Methods of Lean Production to Improve Quality in Manufacturing

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ABSTRACT

Purpose: Quality in manufacturing can be improved by using lean production methods. The paper discusses traditional and modern methods of lean production and their use in different enterprises.

Methodology/Approach: Through a questionnaire survey and research, 90 industrial enterprises were classified by the size, production scope and their ownership. The research results were analyzed by means of statistical methods to determine the differences in the use of lean production methods.

Findings: Regarding the lean production and its different methods, the size of the enterprise is an important factor. The statistics revealed that large enterprises tend to use lean production more. It was also proved that some methods of lean production are not completely common in the Czech Republic. Moreover, some methods are quite new to the majority of the enterprises.

Research Limitation/implication: Some questionnaire surveys conducted in different countries (especially in the US) use a different enterprise size classification. As the research results show, there is still a large potential for the introduction of lean production methods in small and middle-sized enterprises that can help enterprises to improve the quality of their production.

Originality/Value of paper: The application of lean production methods has been investigated so far, especially in large engineering enterprises. The paper deals with the use of these methods also in small and medium sized enterprises. The authors focused their research also on non-engeneering enterprises in the field of the food industry and production of products for domestic use too.

Category: Research paper

Keywords: lean production; lean production methods; size of the enterprise; quality of production

1   INTRODUCTION

The producers keep looking for possibilities of increasing the efficiency of their production and competitiveness. This might be done by a number of ways, such as the purchase of new technology, improvement of the services, quality and waste reduction. Cutting out waste was originally an idea of Toyota, a Japanese company, after the Second World War. Their methods were later called "lean production". The aim of such lean production is to "produce more with less resources" (Krafcik, 1988; Womack, Jones and Ross, 1990; Womack and Jones, 1994). The most popular methods include Just-in-Time, ABC, Kanban; currently supplemented with new methods such as 5S, Andon, etc.

In the references, different authors describe the methods of improving quality of the production, and their application in an enterprise. Pettersen (2009) argued that there is absence of a clear definition of lean that lead to communication difficulties, complicate education or researching the subject. Many authors define lean production as an integrated system of a large number of different methods and principles (Womack and Jones, 1994). However, it is obvious that the better performance, quality and efficiency of production processes is not provided by the methods themselves but their concurrent application and interaction. The methods are complementary to each other.

Levy (1997) noticed that one of the cornerstones in the lean production is a renewed approach towards quality management compared to the practices (methods) within traditional mass production. More important than different methods and techniques is an integrated approach to quality management that emphasizes lean thinking (Lamming, 1993). That's the foundation of total quality management (TQM), which in the long-term simultaneously involve all members of an organization (including management) to participate in the continuous improvement of processes, products and services to achieve success through customer satisfaction.

The aim of the paper is to discuss the use of both traditional and new methods of lean production in the enterprises according to their different characteristics such as enterprise size or scope.

2   STATEMENT OF A PROBLEM

Management of production went through a lot of changes in the past. At first, there are the methods used mostly in the first half of the 20th century at the time of mass production development. Such methods were promoted by Frederick W. Taylor, Henry Ford and others. Their aim was to cut the production time out, by using performance standards, assembly lines and similar methods. The methods were created by the top management, promoted from the top to the bottom as the factory workers were neither educated nor motivated enough to support the initiative. The state changed after the Second World War when the market of the producer was replaced by the market of the customer, much more demanding in

availability of products, their variability, price quality and speed of delivery. Suddenly, it was impossible to ensure the requirements from the top only. It became necessary to engage the workers into the process. Instead of engaging their physical strength only, it was necessary to add their brain, abilities, and initiative. At first, such requirements were applied in Toyota, a Japanese automotive company. After the influence of the requirements on competitiveness increase was proved, the methods started to be popular in other companies. In Toyota, they applied the method called Just-in-Time, followed by other methods, such as Push and Pull, Kanban (maintaining inventory level) and the method for continuous improvement (quality control) promoted by W. Edwards Deming (Liker and Hoseus, 2008). The above mentioned, together with the ABC method, as known before, are referred in the paper as traditional. The ABC is described by Keřkovský and Valsa (2012) as the principle of differentiated management. Tomek and Vávrová (2014) noticed that ABC might be connected to XYZ, creating groups by forecast accuracy.

During the following decades, there was a fast development in technology so that new methods of improvement were needed. The method of Value Stream Management (VSM) has become popular in large industrial enterprises. This method reduces production time and focuses on creating value added for a customer. Another method known as Total Productive Maintenance (TPM) focuses on better approach to machine maintenance. The method uses analyses of production system data and sensors to identify possible failures before they occur, using models of dependency (Mařík, 2016). The development of electronics makes it possible to improve communication between enterprises through the Electronic Data Interchange (EDI) method. The modern computers have programs to manage individual parts of the production process, even production as a whole. These methods, which have been applied since the 1970s, are referred to as the new methods and we are exploring their implementation both in relation to traditional methods and in terms of their application in various large enterprises and in enterprises with different production scope.

As far as quality management is concerned, the lean production emphasizes integrated management systems between companies in a defined value stream (Soderquist and Motwani, 1999). The integrated quality systems support lean production methods and improve performance measurements, core competencies and management processes of enterprises. Quality management contributes to the implementation and integration of lean production methods. On the other hand, it is just lean production methods that improve the quality of the organization processes, products or services. The link between quality and the application of lean production principles (methods), for example, presented Roriz, Nunes and Sousa (2017). They show how improvements based on the 5S technique and visual management achieved an average reduction of 47% setup time in a carton company. Nicholas (2016) describes the factors related to successful implementation and sustainment of TQM/lean production initiatives. Lee and Peccei (2008) analyzed determinants of employe quality commitment in the high

lean plant sample. Their study finds that the employee quality commitment differs in relative importance at different stages of lean production implementation.

3   METHODOLOGY

The paper deals with using different methods of lean production, considering their acceptability. It discussed if the enterprises prefer traditional methods or if they try to use the new methods too. The aim is to suggest possible methods, which are not so common, but useful for small and middle-sized enterprises.

The methods of lean production are partial tools, useful under particular conditions, such as mass production, single-piece production, for enterprises with high/low number of employees etc. The system of lean production methods is not strictly limited; there are new methods applied if they better suit to new technology of production.

The authors of the paper deal with the use of new and traditional methods of lean production in different enterprises and their preferences. The complementary implementation of lean production methods enhance the performance, efficiency and quality of the production processes.

The students of the University of South Bohemia in České Budějovice, the Faculty of Economics, were able to obtain ninety questionnaires dealing with applying lean production in the enterprises, in 2016. The questionnaires are classified into the following categories:

- By the industry of enterprises into: 1. engineering, 2. electro-technical production, 3. food industry, 4. production of products for domestic use;

- by size (according to the number of employees) into: 1. small enterprises (up to 49 workers), 2. medium-sized enterprises (50-249 workers) and 3. large enterprises (over 250 workers);

- by the owner (a part of a foreign enterprise or not);

- by the importance (whether an enterprise is considered a key or dependent article) in the supply chain.

Since there were only 4 businesses in the "electro-technical", we do not lit them as a separate item in the tables, but they are counted in sets classified by enterprise size, ownership and supply chain. In the paper, the distribution by importance in the supply chain is not further analysed.

The results obtained were then subjected to statistical analysis by "individual tests of equal and given proportions without correlation to continuity". In particular, statistical hypotheses were formulated for each category of lean production methods. The null hypothesis is that the observed phenomenon has the same proportion. The statistical alternative hypothesis is that this proportion

is different in at least one case. The following statistical hypotheses are fomulated in this paper:

H_1:   *The enterprises differ in using traditional methods of improving production.*

H_2:   *The enterprises differ in using new methods of improving production.*

In the case of multiple comparisons of relative frequencies, Holm's method of adjusting the level of significance reached was used. The results are interpreted at significance level of 0.05 (resp. with 95% reliability). For reasons of clarity, only significant results, including achieved level of significance (p-value), are given in the text. Statistical evaluation of individual tests was performed using R 3.3.3 programming environment.

4   RESULTS

Using the method of lean production is not an end in itself. It should take the targets as set by the enterprise and possible future trends as the starting point.

The present might be seen as a turning point of a quick development of new technology (known as Industry 4.0) due to which there might be a change in applying digitization, robotization and artificial intelligence in a short-time period of 10 to 15 years. The communities of experts have become familiar with such trend. The question, however, is whether the enterprises are ready for the future development. It is possible to predict that in spite of possible changes in technology, the current methods of lean production will be used as long as the current production procedure is used.

The results of the research are divided into the traditional and new methods.

4.1   Traditional Methods

The traditional methods in our results include such methods that have been known since half of last century: Just-in-Time (JIT) followed by Kanban, ABC method related to both suppliers and customers, and continuous improvement processes (CIP).

Table 1 – Traditional Methods of Production Improvement (%) (Author's Own Work)

Categories of Companies	Number	JIT is Used	Kanban is Used	ABC for Suppliers	ABC for Customers	CIP
Small	26	19.23	**3.85**	**34.62**	38.46	**11.54**
Middle-sized	34	17.65	**8.82**	**44.12**	52.94	**35.29**
Large	30	23.33	**46.67**	**70.00**	53.33	**63.33**
Engineering	45	20.00	**33.33**	60.00	48.89	**51.11**
Food industry	17	35.29	**17.65**	41.18	58.82	**11.76**
Household supplies	24	16.67	**0.00**	33.33	41.67	**29.17**
Foreign owner	35	22.86	**34.29**	57.14	51.43	**60.00**
Czech owner	55	18.18	**10.91**	45.45	47.27	**23.64**

Tab. 1 summarizes the use of methods in enterprises. The percentage for each method shown in the table is always calculated from the number of enterprises in column "Number". The statistically significant differences at the significance level of 5% are marked in bold.

Regarding the using of five traditional methods, the differences between enterprises were determined by three criteria (size, specialization and ownership). The following working hypothesis was formulated:

H_1:   *The enterprises differ in using traditional methods of improving production.*

- By size – COMFIRMED (for Kanban, ABC used for suppliers, and continuous improvement)

Based on the statistics, it was proved that the enterprises differ in three (out of five) traditional methods. The statistically significant difference was found in the Kanban method (p-value = 4.05 · 10-05), especially between the large and small enterprises (p-value = 0.0028), and the large and medium-sized enterprises (p-value = 0.0034). The differences in enterprise size were further significant in the supplier-centred ABC (p-value = 0.020). In the case of the CIP, the differences are also statistically significant (p-value = 0.0003289), in the case of small and large enterprises (p-value = 0.00069). No significant differences were found for other traditional methods classified by the size of enterprises.

- By specialization – CONFIRMED (for Kanban, and continuous improvement)

Using the traditional methods, the enterprises are different in Kanban (p-value = 0.004876) and continuous improvement (p-value = 0.01058) only. Regarding the Kanban method, the significant differences were found comparing engineering

enterprises and household supplies producers (p-value = 0.012). Using continuous improvement is far superior in engineering enterprises compared to food industry (p-value = 0.034). No significant differences were found for other traditional methods classified by the scope of enterprises.

- By ownership – CONFIRMED (for Kanban, and continuous improvement)

Similarly to specialization, the working hypothesis was proved for Kanban (p-value = 0.01499) and continuous improvement (p-value = 0.001171). No significant differences were found for other traditional methods classified by the owner of enterprises.

Further, the paper will focus on traditional methods where the statistically significant differences are highlighted in the tables.

4.1.1 Just-in-Time and Kanban

The Just-in-Time method was developed and successfully applied in Japan in the 1970s. The basic prerequisite is delivery of the necessary items only, in the necessary quantities, the correct quality and at the latest allowable times. This reduces inventory and production and reduces storage space.

Kanban is a self-regulatory production control system. It is a label (card) that fulfils the function of the order. Individual workplaces order with the same Kanban cards the same, limited amount of items that correspond to the permitted level of inventory of finished parts and products. Kanban is part of the Just-in-Time method.

The questionnaires revealed that Just-in-Time method is only applied partially in enterprises, mostly in large enterprises. Although it was created for the needs of the automotive industry, it has approximately the same application in food industry and household supply production. It is less used in enterprises with Czech owners and in dependent supply chain links.

The Kanban method, as a part of Just-in-Time, reported more significant differences in use. Similarly to Just-in-Time, is it applied mostly in large enterprises, in particular in manufacturing enterprises of mass production, foreign owners and if changes of production are not very common.

Both methods have been known for more than fifty years. There has been enough time for the enterprises to test the methods and their advantages and disadvantages of their use. Therefore, their further expansion is not probable.

4.1.2 ABC Method

The method is based on dividing the inventory into three groups: A, B, C. Group A consists of a small number of elements (about 20%) with a high share in total value (around 80%). A proper management of this group helps the manager managing the whole inventory easily.

Using the ABC method, an enterprise can also diversify services between its customers; and it can evaluate its suppliers and focus on the most important customers and suppliers to simplify and streamline their services. However, if the number of suppliers or customers is small, the use of the ABC method is useless.

Applying the ABC method is increased towards large enterprises. For suppliers, this trend is more pronounced than for customers, which may indicate a tendency to deal with all customers equally.

Regarding the specialization of production, ABC is the most common in engineering enterprises. In household supply production, it is not used in almost sixty percent, possibly due to a small number of suppliers. Similarly, in food industry, almost a half of the participants reported that the method cannot be used in their enterprise.

The ABC is an easy method. It does not require any expensive measures and it is appropriate to use it almost in all enterprises, first of all in some small enterprises.

4.1.3   Continuous Improvement Process (CIP)

Continuous improvement in its organized form mostly appears in large enterprises. Such enterprises employ people necessary to implement, monitor and analyze the processes. The small enterprises do not have enough people to do this task, so they report the method as "not organized", meaning that there are no obstacles to carry it out, but there are no people to support and manage it significantly.

However, there are still possibilities of better use of the method by small enterprises. They should support the initiative of their employees at least in a simple way. Continuous improvement is strongly supported in engineering and foreign-owned enterprises.

4.2   New Methods

In the paper, the new methods include 5S, TPM (Total productive maintenance), VSM (Value stream management), Electronic Data Interchange (EDI) and computerized management of production (CAM). Tab. 2 summarizes the use of these methods in enterprises.

The following working hypothesis was analyzed:

H_2:   *The enterprises differ in using new methods of improving production.*

- By size – CONFIRMED (for TPM, computerized management, and 5S)

The working hypothesis was proved for the size classification in most of the new methods. There was a significant difference in enterprises for 5S (p-value = 0.01411). The difference was strong between large and small enterprises (p-value = 0.031). Similarly, there were differences in TPM method (p-value = 0.03256) and computerized management (p-value = 0.0236). In computerized

management, there were strong differences between middle-sized and large enterprises (p-value = 0.046). In using the other methods of production improvement, there were no differences found between the enterprises of different size.

- By specialization – REJECTED

Engineering enterprises seem to have higher levels of use of new production improvement methods than others. However, these differences were not significant in the analysis through statistical tests.

- By ownership – CONFIRMED (for VSM and 5S)

Comparing the enterprises owned by a foreign and a Czech owner, the working method was confirmed for VSM (p-value = 0.04314) and 5S (p-value = 0.03628).

The statistically significant differences at the significance level of 5% are marked in bold.

Table 2 – Five New Methods of Production Improvement (%) (Author's Own Work)

Categories of Companies	Number	5S	TPM	VSM	EDI	CAM
Small	26	11.54	**11.54**	**15.38**	30.77	**23.08**
Middle-sized	34	26.47	**32.35**	**41.18**	35.29	**29.41**
Large	30	46.67	**43.33**	**43.33**	56.67	**3.33**
Engineering	45	35.56	35.56	44.44	42.22	22.22
Food industry	17	23.53	23.53	23.53	58.82	17.65
Household supplies	24	20.83	25.00	20.83	33.33	20.83
Foreign owner	35	**42.86**	42.86	**48.57**	48.57	14.29
Czech owner	55	**20.00**	21.82	**25.45**	38.18	23.64

4.2.1 Method of 5S

The method of workplace organization is supposed to reduce waste by maintenance and organization of both production and offices. There are five steps to do that (sort, set in order, shine, standardize, and sustain).

The complex uses of 5S increases towards large enterprises. A quarter of enterprises uses the method partially. As it is a basic method, requiring discipline and workplace order, its use is not flawless.

4.2.2 TPM and VSM Methods

TPM aims to carry out the maintenance of equipment if necessary, neither earlier nor later. Maintaining is supervised by the workers who work with the machines

because they are best aware of possible issues in the normal operation of these machines and equipment.

TPM use increases towards large enterprises. The method is primarily based on the individual approach of individual operators so that it should be used more in small enterprises.

4.2.3   Value Stream Management (VSM)

Value Stream Management (VSM) is an entirely new method that aims to remove all activities that do not add a new value to the product. Implementation of the VSM is mostly a task for specialized customer-services firms. The method is based on an assessment of time when the value is added (by the standards) to total real production time (from the initial activity to sending the product to the customer). It includes revealing operations and placing the biggest potential for improvement.

As VSM is rather complicated to use, it is mostly used by large enterprises, in particular by engineering enterprises and those owned by a foreign owner, usually implemented by specialized firms. We assume that the method could be used in small or middle-sized enterprises, although in a simplified form with less precise results.

4.2.4   EDI

Electronic Data Interchange (EDI) is an important method of informational technology, making the communication of two subjects easier, by converting the data from one system to another easily, without the long procedure of rewriting the data.

EDI is mostly used by large enterprises (56.7%). Middle-size enterprises try to implement it and the method is partly used by 41.2% of them. The less common use of EDI was reported by small enterprises, with a number of employees of less than 49.

Regarding the specialization, EDI is mostly used by food industry enterprises (58.8) and by 42.2% of engineering enterprises only. The reason for this might be shorter delivery time and larger choice of products, favourable for the EDI system. Regarding the ownership of the enterprise, there are no significant differences. On the other hand, the key parts of the supply chain use EDI twice more compared to the dependent link.

4.2.5   Computerized management of production

The technology development has recently influenced production management through computers. Currently, there is a number of computer supported activities. The highest level of such system is known as computer-integrated manufacturing (CIM), including partial methods of computer-based management, such as CAD (computer-aided design), CAA (computer-aided assembly) and CAP (computer-aided planning).

Our research was carried out in four areas. It showed that enterprises are primarily focused on a more comprehensive approach to managing all important activities directly related to production; on the other hand, the use of computers for managing relations with suppliers and customers is quite rare. The differences between the enterprises in terms of their size, production structure and ownership are not very large.

5 DISCUSSION

At first, this part discusses the difference in use and implementation of lean production methods in the enterprises of different size. In general, there are two opinions on implementing new methods and changes in large enterprises. On one hand, an increase of the size is related to increased bureaucracy and administration, so that it is more difficult to change the current systems (Chandler, 1962). Large organizations are seen as slow and cumbersome, and it influences the implementation of lean production in a negative way (Hannan and Freeman, 1984). On the other hand, large enterprises have more capital, resources and tools to implement changes, compared to small enterprises (Ahmed, Tunc and Montagmo, 1991).

The results of our research suggest that there are significant differences in six out of ten methods of lean production when enterprises are classified by their size. These six methods are Kanban, ABC focused on suppliers, continuous improvement, 5S, TPM and Computer-aided management. The results can be compared with the research by Shah's and Ward's (2003), which divides the lean production into four bundles – JIT, TPM, TQM and HRM (human resources management). Shah and Ward (2003) found that there is a significant difference of all 22 practices, with the exception of cross-functional work force and quality management programs. Their research agrees with White, Pearson and Wilson (1999), which focuses on JIT in small and large enterprises. In these studies, the size of enterprises is certainly an important factor. However, our research did not show differences in the same size range of enteprises categories. The reason why the results of our research are more subtle might be due to different classification of enterprises sizes. In foreign studies have small enterprises less than 250 employees, middle-sized enterprises have 250-999 employees, and large enterprise have more than 1,000 employees. To the contrary, our research is based on the European enterprise size classification (see methodology) which is defined in EU recommendation 2003/361.

Considering the difference in lean production methods use classified by different specialization of enterprises, the dominance of engineering industry, and automotive industry in particular, such as Honda, GM, Suzuki, Mazda, and Nissan, is often discussed (Berggren, 1993). In our research, the difference was confirmed for two methods out of ten - Kanban and continuous improvement. Regarding this, the findings are surprising as increased use of the methods in

engineering was supposed. Also, the enterprises prefer the new methods to the traditional ones.

At last but not least, the enterprises were classified by their owner. It should be noted that foreign authors use different classification. In this case, the category is mostly related to the size of the enterprises and majority of large enterprises in the research have a foreign owner. In our research, the results revealed a greater use of four methods out of ten, if classified by the owner. There were the methods of Kanban, continuous improvement, 5S and VSM. It is possible to assume, that the differences were not reflected clearly, however, they are apparent for some methods of lean production.

The result of the research also showed that lean production methods are not as popular in the Czech Republic to confirm more significant differences in some categories. Furthermore, some of the methods (such as 5S) are rather new in most of the enterprises.

6   CONCLUSION

The size of enterprises is very important factor in implementing and using the methods of lean production. The use of both traditional and new methods increases towards large enterprises. There are significant differences between different sizes confirmed for three traditional and new methods out of five. The results for both groups are rather similar. It means that the enterprises prefer neither the traditional nor the new methods of production improvement.

Regarding the specialization, it was confirmed that the enterprises generally prefer the traditional methods to the new ones. In particular, engineering is active in implementing new methods, followed by the food industry and household supply production, using EDI and computer-aided management a lot. Regarding traditional methods, a less interest in Just-in-Time is noticeable, together with the considerable use of ABC method and focus on continuous improvement in engineering.

Regarding the owner, it was proved that the enterprises with the foreign owner use traditional and new methods of lean production more, compared to the Czech enterprises. Significant differences were found for Kanban and continuous improvement, as the traditional methods, and for VSM and 5S, as the new methods. However, there are no major differences between the use of new and traditional methods.

Regarding the aims of our research, it was showed that there is still a big potential for implementation of new methods of production improvement in small and middle-sized enterprises. Some of the methods even might be easy and financially available and help enterprises to improve quality of their production. On the other hand, it seems that the enterprises try to use new methods of

computer-aided management. However, such methods should be extended to the management of relations with both suppliers and customers.

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REFERENCES

Ahmed, N.U., Tunc, E.A. and Montagno, R.V., 1991. A comparative study of US manufacturing firms at various stages of just-in-time implementation. *International Journal of Production Research*, [e-journal] 29(4), pp.787-802. http://dx.doi.org/10.1080/00207549108930102.

Berggren, C., 1993. Lean Production - The End of History. *Work Employment and Society*, [e-journal] 7(2), pp.163-188. http://dx.doi.org/10.1177/095001709372001.

Hannan, M.T. and Freeman, J., 1984. Structural inertia and organizational change. *American Sociological Review*, [e-journal] 49(2), pp.149-164. http://dx.doi.org/10.2307/2095567.

Chandler Jr., A.D., 1962. *Strategy and Structure: Chapters in the History of the Industrial Enterprise*. Cambridge, MA: MIT Press.

Keřkovský, M. and Valsa, O., 2012. *Moderní přístupy k řízení výroby*. 3rd edition, Praha: C.H. Beck.

Krafcik, J.F., 1988. Triumph of the Lean Production System. *Sloan Management Review*, 30(1), pp. 41-51.

Lamming, R., 1993. *Beyond Partnership: Strategies for Innovation and Lean Supply*. London: Prentice Hall, Hemel Hempstead.

Lee, J. and Peccei, R., 2008. Lean production and quality commitment – A comparative study of two Korean auto firms. *Personnel Review*, [e-journal] 37(1), pp.5-25. https://doi.org/10.1108/00483480810839941.

Levy, D.L., 1997. Lean production in an international supply chain. *Sloan Management Review*, 38(2), pp.94-102.

Liker, J. and Hoseus, M., 2008. *Toyota Culture: The Heart and Soul of the Toyota Way*. New York: McGraw-Hill Education.

Mařík, V. ed., 2016. *Průmysl 4.0 – Výzva pro Českou republiku*. Praha: Management Press.

Nicholas, J., 2016. Hoshin kanri and critical success factors in quality management and lean production. *Total Quality Management & Business Excellence*, [e-journal] 27(3-4), pp.250-264. https://doi.org/10.1080/14783363.2014.976938.

Pettersen, J., 2009. Defining lean production: some conceptual and practical issues. *The TQM Journal*, [e-journal] 21(2), pp.127-142, https://doi.org/10.1108/17542730910938137.

Roriz, C., Nunes, E. and Sousa, S., 2017. Application of Lean Production Principles and Tools for Quality Improvement of Production Processes in a Carton Company. In: Pellicciari, M. and Peruzzini, M., *27th International Conference on Flexible Automation and Intelligent Manufacturing, Faim2017*. Modena, Italy, 27-30 June 2017. Amsterdam: Elsevier. pp.1069-1076.

Shah, R. and Ward., T.P., 2003. Lean manufacturing: context, practice bundles, and performance. *Journal of Operations Management*, [e-journal] 21(2), pp.129-149. http://dx.doi.org/10.1016/S0272-6963(02)00108-0.

Soderquist, K. and Motwani, J., 1999. Quality issues in lean production implementation: a case study of a French automotive supplier. *Total Quality Management*, [e-journal] 10(8), pp.1107-1122. http://dx.doi.org/10.1080/0954412997091.

Tomek, G. and Vávrová, V., 2014. *Integrované řízení výroby. Od operativního řízení výroby k dodavatelskému řetězci*. Praha: Grada.

White, R.E., Pearson, J.N. and Wilson, J.R., 1999. JIT Manufacturing: a survey of implementation in small and large US manufacturers. *Management Science*, [e-journal] 45(1), pp.1-15. http://dx.doi.org/10.1287/mnsc.45.1.1.

Womack, J.P. and Jones, D.T., 1994. From Lean Production to the Lean Enterprise. *Harvard Business Review*, 72(March-April), pp.93-103.

Womack, J.P., Jones, D.T. and Ross, D., 1990. *The Machine that Changed the World*. New York: Rawson Associates.

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Empirical Research of the ISO 9001:2015 Transition Process in Portugal: Motivations, Benefits, and Success Factors

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ABSTRACT

Purpose: With the transition period for ISO 9001 certified organisations to migrate to the 2015 edition ending 15th September 2018, this investigation aims to evaluate the status of ISO 9001:2015 transition process and provide useful knowledge on the corresponding motivations, benefits, and success factors.

Methodology/Approach: An empirical study of more than 300 Portuguese organisations ISO 9001 certified, or in certification process, encompassing a wide range of activities sectors, was carried out.

Findings: As of May 2017, 19% of the respondents already have ISO 9001:2015 certification and all the remaining one's plan to complete the process in time. The principal reported benefits are risk-based thinking, mapping of the organisational context, and stakeholder identification. Simultaneously those were the issues that required more attention and effort to be mastered and implemented. Additionally, there is evidence that ISO 9001:2015 enhances both internal and external organisational issues and generates benefits for all the researched dimensions. Based on the respondents' responses, organisations who claimed that external motivations were the primary drivers to ISO 9001:2015 implementation systematically rate higher all the benefits when compared with the rating ascribed by those organisations who claimed internal motivations. Moreover, it is possible to conclude that the perceived benefits from ISO 9001:2015 implementation and certification seem to be strongly influenced by two primary dimensions: the (smaller) organisation size and the (lesser) international presence.

Research Limitation/implication: Due to ISO 9001:2015 novelty, the results of this investigation should be subject to future confirmation and replicated in other countries to allow a generalisation of the conclusions. Since the survey is based on the perceptions of the organisation's Managers, there is a potential response bias risk that should be acknowledged.

Originality/Value of paper: With more than 1.2 million ISO 9001 certified organisation worldwide, this a highly relevant issue both for organisations, practitioners and academics. Due to ISO 9001:2015 novelty, this investigation aims to fill this research gap.

Category: Research paper

Keywords: ISO 9001:2015; quality management systems; certification; benefits

1   INTRODUCTION

1.1   The ISO 9001:2015 International Standard Edition

ISO 9001:2015 (ISO, 2015) was published in September 2015 comprising a twofold goal: reliability- by ensuring that organizations who meet its requirements on a consistent basis provide products and services that satisfy their customers' needs and expectations addressing the relevant statutory and regulatory requirements; flexibility- by developing the 2015 edition appropriate and suitable for the present complex, demanding and dynamic business environments. According to Fonseca (2015a) some of the major new approaches of the ISO 9001:2015 are:

- A strengthened approach enabling managers to demonstrate their leadership throughout all levels of the organisation;

- A reinforced integration with the organisation's business and other management systems (MS) components;

- The consideration of the organisation's context (including its internal culture, external factors, and the requirements and expectations of the relevant stakeholders);

- The adoption of risk-based-thinking;

- The introduction of novel concepts such as organisational knowledge and change management;

- The consideration of both continual and disruptive improvement;

- The adoption of more pragmatic and non-prescriptive requirements with greater emphasis on the achievement of results and less on documentation.

As of 15th September 2018, all ISO 9001:2008 (ISO, 2008) certificates will be no longer valid. Organisations intending to comply with the requirements of the ISO 9001 certificate should transition from their existing ISO 9001:2008 Quality Management System (QMS) to the new edition, via a successful transition audit, or, in case they are not yet ISO 9001:2008 certified, to be audited and certified against the ISO 9001:2015 international standard. In both cases, either the transition process or the initial certification process should be assessed by a

credible and recognised certification body, preferably operating under ISO 17,021 accreditation. Although still a novel theme, ISO 9001:2015 has "caught" researchers' attention as depicted in Tab. 1.

Table 1 – ISO 9001:2015 Research Summary (Authors Own Elaboration)

Research conclusion	Author(s)
ISO 9001:2015 is compared with Total Quality Management approaches concluding it is a step towards TQM, with significant benefits for the organisations, such as less emphasis on documentation and new/reinforced approaches.	Fonseca (2015a)
A stepwise ISO-based Total Quality Management implementation approach based on ISO 9001:2015 is proposed.	Chen, et al. (2016)
Based on an empirical worldwide study among IRCA registered auditors the authors concluded that ISO 9001:2015 with the adoption of the Annex SL, common high-level structure for MSs, and the adoption of identical core context, common terms, and definitions, favours integration with other MSs such as the ISO 14001:2015- Environment MS.	Domingues, et al. (2016)
The authors propose a model for integrating Lean or Six Sigma projects by systematical linkage with the applicable clauses and sub-clauses of ISO 9001:2015.	Marques, et al. (2016)
Based on a survey of 393 IRCA registered auditors worldwide, the authors conclude that ISO 9001:2015 is in line with modern business and quality management concepts and will be a useful tool for the companies.	Fonseca and Domingues (2017)
By analysing ISO 9001:2015 and gathering feedback during the first six months of its application, the authors consider that there are improvements such as the new harmonized structure, the adoption of risk-based thinking and the reinforced business-centred focus on business processes. However, they claim that ISO 9001:2015 is generally ambiguous and encompasses some incomplete and imperfect text and requirements.	Anttila and Jussila (2017)
Based on an empirical study amidst 1175 German companies the authors point out that there is a lack of training and knowledge concerning the ISO 9001:2015 new requirements particularly concerning the adoption of "risk-based thinking".	Rybskia, et al. (2017)
Given the new ISO 9001:2015 requirements, a survey was held amidst ISO 9001 certified organisations, to ascertain the competencies demanded today for Quality and Organizational Excellence Managers. The results highlight that "the knowledge of culture and the organisational process" is the most highly required competency and skill for these professionals.	Fonseca, Domingues and Sá (2017)

To sum up, on the one hand, there is a stream of authors that regard the ISO 9001:2015 standard a valuable step towards TQM. Concurrently, these authors consider that the last revision of the ISO 9001 standard favours the integration with other management disciplines. Conversely and on the other hand, there is a stream of authors that acknowledge the ISO 9001:2015 benefits but also some shortcomings. Furthermore, some authors point out that there is a lack of awareness and training on ISO 9001:2015. This research study aims to tighten

this research gap, by gathering empirical knowledge (to formulate grounded theoretical propositions) on the ISO 9001:2015 transition and certification phenomenon, notably the approaches adopted by the organisations that proceeded with the transition, the significant benefits attained and the obstacles faced throughout this process. With more than 1.2 million ISO 9001 certified organisation from all sectors of activity, worldwide (ISO, 2017), this is a relevant issue both for organisations, practitioners and academics and due to ISO 9001:2015 novelty, empirical investigations are still scarce.

1.2 Motivations and Benefits of ISO 9001 Certification

Researchers have paid significant attention to the ISO 9001 certification phenomenon focusing on the motivations for its implementation and certification and the achieved benefits. Tab. 2 presents a summary of the more relevant studies addressing this research topic and the soundest conclusions.

Table 2 – ISO 9001 Certification Research Synthesis (Authors Own Elaboration)

Dimension	Conclusions/Authors
Benefits of the ISO 9001 certification	Positive results due to ISO 9001 implementation and certification: Bernardo, et al. (2015); Boiral and Amara (2009); Heras, et al. (2002); Martínez-Costa and Martínez-Lorente (2007); Martínez-Costa, et al. (2009); Poksinska and Dahlgaard (2003); Psomas (2013); Sampaio, Saraiva and Rodrigues (2009); Tari, Molina-Azorin and Heras (2012), Fonseca, et al. (2017).
	Emphasis on positive internal results such as organizational and operational improvements: Calvo, et al. (2016); Martínez-Costa, Martínez-Lorente and Choi (2008); Terziovski and Power (2007); Wahid and Corner (2009).
	Emphasis on positive external results, e.g., better brand image, improved customer relationships; more favourable market position of the company; access to markets; financial benefits, strengthening of relationships in distribution channels and improve logistics: Benner and Veloso (2008); Corbett, Montes and Kirsch (2005); Dick, Heras and Casadesús (2008); Martínez-Costa and Martínez-Lorente (2003, 2007); Sharma (2005); Terlaak and King (2006), Zimon, Gajewska and Bednárová (2017).
The emphasis of the internal/external type of motivation for the implementation and certification of ISO 9001	Emphasis on external motivations such as regulations for market access; customer demands; pressure from competitors; access to government incentives: Bhuiyan and Alam (2010); Heras and Arana (2006); Martínez-Costa, Martínez-Lorente and Choi (2008); Terziovski, Power and Sohal (2003).
	Emphasis on internal motivations lead organisations to implement and certify their QMS to achieve internal and external benefits: Calvo, et al. (2016); Chang and Lo

Dimension	Conclusions/Authors
	(2005); Fotopoulos and Psomas (2010); Llopis and Tari (2003); Willar, Coffey and Trigunarsyah (2015), Castillo-Peces, et al. (2017).
Influence of the internal/external type of motivation for the implementation of the ISO 9001 on achieving positive results	Internal motivations to implement ISO 9001 can foster organisational and process improvements which may contribute to better quality and customer satisfaction, leading to improved financial performance, and competitive position. External motivation contributes to better access to markets and image enhancement, but if no internal improvements are implemented, the external benefits might not endure: Boiral and Roy (2007); Llopis and Tari (2003); Martínez-Costa, Martínez-Lorente and Choi (2008); Prajogo (2011); Sampaio, Saraiva and Rodrigues (2009).
The impact of the organization sector of activity on the positive benefits of ISO 9001 certification	There are observed differences in the driving forces for ISO 9001 certification between manufacturing and services: Pekovic (2010).
Influence of the organization size on the positive benefits of ISO 9001 certification	It is more difficult to SME´s because those organizations have fewer relevant resources than larger ones: Gustafsson, et al. (2001); Ismyrlis and Moschidis (2015).
	Size is not relevant, since SME´s are more flexible and open to change than larger ones, and the start point might be lower: Briscoe, Fawcett and Todd (2005); Lee, To and Yu (2009); Prado, et al. (2013); Fotopoulos and Psomas, (2010); Terziovski, Power and Sohal (2003).
The impact of the organization international presence intensity on the positive benefits of ISO 9001 certification	Some research shows a positive relationship between export intensity (the ratio of export sales to total sales) and firm performance, since firms with a higher rate of export must be more effective and efficient (Bernard and Jensen, 1999; Ling-Yee, 2004), and have access to more knowledge, therefore becoming more competitive (Ellis, Davies and Wong, 2011).
Influence of number of years of the certification on the positive effects of ISO 9001 certification	The benefits of the implementation and certification of an ISO 9001 QMS need time to be achieved and growth with the number of years since certification: Corbett, Montes and Kirsch (2005); Fonseca (2015b); Martínez-Costa, Martínez-Lorente and Choi (2008); Terziovski and Power (2007); Wilson, Walsh and Needy (2003), Castillo-Peces, et al. (2017)
	Time is not significant, and the benefits of certification may even decrease with time: Casadesus and Karapetrovic (2005); Casadesus, Karapetrovic and Heras (2004); Karapetrovic, Fa and Heras (2010); Sampaio, Saraiva and Rodrigues (2009).
Influence on the intensity of Quality improvement methodologies application (such	There are synergies between Six Sigma and ISO 9001: Pfeifer, Reissiger and Canales (2004); Lupan, et al. (2005); Dey (2010).

