

**Memorial:
Emer. Prof. Alexander Linczényi, CSc.
(1932-2019)**

*Former Vice President of the European Organization for Quality for the
East Block*

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Prof. Linczényi is known as one of the pioneers of quality management in academia and among professionals in former Czechoslovakia. Moreover, he is also considered a father of quality in Slovakia. He held back then the function of Vice President of the European Organization for Quality for the East Block. He was a member of the Association of Scientific and Technical Societies and after the division of the Czech and Slovak Republics, he became actively involved in preparatory activities for the establishment of the Slovak Society for Quality. He worked for more than 40 years as the head of the Quality Management department at STU, based in Bratislava. Professor is an author and co-author of many scientific monographs and textbooks such as, e.g. Engineering Statistics, Quality Management, Distance Learning for Quality Managers, Quality Professional, textbook for Quality Management at Secondary Vocational Schools and many others. He published more than 400 articles in domestic and international magazines and participated at domestic and international conferences, symposia and congresses, e.g. in Australia, China, Israel, Greece, Bulgaria, Hungary, Estonia, Portugal, France, Poland, Czech Republic, Croatia, Montenegro, Germany, Netherlands, etc. Regularly, he also attended congresses organized by the European Organization for Quality. Prof. Linczényi is an author of the economic basis idea for quality management, and in

his research, he created quality indicators and profitability indicators of quality. One of his contributions can be considered the definition of Creative Quality Management. For his scientific results, he was awarded the title of Scientist of the Year by the president of the Slovak Republic and similarly he was awarded by the Slovak president and Chairman of the Office for Standardization, Metrology and Testing for the lifelong contribution in the area of Quality Management. Slovak Society for Quality had awarded professor for his lifetime work in the area at the occasion of World Quality Day.

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Lean Management “Quick-Wins”: Results of Implementation. A Case Study

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ABSTRACT

Purpose: This study comprised two main goals. The first goal demonstrates how LT (Lean Tools) allows the highest impact during the implementation phase. The second goal consisted of introducing procedure changes based on the Management of Human Resources through Lean Leadership tool. The target for these two objectives is to achieve an increase of 5% in machine occupancy rate and a reduction of 10% regarding the costs of defective products per hour.

Methodology/Approach: The research methodology is a Action-Research/Research-Action developed by Professor Kurt Lewin of MIT that goes through cycles of five stages: Diagnosis; Planning; Implementation; Evaluation, Conclusions.

Findings: Regarding the two objectives above mentioned, it was observed an increase of 8.5% in machine occupancy rate and a reduction of 27.9% regarding the costs per hour of defective products. It was created an additional motivation in the employees and very satisfying results in every production.

Research Limitation/implication: The study is limited to a Portuguese Small and Medium-sized Enterprise (SME) in the metalworking sector.

Originality/Value of paper: Lean tools can be rapidly and easily implemented and quickly understood by the workers. With that implementation, the occupation of the machines has increased and the defects and their costs have decreased, so the added value grows.

Category: Case study

Keywords: management by objectives; KPI; Daily Kaizen; visual management; Yokoten

1 INTRODUCTION

The present work was developed in a metalworking design and development company, with the manufacturing unit headquartered in the north of Portugal, which exports to foreign market, and which needs to increase its productivity rate in the machining area. This productivity increase is essential in order to face competition from the European market, with innovative products and production from Asian countries that do not compete in terms of quality but have a price-quality ratio that makes them a threat. The increase in the productivity rate and, consequently, the increase in useful, productive hours must be achieved, keeping the human resources in the company with more efficient management of the existing equipment and acquisition of new ones by using Lean Tools (LT).

