
H4	7,062	0,029	The proportion of Advanced Quality Tools use is ***different*** between the different company sizes

Source: authors

With a 95% confidence level, we reject the hypotheses that the proportion of Basic Quality Tools and Advanced Quality Tools use is different between the different activity sectors and between the different company sizes. We also reject the hypothesis that the proportion of Advanced Quality Tools is different between the different company activity sectors.

However, also with a 95% confidence level, we accept the hypothesis that the proportion of Advanced Quality Tools use is different between the different company sizes. The use of Advance Quality Tools seems related with company sizes, with bigger companies showing a higher usage of these tools.

6. Discussion of Results

The results, based on the managers' inputs, show evidence that Portuguese ISO 9001:2008 Quality Management Systems certified organizations are using Basic and Advanced Quality Tools. This is consistent with the literature and with the Quality Management Principles of the ISO 9000 International Standards series. However, a somewhat troubling question might be: "and what about the 22% of companies that report not using even the Basic Quality Tools"? How can these companies assure customer satisfaction by delivering conformity products and applying continuous improvement? This is an issue worth paying attention for certified companies, certification bodies and accreditation bodies.

In addition, many companies still do not use Advanced Quality Tools. In a world of intensive and global competition, this is an improvement opportunity for these companies to study and use these tools to foster their enduring success.

By the use of the chi square test, we achieved the conclusion that, with a 95% confidence level, there are no statistically significant differences between the proportions of use of Basic and Advanced Quality Tools between industry and services. We only have evidences that the use of Advanced Quality Tools is different between companies size, bigger companies show a higher trend to use Advanced Quality Tools than smaller ones. According to industry specialists interviewed during this research, since bigger companies have more specialized resources and work with some high demanding industries (e.g., automotive, where ISO/TS 16949 standards for certification of Automotive Industry Supply Chain require the use of Advanced Quality Planning and Advanced Quality Tools) they could have a higher percent of stronger utilization of Advanced Quality Tools.

These results are consistent with the researches from Tari and Sabater (2004) in Spain, from Sousa *et al*. (2005) in Portugal and Fotopoulos and Psomas (2009) in Greece that found that the use of quality

tools/techniques positively correlates with size. These last authors also found no effect from sector, which is also the case of this research, since we have not found statistically significant differences in the use of both Basic and Advanced Quality Tools between the proportion of organizations that use these tools on the industry and service (and other) sectors.

The results of this investigation also bring further knowledge on the application of Quality Tools in other companies either than Small and Medium enterprises (SMEs). They also show that service sector has approached manufacturing sector in terms of Quality Tools use.

The three basic Quality tools with higher utilization were Check Sheets, Diagram Graphs and Histograms (for Services) or Control Charts/Statistical Process Control (for Industry). Other Quality tools widely used were Improvement Teams and Brainstorming. This is globally in line with the studies of Sousa *et al*. (2004) and Fotopoulos and Psomas (2009).

7. Research Limitations and suggestions for future work

The authors would like to point out the several limitations of this study:

- It was done in a moment in time so quasi-longitudinal and longitudinal studies could be useful;
- There might be a bias by managers of the surveyed organizations as already found in other studies, so triangulation of data (e.g., with qualitative research) can be useful;

For future research, the authors suggest focusing additionally on the motivations, benefits and obstacles for using Quality Tools, on surveying also non-certified organizations and possible studying other countries.

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