Dimension	Conclusions/Authors
as Lean, Kaizen, 6 Sigma) to maximize ISO 9001 certification benefits	There is a potential role of the Lean principles and tools and principles under the requirements of ISO 9001:2008 clauses. There are synergies between the ISO 9001 requirements and improvement Kaizen events and the application of structured Lean tools: Chiarini (2011); Micklewright (2010).

With the introduction of the ISO 9001:2015 new approaches, when compared to the ISO 9001:2008 version, it is advisable to investigate where we stand concerning the motivations, benefits, and success factors for ISO 9001:2015 certification. Moreover, as the three-year transition for ISO 9001 will end 15th September 2018, the Accreditation Forum (IAF) that supersedes the developing of principles and practices for the conduct of conformity assessment, passed a resolution that as of 15th March 2018, conformity assessment bodies must conduct all ISO 9001 audits to the new version ISO 9001:2015 (IAF, 2017). With estimates that more than 50% of ISO 9001 certified organisations still didn´t complete the transition at the end of 2017 (informal survey carried by the authors within ISO 9001 certification bodies), the results of this investigation can be of value to understand and support the ISO 9001:2015 transition process.

2   METHODOLOGY

The research started with the review of the published studies addressing ISO 9001:2015, its benefits and shortcomings and previous studies concerning ISO 9001 certification (motivations, benefits and organisational dimensions that influence its outcomes). Due to ISO 9001:2015 novelty, there are limited empirical studies on its implementation and certification, which lead to the proposal of the following research questions (RQ):

RQ 1: Halfway through the transition period, what is the status concerning ISO 9001:2015 transition and certification?

RQ 2: What are the main benefits achieved with ISO 9001:2015 implementation and certification?

RQ 2.1: Are there significant differences between Quality Managers and CEOs?

RQ 3: What are the new ISO 9001:2015 themes that your organisation considers most difficult to implement successfully?

RQ 3.1: Are there significant differences between organisations that have already been certified and those have not yet done it?

RQ 4: What are the main dimensions that influence the successful ISO 9001:2015 implementation and certification?

RQ 4.1: Does the internal/external type of motivation to implement ISO 9001:2015 influence the achievement of positive results?

RQ 4.2: Does the organisational sector influences the achievement of positive results with ISO 9001:2015 implementation and certification?

RQ 4.3: Does the organisation size influence the achievement of positive results with ISO 9001:2015 implementation and certification?

RQ 4.4: Does the organisation international presence intensity impact on the achievement of positive results with ISO 9001:2015 implementation and certification?

RQ 4.5: Does the number of year of the organisation certification influence the achievement of positive results?

Quantitative research, supported on a survey online was adopted, with a structure similar to Fonseca and Lima (2015), where construct reliability was tested and validated with Cronbach Alpha (greater than 0.7).

The collection of data to address these research questions were supported by in an online survey that was carried out for three weeks, throughout April and May 2017, among organisations ISO 9001 certified or in certification process by the leading Portuguese certification body (APCER, 2017).

The online survey is a suitable research technique widely adopted to reach a restricted population. This technique is particularly appropriate in the context of this study characterised by scarce resources and the need for fast response time. The participants could access their survey via an individual link sent per mail. The survey structure encompassed 4 primary group of questions addressing the following central themes: organisation characterization, ISO 9001:2015 certification/transition, internal/external certification motivation (Likert 1- Totally Internal to 7- Totally External scale), certification benefits (8 items based on literature review, assessed through a Likert Scale: 1- No relevance to 5- Totally Relevant) and respondent data. The statistical analysis and statistical hypotheses testing were supported by the use of IBM SPSS Statistics 23 software. Both the Chi-square and the Wilcoxon signed ranks statistical test were adopted throughout the results analysis.

The survey results were monitored during the survey period to check for possible non-respondent bias using "wave analysis" to compare the results from late respondents and early respondents (Armstrong and Overton, 1977). Since no significant differences were found, we can assume that non-respondents' responses would be similar, minimising the possible bias error. Additionally, the analysis of the survey results suggests that it is representative since the distribution of the sample is consistent with the population.

3   RESULTS AND DISCUSSION

3.1   Characterization of the Respondent Companies

The survey yielded a total of 310 valid responses (response rate 18%). Concerning the sector of activity, industry accounted for nearly 38% of the survey responses, commerce (11%) and services (51%). These results assure a well-balanced sample of service-oriented and producing businesses for this research, as depicted in Fig. 1.
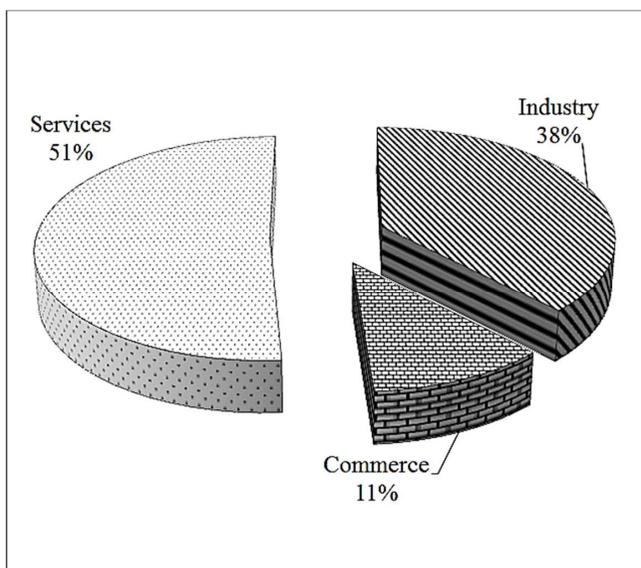
Figure 1 – Respondent Companies - Breakdown by
Sector of Activity (Authors Own Elaboration)

Respondents were mainly quality managers (80%), followed by CEOs (11%) and other quality management collaborators (8%), as one may observe in Fig. 2.
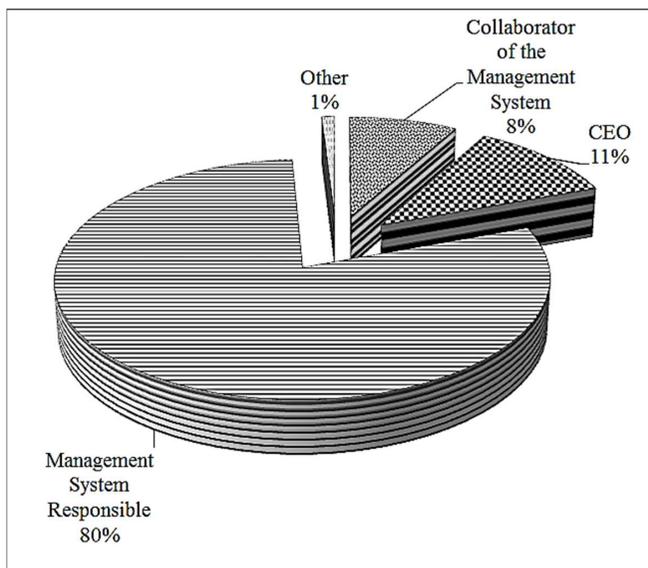
Figure 2 – Respondent Companies - Breakdown by
Organisational Function (Authors Own Elaboration)

As depicted in Fig. 3, most organisations operate in the internal market (41%), while 36% have some international presence (less than 25% of total revenue) and 23% are more internationalised (more than 25% total revenue).
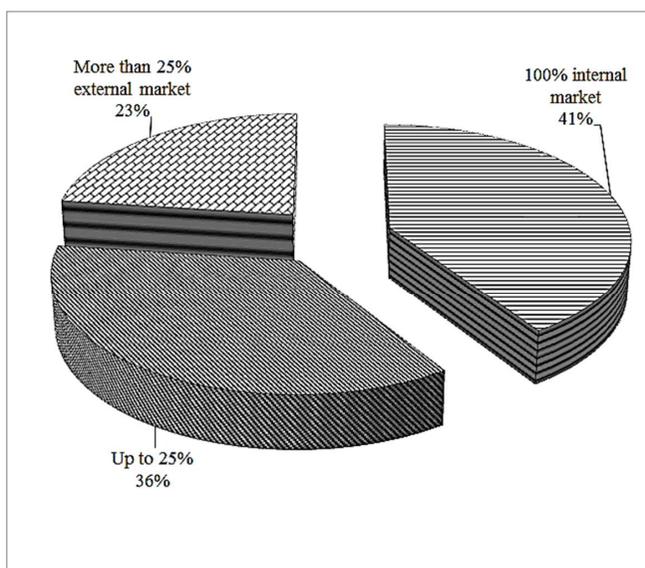
Figure 3 – Respondent Companies - Breakdown by
the International Export Intensity
(Authors Own Elaboration)

Concerning the number of employees, 62% of the respondent organisations employ less than 50 collaborators and 31% employ between 50 and 250 collaborators. Solely 6% of the organisations have more than 250 employees (Fig. 4). These results are aligned with the Portuguese profile of the certified companies which is characterised mainly by a high density of SMEs.
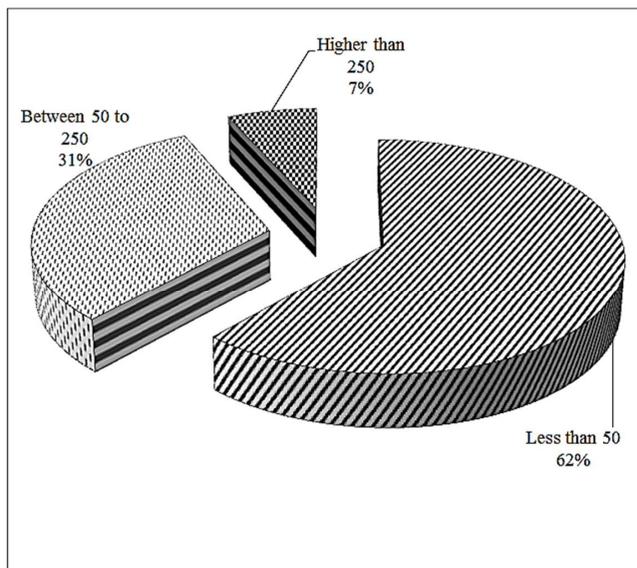
*Figure 4 – Respondent Companies - Breakdown by
the Number of Employees
(Authors Own Elaboration)*

Concerning the distribution of the number of years the organisations have implemented their QMSs, it shows a balanced distribution concerning the QMS years since its implementation and is in line with the population distribution suggesting that the sample accurately matches the population (Fig. 5).
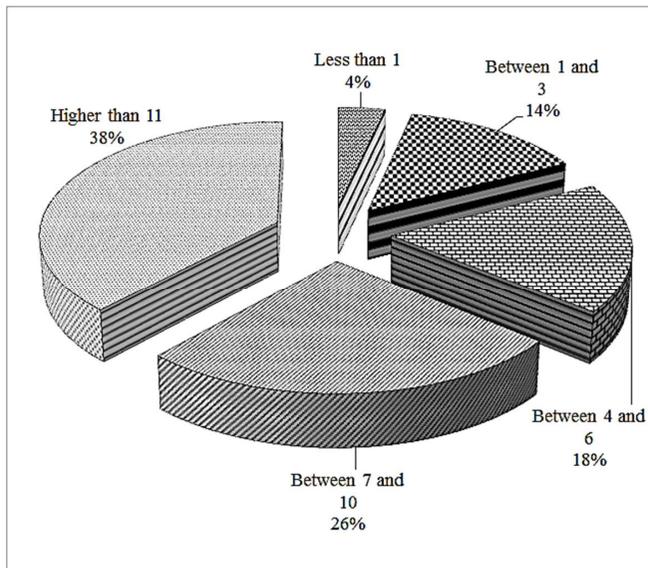
Figure 5 – Respondent Companies - Breakdown by the Number of Years Since the Implementation of the QMS (Authors Own Elaboration)

3.2   Study on ISO 9001:2015 Transition/Certification

Concerning the research question 1 (Halfway through the transition period, what is the status concerning ISO 9001:2015 transition and certification?), as shown in Fig. 6, by May 2015 20% of the respondents were indeed certified accordingly the ISO 9001:2015 (either by transitioning from ISO 9001:2018 or direct certification with ISO 9001:2015) and 79% mentioned the desire to proceed with the transition to ISO 9001:2015.

From the 72 organisations that proceeded with the transition, 58% made only minor adjustments to their QMS, while 37% made a full a substantial reformulation. Concerning the 238 organisations that have not yet completed the transition/certification to ISO 9001:2015 they plan to do it throughout 2017 (46%) and 2018 (52%) (Fig. 8) and stressed that they are in the process of studying the ISO 9001:2015 international standard (39%) or lacked time to do it (36%). However, as one may observe both in Fig. 7 and 8, the rate of transition increased 64% in the first four months of 2017, when compared to 2016, and approximately half of the organisations plan to proceed with the transition in 2017, and the other half throughout 2018 (Fig. 8).
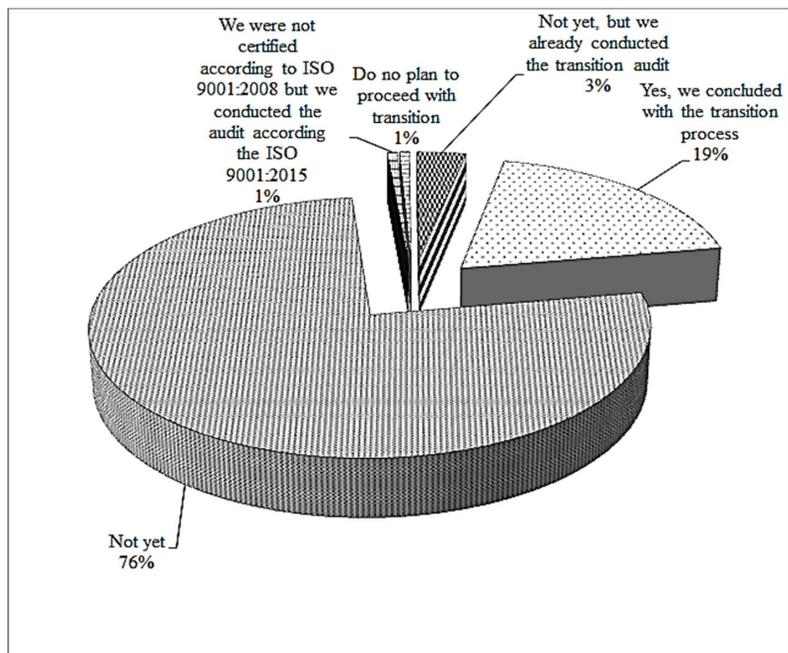
Figure 6 – Respondent Companies - Status Concerning ISO 9001:2015 Transition/Certification (Authors Own Elaboration)

These results suggest that the transition rate is growing and (by May 2017) almost all organisations plan to proceed with it till 15 September 2018. The organizations which proceed with the transition to the novel ISO 9001:2015 relied mainly on external consultants (57%) and training (47%); however, among those organizations that have not yet completed the ISO 9001:2015 transition/certification some are still trying to master the international standard (40%) and others reported lack of time to do it successfully (37%). From the 72 organisations that proceeded with the transition, 58% made only minor adjustments to their QMS, while 37% made a full a substantial reformulation.
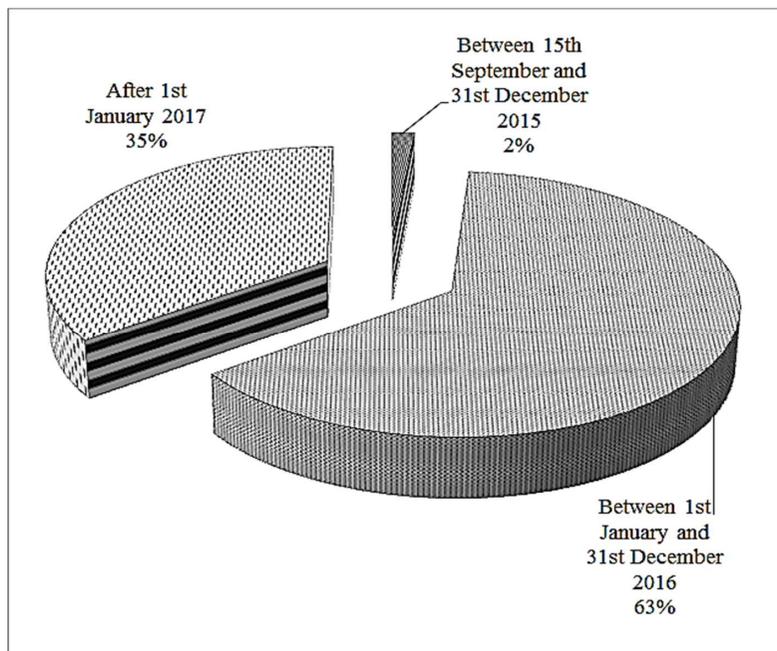
*Figure 7 – Status Concerning ISO 9001:2015 Transition/Certification
- Breakdown by Date of Completion (Authors Own Elaboration)*
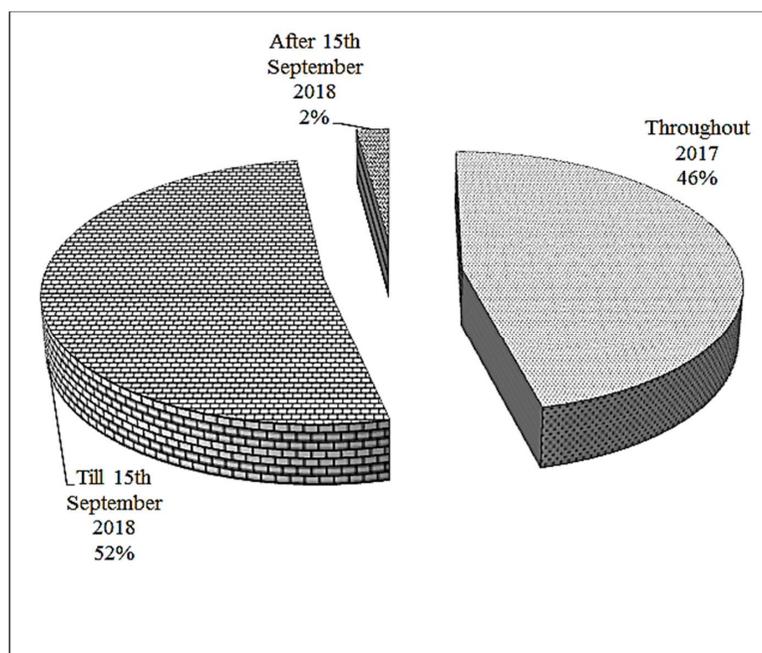
*Figure 8 – Organizations Still in Transition Process - Breakdown
by the Planned Deadline for the ISO 9001:2015 Certification
(Authors Own Elaboration)*

Based on the results collected, five new ISO 9001:2015 themes were identified as the most beneficial ones:

- Risk and opportunities determination and adoption of risk-based thinking;

- Organizational context determination - internal and external relevant issues;

- Determination of the relevant stakeholders and their relevant requirements;

- Organisational knowledge;

- Change control.

Research question 2.1 aims to evaluate if there are there significant differences concerning ISO 9001:2015 main benefits, between the Quality Managers and the CEOs. The graphical depiction of the summarized results (Fig. 9) suggests three main themes as those that experienced the most beneficial evolution upon the ISO 9001:2015 implementation: Risk and opportunities determination and adoption of risk-based thinking, determination of the relevant stakeholders and their relevant requirements and the organizational context determination- internal and external relevant issues. One should stress that both CEOs and Quality Managers pointed out these same three beneficial themes over the others.
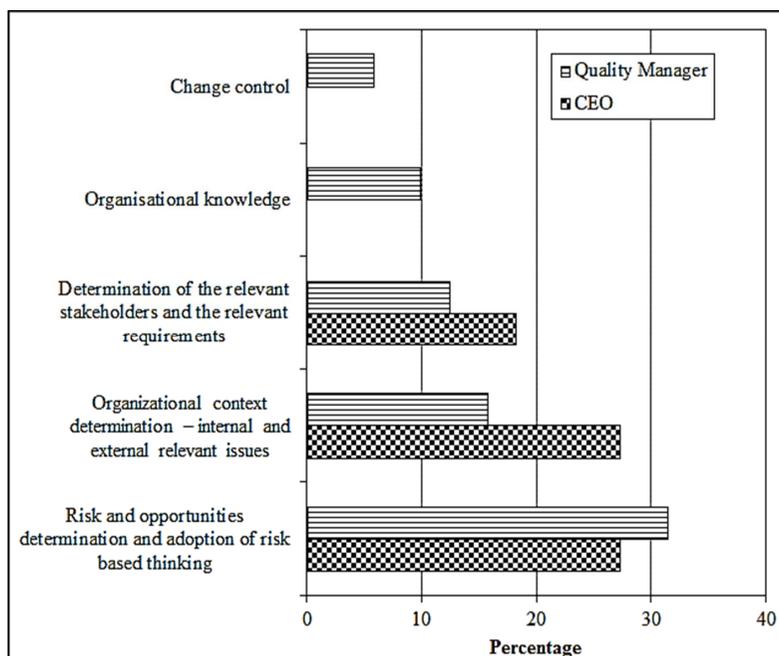
Figure 9 – Relative Distribution of the Most Often Reported Beneficial Themes Collected Upon ISO 9001:2015 Implementation - Breakdown by CEOs and Quality Managers (Authors Own Elaboration)

To statistically assess if a significant difference does exist among the perceptions expressed by the CEOs and those expressed by quality managers the Chi-Square statistical test was conducted. The p-value (0.619) suggests that based on the collected results there is no evidence of statistical differences between the two groups (Tab.3), however, due to the small CEOs sample size, their results need to be considered with caution.

Table 3 – Chi-Square Tests (Authors Own Elaboration)

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	29.967[a]	33	0.619	0.694
Likelihood Ratio	30.510	33	0.592	0.580
Fisher's Exact Test	33.740			0.360
N of Valid Cases	62			

Concerning the research question 3 "What are the new ISO 9001:2015 themes that your organisations consider most difficult to successfully implement?" the summarized results are depicted in Fig. 10. These results (breakdown by companies already certified and not yet certified) concerning the most difficult themes to be implemented (or the themes expected to be most difficult to implement) suggest that both the organizations that proceeded with the transition to the ISO 9001:2015 and those that did not point out the "Risk and opportunities determination and adoption of risk-based thinking" as the theme presenting more challenges to implement. Additionally, the "Determination of the relevant stakeholders and their relevant requirements" and "Organizational context determination- internal and external relevant issues" are mentioned by both groups as other themes indeed difficult to implement (companies that proceeded with the transition) or expected to be difficult to implement (companies that not yet proceeded with the transition).

To answer research question 3.1 "Are there significant differences concerning the ISO 9001:2015 most difficult themes, between organisations already certified with ISO 9001:2015 and those that have not yet done it?", the Chi-Square statistical test was adopted to ascertain statistical differences between the distributions of the two groups. The p-value suggests that based upon the collected results there is no evidence of statistical differences between the two groups, i.e., the expected difficulties to be faced during the implementation process are in fact those that are experienced by the companies that proceeded with the transition.
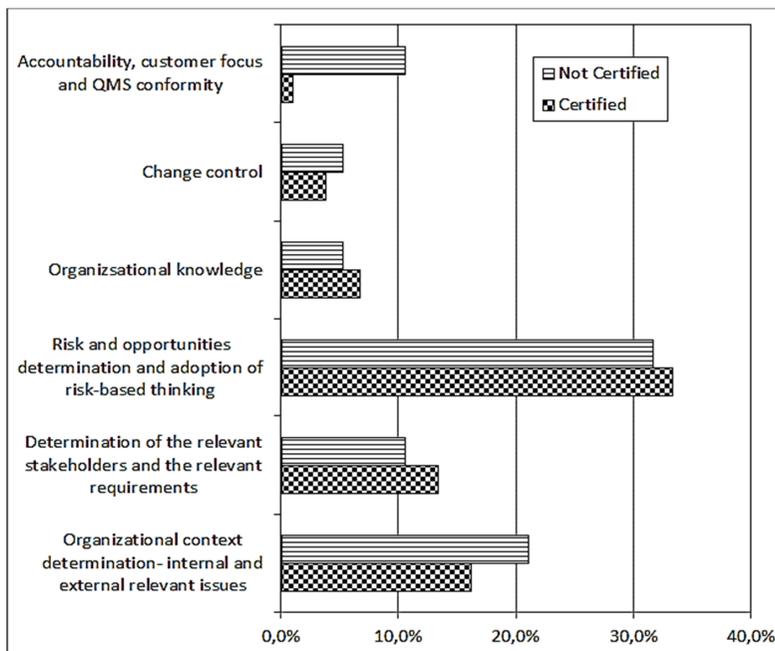
Figure 10 – Relative Distribution of the Most Often Reported Difficulties Faced (or Expected to Be Faced) During ISO 9001:2015 Implementation Process - Breakdown by Certified Organisations and Those Not Yet Certified (According to the ISO 9001:2015 Standard) (Authors Own Elaboration)

3.3 Study on ISO 9001:2015 Motivations and Benefits

Considering ISO 9001:2015 novelty, the investigation aimed to address if the dimensions stated in the literature for achieving successful benefits with ISO 9001 implementation remain valid with the ISO 9001:2015 edition (RQs 4.1 to 4.5). The benefits were outlined according to the literature review and yield the results listed in Table 3 (Likert scale: 1- No relevance to 5- Highly relevant). With the purpose of simplification and benchmarking two composite indicators, presented in equations 1 (for Total Internal Benefits) and 2 (for Total External Benefits) were defined based on each benefit assessed and on it internal or external relevance:

$$Total\ Internal\ Benefits = \left(1 * \frac{\sum I}{8} + 0,5 * \frac{\sum (I+E)}{4} + 0 * \frac{\sum E}{2} \right) \qquad (1)$$

$$Total\ External\ Benefits = \left(0 * \frac{\sum I}{8} + 0,5 * \frac{\sum (I+E)}{4} + 1 * \frac{\sum E}{2} \right) \qquad (2)$$

Based on the results presented in Tab. 4 it is possible to point out that organisations perceived and rate the achievement of external benefits higher than the achievement of internal benefits (Average of 3.9 versus 3.745) upon ISO 9001:2015 implementation and certification. Also, the results suggest that organisations find "Improved awareness regarding risk and its minimisation" as the most beneficial issue attained upon ISO 9001:2015 certification (Average 4.3). Among other high rated benefits (Average 4.0) reported, one should stress the following: increased Top Management commitment, improved awareness of the stakeholders, their expectations, and requirements concerning the products and services (P&S) and opportunities identification. Regarding those potential benefits rated lower by the organisations (Average lower than 3.5) the following should be mentioned: sharpen the definition of the requirements of the products and services (P&S), cost reductions and improved integration with ISO 14001.

Table 4 – ISO 9001:2015 Benefits Summary (Authors Own Elaboration)

Benefits	Internal (I) /External €	Average (1 to 5)	Std Dev.
[B1] Alignment with business strategy	I+E	3.9	1.13
[B2] Increased Top Management commitment	I	4.0	1.15
[B3] Improved accountability from the processes leaders and involved employees	I	3.9	1.09
[B4] Improved awareness of the stakeholders, their expectations, and requirements concerning the P&S	E	4.0	0.85
[B5] Sharpen definition of the requirements of P&S	I+E	3.4	1.06
[B6] Improved awareness regarding risk and its minimization	I+E	4.3	0.83
[B7] Opportunities identification	I+E	4.0	0.97
[B8] Safeguard and access to relevant knowledge	I	3.7	0.93
[B9] Less prescriptive and documentation requirements	I	3.6	1.07
[B10] Cost reductions	I	3.5	1.40
[B11] Productivity improvements	I	3.6	1.29
[B12] Increased product/service quality	E	3.8	1.18
[B13] Improved processes performance	I	3.9	1.15
[B14] Improved integration with ISO 14001	I	3.1	1.48
Total Internal benefits	Equation 1	3.745	---

Benefits	Internal (I) /External €	Average (1 to 5)	Std Dev.
Total External benefits	Equation 2	3.9	---

The external/internal type of motivation, the sector of activity, the organisation size, the international business intensity, and the number of years of the certification were the dimensions used to study the factors that might influence the achievement of ISO 9001:2015 implementation and certification benefits. Tab. 5 summarises the average scores.

Table 5 – ISO 9001:2015 Dimensions That Influence Positive Results. Summary of Research Questions (RQ) Testing (Authors Own Elaboration)

RQ4: What are the main dimensions that influence the successful ISO 9001:2015 implementation and certification?		
Hypothesis	*Average value*	
RQ4.1: Does the internal/external type of motivation to implement ISO 9001:2015 influence the achievement of positive results?	Mainly Internal 3.7	Mainly External 3.9
RQ4.2: Does the organisational sector influences the achievement of positive results with ISO 9001:2015 implementation?	Industry 3.8	Commerce and Services 3.9
RQ4.3: Does the organization size influence the achievement of positive results with ISO 9001:2015 implementation and certification?	Small (less than 50 employees) 3.9	Medium/Large (more than 50 employees) 3.5
RQ4.4: Does the organization international presence influence the achievement of positive results with ISO 9001:2015 implementation and certification?	Small international presence (less than 25% total revenue) 3.8	Medium international presence (more than 25% total revenue) 3.5
RQ4.5: Does the number of years of certification influence the achievement of positive results?	Less than 6 years' certification 3.7	More than 6 years' certification 3.8

To answer research questions 4.1 to 4.5 the statistical Wilcoxon signed rank test was adopted to assess the statistical relevance of the differences among each one of the benefits for the two groups. Concerning the Wilcoxon signed rank test, the solely statistical difference ascertained relates with the benefit- Access to relevant knowledge that was statistically perceived different concerning the type of motivation leading to the implementation of the ISO 9001:2015 ($Z = -2.292$; p-value < 0.05 (0.022)).

Supported on the summarised results listed in Tab. 4 it is possible to conclude that the perceived benefits seem to be strongly influenced by two primary dimensions: the organisation size and the international presence (highest differences). Both the activity sector where the organisation operates and the

organisational number of years since certification seems not to impact so much on the perception of the attained benefits with ISO 9001:2015 implementation (lowest values).

The results are graphically depicted breakdown by benefit throughout Fig. 11 to 15. Tab. 6 presents information regarding the assessment of each group within each assessed dimension. On this regard, it is possible to point out that those organisations who claimed that internal motivations were the primary drivers to ISO 9001:2015 implementation systematically rate lower all the benefits when compared with the rating ascribed by those organisations who claimed external motivations. Furthermore, based on the information in Tab. 6, smaller organisations and those who reported a low international presence rate higher all the benefits attained upon ISO 9001:2015 certification.
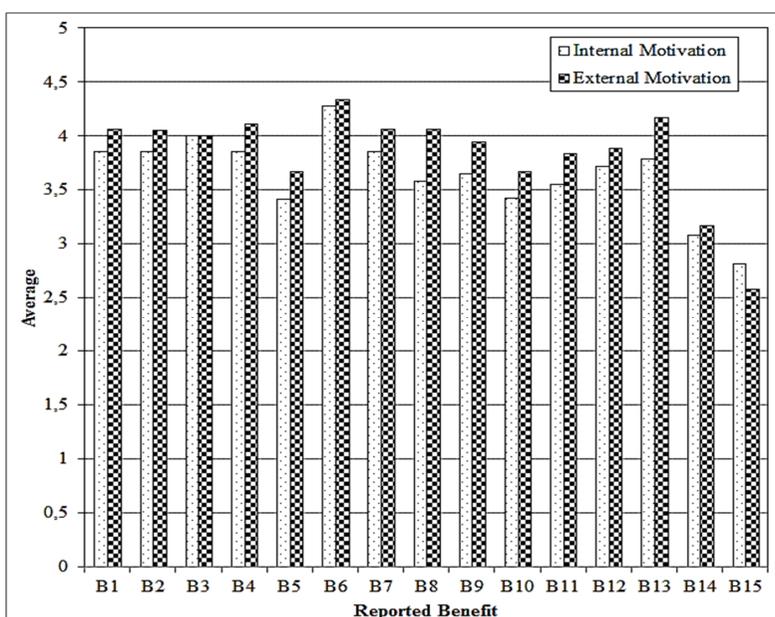
*Figure 11 – Motivation Driving ISO 9001: 2015
Implementation (Authors Own Elaboration)*
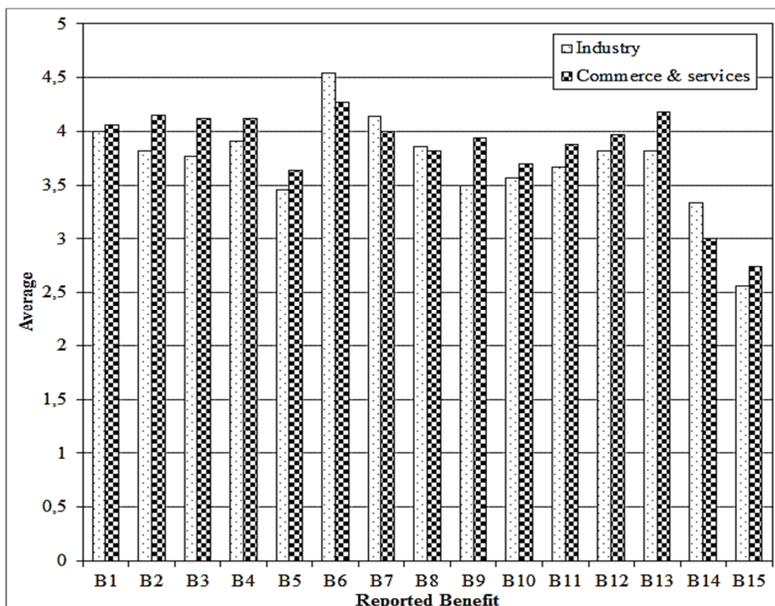
Figure 12 – Activity Sector (Authors Own Elaboration)
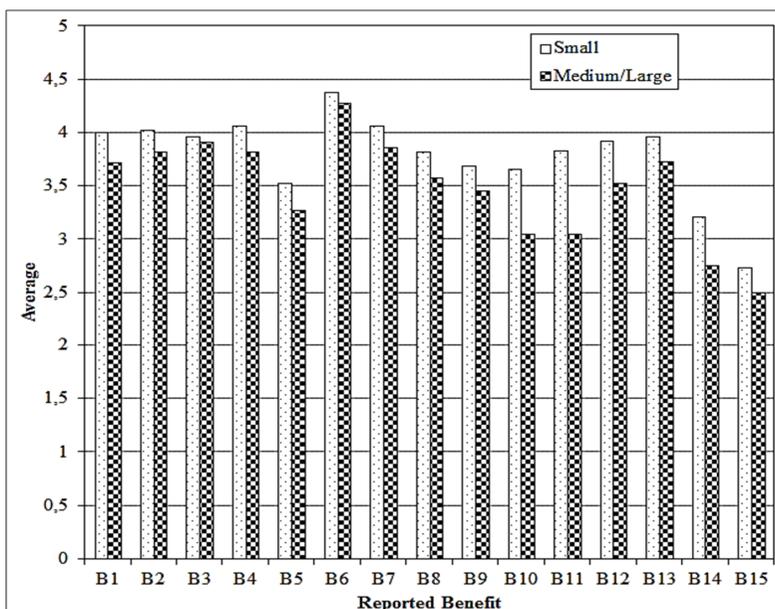
Figure 13 – Organization Dimension (Authors Own Elaboration)
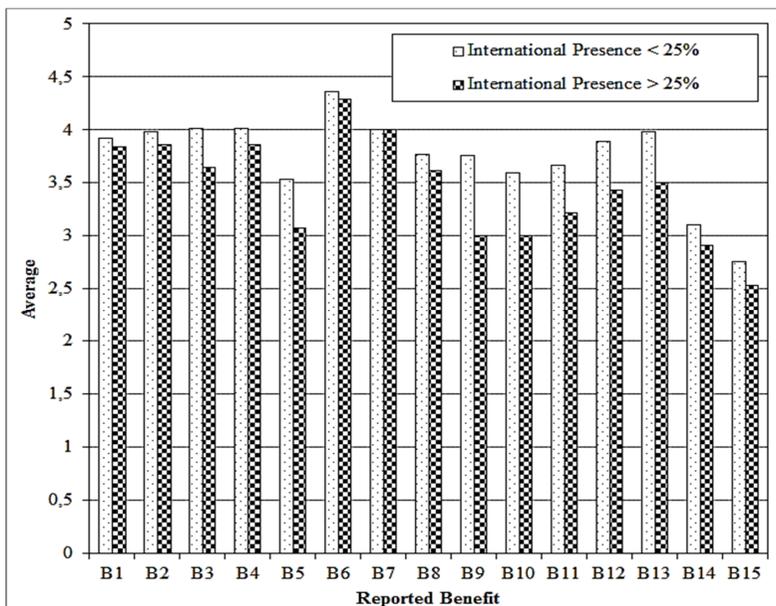
Figure 14 – International Presence (Authors Own Elaboration)
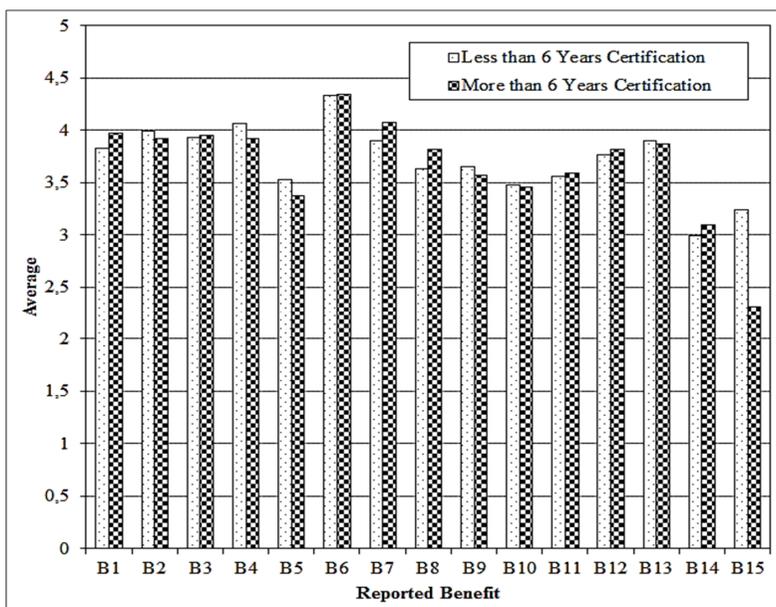
*Figure 15 – The Number of Years Since the QMS First
Certification (Authors Own Elaboration)*

Table 6 – Comparison between Ratings among the Groups within Dimensions (Authors Own Elaboration)

	Internal vs. External motivation	Industry vs. Commerce & Services	Small vs. Medium/Large	Int. Pres. < 25% vs Int. Pres. > 25%	Number of years QMS certification, "less than 6" vs. "6 or more"
B1	↓	↓	↑	↑	↓
B2	↓	↓	↑	↑	↑
B3	↓	↓	↑	↑	↓
B4	↓	↓	↑	↑	↑
B5	↓	↓	↑	↑	↑
B6	↓	↑	↑	↑	↓
B7	↓	↑	↑	→	↓
B8	↓	↑	↑	↑	↓
B9	↓	↓	↑	↑	↑
B10	↓	↓	↑	↑	↑
B11	↓	↓	↑	↑	↓
B12	↓	↓	↑	↑	↓
B13	↓	↓	↑	↑	↑
B14	↓	↑	↑	↑	↓

4   CONCLUSION

Halfway through the transition period, concerning ISO 9001:2015 transition and certification 19% of the respondents are already certified to ISO 9001:2015 and, from this group, 58% made only minor adjustments to their QMS, while 37% made a substantial reformulation. From the remaining 81%, 46% plan to complete the process in 2017 and 52% in 2018; 39% are still studying the ISO 9001:2015 International Standard or lacked time to do it (36%). The rate of transition to ISO 9001:2015 increased 64% in the first four months of 2017 when compared to 2016b (Conclusions concerning RQ1).