This study was developed in a company where metal cutting machines for trimming are the most usual equipment. Thus, the best working philosophy is to group by Manufacturing Cells. Depending on the product to be transformed, the production cells respond effectively and efficiently to demand fluctuations, as well as to product varieties. Improving space optimization, provided by this type of layout, increases performance, and substantially reduces waste. The concept of value is the basis of this philosophy, aimed at increasing competitiveness and keep a continuous improvement philosophy (Sá and Oliveira, 2013; Santos and Barbosa, 2006; Santos, Murmura and Bravi, 2019). The company has structured its equipment in 4 cells (16 machines in total), grouped by typology of machine and volume of parts to be machined. The raw material to be transformed also influences the equipment selection, depending if they are plastics, metallic rods, cast or forged components. The company has in its stock milling machines (usually called “Centers”) and Computer Numerical Control (CNC) lathes, comprising 3 Centers/Milling Machines and 13 CNC Lathes at the beginning of the study, which has increased to 15 at the end of the study. They are also supported with two milling cutters and a conventional lathe, which do not fit into the calculations presented in this work. The machines have a performing work capacity up to 1,000 mm length.

2 LITERATURE REVIEW

Due to a constant change in customer needs, entrepreneurs need to make effective decisions to succeed (Aas and Alaassar, 2017), and the future success of the organization depends on the extent to which we succeed in adapting to the rapidly advancing changes in the organization, without neglecting the values for which the business is oriented (Dana, 2015; Lisiecka and Burka, 2016; Santos et al., 2018). The search for competitive advantages over competitors is one of the strategies needed for companies that want to survive (Pinto, Pimentel and Cunha, 2016; Bravi, Murmura and Santos, 2017). It is vital to improving productivity with the latest technology for any production or service industry. Quality and productivity help a company stay in the global marketplace (Bravi, Murmura and Santos, 2019; Araújo et al., 2019; Doiro et al., 2017). Technology has become

extremely useful for the search for new customers (Krishnan et al., 2018; Bravi, Murmura and Santos, 2018).

In an increasingly competitive environment, it is necessary to effectively manage the companies' processes (Veres et al., 2018). Lean contributes positively to business performance applied in a manufacturing context and is also suggested to do the same in a service context (Andersson, Manfredsson and Lantz, 2015). Thus, a lean production initiative is focused on reducing costs and increasing turnover, systematically and continuously eliminating all non-value-added activities. In a competitive market, Lean is "the solution" for manufacturing industries' survival and success. Lean production helps organizations achieve targeted productivity by introducing easy-to-apply and maintenance-friendly techniques and tools. Its focus on waste reduction and elimination allows it to be rooted in the organization's culture and turns all processes into profit (Oliveira, Sá and Fernandes, 2017; Zgodavova, Hudec and Palfy, 2017).

The Lean Production (LP) paradigm focuses on the elimination of activities with no added value, seeking the use of the smallest space required for production, by the lower number of workers; by the smaller work-in-progress (WIP), for shorter stoppages (Mahendran and Kumar, 2018). Thus, LP (Lean Production) has gained worldwide popularity as a means to reduce waste, improve quality and increase the competitiveness of companies (Zalatar and Siriban-Manalang, 2018), contributing to the survival and success of companies (Oliveira, Sá and Fernandes, 2017; Pinto, Pimentel and Cunha, 2016). It can say that the implementation of LP (Lean Production), even in a fragmented way, helps companies to achieve improvements in operational performance (Filho, Ganga and Gunasekaran, 2016).

Lean Leadership is a methodical system for the sustainable implementation and continuous improvement of Lean Production (Bäckström and Ingelsson, 2015). It describes the cooperation of officials and leaders in their mutual endeavor towards perfection (Dombrowski and Mielke, 2014).

SMART – is an acronym for a goal setting practice. The objectives should be: - "S" specific, "M" measurable, "A" attainable/achievable, "R" relevant and "T" timely. Its origin is attributed to the Management by Objectives developed by Peter Drucker. The focus of it is to ensure that an organization's teams are working towards the same goals, while SMART sets out the action plan. Although SMART is often a contributor to business management, SMART has also been used in the formulation of personal development plans (Campbell, 2018). The measurement of key performance indicators is a widely used instrument to detect changes in the performance of the production system to coordinate appropriate countermeasures. The main challenge in the KPI systems coordinator is to determine relevant KPIs (Stricker, Minguillon and Lanza, 2017; Zhu et al., 2018). The absence of adequate productivity measurement indicators leads to disoriented performance (Azizi, 2015).