Relating to RQ2, "what are the main benefits achieved with ISO 9001:2015 implementation and certification" (respondents: ISO 9001:2015 certified organisations) the results are Risk and opportunities determination and adoption of risk-based thinking" (67%), followed by "Organizational context determination – internal and external relevant issues" (36%) and the "Determination of the relevant interested parties and the relevant requirements" (29%).

To statistically assess if a significant difference does exist among the perceptions expressed by the CEOs and those expressed by Quality Managers (RQ 2.1) the

Chi-Square statistical test was applied. The p-value (0.619) suggests that based on the collected results there is no evidence of statistical differences between the two groups, however, due to the CEO's small sample size, this should be further investigated.

Following with RQ3, "the new ISO 9001:2015 themes that the organisation considers most difficult to successfully implement (respondents: ISO 9001:2015 certified organisations) are also "Risk and opportunities determination and adoption of risk-based thinking" (57%), "Organizational context determination – internal and external relevant issues" (31%) and the "Determination of the relevant interested parties and the relevant requirements" (24%). The Chi-Square statistical test was adopted to ascertain if there are statistical differences between the distributions of the two groups (RQ 3.1). The p-value suggests that based upon the collected results there is no evidence of statistical differences between the two groups, i.e., the expected difficulties to be faced during the implementation process are in fact those that are experienced by the companies that proceeded with the transition.

Table 7 – Summary of RQ 4.1 To 4.5 (Authors Own Elaboration)

Research Question (RQ)	Results of hypotheses testing
RQ 4.1: Does the internal/external type of motivation to implement ISO 9001:2015 influence the achievement of positive results?	The statistical Wilcoxon signed rank test was adopted to assess the statistical relevance of the differences among each one of the benefits between the two groups. Concerning the Wilcoxon signed rank test, the solely statistical difference ascertained relates with the benefit "Access to relevant knowledge" that was statistically perceived different concerning the type of motivation leading to the implementation of the ISO 9001:2015 ($Z = -2.292$; p-value <0.05 (0.022)). However, based on the graphical analysis presented in Figure 11 it is possible to hint that those organisations who claimed that internal motivations were the primary drivers to ISO 9001:2015 implementation systematically rate lower all the benefits when compared with the rating ascribed by those organisations who claimed external motivations.
RQ 4.2: Does the Organisational sector influences the achievement of positive results with ISO	Supported on the summarised results listed in Table 5 it is possible to conclude that the perceived benefits seem to be strongly influenced by two primary dimensions: the organisation size and the international presence (highest differences). Both the activity sector where the organisation operates and the number of certification years seems not to impact so much on the perception of the attained benefits upon ISO 9001:2015 implementation (lowest differences).
RQ 4.3: Does the organisation size influence the achievement of positive results with ISO 9001:2015	Supported by the summarised results listed in Table 5 it is possible to conclude that the perceived benefits seem to be strongly influenced by two primary

Research Question (RQ)	Results of hypotheses testing
implementation and certification?	dimensions: the organisation size and the international presence (highest differences). Both the activity sector where the organisation operates and the number of certification years seems not to impact so much on the perception of the attained benefits upon ISO 9001:2015 implementation (lowest differences).
RQ 4.4: Does the organisation international presence intensity impact on the achievement of positive results with ISO 9001:2015 implementation and certification?	
R Q4.5: Does the number of years of QMS certification influences the achievement of positive results?	

As a conclusion, based on the respondents' responses, it is possible to hint that organizations who claimed that external motivations were the primary drivers to ISO 9001:2015 implementation systematically rate higher all the benefits when compared with the rating ascribed by those organizations who claimed internal motivations, contesting some previous research still based on ISO 9001:2008. Moreover, it is possible to conclude that the perceived benefits from ISO 9001:2015 implementation and certification seem to be strongly influenced by two primary dimensions: the (smaller) organisation size and the (lesser) international presence.

With more than 1 million ISO 9001 certified organisation from all sectors of activity, worldwide, the transition/certification for ISO 9001:2015 is a highly relevant issue both for organisations and their professionals and academics. ISO 9001:2015 aims for the consistent delivery of quality products and services and the fulfilment of the applicable requirements. It also focuses on business and quality approaches that are relevant to the organisations enduring success. It is indeed a highly valuable research topic to observe what will be the successful transition rate for ISO 9001:2015, and if the motivations, critical dimensions, benefits, and obstacles, are consistent with this investigation results. However, due to ISO 9001:2015 implementation novelty, the results of this investigation should be subject to future confirmation and possibly extended to other countries. It should also be acknowledged that the survey was based on the perceptions of the organisation's Managers and there is a risk of some potential response bias.

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REFERENCES

Anttila, J. and Jussila, K., 2017. ISO 9001:2015- a questionable reform. What should the implementing organisations understand and do?. *Total Quality Management and Business Excellence*, [e-journal] 28(9-10), pp.1090-1105. http://dx.doi.org/10.1080/14783363.2017.1309119.

APCER, 2017. *APCER.* [online] Porto. Available at: <https://www.apcergroup.com/portugal/index.php/en/> [Acessed 01 April 2017].

Armstrong, J.S. and Overton, T.S., 1977. Estimating Nonresponse Bias in Mail Surveys. *Journal of Marketing*, 14(3), pp.396-402.

Benner, M. and Veloso, F., 2008. ISO 9000 practices and financial performance: A technology coherence perspective. *Journal of Operations Management*, [e-journal] 26(5), pp.611-629. http://dx.doi.org/10.1016/j.jom.2007.10.005.

Bernard, A.B. and Jensen, J.B., 1999. Exceptional exporter performance: Cause, effect, or both?. *Journal of International Economics*, [e-journal] 47(1), pp.1-25. http://dx.doi.org/10.1016/S0022-1996(98)00027-0.

Bernardo, M., Simón, A., Tarí, J. and Molina-Azorín, J., 2015. Benefits of management systems integration: A literature review. *Journal of Cleaner Production,* [e-journal] 94(1), pp.260-267. http://dx.doi.org/10.1016/j.jclepro.2015.01.075.

Bhuiyan, N. and Alam, N., 2010. An investigation into issues related to the latest version of ISO 9000. *Total Quality Management and Business Excellence*, [e-journal] 16(2), pp.199-213. http://dx.doi.org/10.1080/14783360500054343.

Boiral, O. and Amara, N., 2009. Paradoxes of ISO 9000 performance: A configurational approach. *Quality Management Journal*, [e-journal] 16(3), pp.36-60. http://dx.doi.org/10.1080/10686967.2009.11918240.

Boiral, O. and Roy, M., 2007. ISO 9000: Integration rationales and organizational impacts. *International Journal of Operations and Production Management*, [e-journal] 27(2), pp.226-247. http://dx.doi.org/10.1108/01443570710.

Briscoe, J., Fawcett, S. and Todd, R., 2005. The implementation and impact of ISO 9000 among small manufacturing enterprises. *Journal of Small Business Management,* [e-journal] 43(3), pp.309-330. http://dx.doi.org/10.1111/j.1540-627X.2005.00139.x.

Calvo, M., Redondo, E., Mora, A. and Cristóbal, R., 2016. Sistemas de gestión de la calidad: un estudio en empresas del sur de España y norte de Marruecos. *European Research on Management and Business Economics*, [e-journal] 22(1), pp.8-16. https://doi.org/10.1016/j.iedee.2015.10.001.

Casadesus, M. and Karapetrovic, S., 2005. Has ISO 9000 lost some of its lustre? A longitudinal impact study. *International Journal of Operations & Production Management,* [e-journal] 25(6), pp.580-596. http://dx.doi.org/ 10.1108/01443570510.

Casadesus, M., Karapetrovic, S. and Heras, I., 2004. Beneficios y costes de la implantación de la normativa de calidad ISO 9000: Un estudio comparativo (1998–2002). *Revista de Economía y Empresa*, 21(5), pp.57-74.

Castillo-Peces, C., Mercado-Idoeta, C., Prado-Roman, M. and Castillo-Feito, C., 2017. The influence of motivations and other factors on the results of implementing ISO 9001 standards. *European Research on Management and Business Economics,* [e-journal] 24(1), pp.33-41. http://dx.doi.org/10.1016/j.iedeen.2017.02.002.

Chang, D. and Lo, L., 2005. Measuring the relative efficiency of a firm's ability to achieve organizational benefits after ISO certification. *Total Quality Management and Business Excellence*, [e-journal] 16(1), pp.57-69. http://dx.doi.org/10.1080/14783360420003009866.

Chen, C-K., Anchecta, K., Lee, Y-D. and Dahlgaard, J.J., 2016. A stepwise ISO-based TQM implementation approach using ISO 9001:2015. *Management and Production Engineering Review,* [e-journal] 7(4), pp. 65-75. http://dx.doi.org/10.1515/mper-2016-0037.

Chiarini, A., 2011. Integrating lean thinking into ISO 9001: a first guideline. *International Journal of Lean Six Sigma*, [e-journal] 2(2), pp.96-117. http://dx.doi.org/10.1108/204014611111.

Corbett, C., Montes, M. and Kirsch, D., 2005. The financial impact of ISO 9000 certification in the United States: An empirical analysis. *Management Science*, [e-journal] 51(7), pp.1046-1059. http://dx.doi.org/10.1287/mnsc.1040.0358.

Dey, P., 2010. How to complement ISO 9001:2000 with Six Sigma. *iSixSigma LLC,* [online]. Available at: <http://isixsigma.com/library/content/c020211a.asp> [Accessed 02 January 2017].

Dick, G., Heras, I. and Casadesús, M., 2008. Shedding light on causation between ISO9001 and improve business performance. *International Journal of Operations and Production Management*, [e-journal] 28(7), pp.687-708. http://dx.doi.org/10.1108/01443570810.

Domingues J.P.T., Fonseca L., Sampaio P. and Arezes, P.M., 2016. Integrated versus non-integrated perspectives of auditors concerning the new ISO 9001 revision. In: IEEE, *International Conference on Industrial Engineering and Engineering Management (IEEM)*. Bali, Indonesia, 4-7 December 2016. IEEE. http://dx.doi.org/10.1109/IEEM.2016.7798000.

Ellis, P.D., Davies, H. and Wong, A.H.-K., 2011. Export intensity and marketing in transition economies: Evidence from China. *Industrial Marketing Management,* [e-journal] 40(4), pp.593-602. http://dx.doi.org/ 10.1016/j.indmarman.2010.10.003.

Fonseca, L.M., 2015a. From Quality gurus and TQM to ISO 9001:2015: a review of several quality paths. *International Journal for Quality Research*, 9(1), pp.167-180.

Fonseca, L.M., 2015b. Relationship between ISO 9001 certification maturity and EFQM business excellence model results. *Quality Innovation Prosperity*, [e-journal] 19(1), pp.85-102. http://dx.doi.org/10.12776/QIP.V19I1.556.

Fonseca, L.M. and Domingues, J.P.T., 2017. ISO 9001:2015- Quality, Management, and Value. *International Journal for Quality Research*, [e-journal] 11(1), pp.149-158. http://dx.doi.org/10.18421/IJQR11.01-09.

Fonseca, L.M. and Lima, V.M., 2015. Impact of supplier management strategies on the organizational performance of ISO 9001 certified organizations. *Quality Innovation Prosperity*, [e-journal] 19(2), pp.32-54. http://dx.doi.org/10.12776/QIP.V19I2.592.

Fonseca, L.M., Domingues, J.P. and Sá, J., 2017. Leading Quality in the 21st Century: Profiles of Quality and Organizational Excellence Managers. *Quality - Access to Success*, 18(161), pp-34-38.

Fonseca, L.M., Domingues, J.P., Machado, P.B. and Calderón, M., 2017. Management System Certification Benefits: Where Do We Stand?. *Journal of Industrial Engineering and Management*, [e-journal] 10(3), pp. 476-494. http://dx.doi.org/10.3926/jiem.2350.

Fotopoulos, C. and Psomas, E., 2010. ISO 9001:2000 implementation in the Greek food sector. *The TQM Journal*, [e-journal] 22(2), pp.129-142. http://dx.doi.org/10.1108/175427310110.

Gustafsson, R., Klefsjo, B., Berggren, E. and Granfors, U., 2001. Experiences from implementing ISO 9000 in small enterprises: A study of Swedish organizations. *The TQM Magazine*, [e-journal] 13(4), pp.232-246. http://dx.doi.org/10.1016/j.indmarman.2010.10.003.

Heras, I. and Arana, G., 2006. A Delphi study on motivation for ISO 9000 and EFQM. *International Journal of Quality and Reliability Management*, [e-journal] 23(7), pp.807-827. http://dx.doi.org/10.1108/02656710610.

Heras, I., Dick, G. and Casadesus, M., 2002. ISO 9000 registration's impact on sales and profitability. *International Journal of Quality and Reliability Management,* [e-journal] 19(6), pp.774-791. http://dx.doi.org/10.1108/02656710210.

IAF, 2017. *IAF_Resolution_201713/522*. [online] Canada: International Accreditation Forum. Available at: <https://www.iaf.nu/articles/IAF_Resolution_201713/522> [Acessed 01 February 2018].

Ismyrlis, V. and Moschidis, O., 2015. The use of quality management systems, tools, and techniques in ISO 9001: 2008 certified companies with multidimensional statistics: The Greek case. *Total Quality Management and Business Excellence*, [e-journal] 26(5-6), pp.497-514. http://dx.doi.org/10.1080/14783363.2013.856543.

ISO, 2008. *ISO 9001 quality management systems- requirements*. Geneva: International Organization for Standardization.

ISO, 2015. *ISO 9001 quality management systems- requirements*. Geneva: International Organization for Standardization.

ISO, 2017. *ISO Survey 2016*. [online] Geneva: International Organization for Standardization. Available at: <http//www.iso.org> [Acessed 01 February 2018].

Karapetrovic, S., Fa, M. and Heras, I., 2010. What happened to the ISO 9000 lustre? An eight-year study. *Total Quality Management and Business Excellence*, [e-journal] 21(3), pp.245-267. http://dx.doi.org/10.1080/14783360903553149.

Lee, P., To, W. and Yu, B., 2009. The implementation and performance outcomes of ISO 9000 in service organizations: An empirical taxonomy. *International Journal of Quality and Reliability Management*, [e-journal] 26(7), pp.646-662. http://dx.doi.org/10.1108/02656710910.

Ling-Yee, L., 2004. An examination of the foreign market knowledge of exporting firms based in the People's Republic of China: Its determinants and effect on export intensity. *Industrial Marketing Management*, [e-journal] 33(7), pp.561-572. http://dx.doi.org/10.1016/j.indmarman.2004.01.001.

Llopis, J. and Tari, J., 2003. The importance of internal aspects in quality improvement. *International Journal of Quality & Reliability Management*, [e-journal] 20(3), pp.304-324. http://dx.doi.org/10.1108/02656710310.

Lupan, R., Bacivarof, I.C., Kobi, A. and Robledo, C., 2005. A relationship between Six Sigma and ISO 9001:2000. *Quality Engineering,* [e-journal] 17(4), pp.719-725. http://dx.doi.org/10.1080/08982110500251329.

Marques, P.A., Meyrelles, P.M., Saraiva, P.M. and Frazão-Guerreiro, F.J., 2016. Integrating Lean Six Sigma with ISO 9001:2015. In: IEEE, *International Conference on Industrial Engineering and Engineering Management (IEEM)*. Bali, Indonesia, 4-7 December 2016. IEEE. http://dx.doi.org/10.1109/IEEM.2016.7798006.

Martínez-Costa, M. and Martínez-Lorente, A., 2003. Effects of ISO 9000 certification on firms' performance: A vision from the market. *Total Quality Management and Business Excellence*, [e-journal] 14(10), pp.1179-1191. http://dx.doi.org/10.1080/1478336032000107735.

Martínez-Costa, M. and Martínez-Lorente, A., 2007. A triple analysis of ISO 9000 effects on company performance. *International Journal of Productivity and Performance Management*, [e-journal] 56(5/6), pp.484-499. http://dx.doi.org/10.1108/17410400710.

Martínez-Costa, M., Choi, T., Martínez, J. and Martínez-Lorente, A., 2009. ISO 9000:1994, ISO 9001:2000 and TQM: The performance debate revisited. *Journal of Operations Management,* [e-journal] 27(6), pp.495-511. http://dx.doi.org/10.1016/j.jom.2009.04.002.

Martínez-Costa, M., Martínez-Lorente, A. and Choi, T., 2008. Simultaneous consideration of TQM and ISO 9000 on performance and motivation: An empirical study of Spanish companies. *International Journal of Production Economics*, [e-journal] 113(1), pp.23-39. http://dx.doi.org/10.1016/j.ijpe.2007.02.046 .

Micklewright, M., 2010. *Lean ISO 9001: Adding Spark to Your ISO 9001 QMS and Sustainability to Your Lean Efforts*. Milwaukee, WI: American Society for Quality.

Pekovic, S., 2010. The determinants of ISO 9000 certification: A comparison of the manufacturing and service sectors. *Journal of Economic Issues*, [e-journal] 54(4), pp.895-914. http://dx.doi.org/10.2753/JEI0021-3624440403.

Pfeifer, T., Reissiger, W. and Canales, C., 2004. Integrating Six Sigma with quality management systems. *The TQM Magazine*, [e-journal] 16(4), pp.241-249. http://dx.doi.org/10.1108/09544780410.

Poksinska, B. and Dahlgaard, J., 2003. ISO 9001:2000- the emperor's new clothes?. *European Quality*, 10(3), pp.58-69.

Prado, C., Castillo, C., Mercado, C. and Soto, F., 2013. Los resultados de la implantación de la norma en 9100 en el sector aeroespacial espanol. *Revista Galega de Economía*, 22(1), pp.151-176.

Prajogo, D., 2011. The role of firms motives in affecting the outcomes of ISO 9000 adoption. *International Journal Operations and Production Management*, [e-journal] 31(1), pp.78-100. http://dx.doi.org/10.1108/014435711110.

Psomas, E., 2013. The effectiveness of the ISO 9001 quality management system in service companies. *Total Quality Management and Business Excellence*, [e-journal] 24(7-8), pp.769-781. http://dx.doi.org/10.1080/14783363.2013.791099.

Rybskia, C., Jochemb, R. and Homma. L., 2017. Empirical study on status of preparation for ISO 9001:2015. *Total Quality Management and Business Excellence,* [e-journal] 28(9-10), pp.1076-1089. http://dx.doi.org/10.1080/14783363.2017.1303886.

Sampaio, P., Saraiva, P. and Rodrigues, A., 2009. ISO 9001 certification research: questions, answers and approaches. *International Journal of Quality and Reliability Manageme*nt, [e-journal] 26(1), pp.38-58. http://dx.doi.org/10.1108/02656710910.

Sharma, D., 2005. The association between ISO 9000 certification and financial performance. *International Journal of Accounting*, [e-journal] 40(2), pp.151-172. http://dx.doi.org/10.1016/j.intacc.2005.01.011.

Tari, J., Molina-Azorin, J. and Heras, I., 2012. Benefits of ISO 9001 and ISO 14001 standards: A literature review. *Journal of Industrial Engineering Management,* [e-journal] 5(2), pp.297-332. http://dx.doi.org/10.3926/jiem.488.

Terlaak, A. and King, A., 2006. The effect of certification with the ISO 9000 Quality Management Standard: A signalling approach. *Journal of Economics Behavior and Organization*, [e-journal] 60(4), pp.579-602. http://dx.doi.org/10.1016/j.jebo.2004.09.012.

Terziovski, M. and Power, D., 2007. Increasing ISO 9000 certification benefits: A continuous improvement approach. *International Journal of Quality and Reliability Management,* [e-journal] 24(2), pp.141-163. http://dx.doi.org/10.1108/02656710710.

Terziovski, M., Power, D. and Sohal, A., 2003. The longitudinal effects of the ISO 9000 certification process on business performance. *European Journal of Operational Research*, [e-journal] 146(3), pp.580-595. http://dx.doi.org/10.1016/S0377-2217(02)00252-7.

Wahid, R. and Corner, J., 2009. Critical success factors and improvements in ISO 9000 maintenance. *International Journal of Quality and Reliability Management,* [e-journal] 26(9), pp.881-893. http://dx.doi.org/10.1108/02656710910.

Willar, D., Coffey, V. and Trigunarsyah, B., 2015. Examining the implementation of ISO 9001 in Indonesian construction companies. *The TQM Journal,* [e-journal] 27(1), pp.94-107. http://dx.doi.org/10.1108/TQM-08-2012-0060.

Wilson, J.P., Walsh, M.A.T. and Needy, K.L., 2015. An examination of the economic benefits of ISO 9000 and the Baldrige Award. *Engineering Management Journal*, [e-journal] 15(4), pp.3-10. http://dx.doi.org/10.1080/10429247.2003.11415220.

Zimon, D., Gajewska, T. and Bednárová, L., 2016. Influence of Quality Management System on Improving Process in Small and Medium--Sized Organizations. *Quality - Access to Success*, 17(155), pp.68-69.

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Organizational Excellence: Approaches, Models and Their Use at Czech Organizations

Jaroslav Nenadál, David Vykydal, David Waloszek

ABSTRACT

Purpose: The paper brings a set of original information related to analysis and description of the current state in the area of excellence models implementation in Czech organisations. It defines these terms, analyses results of special research in Czech organisations and proposes a comprehensive and generic framework how to achieve the organisational excellence. The principal goal of this paper is to present the main possibilities, benefits, limitations and risks related to the practical use of excellence models in Czech organisations.

Methodology/Approach: Brainstorming conferences, field research and relevant data analysis, seminars with quality professionals and other managers, comparative literature analysis and interviews were used to reach the principal goal.

Findings: The organisational excellence concept is now widely discussed and implemented throughout the world. Unlike, the real situation in most Czech organizations is rather else. Level of knowledge and overall people awareness related to this concept and various excellence models is very low. This finding supports the assumption that is necessary to change company culture towards never-ending excellence effort in Czech organisations by way of systematic knowledge (including best practices) sharing among all levels of organizations staff.

Research Limitation/implication: Special research activities focused on analysis and description of current state in area of excellence models implementation, which was performed on a sample of 321 Czech organisations (with more than 20% response rate). Such level of response rate was seriously influenced by the fact that practical use of various excellence models in Czech organisations is rather limited in present days. However, we can suppose the obtained results should be valid or interesting also for another organization, not only in the Czech Republic.

Originality/Value of paper: The paper brings an original set of information from special market research as well as the development of a creative and generic framework of the organisational excellence tailored to Czech organisations.

Category: Research paper

Keywords: organizational excellence; excellence models; quality; risks; benefits

1   INTRODUCTION

Organizations in today's ever-changing and global business environment need to focus on creating new approaches to their development. Such approaches should provide confidence in the organisation's ability to achieve long-term and sustained success. So-called "organisation excellence" represents one of the most recognised concepts which can assure such ability. The organisational excellence ensures all organisational systems are aligned and functioning cohesively together.

We can find a lot of opinions and definitions related to the organisation excellence. For example, M. Webster says that "organisational excellence is delivering, and sustaining the delivery of, outstanding value to all key stakeholders" (Webster, 2016). Experts from American Society for Quality argue that "organisational excellence refers to ongoing efforts to establish an internal framework of standards and processes intended to engage and motivate employees to deliver products and services that fulfil customer requirements within business expectations" (ASQ, 2015). D. M. Bailey wrote: "The excellence is a cultural journey" (Bailey, 2014). Moreover, according to European Foundation for Quality Management – EFQM: "Excellent organisations are those that achieve and sustain outstanding levels of performance that meet or exceed the expectations of all their stakeholders" (EFQM, 2012). These four statements create only very small sample of opinions focused on the area of the organisational excellence concept but anyway they prove the organisational excellence has been being an actual phenomenon throughout the world!

On the contrary, we are afraid of fact the journey to excellence is the only exception and rare opportunity for most of the Czech companies now. A lot of Czech organisations are strongly oriented only to quality management systems according to ISO 9001 standard, and various excellence models are looked upon vain instruments. Therefore, it seems to be rational to explore the reasons and consequences of this situation. The primary purpose of this paper is to present interesting findings from special field research in the area of the organisational excellence concept implementation as well as to bring original excellence framework tailored for Czech organisations environment and culture.

2   METHODOLOGY

After necessary literature review and mutual comparison of five known excellence models, the authors used a questionnaire field survey as the instrument to collect data from 321 Czech organisations. Production, as well as service organisations, were included into this sample on the basis of randomly drew. A quantitative and qualitative approach were used in the data processing. The EFQM Excellence Model was used as an example of a time-tested approach to reaching the organisational excellence. Findings enabled to create original excellence framework as basic of Czech journey to excellence.

3   LITERATURE REVIEW

When consulting serious literature resources in the area of the organisational excellence or excellence models, we can discover huge amount of various opinions and experience. Let us remind only some of them.

Experts from the International City/County Management Association (ICMA) for example recommend focusing on eight areas in case organisations strive to achieve organisational excellence:

1) Delight your customers.

2) Get results from vision and strategic planning.

3) Create a culture from your values.

4) Understand and incorporate both leadership and management.

5) Pay attention to engagement and passion.

6) Maximizing performance.

7) Measure progress.

8) Manage changes.

See (ICMA, 2016) for additional details. Some findings from field research projects revealed a significant impact of organizational excellence on overall performance (Musa and Tulay, 2008) or (Kiitam and Tammaru, 2012), human force productivity (Shirvani and Iranban, 2013), company culture creating (Al-Dhaafri, Al-Swidi and Al-Ansi, 2016; Zgodavova, Hudec and Palfy, 2017) and other features of organizations. A lot of other interesting perceptions and beliefs are continuously presented through permanent chatting on www.researchgate.com. Some special approaches were developed on purpose of organisational excellence level assessment. Let us remind only three of them: the RADAR logic as EFQM (2012) developed a dynamic assessment framework and Duffy (2016) have proposed five excellence maturity levels and similar approach is also recommended by the latest version of ISO 9004:2018 standard, which comprises a special annex entirely oriented on organizational self-assessment (ISO 9004; 2018). By the way: this standard brings a new term "quality of an

organisation" as the degree to which the inherent characteristics of an organisation fulfil the needs and expectations of its customers and other interested parties, to achieve sustained success. In our opinion, this term is broadly speaking close to the organisational excellence.

Unfortunately, data relating to the economic impact of the organisational excellence are presented only seldom. For example, results of a particular survey oriented to change of performance indicators show as interesting itself. This survey was executed in 2007 by some specialists from George Washington University (Washington D.C.) They are summed up in Tab. 1.

Table 1 – Effects of Organisational Excellence (Adapted from GWU, 2017)

Performance Indicator	Average Annual Positive Performance Improvement (%)
Timeliness of delivery	4.7
Errors or defects	10.3
Cost of quality	9.0
Employee satisfaction	1.4
Safety and Health	1.8
Overall customer satisfaction	2.5
Customer complaints	11.6
Market share	13.7
Sales per employee	8.6
Return on assets	1.3

However, such data cannot be confirmed by similar research in Czech organisations at all. Impact of organisational excellence to overall performance was discovered by another research, conducted by a team from the University of Leicester at 120 European organisations. The European Quality Award winners were compared against organisations, where the EFQM Excellence Model was not introduced yet. Detailed results are available at (Eraclitus, 2005). According to our investigation, up to now, the broadest qualitative research focused on the real impacts of the organisational excellence was provided by Asian Productivity Organization. Strengths, as well as weaknesses, were precisely identified in five areas:

- impact of business excellence,

- design of business excellence frameworks,

- awareness of business excellence,

- application of business excellence,

- business excellence awards (see Mann (2011) for more details).

Journey to the organisational excellence can also bring some serious risks or obstacles; there is no doubt about it. P. Hoskote (2015) nicely identified 12 essential reasons for possible failing, including misunderstanding and misuse tools, no benchmarking activities, no accountability, etc.

In the course of time, various excellence models have crystallised as a fundamental and critical instrument for promoting and practical implementation of all excellence principles. Such models have already discussed and developed in more than 90 countries throughout the world. Ladzani (2016) has made some interesting comparisons of different versions of excellence models. According to our investigations, it is possible to distinguish two different groups of these models:

a) Models which are launched and presented by institutions and serves not only as guidelines but also as a set of criteria for national or international quality awards. Only three of them were selected for the next investigation:

- Deming Prize Model (JUSE, 2017),

- Malcolm Baldrige National Quality Award Model (ASQ, 2017),

- EFQM Excellence Model (EFQM, 2012).

Currently, these models are widely known and respected.

b) Models which were developed and are promoted by individuals, well-known experts. These models usually serve as a tool of organisational inspiration and support. As examples of such models can be introduced:

- Kanji's Business Excellence Structural Model (Kanji, 2015),

- 4P and 3C Model (Oakland, 2014).

We have studied and mutually compared these models. Essential features are described in Tab. 2.

Table 2 – Basic Features of Selected Excellence Models

Excellence Model	Basic Features
Deming Prize Model (JUSE, 2017)	− It represents probably the oldest model throughout the world. It has been continuously developing and using since 1951. − It accents broad application of the statistical approach to data processing. − Established criteria are a little bit unspecific. − This model is mostly applied in countries in South-East Asia.
Malcolm Baldrige National Quality Award Model	− It was created in 1987 with the strong support of the US government.

Excellence Model	Basic Features
(ASQ, 2017)	− Criteria were gradually developed for different areas (business, education, healthcare, etc.) and they are permanently refined. − This model is highly respected especially in North America, but its implementation could also be discovered in other continents.
EFQM Excellence Model (EFQM, 2012)	− The first version of this model was launched in 1991 as the European Model of TQM. − Its criteria are fully generic, and it is recognized as the most exacting excellence model at present. − All criteria are divided into two parts: enablers, as well as results. − It is widely used particularly in European countries and also serves as the fundament of many national quality awards.
Kanji's Business Excellence Structural Model (Kanji, 2015)	− Kanji has already launched the first version of his model in 1998. − The leadership role is appreciated as a key one. − It is a set of reasonably intangible recommendations. − This model is known and applied to different organisations in Europe and Asia.
4P and 3C Model (Oakland, 2014)	− Primarily, soft items of management are stressed by this model. − The leadership role is strongly oriented to the overall development of company culture. − Practical implementation of this model asks for the manager's creativity.

In practice, many discussions may be held about mutual relationship or differences between the ISO 9000 family of standards concept and organisational excellence concept. Fonseca published some findings in this area (Fonseca, 2015). Our investigation proved his findings, additionally; we can stress three crucial differences:

a) All excellence models (as instruments aimed at achieving the organisational excellence) have dynamic nature. They are upgraded and refined continuously. Unlike, especially ISO 9001 standard is looked upon rather static set of requirements – revision intervals are much longer in comparison to excellence models' development.

b) While ISO 9001 standard aims to product's quality, all excellence models face quality of an organization. Only ISO 9004 standard (mentioned above) is related with the organisational quality.

c) Most of the excellence models recognise ISO 9001 standard as one of the suitable tools, no more, no less.

Finally, we can say the excellent organisations can be distinguished through the following features:

- they highly exceed „mere average" of performance within the relevant branch of business,

- their leaders can reach organisational identity with the support of the clear vision, mission and values through,

- they understand that adding the highest stakeholders' value is their primary reason for being,

- they are strongly oriented to all stakeholders' requirements, not only external customers,

- they see that excellent results are reached as a logic effect of advanced and continuously developed management systems,

- they are distinguished through the highest level of overall company culture,

- soft items of management are usually preferred to hard methods and tools there,

- instead „ex-post" actions, a prevention principle is in place everywhere,

- systematic manner exploits all suitable approaches to organisation's learning,

- they are strongly oriented to products and processes innovations and people creativity,

- they systematically stipulate, manage and improve critical processes,

- they are aware of their role in the sustained development of the regional and national economy,

- corporate social responsibility is fundamental basis of a relationship with the community.