Daily Kaizen meetings are the main subsystem of corporate accountability that enables the culture of continuous improvement, working efficiently in the form of visual management, analysing and acting based on data and root cause analysis, seeking to continually improve its operations in a structured and visible manner (Zarbo et al., 2015; Verbano, Crema and Nicosia, 2017). Integrated in the internal communication project, it is intended that, daily, the entire company has data for decision making. This communication is performed transversally and vertically. Base LEAN Leadership project, in which communication is one of the pillars for the development of employees and for decisions to be made in a timely manner (Carvalho, Santos and Gonçalves, 2018; Santos, Bravi and Murmura, 2018).

Visual management is by itself the management tool that quickly informs its stakeholders about the state of a process and which actions can be taken in a timely manner. It allows team leaders to better engage in problem solving and practice of continuous improvement with their teams (Bateman, Philp and Warrender, 2016).

PDCA is a system for continuously improving an organization. The “Plan” phase initiates the PDCA process by identifying the problem clearly and objectively. The “Do” phase takes the hypothesis and tests it by the scientific method. The “Check” phase is initiated to study the effects of the “do” phase. Facts are revealed, analysed, and discussed to determine what worked and what did not. The “Act” phase is sometimes referred to as “analysing” because it is designed to identify what worked and what did not, and why (Schwagerman III and Ulme, 2013).

The Gemba Walk concept is essentially the time when top management goes to the actual place where the work is performed (Gesinger, 2016; Southworth, 2012; Ahmed, 2014) and to the place where value is created (Nestle, 2013). This is also, an opportunity for leaders to communicate and building trust with the team, enhancing corporate culture with a focus on people and processes (Minter, 2015), having an immediate and significant influence on organizational activity (Dana, 2015; Santos, Rebelo and Santos, 2017).

The 5S system is a rule-rule designed to create a clean and secure working environment (hence, there is a commitment to safety (Czifra, 2017), productive and to provide efficient and effective fulfilment of business tasks. The tool 5S is divided into five steps, which can be enumerated as follows: SEIRI (Sort)/SEITON (Set in Order)/SEISO (Shine)/SEIKETSU (Standardize)/SHITSUKE (Sustain) (Sharma and Lata, 2018). The need to have the 5S method implemented is one of the first steps of the Lean Manufacturing strategy (it has an influence on the behaviour of the LS method). Dana (2015) determines, as a result, the organizational productivity increase (Veres et al., 2018), as well as the increase in operational and profitability indicators in the short and long term, medium term, manufacturing costs and positively affects profitability (Todorovic and Cupic, 2017).

The 5 “Whys” is a technique that uses a systematic approach to problem solving in order to find the root cause of a defect or problem (Mehlretter, 2018). The goal is to identify the negative event factors and determine what needs to change and to avoid similar future occurrences (Marques et al., 2018; Costa, et al., 2019; Santos et al., 2019; Rebelo et al., 2016).

3 METHODOLOGY

The research methodology is Action-Research/Research-Action, developed by Professor Kurt Lewin of MIT who goes through 5-stage cycles:

- (1) *Diagnosis*
- (2) *Planning*
- (3) *Implementation*
- (4) *Evaluation*
- (5) *Conclusions* (Neumann, 2013).

The first stage, (1) *Diagnosis*, which identifies the problems that are affecting the organizations' performance, like the handicap that Lean agents have using and implementation of LT for solving problems in companies, was performed in November and December of 2018. This diagnosis allowed a more detailed collection of the company's KPIs (Key Performance Indicators), as well as the study of the main productive processes and subprocesses, the organization's management of resources flows of people and the components and parts produced. During this period, the State-of-the-Art study of the main Lean Tools (LT) and Leadership Lean (LL) was also started, collecting information on the best practices worldwide in each of the areas.

The second stage, (2) *Planning*, consists of collecting information about LT (Lean Tools) and LL, in order to organize and analyse which are the most appropriate for each phase of the project. At this stage, planning will be developed with proven methodologies for rapid successes and others that allow the “sustainability” of productive efficiency. The processes and methods of human resources management to be used, as well as the analysis of the methodologies that allow structural changes in the company, will also be carried out.

The intermediate stage, (3) *Implementation*, will consist of putting into practice the steps defined in the planning, collecting the results obtained during the process. The collected data will allow to verify the degree of implementation of the established measures.

In the fourth stage, (4) *Evaluation* – Analysis of the Data and validation of the implemented actions, all the registrations, and impressions of the stakeholders will be collected, and this will be the conclusion.

As regards the last stage, (5) *Conclusion*, considering all data available, it will be concluded if the premises are accurate, if the results are in line with expectations or if the trend is negative. This phase will allow the validation or not of the thesis, establishing the actions to be proposed later for the improvement of the company (Tab. 1 as an example).

Table 1 – Plan of Implementation of the “Action-Research”

	Nov, 2018	Dec, 2018	Jan, 2019	Feb, 2019	Mar, 2019	Apr, 2019	May, 2019	Jun, 2019
<i>Diagnosis</i>	X	X						
<i>Planning</i>		X						
<i>Implementation</i>			X	X	X			
<i>Analyze</i>					X	X		
<i>Conclusion</i>						X	X	
<i>Presentation Conclusions</i>								X

4 RESULTS

The following are the gains from applying lean tools.

4.1 Registration and Data Management

4.1.1 Occupancy Rate 2018 vs. Number of Equipment

Regarding the analysis needed to be carried out, a weekly baseline reference has been chosen. In this case, the best five weeks of 2018 were considered, namely the weeks 46 to 50. The occupancy rate is calculated based on the following rule: the percentage of effective working time recorded in each machine had been working for 8 hours (Tab. 2) and, even exists overtime work, it must be added to the availability of the equipment.

Table 2 – Occupancy Rate for Four Cells in Weeks 46 to 50 of 2018

	Week 46, 2018	Week 47, 2018	Week 48, 2018	Week 49, 2018	Week 50, 2018	Average	No. of equipment
	(%)						
<i>Cell 1</i>	57.1	598.0	54.3	47.4	63.8	56.5	5
<i>Cell 2</i>	58.4	64.7	52.9	55.4	49.1	56.1	4
<i>Cell 3</i>	60.6	56.3	53.0	41.7	61.1	54.6	4
<i>Cell 4</i>	41.7	45.2	44.2	45.8	40.6	43.5	3
<i>Week (%)</i>	54.3	56.5	51.1	47.6	53.7	52.7	Total 16

4.1.2 Hours Worked vs. Number of Employees

Using the same weekly basis for the occupancy rate, the number of worked hours by each work cell was recorded (Tab. 3). Depending on the number of employees available, as well as the components typology, the following worked hours were obtained.

Table 3 – Number of Worked Hours by the Four Cells in Weeks 46 to 50 of 2018

	Week 46, 2018	Week 47, 2018	Week 48, 2018	Week 49, 2018	Week 50, 2018	Average	No. of collaborators
<i>Cell 1</i>	125:44	136:11	121:59	84:05	148:17	123:15	5
<i>Cell 2</i>	129:47	135:39	115:47	125:26	91:57	119:43	5
<i>Cell 3</i>	84:20	81:00	78:03	56:02	83:03	76:29	4
<i>Cell 4</i>	51:45	55:46	52:57	59:15	48:50	53:42	3
<i>No. Hours</i>	391:36	408:36	368:46	324:48	372:07	373:10	Total 17

4.1.3 Production Rate of Conforming Parts

The KPIs (Key Performance Indicators) adopted by the company are measured regularly. The production rate is measured as a function of parts and not by the number of defective parts. In order to have more consolidated data, we present the data from September 2018 to December 2018 (Tab. 4). The objective was to have values greater than 98%, in which 99.6% were found.

Table 4 – Production Rate in the Last Quarter of 2018

Production	September	October	November	December	Average
<i>Goal (%)</i>	98.0	98.0	98.0	98.0	98.0
<i>Results (%)</i>	99.7	99.6	99.4	99.8	99.6

The costs of non-quality are easily understood and will be the basis of work to validate the case study. The non-quality costs due to the wrong machine operation by the workers are the sum of the cost of the raw material, plus the time/cost associated with the state of the part added of a fixed cost relatively to administrative costs. The results are shown in Tab. 5.