4   RESULTS OF EMPIRICAL FIELD RESEARCH

We performed empirical field research in Czech organisations from November 2017 till February 2018. A principal goal of this research was to investigate how the excellence models are practically perceived, used and assessed by Czech managers from the point of effects and risks.

For this purpose, we declared three primary hypotheses:

H_1:   *Excellence models are applied only seldom at Czech organisations.*

H_2:   *Time and various resources demands represent the most critical barriers to organisational excellence establishing.*

H₃: Reaching the excellence as a whole helps to organisations' performance improvement.

321 Czech organisations from various areas of business were randomly selected. Data gathering was based on a structured questionnaire which could be filled mostly by electronic aid. Additionally, interviews with some quality professionals were also held. A response rate was 19% what means that 61 organisations gave us relevant data for next processing. Tab. 3 shows the organisation's distribution from the business area point of view.

Table 3 – Organization's Distribution from the Business Area Point of View

Business area	Percentage
Automotive industry	24.72
Machinery	23.60
Healthcare	8.99
Electronic industry	5.62
Food industry	5.62
Chemical industry	4.49
Education	4.49
Metallurgy	3.37
Public service	3.37
Other	15.73

22.95% from this sample were large organisations (it means with more than 500 employees), 57.37 employed from 50 to 500 people and 19.67 of respondents were representatives from small organisations. Only 5.93% of all organisations had not established and certified quality management system minimally against relevant management systems standard (ISO 9001, IATF 16949, ISO/TS 16949, ISO 14001 or so).

There are some interesting findings:

a) Only about 16% of Czech organisations work with some excellence models. Majority of Czech organisations (about 84%) still strongly depend on some of the standards, as ISO 9001 or IATF 16949 only! On the contrary, more than 64% of Czech organisations included declared their awareness of excellence models although this awareness shallow very often.

Causes of insufficient awareness are plotted in Fig. 1. Nearly 46% of organisations look at the most important problems lack of resources and information and lack of top managers concern. Insufficient knowledge of

employees also seems to be grave reason related to insufficient awareness about excellence models.
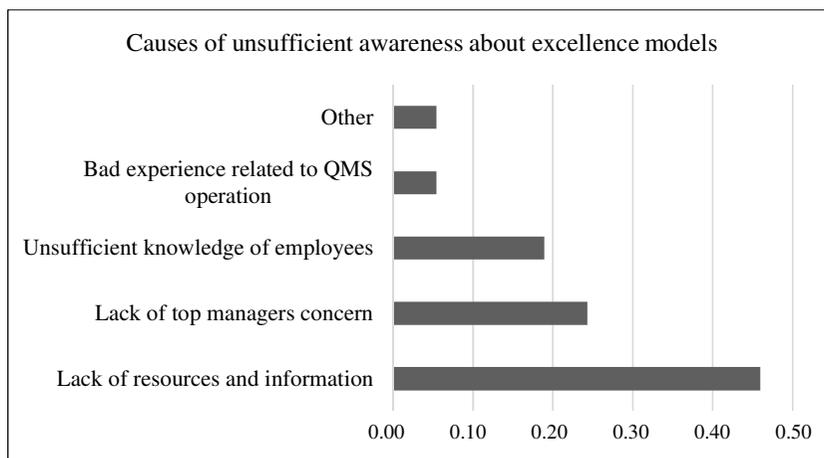
Figure 1 – The Leading Causes of Insufficient Awareness about Excellence Models in Czech Organisations (QMS – Quality Management System)

The fact that only 16% of Czech organisations work with some excellence model despite 64% of them have specific awareness about such models is an apparent discrepancy. It should be explained by the reluctance of many Czech companies to be interested in the area of the organisational excellence (briefly: none of the management standards' requirement asks for such effort!). Additionally: about 75% of organisations included in research have no intention to implement some excellence model in the future!

b) Top managers' strategic decisions need for next quality management development and overall organisation's performance increasing were the most frequent impulses for some excellence model implementation.

c) On the contrary, some severe barriers to successful implementation of excellence models were discovered through our field research (Fig. 2) for their description. The total lack of employees is an unpleasant reality in every Czech company due to rapid decreasing of unemployment level. However, a little bit surprising is a high percentage of top managers' mistrust and a declaration that advanced quality management system is not a priority for them. Such mental obstacles should be difficult to overcome!
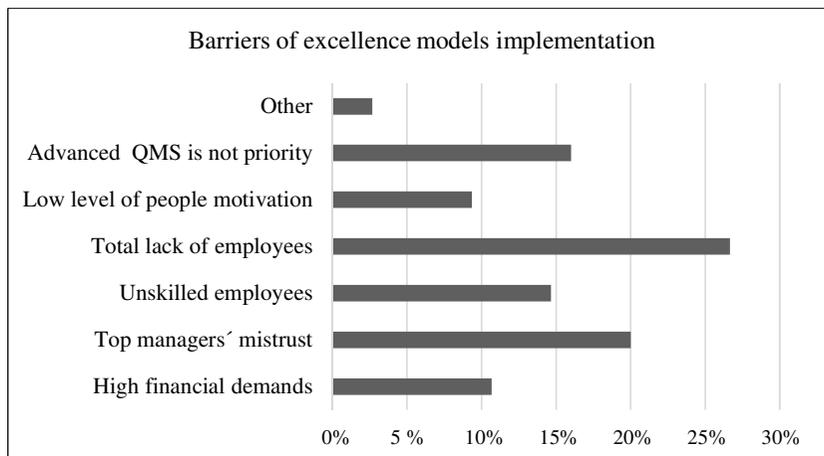
*Figure 2 – The Main Barriers to Excellence Models'
Implementation in Czech Organisations*

More than 86% of Czech organisations are a hundred per cent sure that effort in the area of the organisational excellence will bring them serious performance increasing. Fig.3 draws it.

*Figure 3 – Impact of Organisational Excellence Concept to
Performance Increases in Czech Organisations*

d) When exploring the main benefits of excellence models' implementation, Czech managers primarily stressed quality improvement of the management system. Also, some other positive effects were described. They are briefly presented in Fig. 4 and are mostly linked to the area of certain stakeholders' perception.
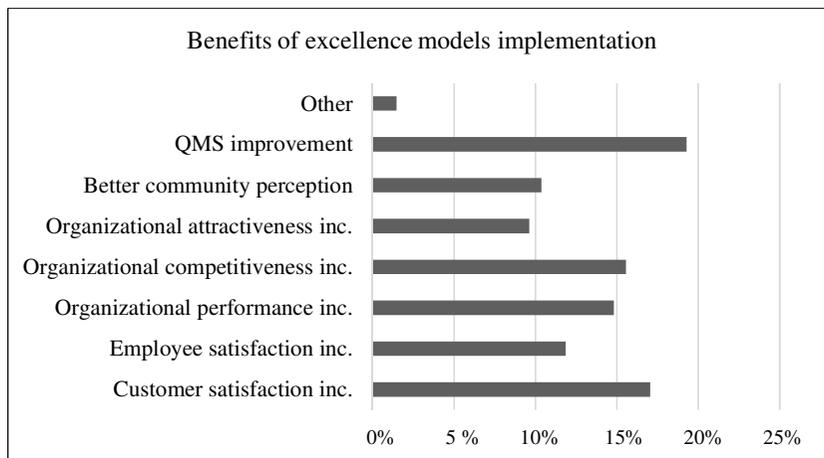
Figure 4 – Estimated Benefits of Excellence Models'
Implementation in Czech Organisations (Inc. – Increasing)

e) A final question of our research targeted to main areas of improvement. Surprisingly, only about 11.5% of Czech organisations consider profit is increasing as the most crucial area. On the other hand, overall cost reduction is preferred by nearly 19% of organisations. Moreover, about 16% of respondents declared customer perception as the most important challenge. See Figure 5 for more details. Practically, all experience throughout the world confirmed that excellence models assure such kinds of improvement from a long-term perspective. Moreover, it can be recognised as another argument for systematic establishing of excellence models at Czech organisations!

As a whole, findings from our investigations convincingly confirmed all three hypotheses! However, they also revealed that most of the Czech managers and other groups of people have entirely insufficient knowledge in the field of excellence models' development and implementation.
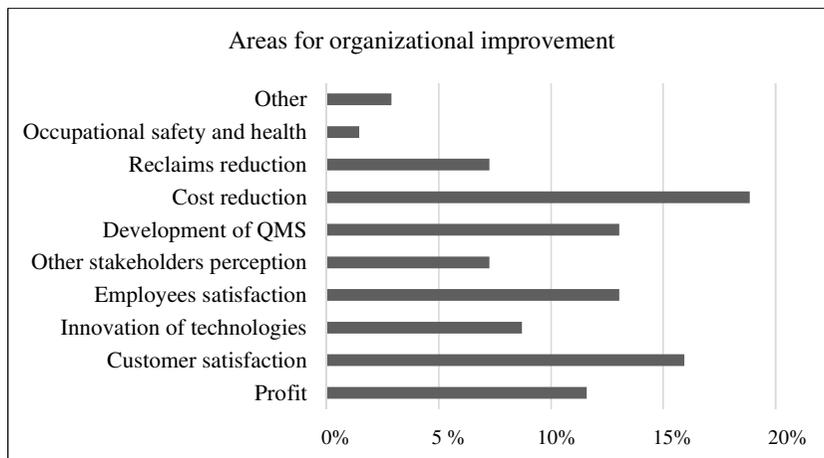
Figure 5 – The Most Important Areas for Improvement of Czech Organisations

5   EXCELLENCE FRAMEWORK

Such aspects as lack of information, insufficient knowledge, managers' mistrust, etc. are coupled with low level of people awareness in the area of the organisational excellence. Many people at Czech organisations simply do not understand the fundamentals, principles and meaning of this way to long-term success. We are sure an overcoming this obstacle through patient explanation and permanent discussion with all levels of employees is a crucial factor of more intensive work with excellence concept at Czech environment! Such communication needs an appropriate supporting tool. That is why a simple excellence framework tailored to the Czech environment and culture was designed. It is outlined by way of the scheme in Fig. 6.

A logic linkage that follows from this picture is not difficult to understand: if we want to assure the long-term success of any organisation, the best way is to adopt an organisational excellence concept. A common effect of this concept is a significant improvement of all organisations' results (financial and non-financial too). Better results are caused by the serious improvement of all stakeholders' perception, especially through external customers loyalty increasing. However, such perception changes must be considered as effects of necessary preconditions focused on permanent and agile improvement and innovations related to all aspects of advanced management systems. Management style, real value delivered to stakeholders, employees' knowledge development, individual processes capability and performance, or optimisation of material, information and natural resources consumption create the most significant aspects of improvement and innovation at present.
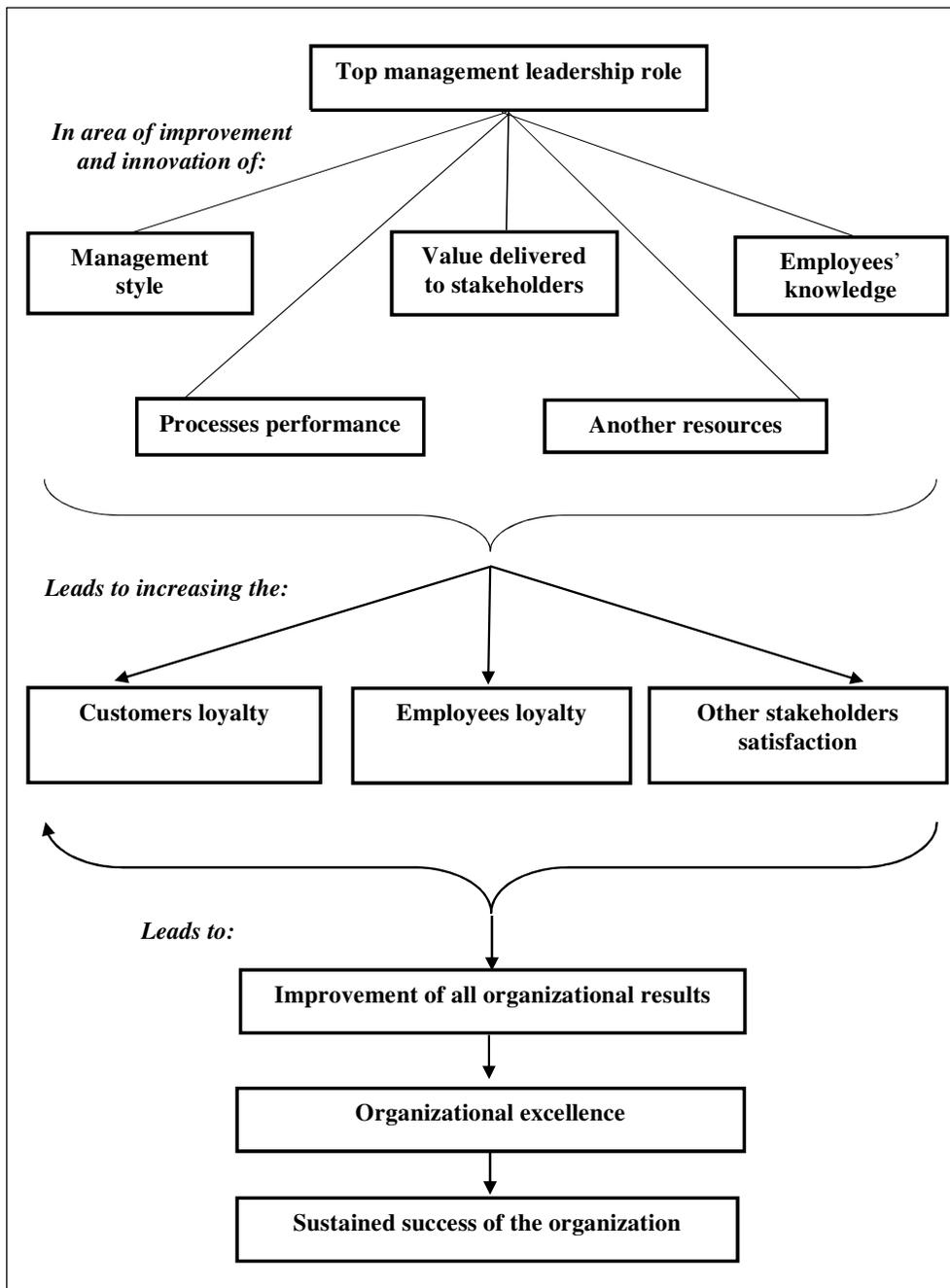
Figure 6 – Excellence Framework for Czech Organisations

Naturally, despite this scheme seems to be very simple, practical implementation can be a questionable effort. A lot of various problems and difficulties can occur. Just a quick troll through the problems linked to customer loyalty measurement at Czech companies is enough to illustrate one subjective limitation (Vykydal,

Halfarová and Nenadál, 2013). Nenadál has already analysed some additional problems of excellence models implementation (Nenadál, 2016).

6   CONCLUSIONS

Organizational Excellence provides a competitive advantage - it is what makes one organization different from all of the other organizations in certain marketplace that provide similar products or services. Continuous commitment to the organizational excellence provides the tools to aggressively enhance your product or service, which in turn will assist you in building loyal customer relationships. Our investigation occurred that most of Czech organizations (including production companies) are not aware of this reality. Therefore, some final remarks concerning possible implications are directed to very them:

a) Journey to excellence is not only "the latest fad" or short-term campaign with risky effects. Working towards excellence means essential reducing costs through individual processes performance increasing and ability to deliver excellent value for any stakeholder;

b) development of advanced quality management strongly supports this journey (Goetsch and Davis, 2015);

c) various excellence models are widely applied not only at production companies, but also at other branches of business, healthcare (Markulik and Nagyová, 2012), education institutionsor other service area (Gouthier, Giese and Bartl, 2012) or (Zgodavova and Colesca, 2007);

d) this lead to improving shareholder's returns (Bolboli and Reiche, 2013), caused by improving all key financial indicators as return to equity, assets and capital, etc. (Dahlgard and Dahlgard, 2013);

e) unfortunately, these impacts cannot be exactly confirmed in the Czech environment due to the insufficient number of organizations engaged in excellence models' implementation;

f) the most of criteria included in excellence models can be difficult to understand by organization's staff and clear, deep and permanent communication or learning seems to be the only possible way how to overcome this barrier;

g) when adopting certain excellence model, all internal and external aspects (an organization's context) and rapidly changing business environment should be under consideration. In case we ignore such changes, huge effort should fail completely;

h) lack of money is not decisive limitation for the most of Czech companies when discussing barriers of journey to the organizational excellence. On the contrary: lack of knowledge was discovered and proved as crucial weakness. Knowledge management (focused on tacit knowledge first of

all) should be considered as necessary precondition for all Czech organizations;

i) all findings presented at this article should come into support of the assumption that concept of the organizational excellence promoted by all excellence models can lead to important increasing not only quality of management but also to better quality of life!

Briefly to say: organisational excellence cannot be considered as overcomplicated matter, not even approach which is not suitable for Czech companies. It must be seen as an excellent opportunity for long-term business success! To successfully implement some excellence model, it does not matter of lack of money, not even lack of hardware. It is a matter of people engagement, education, training and motivation!

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REFERENCES

Al-Dhaafri, H., Al-Swidi, A.K. and Al-Ansi, A.A., 2016. Organizational Excellence as the Driver for Organizational Performance: A Study on Dubai Police. *International Journal of Business and Management,* [e-journal] 11(2), pp.47-52. http://dx.doi.org/10.5539/ijbm.v11n2p47.

ASQ, 2015. *What is Organizational Excellence?.* [online] Available at: <http://asq.org/learn-about-quality/organizational-excellence/> [Accessed 24 November 2017].

ASQ, 2017. *Malcolm Baldrige National Quality Award.* [online] Available at: <http://asq.org/learn-about-quality/malcolm-baldrige-award/overview/overview.html> [Accessed 5 May 2017].

Bailey, D.M., 2014. Journey to Excellence. *Quality Progress*. 2014(August), pp.42-45.

Bolboli, S.A. and Reiche, M., 2013. A model for sustainable business excellence implementation and the roadmap. *The TQM Journal,* [e-journal] 25(4), pp.331-346. https://doi.org/10.1108/17542731311314845.

Dahlgard, J.J. and Dahlgard, S., 2013. Business excellence models: limitations, reflections and further development. *Total Quality Management and Business Excellence,* [e-journal] 24(5-6), pp.519-538. https://doi.org/10.1080/14783363.2012.756745.

Duffy, G., 2016. Achieve higher levels of excellence through the capability maturity model. *Quality Progress*, June, pp.38-44.

EFQM, 2012. *EFQM Excellence Model 2013*. Brussels: EFQM Representative Office.

Eraclitus, 2005. *Organizational Excellence Strategies and Improved Financial Performance.* [pdf] Treviso: CQE University of Leicester. Available at: <www.eraclitus.net/download/3-BQF2005.pdf> [Accessed 15 June 2017].

Fonseca, L.M.C., 2015. Relationship Between ISO 9001 Certification Maturity and EFQM Business Excellence Model Results. *Quality Innovation Prosperity,* [e-journal] 19(1), pp.85-102. http://dx.doi.org/10.12776/qip.v19i1.556.

Goetsch, D. and Davis, S., 2015. *Quality Management for Organizational Excellence: Introduction to Total Quality.* Harlow: Pearson Higher Ed.

Gouthier, M., Giese, A. and Bartl, Ch., 2012. Service Excellence models: a critical discussion and comparison. *Managing Service Quality: An International Journal,* [e-journal] 22(5), pp.447-464. http://dx.doi.org/10.1108/09604521211281378.

GWU, 2017. *The Comparison of the Deming Prize and Baldrige Award.* [online] Available at: <www2.gwu.edu>. [Accessed 22 May 2017].

Hoskote, P., 2015. *Organizational Excellence framework – How to fail.* [pdf] OES. Available at: <http://organizationalexcellencespecialists.ca/wp-content/uploads/2015/10/Organizational-Excellence-Models-How-to-Fail-PH-10.06.2015.pdf> [Accessed 9 May 2018].

ICMA, 2016. *In Search of orgnizational Excellence?.* [online] Available at: <https://icma.org/articles/pm-magazine/pm-article-search-organizational-excellence?> [Accessed 23 October 2017].

ISO 9004, 2018. *Quality management – Quality of an organization – Guidance to achieve sustained success.* Geneve: ISO.

JUSE, 2017. *On revision of Deming Evaluation Criteria.* [pdf] JUSE. Available at: <https://www.juse.or.jp/upload/files/On_revision_of_Deming_Evaluation_Criteria_From_FY_2018_Second%20Announcement.pdf> [Accessed 11 April 2017].

Kanji, K.G., 2015. *Measuring Business Excellence*. New York: Routledge.

Kiitam, A. and Tammaru, T., 2012. Impact of application of excellence models on organizational performance. In: Tallinn University of Technology, *8th International DAAAM Baltic Conference, "Industrial Engineering".* Tallinn, Estonia, 19-21 April 2012. Tallinn: Tallinn University of Technology.

Ladzani, W., 2016. Benchmarking the South African Excellence Model against worldclass best practice business Excellence Models. *Environmental Economics,* [e-journal] 7(4), pp.8-19. http://dx.doi.org/ 10.21511/ee.07(4).2016.01.

Mann, R.S., 2011. *Impact of Business Excellence/Quality Awards on Enterprises.* Tokyo: Asian Productivity Oganization.

Markulik, S. and Nagyová, A., 2012. The proposal of QMS implementation in healthcare office. *Journal of US-China Medical Science,* 9(3), pp.68-71.

Musa, P., Tulay, G., 2008. Investigating the Impact of Organizational Excellence and Leadership on Achieving Business Performance: An Exploratory Study of Turkish Firms. *SAM Advanced Management Journal,* 73(1), pp. 29-45.

Nenadál, J., 2016. *Systémy management kvality. Co, proč a jak měřit?* Praha: Management Press.

Oakland, J.S., 2014. *Total Quality Management and Operational Excellence. Text with Cases.* 4th Ed. London: Routledge.

Shirvani, A. and Iranban, S., 2013. Organizational Excellence Performance and Human Force Productivity Promotion: A Case Study in South Zagros Oil and Gas Production Company, Iran. *European Online Journal of Natural and Social Sciences,* 2(3), pp.3010-3015.

Vykydal, D., Halfarová, P. and Nenadál, J., 2013. Customer Loyalty Measurement at Czech Organizations. *Quality Innovation Prosperity,* [e-journal] 17(1), pp.28-38. http://dx.doi.org/10.12776/qip.v17i1.66.

Webster, M., 2016 Organisational Excellence. *So what is organizational excellence,* [blog] 25 August. Available at: <https://realorganisationalexcellence.com/2011/08/25/so-what-is-organisational-excellence/> [Accessed 12 December 2017].

Zgodavova, K. and Colesca, S.E., 2007. Quality Management Principles – An Approach in Healthcare Institutions. *Management & Marketing,* 5(1), pp.31-38.

Zgodavova, K., Hudec, O. and Palfy, P., 2017. Culture of quality: insight into foreign organisations in Slovakia. *Total Quality Management & Business Excellence*, [e-journal] 28(9-10), pp.1054-1075. http://dx.doi.org/10.1080/14783363.2017.1309120.

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Impact of Employees' Attitudes and Leader's Role on the Innovation Management Linked to Social Responsibility

Mauricio Antonio Bedoya-Villa, Manuela Escobar-Sierra

ABSTRACT

Purpose: The innovation management linked to social responsibility is considered a strategy of organizational growth promoted by the creativity of employees framed in economic, ethical and legal issues. This study analyses socially responsible innovation management base on employee's attitudes and leader's role, from a case study of a company in the Colombian automotive sector.

Methodology/Approach: We began with the review of theories about innovation and social responsibility. Then we collected data through creative techniques, surveys to classify the leader's role, attitudes scale, participant observation and interviews. To finally analyse data with multiple linear regression and other techniques, such as decision trees.

Findings: Finally, the initial concept of socially responsible innovation and its management is complemented by five self-determined employees' attitudes, and one behavior and three perceptions of the leader.

Research Limitation/implication: The choice of the single case study as a research strategy determines the practical scope of the research as analytical. In this sense, the need to replicate the study and analyse the impact of other personal and organizational factors is highlighted.

Originality/Value of paper: It is important to summarise the value of our paper, in relation to the following aspects: the opportunity that represents for companies the correct socially responsible innovation management, the importance of the Enterprise–University integration and, finally, the relevance of hybrid models in this case, a multiple linear regression and decision trees.

Category: Case study

1   INTRODUCTION

Some authors recognize the innovation management linked to social responsibility (SR) as a strategy of organizational growth, promoted by the creativity of employees framed in economic, ethical and legal issues. In this context, and after recognizing the need to manage SR-linked innovation, in an empirical context that benefits sustainability at an organizational level (Escobar-Sierra, 2015; Escobar-Sierra and Vera-Acevedo, 2016),   arise the following question: How do the employees'attitudes and leader's role impact the innovation management linked to SR? To find the answer for this, we chose a company from the Colombian automotive sector as the research field. A series of regional, national and sectoral dynamics explain the empirical relevance of this selection. Among the aforementioned dynamics, the following are considered: (1) the high mortality rate of the companies constituted in the region, this as a consequence of the poor value creation (Cámara de comercio de Medellín para Antioquia, 2013). (2) The predominance of internal idea generation process in Colombian enterprises (DANE, 2015). (3) The lack of innovation management activities in the automotive sector, where the priority has been the enterprise itself, excluding the market (DANE, 2015). And finally (4) a marked decrease in the employment rate of the sector (Programa de Transformación Productiva, 2015).

When verifying the theoretical framework available around the research question, several studies are reviewed, to finally confirm the need to articulate the findings on employees'attitudes, leader's role, innovation and SR. Among these studies, Hashimoto and Nassif (2014) can be mentioned, who "through an empirical study" stressed that the attitude and, in general terms, the role of a leader is critical when referring to the innovation strategy. Corbett, et al. (2013) also specified the individual traits of the employees and of the managers as one of the future lines of the study on innovation and corporate entrepreneurship. Lau, et al. (2012), when analysing the behavior of managers, stress attitudes as essential for innovation. Castrogiovanni, Urbano and Loras (2011) examined which human resource management practices impact innovation, in order to highlight the importance of personal relationships and the need to analyse the impact of attitudes, decision-making and context. Finally, Urbano, Toledano and Ribeiro-Soriano (2011) analysed human resource management practices verifying the importance of establishing good relationships among employees, the creation of an adequate work environment and the importance of promoting risk attitudes and employee participation. Once the theoretical relevance of the project has been verified, the socially responsible innovation is selected as the theoretical framework of the study (Escobar-Sierra, 2015). This concept "i.e. socially

responsible innovation" is a recently conceptualized term in which innovation is linked to corporate social responsibility (CSR).

In this context, and from a quantitative approach to science, a particular case study is adopted as a research strategy (Yin, 1992). The choice of this research strategy is justified with the later study of the same author (Yin, 2002), who recognizes the importance of this type of approach in contexts such as that reviewed "where the researchers are trying to: (1) test a theory, (2) represent an extreme and unique case, (3) symbolize a typical case, (4) become a revealing case or (5) match a conditional case". On the other hand, for the analysis of the collected data, a hybrid model is proposed with statistics and data mining (multiple linear regression and decision tree). This model allows the verification of the relationship between socially responsible innovation, employees' attitudes and leader's role.

Finally, the integrity and significance of the research is verified through the checklist proposed by Creswell, et al. (2011), to finally conclude how employees' attitudes and leader's role explain the innovation management linked to SR. This finding has an analytical scope at a practical level "justified by the selected research strategy". While at the theoretical level, it complements the initial conceptualization of socially responsible innovation (SRI) (Escobar-Sierra, 2015; Escobar-Sierra and Vera-Acevedo, 2016) and its management based on five self-determined employees' attitudes, one type of behavior and three perceptions about the leader's role. The five self-determined attitudes are: (i) the importance of others' approval, (ii) the perceived success based on the objectives, (iii) the unconditional love of the family, (iv) the acceptance of criticism and (v) the impossibility of feeling equal to the others. Furthermore, the one type of behavior includes (a) agreement between a leader's values and way of acting, and the three perceptions include (I) the leader's perception in terms of completion of the beginning tasks, (II) control of emotions and (III) interest in others. To finally, alert about how the results correspond with the previous recommendations of authors such as Castrogiovanni, Urbano and Loras (2011), Corbett, et al. (2013), Hashimoto and Nassif (2014) and Lau, et al. (2012), and with gap identified by Marinova and Phillimore (2003), in the last generation of innovation.

2 LITERATURE REVIEW AND SELECTION OF THE THEORETICAL FRAMEWORK

To select the theoretical framework of the study, we take some previous theories about innovation and SR as the starting point. For the innovation case, the theoretical proposal by Marinova and Phillimore (2003) is selected as a starting

point. They "i.e Marinova and Phillimore (2003)" present the following six generations when referring to innovation:

- The first generation or model of the black box, emphasizes autonomy and independence as essential (Merton, 1973). Under this generation, innovation is related to technological change (Beristain, 2009; Jardón, 2011; Rosenberg, 2000; Schumpeter, 1983; Teece, 2002), which does not include research and development processes, situations that promoted the formulation of the next generation.

- The second generation or linear model, integrates the first two innovation models proposed by Rothwell (1992) through a sequence of activities that promoted the market adoption of different technologies (Beije, 1998; Cooper and Cooper, 2003; Feldman, 1994; Freeman, 1982; Hadjimanolis, 2003; Méndez, 2002; Rothwell and Zegveld, 1985). This generation was replaced by alternative concepts like funding for researchers.

- The third generation or interactive models, adopt the third and fourth model proposed by Rothwell (1992) and introduce innovation as an iterative circular process (Beije, 1998; Dodgson and Bessant, 1996; Kline and Rosenberg, 1986), in which multiple interactions are presented. This model is debated because it does not explain how an organization learns in the environment.

- The fourth generation or systems model, proposes an adaptation of the fifth model proposed by Rothwell (1992), in which the cooperation between firms is highlighted (Hobday, 1991; Marceau, 1992; Sako, 1992). The best-known model of this generation is the 'National Innovation System' (Dodgson, 1993; Freeman, 1991; Gann, 2003; Lundvall, 1992; Metcalfe, 1995; Nelson, 1993; 2000), which identifies gaps related to the role of government and regulations.

- The fifth generation or evolutionary model, stresses limited rationality (Dosi and Egidi, 1991) and the value of diversity (Dowrick, 1995) on the basis of the technological imperatives (Rosenberg, 1976), the avenues of innovation (Sahal, 1981), the technological trajectories (Biondi and Galli, 1992; Pavitt, Robson and Townsend, 1989), the technological (Dosi, 1982; 1988) and techno-economic paradigms (Freeman and Perez, 1988; Perez, 1983). These models have been questioned due to its predictive potential.

- The sixth generation or innovative model, defined innovation as a combination of generic knowledge and specific competencies, linked to the territorial organization (Bramanti and Ratti, 1997; Longhi and Keeble, 2000). Some of the concepts related to this generation are: innovation clusters (Porter, 1990), learning of the area (Florida, 1995; Kirat and Lung, 1999; Macleod, 1996; Simmie, 1997) and collective learning (Keeble, 2000; Lawson, 2000). The future of this model "the last one

listed by Marinova and Phillimore (2003)" may be related to innovation and environment (Honkasalo, 2000).

For SR, the starting point is the proposal of Schwartz and Carroll (2003), who recognized the link between business and society (Klonoski, 1991), and the ambiguity surrounding SR. Schwartz and Carroll (2003) decided to reinterpret the previous proposal by Carroll (1979) and suggest a new model that tries to correct the opportunity areas of the first one, proposing how discretional expectations should be considered or included within ethical or economic responsibilities. They "i.e. Schwartz and Carroll (2003)" finally proposed a model defined with three domains (ethical, economic and legal) and graphically represented through a Venn diagram.

Regarding this, and after the theoretical review, SRI i.e. "socially responsible innovation" is chosen as the theoretical framework of the study (Escobar-Sierra, 2015). This term comes as a response to the gap identified by Marinova and Phillimore (2003) in the sixth generation of innovation "when referring to the importance of taking into account the environment", and also in line with the scope of the studies carried out by Guadamillas and Donate (2008), McFadzean, O'Loughlin and Shaw (2005) and Shaw, O'Loughlin and McFadzean (2005), when highlighting the importance of linking corporate entrepreneurship with innovation and SR. This term "i.e. SRI" has been recently adopted to link innovation with social responsibility, in a first case study, this term was defined by the intrinsic motivation of the employee and the use of knowledge (Escobar-Sierra, 2015).

3   METHODOLOGY

Next, in Tab. 1, the proposed protocol for the research is presented. It details the selected role for the theory, the conceptual framework guiding the study, the research question, the chosen strategy for the fieldwork, the analysis unit to be identified, the variables to be quantified, the data to be gathered, the type of analysis to be applied, the expected results and, finally, the definition of the ethical considerations to be guaranteed (Escobar-Sierra, 2015).

Table 1 – Research Protocol (Own Elaboration)

	Quantitative Approach
Role of the theory	Deductive
Theoretical framework	Socially responsible innovation
Research problem	How the attitudes of employees and the role of a leader impact the management of innovation linked to social responsibility?
Research strategy	Particular case study
Analysis unit	Attitudes and role of a leader

	Quantitative Approach
Sample	37 employees from the automotive sector
Variables	Dependent variable (a measure of adjustment or significance) and independent variables (quality of the ideas related to the SR, attitude, classification of the type of leader).
Techniques for data collecting	− **Technique:** creative and analytical techniques (Pernelle, et al., 2014; Vieira, Alves and Duboc, 2012). − **Variables:** quality parameter for ideas (Reinig and Briggs, 2013) (Likert scale for SR criteria). − **Instrument:** a survey to determine employees' attitudes. The warpy thoughts scale (Parslow, et al., 2006) and a survey to classify the type of leader (The 360-degree emotional competence profiler (Wolmarans and Martins, 2001).
Analysis of results	− Multiple linear regression − Decision tree
Expected results	− Attitude factors and the role of significant leaders in the quality of the ideas generated.
Ethical considerations	− Agreement on the participation of ownership rights − Confidentiality agreement

This protocol was applied during the fieldwork carried out in 2016. During this period, the described instruments were applied to employees from different areas of the automotive sector company.

4   RESULTS AND ANALYSIS

The results obtained with the described protocol, as well as its interpretation, are described below. Then, the research quality criteria proposed by Creswell, et al. (2011) are verified in the selected case study, to finally conclude with the discussion of the results with other authors.

4.1   Results and Analysis of Multiple Linear Regression

To place the results of the quantitative approach, it is pertinent to define the multiple linear regression technique as an statical analysis used to establish the relationship between (1) the dependent variable (Y) "defined in this case study by the quality metric for ideas (Reinig and Briggs, 2013) (Likert scale for SR criteria)" and (2) the set of independent variables represented by ($x_1, x_2, ... x_n$), "defined in this case study by the survey to determine employees' attitudes [The warpy thoughts scale (Parslow, et al., 2006)] and the survey to classify the type of leader [The 360° emotional competence profiler (Wolmarans and Martins, 2001)]". Between the important features of the multiple linear regression analysis techniques, is its capability to fit with real situations (like those considered in this

case study). These real situations can be explained by many variables that directly or indirectly affect the situation (Rodríguez and Mora, 2001).

Once the concepts to be implemented have been specified, the applied procedure for the automated linear modeling is described. During this process, a step-forward technique is applied, to select the significant effects with an accuracy level of 83.5%. In Tab. 2, the resulting significant effects, for the employees' attitudes and the leader's role over the quality of the generated ideas, are presented.

Table 2 – Summary of Automated Linear Modelling (Own Elaboration with the SPSS® Software)

	Step									
	1	2	3	4	5	6	7	8	9	10
Information criteria	-27,421	-35,823	-40,648	-44,249	-48,838	-49,639	-52,592	-53,633	-54,591	-58,591
Approval_2_transformed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Exchange relations_criterion_38_perception		✓	✓	✓	✓	✓	✓	✓	✓	
Self-motivation_criterion_20_behavior_transformed			✓	✓	✓	✓	✓	✓	✓	✓
Need_for_success_12_transformed				✓	✓	✓	✓	✓	✓	✓
Effect love_6_transformed					✓	✓	✓	✓	✓	✓
Exchange_relations_criterion_33_perception_Transformed						✓	✓	✓	✓	✓
Approval_1_transformed							✓	✓	✓	✓
Need_for_success_11_transformed								✓	✓	✓
Emotional education criterion_6_perception									✓	✓

By analysing and interpreting the effect of employees' attitude and leader's role factors over the quality of the generated ideas, the following is highlighted: (1) the remarkable incidence of self-determined factors of employee's attitudes over the quality of the generated ideas, where five of the nine significant effects - referred to in Tab. 2 correspond to attitude issues. And (2) the prevalence of issues related to the perception of a leader's behaviors over the quality of s the generated ideas, where four of the nine significant effects for a leader's role

correspond to perceptual issues. Among the attitude factors that impact the quality of socially responsible ideas, the following are found: (i) the importance of others' approval, (ii) the perceived success based on the objectives, (iii) the unconditional love of the family, (iv) the acceptance of critics and (v) the impossibility of feeling equal to the others. On the other hand, when referring to the effects of leader's role over quality, is highlighted the effect of: (I) the concordance between the leader's values and the leader's way of act, (II) the leader's perception during the finalization of the initiated tasks, (III) leader's emotional control and (IV) leader's interest in others.

4.2   Results and Analysis of the Decision Tree

After reviewing the obtained results for the multiple linear regression through automated linear modeling, it is pertinent to define decision trees as a data mining technique developed from the ideas by Morgan and Sonquist (1963), where a non-parametric segmentation analysis is applied for exploratory purposes. Decision trees comprise an algorithm that allows the construction of contingency tables. These tables are developed from the classification of explanatory variables whose relationship with the response variable has been previously verified.

The decision trees can be applied as a prediction tool, in this case study decision trees would predict quality results for the generated ideas. To apply this data mining technique a procedure based on the CRT growth method was selected, configured with the quality dependent variable and the independent variables defined in the previous number (4.1) as significant effects of the employees' attitudes and the leader's role. Next, in Fig.1, the decision tree is presented for the significant factors that affect the quality of the ideas.
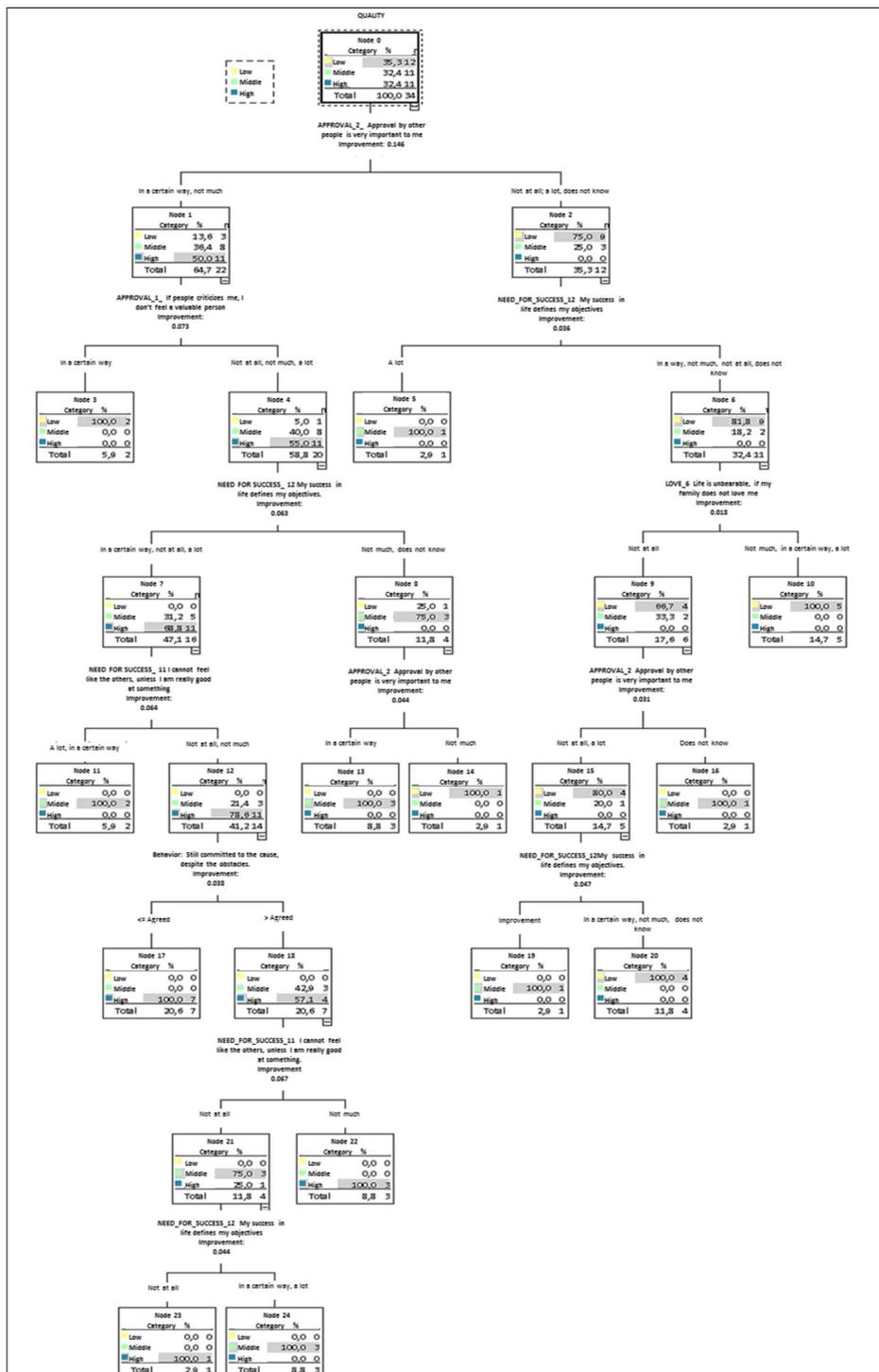
Figure 1 – Decision Tree for Significant Factors that Affect Idea Quality (Own Elaboration with the SPSS® Software)

This decision tree Fig. 1 helps to predict, with a 50% probability, the high quality of the ideas generated by employees who value others' approval in "a certain way or not so much". When considering the acceptance of critics, the high quality of the ideas can be predicted with a 55% probability, when the employee is indifferent to critics. With a 68.8% probability, high quality for ideas generated can be predicted in employees with extreme positions about the fulfillment of the objectives. In this context, quality ideas stand out, with a probability of 78.6%, among employees who feel like others. Meanwhile, high quality for the ideas generated by employees that identify commitment in the behavior of their leader is predicted with a 100% probability.

4.3   Verification of Quality Criteria

After evaluating the significance criteria "e.g. researchers, innovation, approach and the environment" proposed by Creswell, et al. (2011) in his checklist, an average score of 6.7 out of 10 possible points was obtained for the case study. This verification confirms the empirical as well as theoretical validity of the findings discussed below.

4.4   Discussion of the Results Obtained

This research project is based on the previously obtained results in a company from the Colombian graphics sector, where the impact of motivation and knowledge on innovation linked to CSR was evaluated (Escobar-Sierra, 2015; Escobar-Sierra and Vera-Acevedo, 2016). During this research, the SRI was conceptualized and in the future directions, issues like the inclusion of personality traits as well as the employees' attitudes and the leader's role on SRI has been mentioned.

In addition, and attending to the identified gap (Escobar-Sierra, 2015; Escobar-Sierra and Vera-Acevedo, 2016), the results confirm the suspicions of other authors such as (1) Bedoya, Toro and Arango (2017), Corbett, et al. (2013) and Hashimoto and Nassif (2014) when confirm the incidence of a leader's attitudes on the innovation strategy, in this case on the SRI. (2) Castrogiovanni, Urbano and Loras (2011) and Urbano, Toledano and Ribeiro-Soriano (2011) when relating the employees' attitudes with strategic organizational matters such as innovation. And finally, (3) Lau, et al. (2012) when underlining the importance of considering both "i.e. employees' attitudes and the leader's role" with innovation-related matters.

In this sense, the results have managerial implications because they corroborate how important it is to incorporate the role of a transformational leader and its influence on the employees' intellectual stimulation into management practices.

5   CONCLUSIONS AND RECOMMENDATIONS

The obtained results from the quantitative approach of science serve to complement the preliminary conceptualization on SRI and its management. With this case, the SRI management is enriched with five of the self-determined employees'attitudes, one type of behavior and three perceptions about the leader's role. However, it is important to keep in mind that the choice of the single case study as a research strategy determines the practical scope of the research as analytical.

In this context, it is pertinent to summarise other findings related to (a) the lack of consensus and poor structuring around the SR policies, (b) the priority of the internal sources of ideation in the researched context, (c) the opportunity that represent the correct management of SRI as a strategic tool, (d) the importance of the Enterprise–University integration and, finally, (e) the relevance of hybrid models -multiple linear regression and decision trees-.

This research contains some limitations. The first one, related with the ideation process framed in economic, ethical and legal issues, because many times it is difficult for employees to generate innovative ideas that benefit the stakeholders and also respect the economic, ethical and legal issues. Second, CSR practices are discretional, a situation that does not provide sufficient evidence for judgment, because each company decides how to interpret and define its CSR practices. These situations make difficult to establish a pattern to measure organizational performance.

Finally, for future studies about SRI management, it would be important to consider (1) the participation of other stakeholders, (2) the analysis of other competencies and (3) the analysis of other dimensions of human beings such as cognitive style, cultural influences, abilities and emotions control. This in order to encourage the initial SRI management approach.

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REFERENCES

Bedoya, M., Toro, I. and Arango, B. 2017. Emprendimiento Corporativo e Innovación: Una Revisión y Futuras Líneas de Investigación. *Espacios*, 38(17), pp.20-38.

Beije, P., 1998. *Technological change in the modern economy: basic topics and new developments*. Cheltenham: Edward Elgar Publishing.

Beristain, L.M., 2009. Una revisión de la interpretación económica sobre la innovación. *Journal of technology management & innovation*, [e-journal] 4(4), pp.139-149. http://dx.doi.org/10.4067/S0718-27242009000400012.

Biondi, L. and Galli, R., 1992. Technological trajectories. *Futures*, [e-journal] 24(6), pp.580-592. http://dx.doi.org/10.1016/0016-3287(92)90118-Y.

Bramanti, A. and Ratti, R., 1997. The multi-faced dimensions of local development. In: R. Ratti, A. Bramanti and R. Gordon, eds. 1997. *The Dynamics of Innovative Regions: The GREMI Approach*. Aldershot, Brookfield: Ashgate. pp.3-44.

Carroll, A.B., 1979. A Three-Dimensional Conceptual Model of Corporate Performance. *Academy of Management Review*, 4(4), pp.497-505.

Castrogiovanni, G.J., Urbano, D. and Loras, J., 2011. Linking corporate entrepreneurship and human resource management in SMEs. *International Journal Of Manpower*, [e-journal] 32(1), pp.34-47. http://dx.doi.org/10.1108/01437721111121215.

Cámara de comercio de Medellín para Antioquia, 2013. *Revista Antioqueña de Economía y Desarrollo*. [pdf] Medellín: Cámara de comercio de Medellín para Antioquia. Available at: <http://www.camaramedellin.com.co/site/Biblioteca-virtual/Estudios-economicos/Revista-Antioquena-de-Economia-y-Desarrollo-RAED/Revista-Antioquena-de-Economia-y-Desarrollo-6.aspx> [Accessed 18 February 2016].

Cooper, R.G. and Cooper, R.G., 2003. Profitable Product Innovation: The Critical Success Factors. In: L.V. Shavinina, ed. 2003. *The International Handbook on Innovation*. Oxford: Elsevier. pp.139-157. http://dx.doi.org/10.1016/b978-008044198-6/50010-3.

Corbett, A., Covin, J.G., O'Connor, G.C. and Tucci, CH.L., 2013. Corporate Entrepreneurship: state-of-the-art research and a future research agenda. *Journal of Product Innovation Management*, [e-journal] 30(5), pp.812-820. http://dx.doi.org/10.1111/jpim.12031.

Creswell, J.W., Klassen, A.C., Clack, V.L.P. and Smith, K.C., 2011. *Best practices for mixed methods research in the health sciences, Office of behavioral and social sciences research national institutes of health*. Washington, DC: NIH Office of Behavioral and Social Sciences Research.

DANE, 2015. *Encuesta de desarrollo e innovación tecnológica - EDIT (industria manufacturera 2013 – 2014)*. [pdf] Available at: <http://www.dane.gov.co/files/investigaciones/boletines/edit/presentacion_EDIT _manufacturera_2013_2014.pdf> [Accessed 22 February 2016].

Dodgson, M., 1993. *Technological collaboration in industry: Strategy, policy and internationalisation in innovation*. London: Routledge.

Dodgson, M. and Bessant, J.R., 1996. *Effective innovation policy: A new approach*. London: International Thomson Business Press.

Dosi, G., 1982. Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change. *Research Policy*, [e-journal] 11(3), pp.147-162. http://dx.doi.org/10.1016/0048-7333(82)90016-6.

Dosi, G., 1988. Sources, Procedures , and Microeconomic Effects of Innovation. *Journal of economic literature*, 26(3), pp.1120-1171.

Dosi, G. and Egidi, M., 1991. Substantive and procedural uncertainty, An exploration of economic behaviours in changing environments. *Journal of Evolutionary Economics*, [e-journal] 1(2), pp. 145-168. http://dx.doi.org/10.1007/BF01224917.

Dowrick, S., 1995. *Economic approaches to innovation*. Aldershot: Edward Elgar Publishing.

Escobar-Sierra, M., 2015. *Análisis de la gestión de la innovación vinculada con la responsabilidad social desde las dimensiones motivación y conocimiento: un estudio de caso*. Ph. D. Universidad Nacional de Colombia. Available at: <http://www.bdigital.unal.edu.co/51034/1/1128270682.2015.pdf> [Accessed 22 February 2016].

Escobar-Sierra, M. and Vera-Acevedo, L.D., 2016. "Inn-Cumbe": un modelo para la gestión de la innovación socialmente responsable, propuesto a partir de un estudio de caso a nivel organizacional. *Espacios*, 37(17) [online] Available at: <http://www.revistaespacios.com/a16v37n17/in163717.html> [Accessed 22 February 2016].

Feldman, M.P., 1994. *The Geography of Innovation*. Dordrecht: Springer.

Florida, R., 1995.Toward the learning region. *Futures*, [e-journal] 27(5), pp.527-536. http://dx.doi.org/10.1016/0016-3287(95)00021-N.

Freeman, C., 1982. *The Economics of Industrial Innovation*. 2nd Ed. London: Printer.

Freeman, C., 1991. Networks of innovators: a synthesis of research issues. *Research Policy*, [e-journal] 20(5), pp.499-514. https://doi.org/10.1016/0048-7333(91)90072-X.

Freeman, C. and Perez, C., 1988. Structural crises of adjustment, business cycles and investment behaviour. In: D. Preece, I. McLoughlin and P. Dawson, eds. *Technology, Organizations and Innovation: Theories, concepts and paradigms*. London: Pinter. pp.38-66.

Gann, D.M., 2003. *Building innovation: Complex constructs in a changing world*. London: Thomas Telford Publishing.

Guadamillas, F. and Donate, M.J., 2008. Responsabilidad social corporativa, conocimiento e innovación: hacia un nuevo modelo de dirección de empresas. *Revista europea de dirección y economía de la empresa*, 17(3), pp.11-26.

Hadjimanolis, A., 2003. The barriers approach to innovation. In: L.V. Shavinina, ed. 2003. *The international handbook on innovation*. Oxford: Elsevier. pp.559-573.

Hashimoto, M. and Nassif, V.M.J., 2014. Inhibition and encouragement of entrepreneurial behavior: antecedents analysis from managers' perspectives. *BAR - Brazilian Administration Review*, [e-journal] 11(4), pp.385-406. http://dx.doi.org/10.1590/1807-7692bar2014130008.

Hobday, M., 1991. *Dynamic networks, technology diffusion and complementary assets: Explaining U.S. decline in semiconductors*. Falmer: Science Policy Research Unit, University of Sussex.

Honkasalo, A., 2000. Eco-efficiency, Entrepreneurship and co-operation: the finnish environmental cluster research programme. In: OECD, ed. 2000. *Innovation and the Environment*. Paris: OECD. pp.137-142.

Jardón, C.M., 2011. Innovación empresarial y territorio: una aplicación a Vigo y su área de influencia. *Eure (Santiago)*, [e-journal] 37(112), pp.115-139. http://dx.doi.org/10.4067/S0250-71612011000300006.

Keeble, D., 2000. Collective Learning Processes in European High-Technology Milieux. In: D. Keeble and F. Wilkinson, eds. 2000. *High-technology Clusters, Networking and Collective Learning in Europe*. Aldershot: Ashgate. pp.199-229.

Kirat, T. and Lung, Y., 1999. Innovation and proximity. Territories as loci of collective learning processes. *European Urban and Regional Studies*, [e-journal] 6(1), pp.27-38. http://dx.doi.org/10.1177/096977649900600103.

Kline, S.J. and Rosenberg, N., 1986. An overview of innovation. In: R. Landau and N. Rosenberg, eds. 1986. *The Positive Sum Strategy: Harnessing Technology for Economic Growth*. Washington: National Academy Press. pp.275-305.

Klonoski, R.J., 1991. Foundational considerations in the corporate social responsibility debate. *Business Horizons*, 34(4), pp.9-19.

Lau, T., Shaffer, M., Chan, K.F. and Man, T.W.Y, 2012. The entrepreneurial behaviour inventory: A simulated incident method to assess corporate entrepreneurship. *International Journal of Entrepreneurial Behavior & Research*, [e-journal] 18(6), pp.673-696. http://dx.doi.org/10.1108/13552551211268120.

Lawson, C., 2000. Collective learning, system competences and epistemically significant moments. In: D. Keeble and F. Wilkinson, eds. 2000. *High-technology Clusters, Networking and Collective Learning in Europe*. Aldershot: Ashgate. pp.182-198.

Longhi, C. and Keeble, D., 2000. High-tech clusters and collective learning in Europe: regional evolutionary trends in the 1990s. In: D. Keeble and F. Wilkinson, eds. 2000. *High-technology Clusters, Networking and Collective Learning in Europe*. Aldershot: Ashgate. pp.21-56.

Lundvall, B.-Å., 1992. *National systems of innovation: Towards a theory of innovation and interactive learning*. London: Pinter.

Macleod, G., 1996. The cult of enterprise in a networked, learning region? Governing business and skills in lowland Scotland. *Regional Studies*, [e-journal] 30(8), pp.749-755. http://dx.doi.org/10.1080/00343409612331350038.

Marceau, J., 1992. *Reworking the World: Organisations, Technologies, and Cultures in Comparative Perspective*. Berlin: De Gruyter studies in organization.

Marinova, D. and Phillimore, J., 2003. Models of innovation. In: L.V. Shavinina, ed. 2003. *The international handbook on innovation*. Oxford: Elsevier. pp.44-53.

McFadzean, E., O'Loughlin, A. and Shaw, E., 2005. Corporate entrepreneurship and innovation part 1: the missing link. *European Journal of Innovation Management*, [e-journal] 8(3), pp.350-372. http://dx.doi.org/10.1108/14601060510610207.

Méndez, R., 2002. Innovación y desarrollo territorial: algunos debates. *Revista EURE*, [e-journal] 28(84), pp.63-83. http://dx.doi.org/10.4067/S0250-71612002008400004.

Merton, R.K., 1973. *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago: University of Chicago Press.

Metcalfe, J.S., 1995. Technology systems and technology policy in an evolutionary framework. *Cambridge Journal of Economics*, [e-journal] 19(1), pp.25-46. https://doi.org/10.1093/oxfordjournals.cje.a035307.

Morgan, J.N. and Sonquist, J.A., 1963. Problems in the analysis of survey data and a proposal. *Journal of the American Statistical Association*, 58(302), pp.415-434.

Nelson, R.R. ed., 1993. *National innovation systems: a comparative analysis*. New York: Oxford University Press, USA.

Nelson, R.R., 2000. National innovation systems. In: Z.J. Ács, ed. 2000. *Regional Innovation, Knowledge and Global Change*. London: Pinter. pp.11-26.

Parslow, R.A., Christensen, H., Griffiths, K.M. and Groves, CH. 2006. The warpy thoughts scale: a new 20-item instrument to measure dysfunctional attitudes. *Cognitive behaviour therapy*, [e-journal] 35(2), pp.106-16. https://doi.org/10.1080/16506070500372279.

Pavitt, K., Robson, M. and Townsend, J., 1989. Technological Accumulation, Diversification and Organisation in UK Companies, 1945-1983. *Management Science*, 35(1), pp.81-99.

Perez, C., 1983. Structural Change and Assimilation of New Technologies in the Economic and Social Systems. *Futures*, [e-journal] 15(5), pp.357-375. https://doi.org/10.1016/0016-3287(83)90050-2.

Pernelle, P., Carron, T., Elkadiri, S., Bissay, A. and Marty, J.-C., 2014. PLM serious game approach available both for change management and knowledge assessment. In: S. Fukuda, A. Bernard, B. Gurumoorthy and A. Bouras, eds. 2014. *Product Lifecycle Management for a Global Market. PLM 2014*. IFIP Advances in Information and Communication Technology. Berlin, Heidelberg: Springer. pp.323-332. https://doi.org/10.1007/978-3-662-45937-9_32.

Porter, M.E., 1990. *The Competitive Advantage of Nations*. New York: The Free Press.

Programa de Transformación Productiva, 2015. *Sector industrial autopartes y vehiculos*. [online] Available at: <http://ptp.amagi4all.com/informacion-estadistica/industria-autopartes/autopartes-produccion> [Accessed 22 February 2016].

Reinig, B.A. and Briggs, R.O., 2013. Putting quality first in ideation research. *Group decision and negotiation*, [e-journal] 22(5), pp.943-973. https://doi.org/10.1007/s10726-012-9338-y.

Rodríguez, M.J. and Mora, R.C. eds., 2001. *Estadística informática: casos y ejemplos con el SPSS*. Alicante: Universidad de Alicante.

Rosenberg, N., 1976. *Perspectives on Technology*. New York: Cambridge University Press.

Rosenberg, N., 2000. *Schumpeter and the Endogeneity of Technology: Some American Perspectives*. London: Routledge.

Rothwell, R., 1992. Successful industrial innovation: critical factors for the 1990s. *R&D Management*, 22(3), pp.221-239.

Rothwell, R. and Zegveld, W., 1985. *Reindustrialization and Technology*. New York: M.E. Sharpe.

Sahal, D., 1981. *Patterns of technological innovation*. New York: Addison-Wesley Publishing Company.

Sako, M., 1992. *Prices, Quality and Trust: Inter-firm Relations in Britain and Japan*. Cambridge: Cambridge University Press.

Schumpeter, J.A., 1983. *The theory of economic development*. New Jersey: Transaction Publishers.

Schwartz, M.S. and Carroll, A.B., 2003. Corporate social responsibility: a three-domain approach. *Business ethics quarterly*, [e-journal] 13(4), pp.503-530. https://doi.org/10.2307/3857969.

Shaw, E., O'Loughlin, A. and McFadzean, E., 2005. Corporate entrepreneurship and innovation part 2: a role   and process based approach. *European Journal of Innovation Management*, [e-journal] 8(4), pp.393-408. https://doi.org/10.1108/14601060510627786.

Simmie, J. ed., 1997. *Innovation Networks and Learning Regions?*. London: Jessica Kingsley Publishers.

Teece, D.J., 2002. *Managing intellectual capital: organizational, strategic, and policy dimensions*. New York: Oxford University Press.

Urbano, D., Toledano, N. and Ribeiro-Soriano, D., 2011. Prácticas de gestión de recursos humanos y desarrollo de nuevos proyectos innovadores: Un estudio de casos en las PYMEs. *Universia Business Review*, 29, pp.116-130.

Vieira, E.R., Alves, C. and Duboc, L., 2012. Creativity patterns guide: support for the application of creativity techniques in requirements engineering. In: M. Winckler, P. Forbrig, and R. Bernhaupt, eds. 2012. *Human-centered software engineering*. Berlin: Springer. pp.283-290.

Wolmarans, S. and Martins, N., 2001. *The 360 degree emotional competency profiler*. Johannesburg: Organisational Diagnostics and Learning Link International.

Yin, R.K., 1992. The case study method as a tool for doing evaluation. *Current Sociology*, [e-journal] 40(10), pp.121-137. https://doi.org/10.1177/001139292040001009.

Yin, R.K., 2002. *Case study research: design and methods. Applied Social Research Methods Series, Vol 5*. 3rd Ed. Thousand Oaks, CA, US: Sage publications.

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Analysis of Data on Staff Turnover Using Association Rules and Predictive Techniques

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ABSTRACT

Purpose: The purpose of this paper is to present the results of an analysis and evaluation of data on employee turnover based on deep data mining using association rules and decision trees in a specific organisation.

Methodology/Approach: For the analysis, we chose deep data mining methods, primarily a search for association rules using the Apriori algorithm in the R programming language. For the sake of supplementation and comparison of results, data were also analysed using the predictive decision trees method, applying the C5.0, rpart and ctree algorithms in the R program.

Findings: The results of the analyses showed that observing the basic principles of correct communication from the beginning of an employment relationship, or during hiring, is justified. Communication and regular conversations between a superior and employees can help identify problems earlier, address them and reduce the number of people leaving the company. The results of the analysis helped the organisation to set measures to reduce the number of an employee leaving.

Research Limitation/implication: A limiting factor in performing such analyses is the availability of quality data in the required quantity. Our most significant advantage when performing our analysis was that quality data were available. To create the final structure of the required data set, we used data from the organisation's internal information systems.

Originality/Value of paper: This contribution offers a new approach to analysing data on employee turnover, whose essence is that we need to find the most interesting and frequent correlations in a significant amount of data.

Category: Case study

1   INTRODUCTION

Organizations nowadays try to ensure the loyalty of their workforce in various ways. However, instead of investing in precise research to understand employees' motivation to leave, or their motivation to stay, most companies invest in additional benefits or measures to search for talent (Zulla Consulting & Partners, 2017).

Employee turnover, or staff turnover, is a measurement of how many employees leave a company (Wilkonson, 2014).

According to Ongori (2007), the essential characteristic of the concept of staff turnover is a situation where an organisation faces the fact that many employees leave because of dissatisfaction, new opportunities on the market, retirement or for other reasons. It is important to distinguish whether employees leave because they are forced to do so or whether they leave voluntarily and to avoid seeing this as an exclusively negative phenomenon. Staff turnover may also have positive aspects. It is mainly in the IT industry that staff turnover is highly beneficial. On the one hand, companies lose their employees, but on the other hand, staff turnover opens the door to other employees, who can bring in new ideas and new ways of thinking (Janice, 2014).

Staff turnover is generally very high when there is an urgent need to hire people in a particular sector or when a large number of people retire. In normal circumstances, employees are likely to leave a company when there are enough opportunities to find jobs elsewhere. The IT industry also struggles with staff turnover due to globalisation, open borders and a high demand for these services and products (Methot, et al., 2017).

Staff turnover as a way of reducing employee numbers is suitable especially in situations where a company needs to reduce costs. According to the expert and speaker John Sullivan (2017), it is true of the vast majority of cases that costs of retaining an employee who is an average performer are lower than costs associated with having the position temporarily unfilled and with replacing him. The most common numerical indicator of staff turnover is the level of staff turnover. This indicator is commonly used in practice even though it is not a very suitable measure, as it does not tell us whether the figure is good or not. As a reference, a healthy level of staff turnover is considered to be 10% (Smith and Rutigliano, 2002). It is not the exact figure that is important, but rather who leaves. Staff turnover is critical for organisations when it involves vital employees and talent. Organizations should, therefore, focus on the level of staff turnover among key employees and those who are top performers. Studies have shown that top performers contribute to the operation of the company ten times more than average performers (Bardessono, 2016). Top companies such as

Microsoft try to maintain their level of employee turnover among top performers, who make up 25% of the total workforce, at 5%, and the average time employees remain at the company is 1.81 years (Peterson, 2017). The level of staff turnover among employees who are the weakest performers should be at least 10% because these employees increase the company's costs.

Every company should specify its level of staff turnover that should be based on strategic planning of the flow of crucial employees throughout the company. It is also necessary to manage the timing of critical employees' leaving. The exact time an employee leaves his team or company helps to understand how significant his leaving is. For example, if an employee who is working on a project decides to leave at the start of the project, this has a lesser impact than a decision to leave the company just before implementing an important part of a project he has been working on (Janice, 2014). The timing of key employees' leaving is an important problem regarding staff turnover even though there are very little literature and very few studies that are dedicated to it. Further research should, therefore, focus on more specific questions such as how to deal with or even how to predict the leaving of key employees' and talent (Janice, 2014). Communication with employees plays an important role here. Even before an employee decides to leave, it is necessary to find out the real reasons for his leaving, which can help prevent key employees' leaving in the future (Sullivan, 2017).

2   METHODOLOGY

Inducing Data Driven culture into an organisation is the key to making fact-based decisions (Mueller, 2017; Zgodavova, Hudec and Palfy, 2017). Markulik, et al. (2018) state that the process has inputs divided into several categories, the most commonly used in practice: people, machines, method, measurement, material, money, market, environment, information, and data collection and archiving are a crucial source of generating information for future decision-making.

For the analysis, we chose deep data mining methods, i.e. the search for association rules and the predictive decision trees method.

The data for analysis come from the company's internal human resources (HR) systems. The company's HR department uses two central information systems. These applications offer a wide range of options to download lists and overviews, which we used to create the final structure of our dataset.

Tab. 1 lists the items used to display the essential statistical indicators and to search for association rules. Information about employees' reasons for leaving is obtained directly from employees using the so-called exit interview.

Table 1 – List of Attributes Used to Analyse Association Rules

Item	Description
Team	the team, the employee, is leaving
Month of Leaving	the month of leaving the company
Duration of service	the number of years at the company
Type of leaving	type of leaving – forced or unforced
Reason for leaving	reason for leaving
Position	employee's position
PPR results	performance and potential review result for the past year
Gender	gender
Age	employee age
Marital status	marital status
Training in the last year	training in the last year – yes or no
Overtime [hours] per month	overtime hours (average hours per month)
On calls [hours] per month	on-call duties (average hours per month)
Home office days per month	home office (average days per month)

Using a different database for the decision trees method was necessary. The list of items is shown in Tab. 2.

Table 2 – List of Attributes Used to Analyse Decision Trees

Item	Description
On-calls [hours] per month	on-call duties (average hours per month)
Home office days per month	home office (average days per month)
Overtime [hours] per month	overtime hours (average hours per month)
Duration of service	the number of years at the company
Age	employee age
Position	employee's position
Exit	employee's exit from the company
Gender	gender
Training in the last year	training in the last year – yes or no
PPR results	the result of performance and potential evaluation for the past year
Change of position last year	change of position last year
Change of CoCe last year	change of location last year
Marital status	marital status

Before we could go ahead with the analysis, we needed to prepare the data thoroughly and clear them of duplicate records. As we worked with two tools, we also created two separate databases containing the data mentioned above. The analysis used data from the past two years, so we needed to unify the values of specific attributes such as the performance and potential review results (PPR) from two different years, where the value was the same, but it was recorded under different symbols. The algorithm would treat it as different values, which would lead to different results and associations in particular. Then we needed to set the right type of individual attributes. In the case of numerical values, we needed to set the type "number" in a ".csv" file, and in the case of a categorical variable, we needed to set the data type "text" for these cells. The data type is significant for the technique of decision trees and association rules.

If a wrong data type was set in the individual analyses, this could show in the results, which would not be correct. Therefore, in the analysis of association rules, it was necessary to change all attributes to the "categorical" data type. The change of data type was performed after entering a command in the R Studio program.

However, when preparing data for analysis through decision trees, numerical values needed to stay numerical and symbolic (text) attributes needed to be changed to categorical.

2.1   Association Rules Mining

According to numerous experts, association rules are seen as one of the most popular methods of data mining. The basic idea is to find the most exciting and most frequent correlations, called associations, in a significant amount of data (Paralič, 2003).

Association rules involve three parameters that need to be explained. These parameters are support, reliability and so-called lift (Agrawal, Imielinski and Swami, 1993).

The result of the algorithm is an association rule, such as one with this form: Training last year = no => Reason for leaving = Career development prospects [0.2, 0.7]. An illustrative example is included in (Tab. 3). Each line represents one transaction and columns represent items.

Table 3 – Illustrative Table for an Association Rule

Duration of service	Type of leaving	PPR results	Training in the last year	Overtime [hours] per month	On-calls [hours] per month	Home office days per month
Four years	Unforced	FIT	Yes	none	none	less than one
Four years	Unforced	FIT	Yes	from 0 to 10	none	less than one

Duration of service	Type of leaving	PPR results	Training in the last year	Overtime [hours] per month	On-calls [hours] per month	Home office days per month
One year	Unforced	IMPROVE	Yes	none	none	less than one
Three years	Unforced	FIT	Yes	from 0 to 10	from 31 to 70	three
Three years	Unforced	FIT	No	none	none	less than one

Support refers to the probability of two items occurring in the same record. The concept of reliability reflects the conditional probability of a transaction containing all items from set Y and at the same time all items from set X. A measure of quality or so-called lift is also used in the case of association rules. If the lift is higher than one, the rule is reliable and of high quality.

The most commonly used and best-known algorithm whose task is to search for association rules from a given set is the Apriori algorithm. This algorithm was also used in our analysis of association rules through the rules package in the R programming language. Apriori searches for association rules in two phases: generation of standard sets of items and generation of the association rules themselves.

Fig. 1 shows a specific association rule from an illustrative set of data that can be interpreted as follows: Employees whose PPR result were Fit and those who had completed training in the previous year and had had no on-calls in a month were all employees who had been at the company for four years. In 40% of the cases, these items appeared together in one record. Lift is 2.5, which indicates a quality rule.

```
      lhs                              rhs                        support confidence lift
[1]  {PPR results=FIT,
      Trainings during last year=yes,
      oncalls [hours] per month=none}  => {Lenght in service=4 years}   0.4      1 2.50
```

Figure 1 – Illustrative Association Rule

2.2 Predictive Analysis of Decision Trees

Our analysis also focused on a different type of data mining, i.e. predictive methods. This type was chosen to supplement the first analysis through association rules, primarily for the sake of comparing results.

The main reason why this data mining technique is useful is its clarity and easy interpretation (Berikov, Litvinenko and Lbov, 2008). The primary aim of this tool is to identify objects represented by the columns in the table regarding classes.

A decision tree is mostly a classifier with a tree structure (Berson, Smith and Thearling, 1995). To create a decision tree, we need to divide the data set into a

testing set and a training set. A testing set specifies a test performed over an instance attribute, where a single branch represents every possible test result. A leaf represents the value of a target property. A decision tree leads from the tree root through individual nodes to the leaf.

Algorithms used to generate decision trees apply the top-down principle. For this analysis, we used algorithms in the R program through the rpart, C5.0 and ctree packages.

2.3   Tool Selection

The R programming language was used for data mining. The environment of this language, the RStudio, met the criteria of availability on the market free of charge and simplicity of user interface. One of the most significant advantages of this language is its rich graphic displaying of results, e.g. box, column, 3D graphs or even more complex interactive graphs. The second significant advantage is the wide range of fields in which it is possible to use the language. Numerous packages have been designed, which are dedicated to topics such as data mining, econometrics or creation of web applications (Berson, Smith and Thearling, 1995).

Creating a code and a procedure for the applied methods of deep data mining was the most critical and challenging part. In the case of procedures, we used knowledge gained from specialist literature and specialist video tutorials freely available on the internet. In the beginning, we needed to load the data into the right format and then process the data to analyse them. Any subsequent procedure is different depending on the type of analysis. Both analyses required the selection of the right R program packages, which allow performing the individual functions, such as the party, party kit, rpart, MASS and c50 packages, etc.

3   RESULTS AND DISCUSSION

It followed from the simple descriptive statistic that the most frequent reasons for leaving were career growth opportunities, dissatisfaction with job description and dissatisfaction with the employee's performance.

	lhs	rhs	support	confidence	lift
[1]	{PPR results=NO PPR, Trainings during last year=no}	=> {Lenght in service=1 year}	0.1488251	0.9268293	3.241786
[2]	{PPR results=NO PPR, Status=single}	=> {Lenght in service=1 year}	0.1618799	0.9253731	3.236693
[3]	{PPR results=NO PPR, Gender=male}	=> {Lenght in service=1 year}	0.1409922	0.9152542	3.201300
[4]	{PPR results=NO PPR, Trainings during last year=no}	=> {Overtimes [hours] per month=none}	0.1449086	0.9024390	1.719573
[5]	{PPR results=NO PPR}	=> {oncalls [hours] per month=none}	0.2140992	0.9590643	1.490149
[6]	{PPR results=NO PPR}	=> {Home office days per month=less than 1}	0.2114883	0.9473684	1.460129
[7]	{Overtimes [hours] per month=none}	=> {oncalls [hours] per month=none}	0.4895561	0.9328358	1.449396
[8]	{Trainings during last year=no, oncalls [hours] per month=none}	=> {Home office days per month=less than 1}	0.1788512	0.9319728	1.436401
[9]	{Lenght in service=1 year}	-> {oncalls [hours] per month=none}	0.2637076	0.9223744	1.433142
[10]	{Gender=female, Home office days per month=less than 1}	=> {oncalls [hours] per month=none}	0.1344648	0.9115044	1.416252
[11]	{Trainings during last year=no, overtimes [hours] per month=none}	=> {Home office days per month=less than 1}	0.1592689	0.9172932	1.413776
[12]	{Lenght in service=1 year}	=> {Home office days per month=less than 1}	0.2584856	0.9041096	1.393457
[13]	{Type of leavings=Forced}	=> {Home office days per month=less than 1}	0.1174935	0.9000000	1.387123
[14]	{Lenght in service=2 years}	=> {Trainings during last year=yes}	0.1514360	0.9747899	1.246559
[15]	{Reason of leaving=Career development perspectives, overtimes [hours] per month=from 0 to 10}	=> {Trainings during last year=yes}	0.1109661	0.9444444	1.207754
[16]	{Position=ICT Administrator III}	=> {Gender=male}	0.1227154	0.9400000	1.204080
[17]	{Overtimes [hours] per month=from 11 to 25}	=> {Gender=male}	0.1201044	0.9387755	1.202512
[18]	{Lenght in service=4 years}	=> {Trainings during last year=yes}	0.1214099	0.9393939	1.201295
[19]	{Overtimes [hours] per month=from 11 to 25}	=> {Trainings during last year=yes}	0.1201044	0.9387755	1.200504
[20]	{Position=ICT Administrator II}	=> {Gender=male}	0.1749347	0.9305556	1.191983

Figure 2 – The Most Robust Association Rules According to the Selected Parameters

3.1 Association Rules

Immediately at the beginning of the analysis of actual data, the set support parameters were 0.1, and the set reliability parameters were 0.9. After removing duplicate association rules, 20 most robust rules were displayed (strong support and reliability). The result of the algorithm according to the selected parameters is shown in Fig. 2.

The 20 most robust rules can be seen in Fig. 2. In the case of support parameters 0.15 and reliability parameters 0.93, the first and the most reliable rule was that an employee without PPR results and training in the past year had been at the company for one year. The first rules are extreme and logical at the same time. Of all employees who leave, it is those who leave within one year that shares the most attributes. Such employees do not participate in PPR reviews, do not complete any training and have no on-call work or work from home. For the sake of a more detailed analysis of the reasons for leaving and to search for more specific association rules, the basic set was divided into so-called subsets according to the reason for leaving. The first was a set with data on employees who had left due to career growth opportunities (Fig. 3).

```
     lhs                                         rhs                                             support    confidence   lift
[1]  {Overtimes [hours] per month=none,
      Home office days per month=less than 1}    => {Oncalls [hours] per month=none}  0.2391304  0.9649123 1.733827
[2]  {Status=single,
      Overtimes [hours] per month=none}          => {Oncalls [hours] per month=none}  0.2913043  0.9178082 1.649187
[3]  {Overtimes [hours] per month=from 0 to 10,
      Home office days per month=less than 1}    => {Gender=male}                      0.2000000  0.9387755 1.148502
[4]  {Status=single,
      Overtimes [hours] per month=from 0 to 10}  => {Gender=male}                      0.2695652  0.9117647 1.115457
[5]  {PPR results=FIT,
      Gender=male}                               => {Trainings during last year=yes}  0.2956522  0.9444444 1.097082
[6]  {Gender=male,
      Overtimes [hours] per month=from 0 to 10}  => {Trainings during last year=yes}  0.3347826  0.9390244 1.090786
[7]  {PPR results=FIT,
      Status=single}                             => {Trainings during last year=yes}  0.2434783  0.9333333 1.084175
[8]  {Status=single,
      Overtimes [hours] per month=from 0 to 10}  => {Trainings during last year=yes}  0.2739130  0.9264706 1.076203
[9]  {Position=ICT Administrator II,
      Gender=male}                               => {Type of leavings=Unforced}        0.2086957  1.0000000 1.004367
[10] {Gender=male,
      Status=married}                            => {Type of leavings=Unforced}        0.2043478  1.0000000 1.004367
[11] {Status=married,
      Trainings during last year=yes}            => {Type of leavings=Unforced}        0.2173913  1.0000000 1.004367
[12] {PPR results=FIT,
      Status=single}                             => {Type of leavings=Unforced}        0.2608696  1.0000000 1.004367
[13] {PPR results=FIT,
      Gender=male}                               => {Type of leavings=Unforced}        0.3130435  1.0000000 1.004367
[14] {PPR results=FIT,
      Trainings during last year=yes}            => {Type of leavings=Unforced}        0.3565217  1.0000000 1.004367
[15] {Overtimes [hours] per month=from 0 to 10,
      Home office days per month=less than 1}    => {Type of leavings=Unforced}        0.2130435  1.0000000 1.004367
[16] {Status=single,
      Overtimes [hours] per month=from 0 to 10}  => {Type of leavings=Unforced}        0.2956522  1.0000000 1.004367
[17] {Gender=male,
      Overtimes [hours] per month=from 0 to 10}  => {Type of leavings=Unforced}        0.3565217  1.0000000 1.004367
[18] {Trainings during last year=yes,
      Overtimes [hours] per month=from 0 to 10}  => {Type of leavings=Unforced}        0.3695652  1.0000000 1.004367
[19] {Gender=male,
      Overtimes [hours] per month=none}          => {Type of leavings=Unforced}        0.2782609  1.0000000 1.004367
[20] {Gender=male,
      Oncalls [hours] per month=none}            => {Type of leavings=Unforced}        0.3913043  1.0000000 1.004367
```

Figure 3 – Association Rules – Career Growth Opportunities I

As we can see from the Fig. 3, the first and the second rules contain the on-calls and overtime items. In both cases, the values of these items were zero, so employees who state career growth opportunities as their reason for leaving had no on-calls or overtime. Based on this result, it is possible to conclude that on-calls and overtime had no impact on career growth.

We also focused on this reason for leaving in the case of employees who had been at the company for one year. The results of running the algorithm after adding the "duration of the service=1 year" are shown in Fig. 4.

```
     lhs                                        rhs                                       support    confidence   lift
[1]  {PPR results=NO PPR}                       => {Lenght in service=1 year} 0.2325581  1.0000000 3.307692
[2]  {Trainings during last year=no,
      Overtimes [hours] per month=none,
      Home office days per month=less than 1}   => {Lenght in service=1 year} 0.1162791  0.9090909 3.006993
```

Figure 4 – Association Rules – Career Growth Opportunities II

Employees who had been at the company for one year and had not participated in PPR reviews had not had any training, home office or overtime. We could conclude based on this association rule that PPR reviews are critical as they give employees an opportunity to define their career paths at the company, plan their training and obtain their superiors' evaluation.

Since education has an impact on careers, the parameters for searching for association rules were extended to include a rule for searching for associations in the case of those employees who had completed training in the previous year

(Fig. 5). The results implied that employees who had been at the company for four years had completed some training in the previous year. This rule shows that it is likely that the company does not offer an employee who has been at the company for quite large opportunities for career growth even through training.

```
      lhs                                    rhs                                          support   confidence  lift
[1]   {Lenght in service=4 years}        => {Trainings during last year=yes} 0.1162791  1.0000000  1.283582
[2]   {oncalls [hours] per month=from 31 to 70} => {Trainings during last year=yes} 0.1162791  1.0000000  1.283582
[3]   {Home office days per month=one}   => {Trainings during last year=yes} 0.1744186  1.0000000  1.283582
[4]   {Lenght in service=2 years}        => {Trainings during last year=yes} 0.1860465  1.0000000  1.283582
[5]   {Position=ICT Administrator II}    => {Trainings during last year=yes} 0.1744186  0.9375000  1.203358
[6]   {Month of exit=February}           => {Trainings during last year=yes} 0.1279070  0.9166667  1.176617
[7]   {Age=28}                           => {Trainings during last year=yes} 0.1279070  0.9166667  1.176617
[8]   {PPR results=FIT}                  => {Trainings during last year=yes} 0.3837209  0.9166667  1.176617
[9]   {Status=single,
       Overtimes [hours] per month=from 11 to 25} => {Trainings during last year=yes} 0.1162791  0.9090909  1.166893
[10]  {Month of exit=June}               => {Trainings during last year=yes} 0.1046512  0.9000000  1.155224
[11]  {Age=30}                           => {Trainings during last year=yes} 0.1046512  0.9000000  1.155224
```

Figure 5 – Association Rules – Career Growth Opportunities III

Rule number 11 is also impressive, as employees who were 30 years of age and completed training stated career growth opportunities as their reason for leaving. The group of employees aged 30 is probably a critical one, as they tend to reconsider their careers and change their work environments if they can.

Another frequent reason for leaving was "dissatisfaction with job description". The interpretation of the strongest rule is that employees who had been at the company for one year had had no overtime (Fig. 6). Other rules suggest that employees who had been at the company for one year were single and had worked from home less than one day a month stated dissatisfaction with the job description as their reason for leaving. As we can also see in other associations, several rules contain the "NO PPR" item, which means that the given employees had not had a review. These facts allow concluding that it is essential to evaluate employees.

```
      lhs                                    rhs                                              support   confidence  lift
[1]   {Lenght in service=1 year,
       Overtimes [hours] per month=none}  => {Home office days per month=less than 1} 0.2558140  0.9565217  1.645217
[2]   {Lenght in service=1 year,
       Status=single}                     => {Home office days per month=less than 1} 0.2441860  0.9545455  1.641818
[3]   {Lenght in service=1 year,
       PPR results=NO PPR}                => {Home office days per month=less than 1} 0.2209302  0.9500000  1.634000
[4]   {Lenght in service=1 year,
       Gender=male}                       => {Home office days per month=less than 1} 0.2209302  0.9500000  1.634000
[5]   {Lenght in service=1 year,
       PPR results=NO PPR}                => {Overtimes [hours] per month=none}       0.2209302  0.9500000  1.601961
[6]   {PPR results=NO PPR,
       Home office days per month=less than 1} => {Overtimes [hours] per month=none}  0.2093023  0.9473684  1.597523
[7]   {Lenght in service=1 year,
       PPR results=NO PPR}                => {oncalls [hours] per month=none}         0.2325581  1.0000000  1.409836
[8]   {PPR results=NO PPR,
       Home office days per month=less than 1} => {oncalls [hours] per month=none}    0.2209302  1.0000000  1.409836
[9]   {PPR results=NO PPR,
       Overtimes [hours] per month=none}  => {oncalls [hours] per month=none}         0.2209302  1.0000000  1.409836
[10]  {Lenght in service=1 year,
       Home office days per month=less than 1} => {oncalls [hours] per month=none}    0.2906977  1.0000000  1.409836
```

Figure 6 – Association Rules – Dissatisfaction With Job Description I

As the second most robust rule contained the marital status = single item, we focused on the employees who are single (Fig. 7). It is single employees aged 25 and 26 that left the company due to dissatisfaction with job description with 100% reliability. 25-26 is the age when most university graduates find their first jobs. If they did not work during their studies or had no experience with work

discipline, they may surprise by the fast pace of work, and because of having unrealistic expectations, they state dissatisfaction with the job description as their reason for leaving. This result prompted the inclusion of another question in the exit interview. The question was whether this was the employee's first work experience.

	lhs	rhs	support	confidence	lift
[1]	{Age=25}	=> {Status=single}	0.1046512	1.0000000	1.228571
[2]	{Oncalls [hours] per month=from 31 to 70}	=> {Status=single}	0.1162791	1.0000000	1.228571
[3]	{Age=26}	=> {Status=single}	0.1395349	1.0000000	1.228571

Figure 7 – Association Rules – Dissatisfaction with Job Description II

The next most frequent reason for leaving was "work-life balance" (Fig.8). The most robust rules show that those employees who stated this reason for leaving were single and had had no overtime or on-calls. The second rule was that these were cases of unforced leaving of employees who had been at the company for one year and their average use of benefits had been less than one day a month.

	lhs	rhs	support	confidence	lift
[1]	{Status=single, Overtimes [hours] per month=none}	=> {Oncalls [hours] per month=none}	0.1363636	1.0	4.400000
[2]	{Lenght in service=1 year, Type of leavings=Unforced}	=> {Home office days per month=less than 1}	0.1136364	1.0	1.760000
[3]	{Lenght in service=2 years, Position=ICT Administrator II}	=> {Home office days per month=less than 1}	0.1136364	1.0	1.760000
[4]	{Status=single, oncalls [hours] per month=from 31 to 70}	=> {Home office days per month=less than 1}	0.1136364	1.0	1.760000
[5]	{Gender=male, Overtimes [hours] per month=from 0 to 10, oncalls [hours] per month=from 31 to 70}	=> {Home office days per month=less than 1}	0.1363636	1.0	1.760000
[6]	{Status=single, Overtimes [hours] per month=from 0 to 10}	=> {Home office days per month=less than 1}	0.2045455	0.9	1.584000
[7]	{Lenght in service=1 year, Home office days per month=less than 1}	=> {Status=single}	0.1363636	1.0	1.466667
[8]	{Lenght in service=1 year, Type of leavings=Unforced}	=> {Status=single}	0.1136364	1.0	1.466667
[9]	{Position=ICT Administrator II, PPR results=FIT, Home office days per month=less than 1}	=> {Status=single}	0.1136364	1.0	1.466667
[10]	{Gender=male, Overtimes [hours] per month=from 11 to 25}	=> {Status=single}	0.2045455	0.9	1.320000

Figure 8 – Association Rules – A Work-Life Balance I

Fig. 9 shows the results of an analysis of association rules where the search was extended to include the parameter of searching for rules for single employees. Again, the rule emerging here is that these employees had been at the company for one year, had had no overtime or on-calls. In most cases these employees' position was ICT Administrator II, their PPR result was Fit, and their average use of benefits had been less than one day a month.

	lhs	rhs	support	confidence	lift
[1]	{Lenght in service=1 year}	=> {Status=single}	0.1363636	1.0000000	1.466667
[2]	{Gender=male, Overtimes [hours] per month=none, oncalls [hours] per month=none}	=> {Status=single}	0.1136364	1.0000000	1.466667
[3]	{Position=ICT Administrator II, PPR results=FIT, Home office days per month=less than 1}	=> {Status=single}	0.1136364	1.0000000	1.466667

Figure 9 – Association Rules – Work-Life Balance II

3.2 Decision Trees

```
Lenght in service <= 1: no (789/57)
Lenght in service > 1:
:...PPR results in {Best fit,Fit,Grow,Improve,Jump,Move}: no (3198/229)
    PPR results = NO PPR:
    :...Training last year = no:
        :...Lenght in service <= 1.8: yes (5)
        :   Lenght in service > 1.8:
        :   :...Status in {divorced,married,widow}: no (36/4)
        :       Status = single:
        :       :...Position in {EG1,EG2}: yes (8/2)
        :           Position in {EG3,EG4,MG,N/A}: no (4)
        Training last year = yes:
        :...Status = widow: yes (0)
            Status = divorced: no (3)
            Status in {married,single}:
            :...Home office <= 0.3333333:
                :...Position in {EG1,EG2,EG3,EG4,N/A}: yes (113/9)
                :   Position = MG: no (12/5)
                Home office > 0.3333333:
                :...Overtime <= 12.375: no (62/21)
                    Overtime > 12.375: yes (7)
```

Figure 10 – Decision Tree of the C5.0 Algorithm

In this phase of the analysis, we used algorithms in the R program through the C5.0, rpart and ctree packages.

Fig. 10 shows an output from the R program after entering the command for generating the decision tree through the C5.0 algorithm. The primary classifier from which the tree was developed was the Exit variable, i.e. whether the given employee had left the company. The end leaves of this decision tree should result in information about whether an employee has left the company or not. The first branch where the tree branches out is the "Duration of service" attribute, i.e. how long an employee has been at the company. This branch branches out further depending on whether an employee has been at the company for more than one year. If not, the algorithm does not continue, as only 57 employees ended their employment, which is too low a number for further development of the tree. The tree then continues to branch out according to PPR results. Here we can see another end leaf, where the tree stops developing if the employees participated in the performance and possible review. Of these employees, 229 terminated their employment. If the employees did not participate in the PPR review, the tree continues and the attribute of whether employees had training in the previous year. According to this attribute, the tree branches out into two separate parts.

If the employees did not participate in training in the previous year, the algorithm continues with the "Duration of service" attribute, like in the first layer. If this was less than 1.8 years, then five employees left the company, to which the specifications mentioned above also applied. If the employees had been at the company longer than 1.8 years, were single and in a junior position, they left the company.
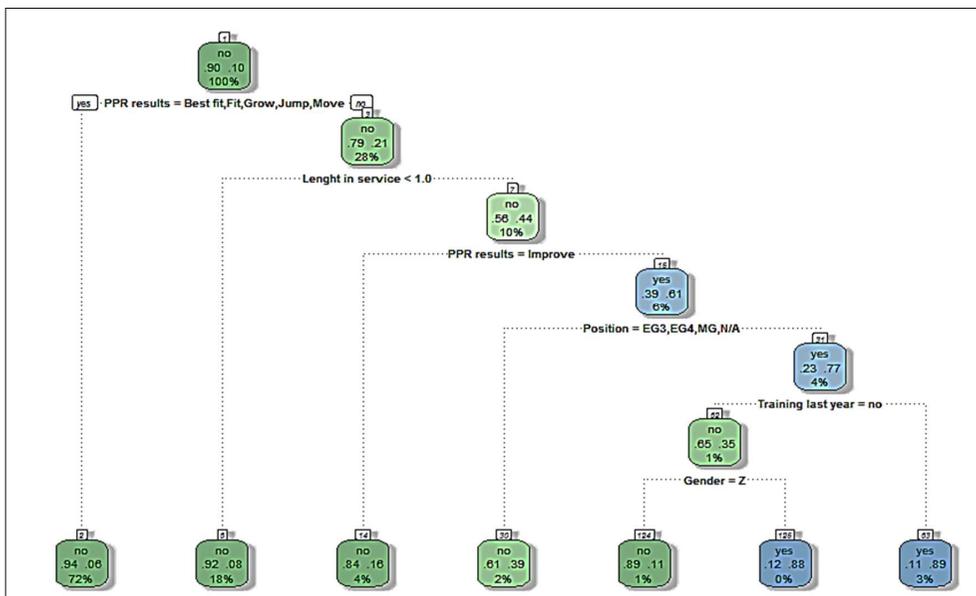
Figure 11 – Decision Tree of the rpart Algorithm

The second part of this tree applies to those employees who had had training in the previous year. If they were single or married and their average use of benefits had been less than 0.33 days a month, 113 employees terminated their employment. If they had worked an average of more than 0.33 days a month from home and had not worked more than 12.375 days of overtime on average, they stayed at the company and did not terminate their employment.

Another algorithm we used was rpart. The result of this algorithm is a decision tree shown in Fig. 11. The different colours make it easier to find the required result. The green colour refers to nodes, or leaves, where the employees did not leave the company, and the blue colour refers to those where they did.

The tree begins with the attribute of PPR results. If the employees' results were Bes fit, Fit, Grow, Jump and Move, they did not leave the company in 72% of cases. The remaining 28 % of employees had a different result, i.e. Improve or no result if they had not participated in the review. If the employees had been at the company more than one year and their PPR result was other than Improve, i.e. they had not participated in PPR, they terminated their employment (the first blue leaf). The second blue leaf shows that employees who had been in EG1 and EG2 positions left the company. The last leaves show that the employees who leave the company do not participate in training and if they do, they turn out to be women who decide to leave the company.

The last algorithm we used in our decision tree analysis was the ctree algorithm. For ease of understanding, Fig. 12 shows a decision tree in the graphic form of a standard decision tree. The end of this decision tree features rectangles that allow us to compare when the employee for the given branch left his employment and

when he did not. The results are also shown as a percentage ratio. The darker the part in the broader area of the rectangle, or the higher the value it reaches, the more important and more interesting this branch is for prediction.
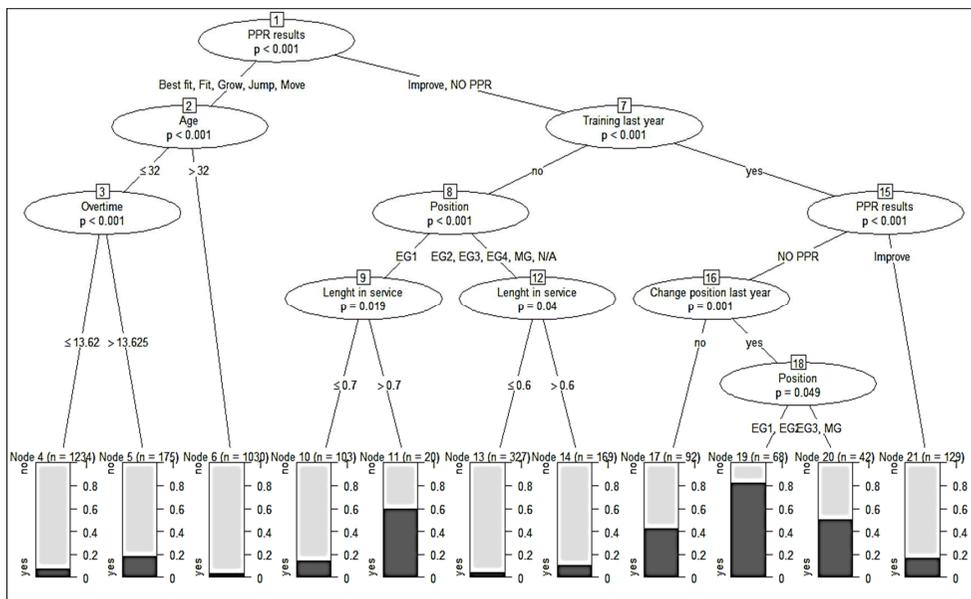
Figure 12 – Decision Tree of the ctree Algorithm I

The root of the tree contains employees with PPR results in Best fit, Fit, Grow, Jump a Move. This part branches out further according to age. If an employee was aged 32 or less and had worked an average of more than 13.625 hours of overtime a month, almost 20% of these employees, who share the given attributes, out of the total 175 employees left the company, see Leaf no. 5.

The right part of the decision tree applies to employees whose PPR result was Improve or had not participated in the review. If these employees had not had training in the previous year, their positions were at the EG1 level and had been at the company more than 0.7 years, then in 60% of cases, these employees left the company, see Leaf no. 11.

Employees who had done training in the previous year, but had not participated in the PPR review and had not changed their position in the previous year, then 40% of the total of 92 employees left the company, see Leaf no. 17 Even if they had changed their position and stayed at the EG1 level, they left the company in 80% of cases. Leaf no. 19 since in most cases the root of the tree contained PPR results, this column was removed from the database, and the algorithm was rerun (Fig. 13).
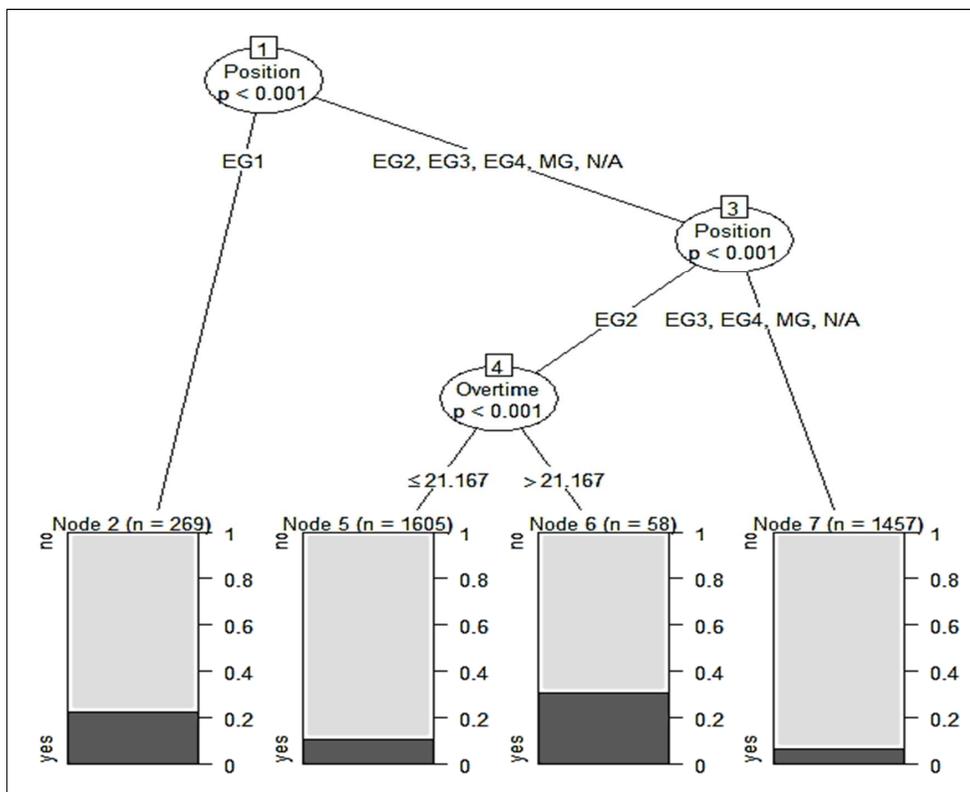
Figure 13 – Decision Tree of the ctree Algorithm II

Compared to the above decision tree, this decision tree is much smaller and only contains four leaves. The root of this tree contains position. If an employee's position is EG1, then 20% of the total of 269 employees left the company. In the case of EG2 positions, a branch for overtime was added to the decision tree. If employees' average overtime per month is more than 21.167, around 30% of them leave the company.

4   CONCLUSION

We first performed a simple analysis of the frequency of the individual types of exit. That served as preparation for further analyses and provided results that were not negligible. The most frequent reasons for leaving the given company in the past two years were career growth opportunities, dissatisfaction with job description and dissatisfaction with the employee's performance. These results were also confirmed in analyses using association rules and decision trees.

The results of the analyses generally showed that observing the basic principles of correct communication from the beginning of an employment relationship, or during hiring, is justified. It is necessary for every potential employee to be familiar with their job description, so they do not leave when they are still in

their trial period, which is a point when employees often state dissatisfaction with the job description as their reason for leaving. Communication and regular conversations between a superior and his employees can help identify problems earlier, address them and reduce the number of people leaving the company. The following recommendations were put forward for the company:

- Improve the methods of graduate hiring, i.e. prepare future employees by offering internships to students who can switch to full-time employment after graduation.

- At the end of the trial period, discuss with the given employees whether the position for which they have been hired meets the requirements and expectations they had before they started.

- Set an education plan and training plans for the individual types of employees.

- Motivate loyal employees with benefits.

- Monitor the amount of overtime and if an absolute limit is exceeded, review the employees' job description to avoid unnecessary overtime that may have an adverse effect on them.

The most significant advantage when performing the analysis was the availability of quality data in large amounts. It was not possible to perform such an analysis in specific industries or at certain companies precisely because detailed databases and overviews were not available.

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REFERENCES

Agrawal, R., Imielinski, T. and Swami, A., 1993. Mining Association Rules Between Sets of Items in Large Databases. In: P. Buneman and S. Jajaodia eds., *Proceedings of the 1993 ACM SIGMOD international conference on Management of data.* Washington, DC, USA, 25-28 May 1993. New York, USA: ACM.

Bardessono, D., 2016. 5 Signs You're A "Unicorn" Employee, Benchmark Consulting, [online] 10 October. Available at: <http://www.benchmarkhr.com/5-signs-youre-a-unicorn-employee/> [Accessed 05 March 2018].

Berikov, V., Litvinenko, A. and Lbov, G.S., 2008. *Methods for statistical data analysis with decision trees*. [pdf] s.l.: Sobolev Institute of Mathematics. Available at: <http://www.math.nsc.ru/AP/datamine/eng/context.pdf> [Accessed 05 March 2017].

Berson, A., Smith, S. and Thearling, K., 1995. *An Overview of Data Mining Techniques*. [pdf] s.n. Available at: <http://weber.itn.liu.se/~jimjo94/courses/TNM048/documents/DM-Techniques.pdf> [Accessed 05 March 2017].

Janice, L., 2014. New Perspectives on Staff Turnover in the IT Field. *Knowledge HEC*, [online] 11 December. Available at: <http://www.hec.edu/Knowledge/Strategy-Management/Human-Resources-Management/New-Perspectives-on-Staff-Turnover-in-the-IT-Field> [Accessed 08 January 2017].

Markulik, Š., Cehlár, M. and Kozel, R., 2018. Process approach in the mining conditions. *Acta Montanistica Slovaca*, 23(1), pp.46-52.

Methot, J.R., Lepak, D., Shipp, A.J. and Boswell, W.R., 2017. Good Citizen Interrupted: Calibrating a Temporal Theory of Citizenship Behavior. *ACAD MANAGE REV*, [e-journal] 42(1), pp. 10-31. http://dx.doi.org/10.5465/amr.2014.0415.

Mueller, R., 2017. How Can An Organization Transform Its Culture To Become More Data Driven?. MacroSoft, [online] 13 October. Available at: <https://www.macrosoftinc.com/blog/how-organization-transform-culture-more-data-driven.html> [Accessed 02 March 2018].

Ongori, H., 2007. A review of the literature on employee turnover. African Journal of Business Management, [e-journal] 1(2), pp.46-54.

Paralič, J., 2003. *Discovering knowledge in databases*. Košice: Elfa.

Peterson, B., 2017. Travis Kalanick lasted in his role for 6.5 years — five times longer than the average Uber employee. *Business Insider,* [online] 20 August. Available at: <http://www.businessinsider.com/employee-retention-rate-top-tech-companies-2017-8> [Accessed 05 March 2018].

Smith B. and Rutigliano T., 2002. The truth about turnover. *Business Journal*, [online]. Available at: <http://www.gallup.com/businessjournal/316/truth-about-turnover.aspx> [Accessed 16 January 2017].

Sullivan, J., 2017. The Ideal Turnover Rate. *Monster*, [online]. Available at: <http://hiring.monster.ca/hr/hr-best-practices/recruiting-hiring-advice/strategic-workforce-planning/employee-turnover-rate-canada.aspx> [Accessed 15 February 2017].

Wilkonson, J., 2014. Employee Turnover Definition. *The Strategic CFO*, [online] 7 April. Available at: <https://strategiccfo.com/employee-turnover/> [Accessed 05 March 2018].

Zgodavova, K., Hudec, O. and Palfy, P., 2017. Culture of quality: insight into foreign organisations in Slovakia. *Total Quality Management & Business Excellence*, [e-journal] 28(9-10), pp.1054-1075. http://dx.doi.org/10.1080/14783363.2017.1309120.

Zulla Consulting & Partners, 2017. Should I stay or should I go – Why your employees have this doubt?. *Zulla Consulting & Partners*. [online] 26 April. Available at: <http://zulla-consulting.com/employee-fluctuation> [Accessed 15 February 2018].

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Electronic Auctions: Role of Visibility Settings in Transparency Analysis

Radovan Dráb, Radoslav Delina, Tomáš Štofa

ABSTRACT

Purpose: Main objective of the paper is to assess whether the auctions issuers have changed their preferences regarding the auction transparency described through the visibility settings, and to asses which and to what extent had the other auction parameters impact on the auction transparency and also to assess the effect of the transparency onto the achieved auction savings.

Methodology/Approach: The paper analyses sample records of 5,000 electronic auctions of SR and CR auction issuers on the time frame of 2009-2016, using methods of higher statistics. An composite index for transparency analysis has been developed and assessed. Two standalone regression models were applied to analyse the papers hypotheses regarding the transparency and auctions' savings.

Findings: The size of the auction described does not have a significant effect on the transparency settings, but the auction complexity does. The most saving generating visibility settings is the visible order of the participants and the visibility of the other measurements settings for the auctions. Increasing the auction complexity can decrease the generated saving by an average 9.3%.

Research Limitation/implication: Research was based on real secondary data from one electronic auction provider. The results are limited to the features enabled on this electronic platform. Results show that the application of visibility setting in auctions can generate additional benefits like savings, but also has to be applied carefully when assessing the transparency.

Originality/Value of paper: The analysis and results based on real secondary data are scare in the current research area, therefore is this article a valued contribution.

Category: Research paper

Keywords: electronic reverse auctions; transparency; auction benefits

1   INTRODUCTION

The history of electronic reverse auctions presented in this article can go back to 1990 when they were claimed as a standart sourcing tool for organisations (Beall, 2003). Although they had many "defenders" they have received also several criticism. Despite their masive implementation (Giampietro and Emiliani, 2007), if uncontrolled or unstandarded without any regulation, electronic auctions can significantly damage the relationships between its participants (Caniëls and van Raaij, 2009; Emiliani, 2005; Hartley, Lane and Hong, 2004; Tassabehji, et al., 2006). Those with a positive relation to electronic auctions claimed its most benefits in obtaining low prices for buyers, inreasing the sourcing time, access to many suppliers at the same time, creating a more competitive environment, standardisation or repeatability of the sourcing process (Bartezzaghi and Ronchi, 2003). Suppliers can benefit from lower selling and customer generation costs as well as opening to new markets, customers, standardisation or increased transparency in biding (Smart and Harrison, 2003).

Ususally the research dealing with the auctions analysis is focused on the buyers' perspective and fewer are concentrated on the suppliers or sellers' opinion on the auctions. To attract more suppliers and to introduce elecronic auction to a wider subject have the auction systems and providers of the auction systems improved the visibility settings to adjust the auction environment to the needs of the auctioned good or service.

This article's main objective is to assess the role of transparency defined through various visibility setting of the auction. The analisys should also identify differences in the "standardised" transparency settings between various auction types, or categories of the auctioned items.

To execute the analysis, we have been provided secondary source data from an auction platform provider.

2   METHODOLOGY

We analyse secondary data provided by an electronic auction platform provider. Altogether a random sample records of 5,000 electronic auctions have been processed for the analysis. All the auction issuers were from Slovakia or Czech Republic although the participants could be international. The analysed time frame ranges from 2009 until mid 2016, due to the internal rules of the platform provider. Database includes Sealed bid auctions, English reverse auctions, Nippon and Holland type auctions and RFq's. The database was anonymised with the respect of uniqe records identification. After the screening and data pre-processing we were left with 4,255 auction records. Each record captured severall information about the auction: Issuer ID, Auction ID, date, Auction duration, Auction assessment type, visibility settings (what type of information is available to participants during the auction rounds), Estimated price, first offer price, Winners price, Saving achieved, Number of participants, Numer of new

participants, Name of the winner, Auction type, Buy or Sell type auction, Category od the auctioned item, Number of rounds, Type of these rounds, Number of changes, The absolutely best offer.

To assess the role of the transparency we have created a transparency index that captures the visibility setting of the auction.

The index is constructed so that it can capture each uniqe visibility settings. The visibility settings are described in the next table with the frequency of their application in our dataset. Also an option of no settings used was considered in the analysis.

Table 1 – Frequency of Visibility Setting in the Dataset (Authors)

Winning / Loosing infromation	Order of first 3 visible	Order of all visible	Ordering per item visile	Ordering of additonal conditions
15	72	1961	473	236

Index composition

To establish the index, we have ordered the visibility setting from those that contribute to the transparency the least to those that contribute the most. This ordering was carried oud based on authors experiences with electronic auctions and based on the consultation with an expert referee from the data provider company.

Table 2 – Transparency Index Composition (Authors)

Order	Visibility setting	Asigned value in index
1	No settigs active	0
2	Winning / Loosing infromation	1
3	Order of first 3 visible	2
4	Order of all visible	4
5	Ordering per item visile	8
6	Ordering of additonal conditions	16

To each of the visibility setting a unique value was asigned so that the final sum of all the setting will add up a number that if decomposed can be exactly identified which of the visibility settings were turned on in the specific auction record. All these visibility settings are set to assess the role of transparency on the perceived savings a linear regression model and probit model that were applied using SPSS statistics program.

Paper Objectives

Main objective of the paper is to assess whether the auctions issuers have changed their preferences regarding the auction transparency described through the visibility settings, and to asses which and to what extent had the other auction parameters impact on the auction transparency and also to assess the effect of the transparency onto the achieved auction savings.

To help fulfill the main objective we have created a set of research questions and hypothesis that were assessed during the analysis.

Research questions

1. Intensification of electronic auction application should increase the general knowledge of the auctions issuers' about their full potential so an increase in the application and variability of visibility settings and so in transparency should be visible.

2. Althoug the increase if the auction application there shoud be no significant change towards transparency increase in the sealed bid auctions where the auction issuer is a public body.

3. We expect a positive increase in transopareny in auctions by public bodies, due to changes in the public procurement laws form 2014.

Hypotheses being tested using the regression models

a) We expect the greater the auctioned value the greater the effort of the auction issuer for greater competition, so an increase in the auction transparency should be significant.

b) The more the auction participants the "tighter" the auction settings increasing transparency.

c) The more complex the auction is the higher the transparency settings.

d) Increase in transparency should increase the achieved auction savings.

e) The more complex the auction, the less effective they are, and less savings are achieved.

3   TRANSPARENCY ANALYSIS

The values of transparency index indicate how the issuers set up the environment during the auctions. The development of this index value should reveal if there is any shift in the behaviour of auction issuers regarding these settings.
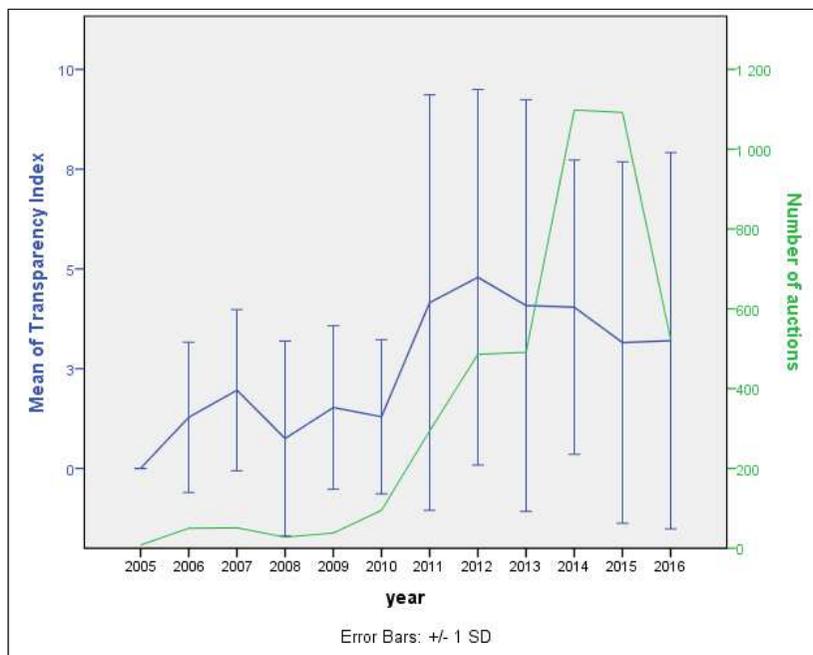
*Figure 1 – Development of the Transparency Index with Respect
Number of Auctions (Authors Computations in SPSS)*

As can be seen in the Fig. 1 the average transparency index has an incresing trend during the analysed period with incresing variance in the standard deviation. This development suggest that auctions issuers have found usefull to adjust the visibility settings of their auctions to achieve better control of the auction process and generete more benefits through transparency increase. The average value of the index starts at 2 what means that the issuers usually turn on the visibility of the participants' order on the first 3 places. When looking on the standard deviation almost 68% of all auctions never went with the settings above 4 until the 2011. After that year the variability for the visibility settings and so the transparency index has significantly increased and so did the number of auctions. After the 2013 the average index value has started to decrease even the increasing number of auctions. The decrease can be the result of several factors, where one of it could be the change in the law regarding the public procurement rules. To assess wether this assumption can be correct a simple Fig. 2 was created where the different auction types regarding the issuer type can be seen. The GOV labeled auctions correspond to those where a public body represented the electronic auction issuer. To go beyond that, we have separeted auctions where the public issuer set up a sealed bid type of auction or a one closed round only auction (GOV Sea).
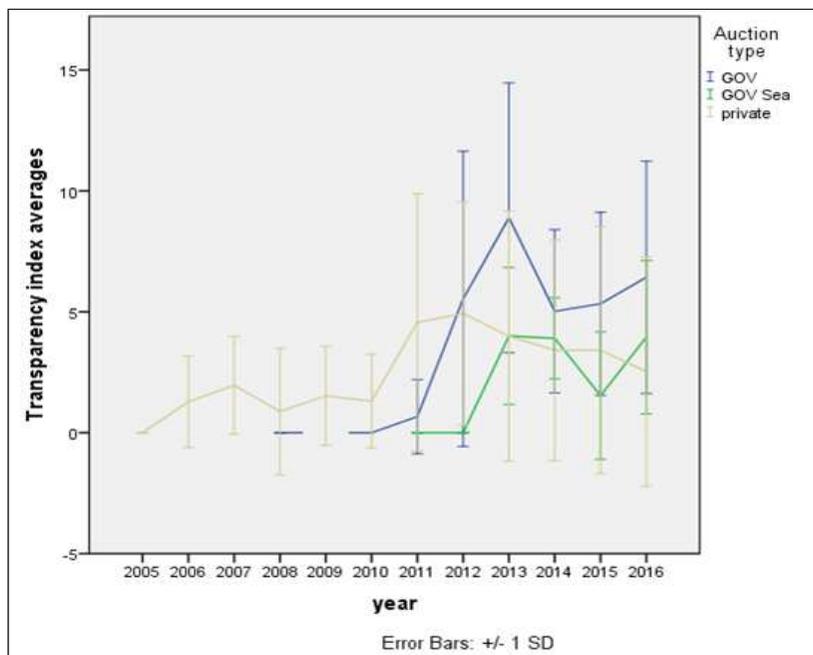
Figure 2 – Average Transparency Index per Auction Type
(Authors Computations in SPSS)

Fig. 2 shows an overall increase in the transparency settings as defined through the transparency index. After the initial rapid increase in transparency from 2011 to 2013 due to changes in the law regarding the public procurement regulations a slight decrease in 2014-2015 has followed. The decline in the index during 2013-2015 is present most in the case where the issuer is from public sector. The decline in case of private sector subjects is a bit slower. Although the number of auctions carried out through the platform has in the years 2014 and 2015 reached its peak the transparency index has decreased to an average of 4 meaning that mostly the visibility of the full ordering to all participants was set. Also a low average transparency value is suggesting that less auctions have used the multiple auction criteria except the price. So in general can be concluded that in the recent rears took the lead auctions focused only on the price as the only criterion for auction evaluation in the case of private auctions. During the last analysed year, the situation is changing towards more complex and transparent settings due to increasing transparency index at least in the case where the procurer is a public body.

When looking on the Fig. 3 the average transparency index per auction type and auctioned item category can be identified.
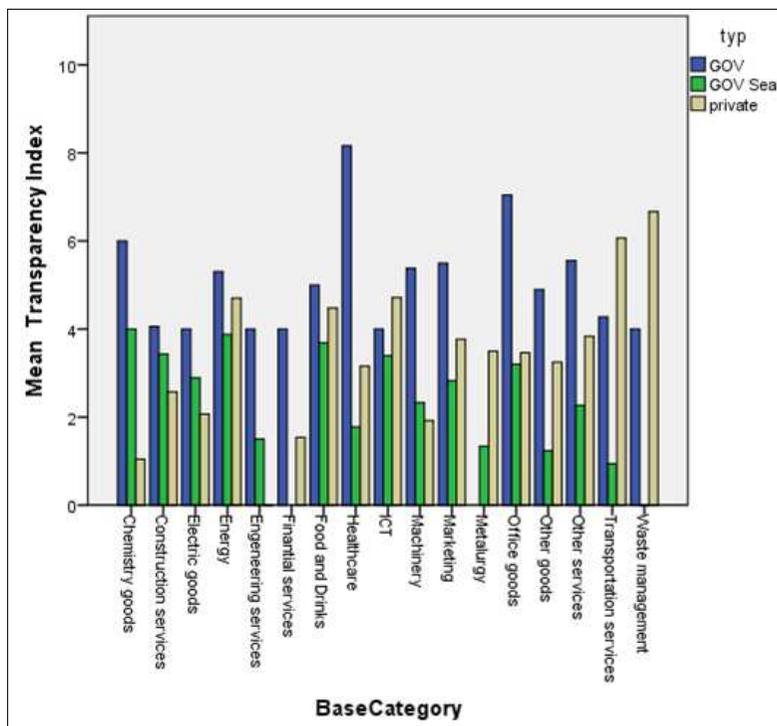
*Figure 3 – Transparency Index According to Base Category of
the Auctioned Item an Auction Type
(Authors Computations in SPSS)*

To assess the which factors, have an influence on the transparency settings we have conducted a simple econometric regression analysis to reveal wether some of the variables in our databes have a direct influence on the visibility settings defined through the transparency index. A logistic multinomial regression model was applied. Before the model application the statistic assumption on residual normality tests, autocorrelation and multicolinearity were tested. Through no significant disturbances in the data were observed a backward step wise regression model was performed. All the measures were carried out using the SPSS platform. As the transparency index is an ordinal variable, we have chosen a probed model that suits best for the ordinal dependent variables. The estimates and results are captured in the Tab. 3.

The results show that despite our assumption that the greater the auction size the more effort the issuer will put into the transparency assurance and so adjust the visibility setting to generate most benefits from the transparency settings, the volume had in the end no effect on the. The estimate for the auction volume is zero that is suggesting that the size of the auction has no efect on the transparency settings transparency so the first hypothesis a) could not be supported by the model. Another variable reflecting the size of the auction is the number of participants which has a significant but rather neutral to little positive

effect on the transparency increase. This results can be questionaed to have the declared effect, because the number of participants is known and fixed after the auction anouncement and can be slightly changed after the start but the transparency settings are set long before even the invitations are set or the auction is made public. In general our model suggest to confirm the hypothesis b) regarding the number of participants and their impact on the transparency.

Table 3 – Regression Model for the Transparency Index (Authors Computations in SPSS)

Parameter Estimates							
Parameter		**Estimate**	**Std. Error**	**Z**	**Sig.**	**95% Confidence Interval**	
						Lower Bound	*Upper Bound*
PROBITa	Number of participants	.000	.000	-1.476	.140	.000	.000
	Number of new participants	.037	.000	128.411	.000	.036	.037
	Number of items	-.001	.000	-37.976	.000	-.001	-.001
	Number of rounds	-.100	.001	-83.804	.000	-.103	-.098
	Auction volume	.000	.000	-79.962	.000	.000	.000
	Number of prolongation	.001	.000	64.198	.000	.001	.001
	Number of price changes	-.001	.000	-153.21	.000	-.001	-.001
	Rounds before_auction_round	.065	.001	60.691	.000	.063	.067
	Rounds after_auction_round	.119	.002	61.258	.000	.115	.122
	Intercept	-.986	.002	-408.09	.000	-.988	-.983
PROBIT model: PROBIT(p) = Intercept + BX, Dependent Variable: Transparency index							

The auction complexity is represented through the number of items auctioned, through the number of rounds and especially through the indicators number of rounds before and after the auction round. The model results show some contraindication in these variables. Where in more complex auctions (more rounds in general, more items in general) show a negative implication for the transparency so an increase in these values is decreasing the transparency, the variables round before and after the auction round show an opposite impact. Both of the last mentioned were identified as significant and have a positive effect on transparency. So in the end we can coclude the hypothesis c) as approved.

To assess the last two hypotheses, we have changed the econometric model due to the nature of the dependent variable that is no more an ordinal but a scale variable representing the percentual savings achieved from an auction.

Next table is summing up the results from the regression model build fo the savings variable as the dependent one.

Table 4 – Regression Model for the Auction Savings (Authors Computations in SPSS)

	Coefficientsa				
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	*Std. Error*	*Beta*		
(Constant)	5.679	1.098		5.172	.000
Transparency index	-.728	.093	-.222	-7.793	.000
S: Participant order	5.784	.614	.192	9.413	.000
S: Other conditions order	9.301	1.733	.152	5.368	.000
Invitations send (days before)	.140	.049	.048	2.882	.004
Number of new participants	.458	.113	.067	4.070	.000
Numer of participants	-.135	.060	-.039	-2.256	.024
Number of items	-.010	.007	-.023	-1.350	.177
Number of rounds	.508	.500	.023	1.015	.310
Numer of price changes	.013	.002	.188	8.055	.000
Number of auction prolongations	.019	.006	.065	2.927	.003
Rounds_before_auction_round	-1.158	.431	-.055	-2.686	.007
Rounds_after_auction_round	-2.158	1.116	-.036	-1.935	.053
Dependent Variable: Savings					

As can be seen from the significancy values and from the estimates values the transparency index defined through the visibility setting has been identified as significant but with a general negative value suggesting that by a unit increase in transparency setting the savings should decrease by 0.73%. So in general the hypothesis d) can not be confirmed and a more detailed analysis should be performed on this issue. On the other hadn also two componental dummy variables were left as significat in the model: S: Participant order and S: Other conditions order, which are representing if these visibility settings were turned on or off. Both of the last mentioned variables resulted with a high positive estimate suggesting that triggering these setting on has a positive impact on the savings (5.8 and 9.3%).

4   CONCLUSION

Despite the long proclaimed benefits of electronic autions in the procurement processes there are many of those, who leak the trust, criticise or even openly disagree with their application. In our article we have been trying to investigate whether the transparency generated by these electronic tools have become a common feature in the current auctions and if the transparency is somehow dependent on the auction type or its parameters. At the end we have explored using an econometric approach wheter the transparency and auction visibility setting do have a direct impact on the achieved auction savings. The resuls instead of answering these question have opened new ones that have to be analysed in more detail.

Among the most interesting findings can be concluded: The size of the auction described through the auctioned value had not a significant impact on the transparency settings what was contrary to our assumptions. When assessing the auctions' complexity the results have showed some contraindication, where the number of auctioned items and number of auction round have showed a negative effect the number of round before and after the auction round have shown a positive effect. Therefore, here we would like to continue our research and analyse this issue in more detail.

Regarding the saving analysis two interesting results were identified. Visibility setting of the auction participants order and the visibility of other measuring means order of the auction parameter had a significant very positive effect on the savings (5.8 and 9.3%). Not less interesting is the impact of the auctions' complexity described by the number of round before anfter the auction round, where the increase in the numbers of these round have a negative effect on the achieved savings, so they are suggesting less efficient auction processes. This issue should be also analysed in more detail. All in all, the analysis and results based on real secondary data are scares in the current research area, therefore is this article a valued contribution.

ACKNOWLEDGEMENTS

REFERENCES

Bartezzaghi, E. and Ronchi, S., 2003. Internet supporting the procurement process: Lessons from four case studies. *Integrated Manufacturing Systems*, [e-journal] 14(8), pp.632-641. https://doi.org/10.1108/09576060310503447.

Beall, S. ed., 2003. *The role of reverse auctions in strategic sourcing*. Tempe, AZ: W.P. Carey School of Business, Arizona State University; CAPS Research.

Caniëls, M.C.J. and van Raaij, E.M., 2009. Do all suppliers dislike electronic reverse auctions?. *Journal of Purchasing and Supply Management*, 15(1), pp.12-23. https://doi.org/10.1016/j.pursup.2008.10.003.

Emiliani, M.L., 2005. Regulating B2B online reverse auctions through voluntary codes of conduct. *Industrial Marketing Management*, [e-journal] 34(5), pp.526-534. https://doi.org/10.1016/j.indmarman.2004.12.003.

Giampietro, C. and Emiliani, M.L., 2007. Coercion and reverse auctions. *Supply Chain Management: An International Journal*, [e-journal] 12(2), pp.75-84. https://doi.org/10.1108/13598540710737253.

Hartley, J.L., Lane, M.D. and Hong, Y., 2004. An exploration of the adoption of E-auctions in supply management. *IEEE Transactions on Engineering Management*, [e-joournal] 51(2), pp.153-161. https://doi.org/10.1109/TEM.2004.826010.

Smart, A. and Harrison, A., 2003. Online reverse auctions and their role in buyer-supplier relationships. *Journal of Purchasing and Supply Management*, [e-journal] 9(5), pp.257-268. https://doi.org/10.1016/j.pursup.2003.09.005

Tassabehji, R., Taylor, W.A., Beach, R. and Wood, A., 2006. Reverse e-auctions and supplier-buyer relationships: An exploratory study. *International Journal of Operations and Production Management*, [e-journal] 26(2), pp.166-184. https://doi.org/10.1108/01443570610641657.

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The Effect of E-WOM and Perceived Value on the Purchase Decision of Foods by Using the Go-Food Application as Mediated by Trust

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ABSTRACT

Purpose: This study examined the effect of electronic word of mouth and perceived value on purchase decisions of foods when using the Go-Food Application, which is a purchase decision mediated by trust. The increasing the number of Go-Food Application users makes this study a timely survey.

Methodology/Approach: This research explored how the Go-Food Application is able to obtain more consumers compared to similar mobile apps. This research is quantitative in nature by testing the hypotheses. The sample size used was 175 respondents from a non-probability sampling with a convenience sampling technique. The analysis uses a SEM model analyzed using the AMOS program 24.

Findings: The results based on Confirmatory Factor Analysis (CFA) shows that each variable is valid and reliable, and the result of Goodness of Fit shows all variables fit the data. The result of hypotheses testing show: (1) electronic word of mouth affects significantly and positively on trust; (2) perceived value affects significantly and positively on trust; (3) electronic word of mouth affects significantly and positively on purchase decision; (4) perceived value affects significantly and positively on purchase decision; (5) trust affects significantly and positively on purchase decision.

Research Limitation/implication: The respondents were only those who live in Jakarta and those who use Go-Food application owned by Go-Jek Indonesia Ltd., exclude its other application such as Go-Car, Go-Mart, Go-Send, Go-Box, Go-Pulsa, Go-Massage, Go-Clean.

Originality/Value of paper: Trust proved as mediation variable between of electronic word of mouth and perceived value and purchase decision by using

Go-Food application. So this research has distribution to Go-Jek Indonesia Ltd. to maintain the costumer trust to get sustainable competitive advantage.

Category: Research paper

Keywords: electronic word of mouth; perceived value; trust and purchase decision

1   INTRODUCTION

In this digital era the development of technology has a great impact on daily life for its users. Technology increasingly makes things easier for people in conducting their activities, including for businessman or enterpreneurs. Creating an innovative and creative thing in running a business will differentiated from its competitors. Creating a technology based business or online business has became a trend in this era and fulfills the increasing of people's diverse needs. The proliferation of online businesses in Indonesia is also caused by the country's s high number of internet users

Table 1 – The Data of Internet Users in Countries (KOMINFO, 2017)

		Top 6 countries by Internet Users 2013-2017 (millions)				
		2013	*2014*	*2015*	*2016*	*2017*
1	China	620.7	643.6	669.8	700.1	736.2
2	United States	246.0	252.9	259.3	264.9	269.7
3	India	167.2	215.6	252.3	283.8	313.8
4	Brazil	99.2	107.7	113.7	119.8	123.3
5	Japan	100.0	102.1	103.6	104.5	105.0
6	Indonesia	72.8	83.7	93.4	102.8	112.6

Based on the data, Indonesian internet users have been increasing every year. One of the businesses that is enjoying extraordinary success is Go-Jek Indonesia Ltd., which provides an application that can be downloaded on iOS or android based smartphones. This application is called Go-Food from which people can order foods. The availability of restaurants in the application is about 30,000, and even more have become partners of the Go-Food application by providing many kinds of foods to choose from www.go-food.co.id. The following insight is based on the result of a survey conducted using a business perspective on how many Go-Food users exist and what are other similar mobile applications used for ordering foods.

Tab. 2 shows the survey was conducted on 400 respondents that use one or more food applications. Go-Food has 46% users, and compared to its competition namely Grab Food, which is only has 1% users. This marked difference indicates

that the Go-Food application is preferred by users. Further information from the survey shows that users who have more than one application on their mobile device are mostly Go-Food users. The result means that the users of the Go-Food application have reached more than 90% of the total number of respondents.

Table 2 - The Data of Foods Application Users(The Business Perspective, 2017)

Foods Applications	Users percentage
Go-Food	46%
Grab Food	1%
Restaurants Apps	3%
> 1 Applications	50%

The study was preceded by identifying the following issues from other studies: (1) A research conducted by Baskara (2014) stated that trust does not affect significantly on purchase decisions, whereas Permatasari (2015) found that trust has a positive and significant effect on purchase decisions. This leads to the research question of customer trust towards the Go-Food application while deciding to order foods. (2) To create a positive electronic word of mouth (E-WOM) promotion will be difficult if the services provided are not in-line with customer expectation. Thus, the question of how E-Wom can affect trust and purchase decision on Go-Food users is derived. In addition, (3) through perceived value, a customer can evaluate and judge the product or service before it is purchased. If the experience of ordering food through the Go-Food application is unfavorable, it will impact the perceived value, which becomes negative and will affect trust and subsequent purchase decisions.

Based on the above problem identification, the research problems are as follows: (1) Is purchase decision influenced by electronic word of mouth? (2) Is purchase decision influenced by perceived value? (3) Is purchase decision influenced by trust? (4) Is trust influenced by electronic word of mouth? (5) Is trust influenced by perceived value?

Subsequently, the objectives of this research are as follows: (1) To prove the effect of electronic word of mouth on purchase decisions. (2) To prove the effect of perceived value on purchase decisions. (3) To prove the effect of trust on purchase decisions. (4) To prove the effect of electronic word of mouth on trust. (5) To prove the effect of perceived value on trust.

2 LITERATURE REVIEW

According to Kotler and Keller (2016, pp. 198), at the evaluation stage, a consumer will choose one preferred thing among several brands and will also create an intention to purchase it. This means that people will decide if a product or service to be bought already exists among alternative options, enabling

evaluation and the best choice in the end. Schiffman and Kanuk (2009, pp.112) assert that a purchase decision is the choice of two alternatives, which means when someone makes a purchase decision, the act is already to choose one of several options. Purchase decision involves how the process of decision making is done.

Previous studies show that one of factors that influences purchase decisions is electronic word of mouth. Electronic word of mouth is a positive or negative statement that is made by potential customers, actual customers, and previous customers regarding to the product or company. This information is available for people or institutions via the internet. The development of online media makes it easy to deliver information. Jalilvand and Samiei (2012) said that electronic word of mouth is an important online space for customers to give their opinions and is considered more effective rather than word of mouth because its scope and accessibility is broader.

A study conducted by Themba and Mualala (2013) reported that electronic word of mouth affects positively and significantly on purchase decision. This means that experience expressed through electronic word of mouth will affect purchase decisions. Chang, Lee and Huang (2016) also found that electronic word of mouth affects positively and significantly on purchase decision. Almana and Mirza (2013) reinforces the finding that electronic word of mouth affects positively and significantly on purchase decision. This is due to many consumers obtaining information about products online, especially comments and reviews by other consumers. Based on the findings above, this research purposes the first hypothesis:

H1:   Electronic word of mouth affects positively on purchase decision.

Another factor that influences purchase decision making is perceived value. Before making a purchase decision, generally customers will evaluate the product or service that is offered. The evaluations include comparingprice, quality, and whether or the product fulfills the customer's needs. Mosavi and Ghaedi (2012) stated that perceived value is defined as customers perceive the sacrifice and expenditure given in accordance with benefits they expect. Kotler and Amstrong (2014, pp.35) suggested that perceived value is based on customer evaluation about a product or service that is offered and considers the benefits received and cost incurred. Therefore, it can be concluded that perceived value is a customer's assessment of a product or service before purchasing it.

Research conducted by Yee and San (2013) stated that perceived value affects significantly on purchase decisions. This means that when perceived value is good, a customer will have a greater purchase decision intent. Hoang, et al. (2016) found that perceived value affects positively and does not significantly impact on purchase decisions because consumers think that perceived value does not necessarily guarantee a product has good quality. Priansa (2016) argued that perceived value affects positively and significantly on purchase decisions. Based on the findings above, this research purposes the second hypothesis:

H2:   Perceived value affects positively on purchase decision.

Trust is also a factor that influences a purchase decision. Morgan and Hunt (1994) argued that trust arises as a result of the partner reability and integrity, which is demonstrated through various attitudes such as consistency, competence, fairness, responsibility, and caring. Kim, Ferrin and Rao (2008) showed that trust plays an important role in the e-commerce system, how trust is the first thought of a consumer before doing an online transaction. If customers do not trust e-commerce, they will not buy a product or service.

Research conducted by Anggraeni and Madiawati (2016) stated that trust affects significantly on purchase decisions because many customers already trusted a product such as Traveloka Apps. Chin, Wafa and Ooi (2009) revealed that trust affects positively on purchase decisions. However, Baskara (2014) asserted that trust affects positively but not significantly on purchase decision because lack of attention during the transaction makes consumers feel uncertain about doing a purchase. Based on the findings above, this research purposes a third hypothesis:

H3:   Trust affects positively on purchase decision.

A study conducted by Al-Debei, Akroush and Ashouri (2015) found that electronic word of mouth affects positively and does not significantly impact on trust. This is due to lack of information obtained by customers; they feel doubt in terms of personal data security and the transaction. Furthermore, Abubakar, et al. (2017) found that electronic word of mouth affects positively ontrust. Xiaorong, et al. (2011) agreed that electronic word of mouth affects positively and significantly on trust because when information is received continuously, this consistency increases the level of a customer's trust. Based on the findings above, this research purposes the fourth hypothesis:

H4:   Electronic word of mouth affects positively on trust.

Research conducted by Lai (2015) stated that perceived value also affects positively on trust. Widiartini and Yasa (2017) found that perceived value affects positively and significantly on a customer's trust. Chinomona, Okoumba and Pooe (2013) found that perceived value affects positively and significantly on customer's trust when deciding to purchase a gadget. Based on the findings above, this research purposes the fifth hypothesis:

H5:   Perceived value affects positively on trust.
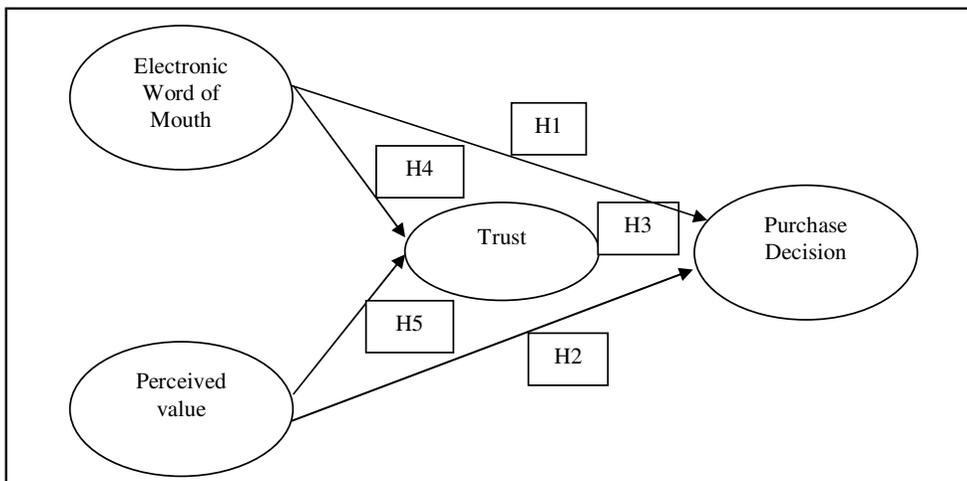
Figure 1 – Conceptual Framework

3   METHODOLOGY

According to Sekaran and Bougie (2013, pp. 240) population refers to an entire group of people, events, or things that attract a researcher to investigate it. The population for the current study is the users of the Go-Food Application in Jakarta. A Likert scale is more suitable to be used would this population because the Likert scale aims to measure attitudes, opinions, and perceptions of a person or group about a given social phenomena (Sugiyono, 2012, pp. 134) with a range from 1 to 5.

This research used nonprobability sampling with a convenience sampling technique, in which, according to Solimun (2002) the size of the sample is about 5 to 10 times the number of manifest variables (indicator) from the entire latent variables (see also Karno and Purwanto, 2017; Jauw and Purwanto, 2017). The number of the whole indicator in this research is 24, and minimal sample size be used in this research is $24 \times 7 = 168$ samples. In this research, the sample used is 175 respondents, which exceeds the recommended minimum.

According to Ghozali (2013, pp. 53), the validity test is used to measure whether or not a questionnaire is valid. A questionnaire is valid if the questions or statements are able to measure something that are in accordance with the questionnaire itself. Hair, et al. (2010) stated that an indicator is valid if it has a loading factor value ≥ 0.50. A questionnaire is reliable if a respondent's answer is stable over time. In this research, an indicator of each variable is reliable if Variance Extracted (AVE) ≥ 0.50 and Construct (CR) ≥ 0.70 Reliability (Ghozali, 2013, pp. 47-48).

The analysis technique is based on a Structural Equation Model (SEM) and analyzed using AMOS (Analysis of Movement Structure) software. SEM is a set of statistical techniques that testa set of relatively complex stimuli (Pardede and

Manurung, 2015, pp. 60). There are three types of techniques according to Ferdinand (2002, pp. 70) as follows:

1. Confirmatory factor analysis on SEM is used to confirm the most dominant factors in variable groups. Confirmatory factor analysis is used to test indicators that create a purchase decision through Go-food Application.

2. Regression weights on SEM are used to examine how much variables can affect each other. Regression weights are used to test the hypotheses H1 to H5.

3. Evaluation criteria for Goodness of Fit have some indexes and a cut-off value to test whether a model can be accepted or not.

    a. X^2 Chi-square statistics, a model is good if has a lowchisquare value. The smaller the X^2 value, the better the model is, and it can be accepted with a probabilily of p > 0.50.

    b. RMSEA (The Root Mean Square Error of Approximation) indicates the goodness of fit will be accepted if it has a small value or is equal to 0.08. It shows a close fit model based on the degree of freedom.

    c. GFI (Goodness Fit of Index) is a non-statistical measure that has a range between 0 (poor fit) to 1.0 (perfect fit). A high score indicates a better fit.

    d. AGFI (Adjusted Goodness Fit of Index) is recommended to be equal or higher than 0.90.

    e. CMIN/DF (The Minimum Sample Discrepancy Function divided by Degree of Freedom) is an acceptable fit if it has an X^2 valueless than 2.0 or 3.0.

    f. TLI (Tucker Lewis Index) is an incremental index that compares a tested model with a baseline model. A model will show a very good fit if the results of the test are more than 0.95 or close to 1.0.

    g. CFI (Tucker Lewis Index) is recommended if the value his close to 1.0 or more than 0.95.

4 FINDINGS AND DISCUSSION

All questionnaires were disseminated online, with 175 respondents who are considered to have appropriately completed the survey. Furthermore, respondents will be identified into several demographic categories for customer segments in order to better understand response characteristics. Respondents are grouped by gender. 65% were women and 35% were men. Based on age, there are of respondents 3% under 17 years old, 61% between 17 to 25 years old, 24%

between 26 to 35 years old, 11% between 36 to 50 years old, and 1% over 50 years old. Education can be divided into 3% having completed junior high school, 46% senior high school, 11% having a diploma, 38% having earned a bachelor's degree, and 2% with a master's degree. Regarding occupation, 9% were house wives, 53% were private employees, 26% were students and 13% were self employed. Based on monthly income, 23% earn 1-5 million, 38% earn 6-10 million, 10% earns above 10 million, and 28% have not earned an income yet.

Table 3 - Validity and Reliability Test

No	Variable	Indicators	SLF	Validity	AVE	CR	Reliability
1	Electronic word of mouth	EWOM1	0.660	Valid	0.566	0.766	Reliable
		EWOM2	0.682	Valid			
		EWOM3	0.624	Valid			
		EWOM4	0.628	Valid			
		EWOM5	0.547	Valid			
2	Perceived Value	PV1	0.659	Valid	0.666	0.821	Reliable
		PV2	0.625	Valid			
		PV3	0.666	Valid			
		PV4	0.619	Valid			
		PV5	0.724	Valid			
		PV6	0.653	Valid			
3	Trust	T1	0.738	Valid	0.672	0.822	Reliable
		T2	0.621	Valid			
		T3	0.517	Valid			
		T4	0.647	Valid			
		T5	0.741	Valid			
		T6	0.681	Valid			
4	Purchase Decision	PD1	0.763	Valid	0.798	0.883	Reliable
		PD2	0.677	Valid			
		PD3	0.699	Valid			
		PD4	0.619	Valid			
		PD5	0.742	Valid			
		PD6	0.781	Valid			
		PD7	0.754	valid			

Regarding the first time knowing about the Go-Food application, 15% knew about the application via the internet (website), 8% through family or relatives,35% through social media (Facebook, Twitter, Instagram, Path, YouTube, Testimonial), and 42% new about the Go-Food application through friends or relations.

Based on Tab. 3, all variables and indicators are shown to be valid and reliable because they met the criteria of standard loading factor (SLF ≥ 0.50), variance extracted (AVE ≥ 0.50), and construct reliability (CR ≥ 0.50). Prior to hypothesis testing, the data needs to be tested using the Goodness of Fit test.

Tab.4 shows that all of the indexes in the Goodness of Fit test are fit or good. The chi square result is 259.594, which is smaller than the degree of freedom 263.147 with the level of significance set to 0.05 (5%) which is good or fit. Other criteria such as Probability, RMSEA, GFI, AGFI, CMIN/DF, TLI, CFI are fit and results are also supported by the value of loading factor for each indicator being valid.

Table 4 – Goodness of Fit Index

Goodness of Fit Index	Cut-off Value	Result	Evaluation
X^2Chi-Square (df = 227)	Expected small	259.594	Fit
Probability	≥ 0.05	0.068	Fit
RMSEA	≤ 0.08	0.029	Fit
GFI	≥ 0.90	0.894	Fit
AGFI	≥ 0.90	0.860	Marginal
CMIN/DF	≤ 2.00	1.144	Fit
TLI	≥ 0.95	0.980	Fit
CFI	≥ 0.95	0.983	Fit

The next analytic step is hypotheses testing to find out whether the hypotheses are accepted or not. The test itself will be looking at p-value on the output of regression weights. If the p-value is less than 0.05, then the hypothesis is accepted and significant. The table of regression weights are shown in Tab.5.

Table 5 - Regression Weights

			Estimate	S.E.	C.R.	P	Label
Purchase Decision	←	E-WOM	.182	.089	2.044	.041	par_13
Purchase Decision	←	Pervceived Value	.393	.184	2.133	.033	par_14
Purchase Decision	←	Trust	.577	.217	2.661	.008	par_24
Trust	←	E-WOM	.188	.092	2.053	.040	par_25
Trust	←	Pervceived Value	.714	.115	6.181	***	Par_26

Hypothesis 1 (H1) states that electronic word of mouth has an effect on purchase decision. On Tab.5 shows that -value is 0.041 or under 0.050, so the hypothesis is accepted. This means that electronic word of mouth affects the respondents to use Go-Food application. Hypothesis 2 (H2) states that perceived value has an effect on purchase decision. Tab.5 shows that the p-value is 0.033 or under 0.050, so the hypothesis is accepted, which means that perceived value of respondents affects them to make a purchase decision through the Go-Food application. Hypothesis 3 (H3) states that trust effects purchase decisions. Tab.5 shows that the p-value is 0.008 or under 0.050, so the hypothesis is accepted. This means that the majority of respondents trust the Go-Food application and will make a purchase decision when using the application. Hypothesis 4 (H4) states that electronic word of mouth has an effect on trust. Tab.5 shows that the p-value is 0.040 or under 0.050, so the hypothesis is accepted. This result means that electronic word of mouth affects a respondent's trust in using the Go-Food application. Hypothesis 5 (H5) states that perceived value impacts trust. Tab.5 shows that p-value is 0.000 or under 0.050, so the hypothesis is accepted, meaning that perceived value of respondents affects their trustin using the Go-Food application.

The study proves that the first hypothesis is accepted, which is that the electronic word of mouth has a direct positive effecton purchase decisions. This finding is supported Themba and Mulala (2013) whereby electronic word of mouth affects positively and significantly on purchase decision. The majority of respondents' ages are between 17-25 years old, and at that age the respondents are likely to have a sense of curiousity to prove something. If the information about Go-Food are interesting, then the user in this age bracket is likely toimmediately make a purchase. The average respondent income is 6 to 10 million IDR or about US $600 to $1,000 (39%), and it is possible to purchase through Go-Food application.

The study also proves that the second hypothesis is accepted, in which perceived value has direct positive effects on purchase decisions. This result is supported Yee and San (2013) who also found that perceived value affects significantly on purchase decisions. Regarding the respondent's profile who are dominated by young ages and good educational background, it is easy to find out any information through the internet and users can interact with others about the Go-Food application. This leads them to form a sense of perceived value. Respondents have gained experiences after using the application and most of themagree with the perceived value statements and will form a purchase decision. In this research, perceived value affects positively on purchase decision, which means they think positively thus far about the Go-Food application.

The third hypothesis also is accepted. Trust has a direct positive effect on purchase decisions. This result is supported by Anggraeni and Madiawati (2016) who argued that trust affects significantly on purchase decisions. By looking the majority of respondents being 17-25 years old (61%) and most recent education is senior high school (44%), nonetheless students (27%) are smart to formulate

trust by feeling the services given. When the trust is established, the tendency to buy foods through the Go-Food application will be greater. Most of them also claim that they learned about the Go-Food application for the first time from friends or relations (36%), which means they can find out more about the application by asking people they know directly. Therefore, the trust itself can increase the purchase transactions.

The fourth hypothesis is also accepted, demonstrating that electronic word of mouth has a direct positive effect on trust. This result is supported by the work of Xiaorong, et al. (2011) who that electronic word of mouth affects positively and significantly on respondent's trust. The respondents' profile shows that the majority of them are 17-25 years old (61%) and have a tendency to think critically, whereby they can analyze the truth of information through social media. This is also supported by good background education being senior high school (44%) and recent technological advances will facilitate them to seek information through electronic media because it easier and faster than more traditional means of obtaining information from from others face-to-face. In this research, what has been read about the Go-Food application through social media will create a respondent's trust.

Finally, the fifth hypothesis also is accepted, in which perceived value has a direct positive effect on trust. This result is supported Widiartini and Yasa (2017) who stated that perceived valuehas apositiveand significant effect on trust. Through the respondent's profile, most of them have a good background education, which is senior high school (44%) up to bachelor's degree (40%), such that these respondents can evaluate information before developing trust in order to form a perceived value later. This perceived value is not limited by evaluation of quality band price, but also by how the respondents feel about the Go-Food application itself. They tend to do an assessment before finally being able to trust the application

5   CONCLUSION

The above summaries provide the conclusions for the current research. Firstly, purchase decision is affected by electronic word of mouth, which means electronic word of mouth is being read in social media and can encourage people to buy foods on the Go-Food application. Secondly, purchase decision is affected by perceived value, which means the better perceived value formed by Go-Food users, the higher the tendency to purchase foods through the application. When the services given are good, that will create a better perceived value because users can evaluate all services from the experiences, whether it already met their needs or not. Thirdly, purchase decision is affected by trust, which means if trust is increased, then the purchase decision will be increased as well. Creating the customer's trust is not easy but Go-Jek needs to improve service quality especially in the Go-Food apps. Fourthly, trust is affected by electronic word of mouth, which means through reading the reviews or Go-Food's users'

experiences in social media impact someone's trust towards the information. Fifthly, trust is affected by perceived value, which means if perceived value increases, then the user's trust will increase as well. After purchasing foods through the Go-Food applicaton, users can evaluate the services that they experienced. Through perceived value, users can evaluate the Go-Food application in terms of price, quality, and what they feel after having used it. Sixthly, this result indicates that electronic word of mouth affects positively and significantly on purchase decision if mediated by trust and that perceived value affects positively and significantly on purchase decisions if mediated by trust.

6   SUGGESTIONS AND LIMITATIONS

The suggestions of the research are: (1) the variable of electronic word of mouth has the lowest value compare to other variables based on the respondents' answers. Nonetheless, it is difficult for Go-Jek Indonesia Ltd. to direct its users to write good reviews on social media because it depends on what they feel about the Go-Food application. However, as long as the information and services are well provided, it is possible to create positive electronic word of mouth. Other important factors, such as information about price, food choices, and security in the Go-Food application should be appropriate to reality because any discrepancy between what is promised and what is experienced will decrease the level of user trust and their subsequent purchase decisions. (2) Perceived value itself is considered good by Go-Food users, and can be seen on in their average answer about the safety, food choices, and enjoyment in using this app. This result needs to be defended by Go-Jek and be improved to add more food items to the menu to increase interest in purchasing foods through the Go-Food application. (3) the existence of promotions by Go-Jek such giving a discount on particular foods will attract other users to engage in purchasing behavior. According to this research, the information about promos is mostly read by the respondents through social media, which is a practice that should be maintained. Moreover, the advantage of using promos will increase the user' s trust, perceived value, and results with a purchase decision. All the suggestions above need to be maintained in order to keep this application improving in the future.

The limitations of the research are: (1) this research proves that there are positive and significant affects between variables, weather dependent (trust and purchase decision) or independent (electronic word of mouth and perceived value). Further research can expand the indicators or add other variables that can affect purchase decisions such as service quality, word of mouth, or customer loyalty. (2) This research is limited to the Go-Food application owned by Go-Jek Indonesia Ltd. Future research can change the objects of research besides Go-Food, such as Go-Car, Go-Mart, Go-Send, Go-Box, Go-Pulsa, Go-Massage, Go-Clean, or any transportation objects beyond Go-Jek's ownership. (3) The sample area of respondents is only those who live in Jakarta. Thus, additional research can take a wider respondent area and include other cities in Indonesia. Go-Jek itself is

already spread across several cities, which will provide interesting insight to whether respondents' answers are consistent with the findings of this research.

REFERENCES

Abubakar, A.M., Ilkan, M., Al-Tal, R.M. and Eluwole, K.K.,2017. eWOM, revisit intention, destination trust and gender. *Journal of Hospitality and Tourism Management*, [e-journal] 31, pp.220-227. https://doi.org/10.1016/j.jhtm.2016.12.005.

Al-Debei, M.M., Akroush, M.N. and Ashouri, M.I. 2015. Consumer attitudes towards online shopping: The effects of trust, perceived benefits, and perceived web quality. *Internet Research*, [e-journal] 25(5), pp.707-733. https://doi.org/10.1108/IntR-05-2014-0146.

Almana, A.M. and Mirza, A.A., 2013. The Impact of electronic word of mouth on consumer's purchasing decisions. *International Journal of Computer Applications*, 82(9), pp.23-31.

Anggraeni, P. and Madiawati, P.N., 2016. Pengaruh kepercayaan dan kualitas informasi terhadap keputusan pembelian secara online pada situs www.traveloka.com. *e-Proceeding of Management,* 3(2), pp.1880-1887.

Baskara, I.P., 2014. *Analisis pengaruh kepercayaan, keamanan, kualitas pelayanan dan persepsi akan resiko terhadap keputusan pembelian melalui situs jejaring sosial.* Final Project. Semarang: Universitas Dian Nuswantoro Semarang.

Chang, L.Y., Lee, Y.J. and Huang, C.L., 2016. The influence of e-word-of-mouth on the consumer's purchase decision: a case of body care products. The Journal of Global Business Management, [e-journal] Available through: The Journal of Global Business Management <http://www.jgbm.org/page/2%20Yu_je%20Lee.pdf> [Accessed 15 June 2017].

Chin, A.J., Wafa, S.A.W.S.K. and Ooi, A.Y., 2009. The effect of internet trust and social influence towards willingness to purchase online in Labuan, Malaysia.*International Business Research*, [e-journal] 2(2), pp.72-81. http://dx.doi.org/10.5539/ibr.v2n2p72.

Chinomona, R., Okoumba, L. and Pooe, D., 2013. The impact of product quality on perceived value, trust and students' intention to purchase electronic gadgets. *Mediterranean Journal of Social Sciences*, 4(4), pp.463-472.

Ferdinand, A., 2002. *Structural equation modeling dalam penelitian manajemen*. Semarang: Badan Penerbit Universitas Diponegoro.

Ghozali, I., 2013. *Aplikasi analisis multivariate dengan program IBM SPSS 21*. Semarang: Badan Penerbit Universitas Diponogoro.

Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E., 2010. *Multivariate data analysis: A global perspective*. New Jersey: Pearson Education, Inc.

Hoang, T.P., Tuan, N.M., Khanh, V.H. and Duc, L.M., 2016. The impact of perceived value to the purchasing decisions of consumers for natural cosmetic products: A study on "M White" natural cosmetic brands of D.O PRO Joint Stock Company in Vietnam. *American Based Research Journal*, 5(12), pp.25-33.

Jalilvand, M.R. and Samiei, N., 2012. The effect of electronic word of mouth on brand image and purchase intention: An empirical study in the automobile industry in Iran. *Marketing Intelligence & Planning*, 30(4), pp.460-476.

Jauw, A.L.J. and Purwanto, E., 2017. Moderation effects of cultural dimensions on the relationship between e-service quality and satisfaction with onlinepurchase. *Quality - Access to Success*, 18(157), pp.55-60.

Karno, C.G. and Purwanto, E., 2017. The effect of cooperation and innovation on business performance. *Quality - Access to Success*, 18(158), pp.123-126.

Kim, D.J., Ferrin, D.L. and Rao, H.R., 2008. A trust-based consumer decision-making model in electronic commerce: The role of trust, perceived risk, and their antecedents. *Decision support system*, 44(2), pp.544-564.

KOMINFO, 2017. *Kementerian Komunikasi dan Informatika Republic Indonesia.* [online] Available at: <https://www.kominfo.go.id/> [Accessed 15 June 2017].

Kotler, P. and Amstrong, G.,2014. *Principle of marketing.* 15 ed. Upper Saddle River, NJ, US: Pearson Prentice Hall, Inc.

Kotler, P. and Keller, K.L., 2016. *Marketing management.* 15 ed. Upper Saddle River, NJ, US: Pearson Education, Inc.

Lai, Y.H., 2015. Enhance online purchase intentions: The role of rerceived value, trust, and commitment. *Journal of Tourism and Hospitality Management*, 3(2), pp.89-99.

Morgan, R.M. and Hunt, S.D. 1994. The commitment-trust theory of relationship marketing. *Journal of Marketing*, 58(3), pp.20-38.

Mosavi, S.A. and Ghaedi, M., 2012. An examination of the effects of perceived value and attitude on consumers behavioral intentions in e-shopping. *African Journal of Business Management*, 6(5), pp.1950-1959.

Pardede, R. and Manurung, R., 2015. *Prosedur dan aplikasi AMOS dalam penelitian model persamaan struktural.* Jakarta: Penerbit Harfamedia.

Permatasari, C.D.W., 2015. *Pengaruh kepercayaan, keamanan, persepsi resiko, dan kualitas pelayanan terhadap keputusan pembelian secara online (Studi pada pengguna situs olx.co.id d/h berniaga.com)*. Final Project. Semarang: Universitas Dian Nuswantoro Semarang.

Priansa, D.J., 2016. Pengaruh e-wom dan persepsi nilai terhadap keputusan konsumen untuk berbelanja online di Lazada. *Journal of Ecodemica*, 4(1), pp.117-124.

Schiffman, L.G. and Kanuk, L.L., 2009. *Consumer behavior*. Upper Saddle River, NJ, US: Prentice Hall, International.

Sekaran, U. and Bougie, R., 2013. *Research methods for business*. United Kingdom: John Wiley & Sons Ltd.

Solimun, 2002. *Structural equation modeling, Lisreldan Amos*. Malang: Fakultas MIPA, Universitas Brawijaya.

Sugiyono, 2012. *Metode penelitian kuantitatif kualitatif dan R&D*. Bandung: Alfabeta.

The Business Perspective, 2017. *The business perspective oleh Fakhrurroji Hasan.* [online] Available at: <https://thebusinessperspectiveblog.wordpress.com/> [Accessed 15 June 2017].

Themba, G. and Mulala, M., 2013. Brand-related e-wom and its effects on purchase decisions: An empirical study of University of Botswana students. *International Journal of Business and Management*, 8(8), pp.31-40.

Widiartini, P.R. and Yasa, N.N.K., 2017. Peran kepercayaan dalam memediasi hubungan persepsi nilai dengan niat menggunakan e-money. *Matrik: Jurnal Manajemen, Strategi Bisnis dan Kewirausahaan*, 11(1), pp.11-25.

Xiaorong, F., Bin, Z., Qinghong, X., Liuli, X. and Yu, C., 2011. Impact of quantity and timeliness of e-wom information on consumer's online purchase intention under C2C environment. *Asian Journal of Business Research*, 1(2), pp.37-52.

Yee, C.J. and San, N.C., 2013. Consumer's perceived quality, perceived value and perceived risk towards purchase decision on automobile. *American Journal of Economics and Business Administration,* 3(1), pp.47-57.

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The Usage of Video Tutorials, Personal Support and Written Instructions for Knowledge Acquisition and Refreshment

Jane Worlitz, Anne Stabler, Ralf Woll

ABSTRACT

Purpose: The target of this study is to reveal which aids used are the best method for acquiring knowledge. Especially by the use of Quality management tools regarding spreadsheets and statistics software. Therefore video tutorials, personal support and written instructions, as aids, are compared with and without time pressure.

Methodology/Approach: Students of the quality management class participated in two tests in order to capture user behavior. In the first part the students (n = 56) were asked about their user behavior regarding aids after a project that lasted several months. In the second part the students (n = 40) were given two aids and captured which aids they are using. The duration period and the quality of the results were also documented. At the end of both tests, the students were asked about their future favorite aids.

Findings: The first test revealed that 73% of the students used the video tutorial as an aid for their work. In future situations the students would work with written instructions, as long as there is no time pressure. If time limitation is a factor, they would rather work with video tutorials again. The second test confirmed that using video tutorials allowed for a shorter duration period. 48% were using the video tutorial while 38% used the written instruction. The suitability rating of the aids as well as the quality of the result did not differ. In future situations, the students would work again with video tutorials with or without time pressure.

Research Limitation/implication: The usage of video tutorials, personal support and written instructions for the application of Quality management tools with the use of appropriate software has been examined. The results do not show conclusions about the extent to which the aids are used for the mediation of complex issues. Follow-up studies are required for this purpose.

Originality/Value of paper: Among these three aids with regard to time pressure, video tutorials as well as the personal support seem to be the most efficient. If time pressure was applied to the test setting, the video tutorial was preferred. In the considered setting the use of video tutorials is recommended.

Category: Research paper

Keywords: video tutorial; education; knowledge transfer; quality tools; software

1   INTRODUCTION

The usage of new media and technologies has changed the knowledge transfer over the past several decades. Learning platforms are often used to provide scripts, texts, and handouts, via the Internet, for all learners. Another innovation of the computer age is e-learning. Computer-based learning has evolved the increasingly popular teaching style of the video tutorial. Such learning videos can be used for self-organized learning.

In this work, the available tools that are used for the acquisition of knowledge and revitalization is investigated. The use of video tutorials as an aid is compared with the use of written instructions and the personal support of third parties.

The user behavior in regard to the aids will be tested in the utilization of Quality management (QM) software tools. The software skills among the participants are heterogeneous. For that reason, aids for the acquisition of knowledge and revitalization are necessary.

In 2004 the European Commission of Statistics published a statistic regarding the computer skills among the European population. It was noticed that 45% of the interviewees have little to no computer skills. 44% of the 16-74 year olds and 65% of the 16-24 year olds have basic knowledge in the usage of spreadsheet software such as common arithmetic formulae (Eurostat, 2015).

Computer skills are necessary in today's professional life. In 2017, 55% of European employees regularly used a computer. Using software is also required by the implementation of software tools in quality management (Eurostat, 2018).

The efficient knowledge transfer and the provision of suitable tools requires the learner's awareness and willingness to use these aids.

2   LITERATURE REVIEW

The use of video tutorials for different areas of learning at universities and schools has been analyzed in a number of studies.

Siegel, Omer and Agrawal (1997) examine the suitability of video tutorials for an introductory course of accounting, Stefanidis, et al. (2007) for medical students, DeVaney (2009) for an online statistic course, He, Swenson and Lents (2012) for a chemistry course and Truebano and Munn (2015) for molecular biology class.

Further studies dealing with this topic can be found from authors such as Morgan, et al. (2002) Balsley, et al. (2005), Boster, et al. (2006), Coffee and Hillier (2008), Jones, Dean and Hui-Chan (2010) and van der Meij and van der Meij (2015). All studies confirm that the learning performances supported by the use of video tutorials are similar to those supported by a teacher or other teaching materials. In some cases, the groups that used video tutorials even performed better.

In a study, the suitability of video tutorials for teaching software skills in quality management has been examined. Sixty-five students in the quality management class (n = 65) in the age of 19 to 28 participated in this study. 62% of the participants study Business Administration, 32% Industrial Engineering and 7% in other technical disciplines. The students were divided into two groups (Group 1: n = 31, Group 2: n = 34) and separated into two rooms. Both groups received an identical task. A QM tool should be used with the help of a software. One group was supported by a tutor, the other group got a video tutorial. Before and after the experiment, both groups got a survey to gather data such as personal data, software skills, requirements of aids and the suitability of the aids. Additionally, the task from the experiment was clocked and the result was rated. The analysis was done with the help of IBM SPSS and Microsoft Excel. The following results were revealed. The type of the used aid has no influence on the suitability of the aid, rated by the students or on the experiment's result rating and neither on the needed time to solve the problem. Video tutorials are a valid alternative to the personal tutor (Worlitz, et al., 2016).

It is questionable how these aids are provided and used with reflection on praxis.

3 RESEARCH METHODOLOGY AND RESULTS PART I

In order to record the user behavior, two experiments with students of the quality management class were preformed.

3.1 Database of the Survey Part I

In the first part a study with fifty-six students was implemented. 71% of the participants study Business Administration, 23% Industrial Engineering and 5% other technical disciplines. 55% of the participants were male, 45% female.

3.2 Survey Strategy Part I

The students worked on an improvement project in cooperation with a company. It was necessary to use QM tools with the help of software. In the beginning different aids were provided to the students, such as video tutorials. After the project was finished, the students were interviewed with the use of an online survey about their usage of the aids.

3.3   Survey Results Part I

In these improvement projects, 73% of the students used video tutorials. The students were asked to rank the aids for knowledge acquisition and revitalization, from most efficient to least efficient, if they would be part of an improvement project team in a company and would have to use a QM tool (see Fig. 1).
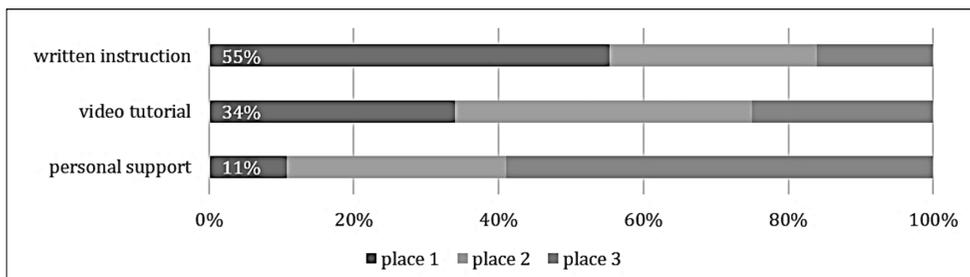
Figure 1 – Ranking of Aids

As a result it can be assumed that the students would predominantly use written instructions, rather than video tutorials and as a last resort the personal support.

The students were also asked if they would change this ranking if they would have to complete the task as quickly as possible (see Fig. 2).
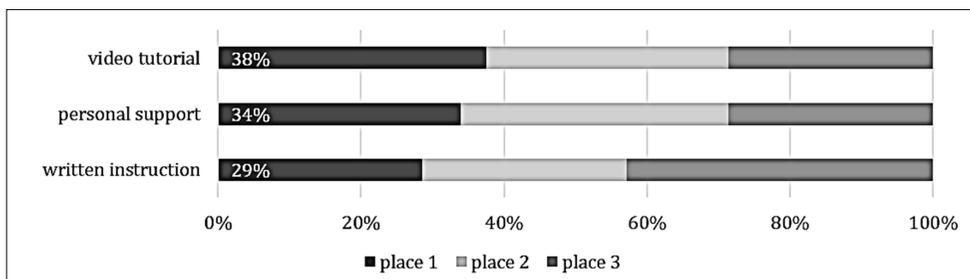
Figure 2 – Ranking of Aids, Pressed for Time

As the results reveal, written instructions drop from the first rank to the third. 38% would use video tutorials, 34% would prefer personal support.

4   RESEARCH METHODOLOGY AND RESULTS PART II

Based on the results of the first study, the suitability and user behavior of video tutorials was compared to written instructions.

The following three hypothesis were created.

H 1 a   The type of the predominantly used aid (video tutorial or written instruction) has an influence on the rated suitability of the aid in order to solve the task.

H 1 b   The type of the predominantly used aid (video tutorial or written instruction) has an influence on the results the students achieved in the task.

H 1 c   The type of the predominantly used aid (video tutorial or written instruction) has an influence on the time which was necessary to solve the task.

4.1   Database of the Survey Part II

Fourty students in the age from 19 to 31 from the quality management class participated in this study. 53% of the participants study Business Administration, 40% Industrial Engineering and 7% other technical disciplines. 58% of the participants were male, 43% female.

4.2   Survey Strategy Part II

The task given to the students was to create a Quality Control Chart by the use of MS Excel. All data was provided via an online portal. Aids for the task were provided, such as a video tutorial a as well as written instructions, both were created by the same tutor. The students were free to choose which aid they used and asked to record the claimed time for the task. The task was provided within an MS Excel spreadsheet. The result was submitted via e-Mail.

The students were asked to fill out a questionnaire before and after the task. By using identification numbers it was possible to match the questionnaires with the submitted task. It took about ten minutes to complete the survey. The two questionnaires were designed as follows.

The first questionnaire, which was completed before the task, contained a small introductory text followed by personal data, software skills and general knowledge acquisition.

After the task, a second questionnaire was filled out by the students. The questionnaire was divided into two parts. In one part the general user behavior regarding aids was gathered. In the other part the students were asked about the suitability of the aids regarding the given task.

4.3   Survey Results Part II-I

The survey revealed following results regarding software skills, the acquisition of knowledge and the general user behavior regarding the aids.

With the use of a 7-Point-Likert scale from 1 "very low" to 7 "very high" the participants were asked about their software skills. The students estimated their MS Excel skills in a medium range ($\bar{x}$ = 3.85). Knowledge with similar software was rated lower ($\bar{x}$ = 2.71). So the students are capable to use basic functions such as formulas, diagrams and formatting.

With the use of a 7-Point-Likert scale from 1 "rarely" to 7 "very often" the participants were asked about for which purpose they would use this aid. The students used the aids for knowledge acquisition as well as knowledge revitalization (Fig. 3).
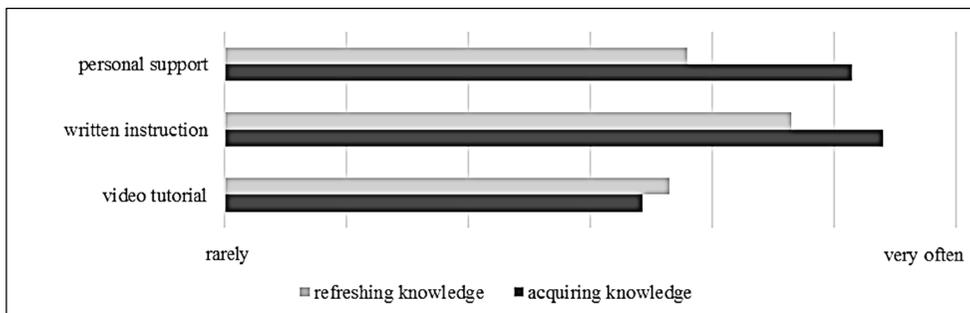
Figure 3 – Usage of Aids

The participants are using video tutorials often for personal purposes ($\bar{x}$ = 5.18) as well as university purposes ($\bar{x}$ = 5.15). Written instructions are used somewhat often for personal purposes ($\bar{x}$ = 4.45) and often for university purposes ($\bar{x}$ = 5.37). Both aids are occasionally used to improve MS Excel knowledge ($\bar{x}_{VT}$ = 3.5; $\bar{x}_{SI}$ = 3.11).

Written instructions are predominantly used to demand facts and video tutorials are used to gain user oriented knowledge (Fig. 4).
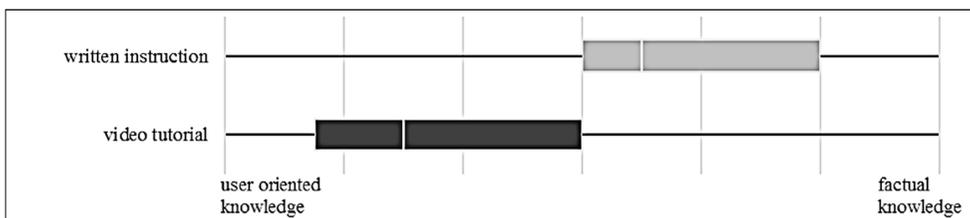
Figure 4 – User Behavior Based on the Type of Knowledge

More than 50% of the participants are using video tutorials and written instruction once a week (see Fig. 5).
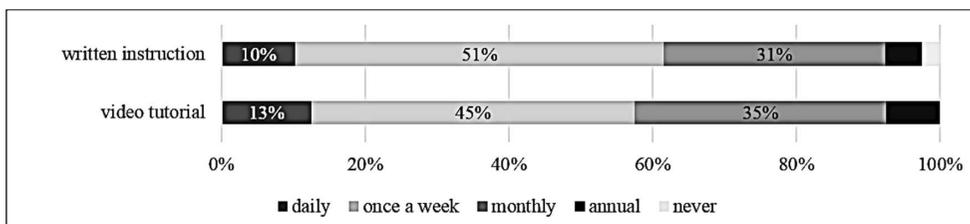
Figure 5 – Usage Frequency

In the process of the practical task, 48% (19 students) predominantly used the video tutorial, which means more than 60% of the overall-aid-usage. 38% (15 students) predominantly used written instructions. The others (15%) did not use one of the two aids to more than 60%. That means, no aid was used or a different aid was used or both aids were used in equal shares.

4.4 Survey Results Part II-II

The survey regarding the suitability of aids enables the review of the hypothesis. Thirty-four students (n = 34) participated in this survey, which were using predominantly one aid. Based on the students' answers the hypotheses were tested. The analysis was done with the help of IBM SPSS Statistics (see Tab. 1, Tab. 2 and Tab. 3).

Table 1 – Test Hypothesis a

How useful was the provided aid regarding the task?			
Null hypothesis	Test	Sig.	Decision
The distribution across the categories „type of aid" is identical.	Mann-Whitney-U-Test for independent sample	0.127	Keep null hypothesis

→ *H0 a is not rejected. The type of the predominantly used aid has no influence on the rated suitability of the aid in order to solve the task.*

Table 2 – Test Hypothesis b

How good was the task done?			
Null hypothesis	Test	Sig.	Decision
The distribution across the categories „type of aid" is identical.	Mann-Whitney-U-Test for independent sample	0.228	Keep null hypothesis

→ *H0 b is not rejected. The type of the predominantly used aid has no influence on the results the students achieved in the task.*

Table 3 – Test Hypothesis c

How long was the duration period of the task in minutes?			
Null hypothesis	Test	Sig.	Decision
The distribution across the categories „type of aid" is identical.	Mann-Whitney-U-Test for independent sample	0.047	Reject null hypothesis

→ *H0 c is rejected. H1 c has a significance level of 95.3%. The type of the predominantly used aid has influence on the time which was necessary to solve the task.*

Students who predominantly used the video tutorial needed in average 30 min to process the task. Students who used the written instructions needed in average

39 min to process the task. That implies, video tutorials suit better for tasks that have to be accomplished under time pressure.

After the task, the students were asked how they would rank the used aids, if they would have to refresh their knowledge, and if they would have to work on a similar task later (see Fig. 6).
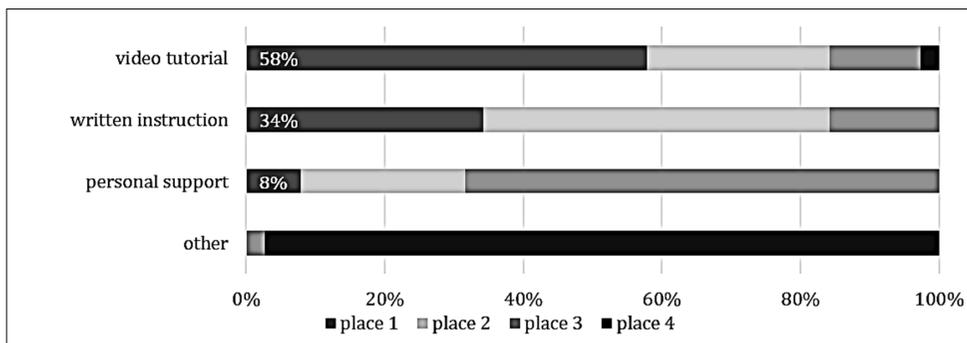
Figure 6 – Ranking of Aids

The majority of students would use the video tutorial, and secondly the written instruction. The video tutorial was rated higher than in the previous ranking.

Also the students were asked how they would change the order, if they would have to work on the task under time pressure (Fig. 7).
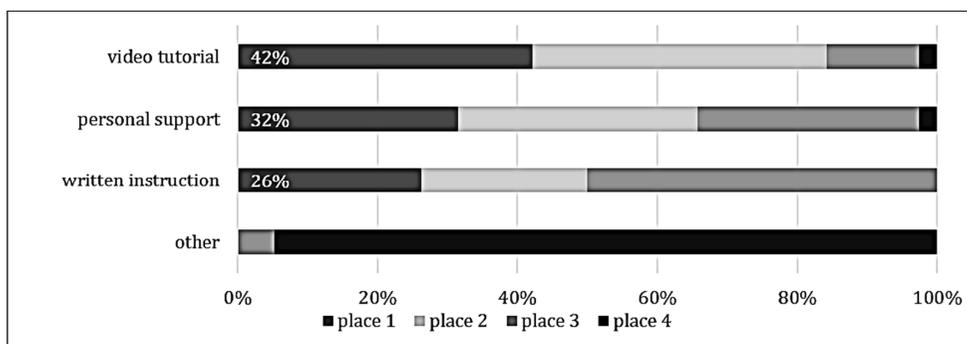
Figure 7 – Ranking of Aids, Pressed for Time

As the results reveal, written instructions are now ranked third. 42% of the students would use a video tutorial first, 32% would use the personal support.

5   DISCUSSION AND FUTURE RESEARCH DIRECTION

The students have basic knowledge and respectively enhanced knowledge in the use of statistical and spreadsheet software. Only a few are able to work on a very advanced level. Accordingly, there is a need to close the lack of competence.

Among the three aids, video tutorials and the personal support are the most suitable when under time pressure. In regards to time pressure, the video tutorial is preferred.

Experienced video creators would spend approximately four hours for recording a video tutorial as it was used in this experiment. The used time for the experiment's task was in average approximately half an hour. As a consequence, up to eight requests to the same topic, the personal support is the most efficient aid; assuming that personal support is available every time. Over eight requests to the same topic, video tutorials are the recommended aid.

The results are limited on the user behavior of aids used for QM tools within MS Excel. It can be assumed, that the results can be transferred on the use of QM tools within other statistical and spreadsheet software. More studies are necessary to support this thesis.

The results do not cover the user behavior of aids in complex tasks. To examine this, more studies would be necessary.

The study was implemented with students of the quality management class. Further research should focus on knowledge management in companies.

6 CONCLUSION

In private, as well as in university life, students regularly use video tutorials and written instructions. Video tutorials are predominantly used for gaining user oriented knowledge. For gaining factual knowledge, written instructions are used more often. Providing video tutorials for user oriented knowledge is recommended for universities, training academies and companies. Especially under time pressure, video tutorials are an efficient alternative to written instructions and personal support.

REFERENCES

Balslev, T., De Grave, W., Muijtjens, A. and Schrepbier, A., 2005. Comparison of text and video cases in a postgraduate problem based learning format. *Medical Education*, [e-journal] 39(11), pp.1086-1092. http://dx.doi.org/10.1111/j.1365-2929.2005.02314.x.

Boster, F., Meyer, G.S., Roberto, A.J., Inge, C. and Strom, R., 2006. Some Effects of Video Streaming on Educational Achievement. *Communication Education*, [e-journal] 55(1), pp. 46-62. http://dx.doi.org/10.1080/03634520500343392.

Coffee, J. and Hillier, S., 2008. Teaching pre-cursor clinical skills using an online audio-visual tool: an evaluation using student responses. *Merlot Journal of Online Learning and Teaching*, 4(4), pp.469-476. Available at: <http://jolt.merlot.org/vol4no4/coffee_1208.pdf> [Accessed July 2018].

DeVaney, T.A., 2009. Impact of Video Tutorials in an Online Educational Statistics Cours. *Journal of Online Learning and Teaching*, 5(4). Available at: <http://jolt.merlot.org/vol5no4/devaney_1209.htm> [Accessed July 2018].

Eurostat, 2015. *Individuals' level of computer skills*. [Database by themes > General and regional statistics > Degree of Urbanisation > Digital economy and society > Digital skills > ICT users] Eurostat. [online] Available through: Eurostat – Data Explorer: <http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_sk_cskl_i&lang= en> [Accessed July 2015].

Eurostat, 2018. *Use of computers and the internet by employees*. Eurostat. [online] Available through: Eurostat – Data Explorer: <http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_ci_cm_pn2&lang =en> [Accessed July 2018].

He, Y., Swenson, S. and Lents, N., 2012. Online video tutorials increase learning of difficult concepts in an undergraduate analytical chemistry course. *Journal of Chemical Education*, [e-journal] 89(9), pp.1128-1132. http://dx.doi.org/10.1021/ed200685p.

Jones, A.Y.M., Dean, E. and Hui-Chan, C., 2010. Comparison of teaching and learning outcomes between video-linked, web-based, and classroom tutorials: An innovative international study of profession education in physical therapy. *Computer & Education*, [e-journal] 54(4), pp.1193-1201. http://dx.doi.org/10.1016/j.compedu.2009.11.005.

Morgan, P., Cleave-Hogg, D., McIlory, J. and Devitt, J., 2002. Simulation technology a comparison of experiential and visual learning for undergraduate medical students. *Anesthesiology*, [e-journal] 96(1), pp.10-16. http://dx.doi.org/10.1097/00000542-200201000-00008.

Siegel, P., Omer, K. and Agrawal, S., 1997. Video simulation of an audit: Experimental learning theory. *Accounting Education*, [e-journal] 6(3), pp.217-230. http://dx.doi.org/10.1080/096392897331451.

Stefanidis, D., Korndorffer, J.R., Heiniford, B.T. and Scott, D.J, 2007. Limited feedback and video tutorials optimize learning and resource utilisation during laparoscopic simulator training. *Surgery*, [e-journal] 142(2), pp.202-206. http://dx.doi.org/10.1016/j.surg.2007.03.009.

Truebano, M. and Munn, C., 2015. An evaluation of the use of video tutorials as supporting tools for teaching laboratory skills in biology. *Practice and evidence of scholarship of teaching and learning in higher education*, 10(2), pp.121-135.

van der Meij, J. and van der Meij, H., 2015. A test of the design of a video tutorial for software training. *Journal of Computer Assisted Learning*, [e-journal] 31(2), pp.116-132. http://dx.doi.org/10.1111/jcal.12082.

Worlitz, J., Stabler, A., Peplowsky, S. and Woll, R., 2016. Video Tutorials: An Appropriate Way of Teaching Quality Management Tools Applied with Software. *Quality Innovation Prosperity*, [e-journal] 20(2), pp.169-184. http://dx.doi.org/10.12776/QIP.V20I2.754.

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