Table 5 – NC Quantities and Costs Regarding the Last Quarter of 2018

Production	September	October	November	December	Average	Total
<i>Quantity NC</i>	22	83	27	11	36	144
<i>NC Costs (€)</i>	870	553	620	393	609	2,436

4.1.4 Costs Non-Compliance vs. Number of Hours Worked

It was established the strategic objective of increasing the number of worked hours. The goal is to create a ratio between the number of worked hours and the nonconformities associated costs. The values regarding the year of 2018 shown in Tab. 6.

Table 6 – Costs of NQ/Production Hours

Cost of NQ/week (€)	Production Hours (h)	Ratio Costs of NQ/Production Hours
152.25	373	0.408

4.2 Application of Lean Tools

Ten tools have been selected in this work (Lean and Quality), expecting they generate great impact within a 3-month period, in association with the employees. The chosen tools allowed for changes in processes, manufacturing methods and cooperative management. After analysing scientific articles and determining the company's stage of maturity, the following tools were selected for implementation: (1) Management by Objectives/SMART Objectives – Each worker's objectives were controlled weekly; (2) KPI – A more generalized concept was transmitted to the entire company and its staff; (3) Daily Kaizen – besides being implemented in the main production area, it was also replicate to small areas (cells of production); (4) Visual Management – reformulated to include cells; (5) PDCA – tool used in daily Kaizen to progress in problem solving; (6) Gemba Walk – the process was performed to include the entire hierarchy, including the CEO; (7) 5S – introduction of the first 3 S to enable the spaces organization; (8) The “5 Whys” – to address the production of NCs (Non-Conformities) which require more complex solutions; (9) Yokoten: used to disseminate actions taken in the “5 Whys” throughout the manufacturing area; (10) Brainstorming – working with cell operators to find proposals for continuous improvement.

4.2.1 Management by Objectives/SMART Objectives

The objectives are usually defined for periods of 1 year, in the several articles studied. However, in this work it was decided to establish quarterly targets for the machining area, aiming at the achieved results will be immediately rewarded, being one of the main advantages. SMART goals are ambitious and achievable. In this sense, they have been proposed to be accepted by collaborators; the following objectives were set up for the first quarter (Tab. 7).

Table 7 – Management by Objectives 1st Quarter

Goal description	Cell 1	Cell 2	Cell 3	Cell 4	Weighting/ Retribution (%)
<i>Occupancy Rate Cell</i>	≥61.5%	≥61.1%	≥59.6%	≥48.5%	25
<i>NC: Cost Not Quality</i>	≤0.3% of Budget				15
<i>No expected components / No Components produced x 100%</i>	≥10% value in 2018				10
<i>Customer Complaints- Non-Quality Costs</i>	≤0.5% Budget				10
<i>Billing Amount</i>	Budget				20
<i>Performance evaluation (Semester)</i>	Grid 17 Questions + weighting				20
<i>Total</i>					100

An easy-to-read form has been developed, which establishes an “agreement” between the manager and the employee for the time period, in this case, the established quarter. The file is pre-established with formulas that according to the remuneration that the employee enjoys, and depending on the objectives achieved, gives the value of the bonus. Some general rules have been established: 1st the management agreement by objectives is valid only in the agreed period; 2nd the indicators should be monitored monthly, recording data as well as analysis of causes and actions, if the targets are not reached; 3rd there were regular audits to validate the process; 4th the final result will be rated according to the time in the service of the company; 5th in case of any irregularity in the data provided, the agreement will be considered voided and will follow the legal procedures; 6th the evaluation of the individual performance must be carried out in the first half of each semester; 7th the remuneration resulting from the Management by objectives will be distributed within two months after the closing date of the evaluation.

4.2.2 KPI (Key Performance Indicators)

All the ten processes of the Quality Management System in the company have their corresponding indicators, increasing to 32 KPIs (Key Performance

Indicators) on the company in 2019, because everything that cannot be measured cannot be improved. With Lean Leadership philosophy, the company started to disclose all KPIs (Key Performance Indicators) in the company's dashboard with access and explanation to all employees.

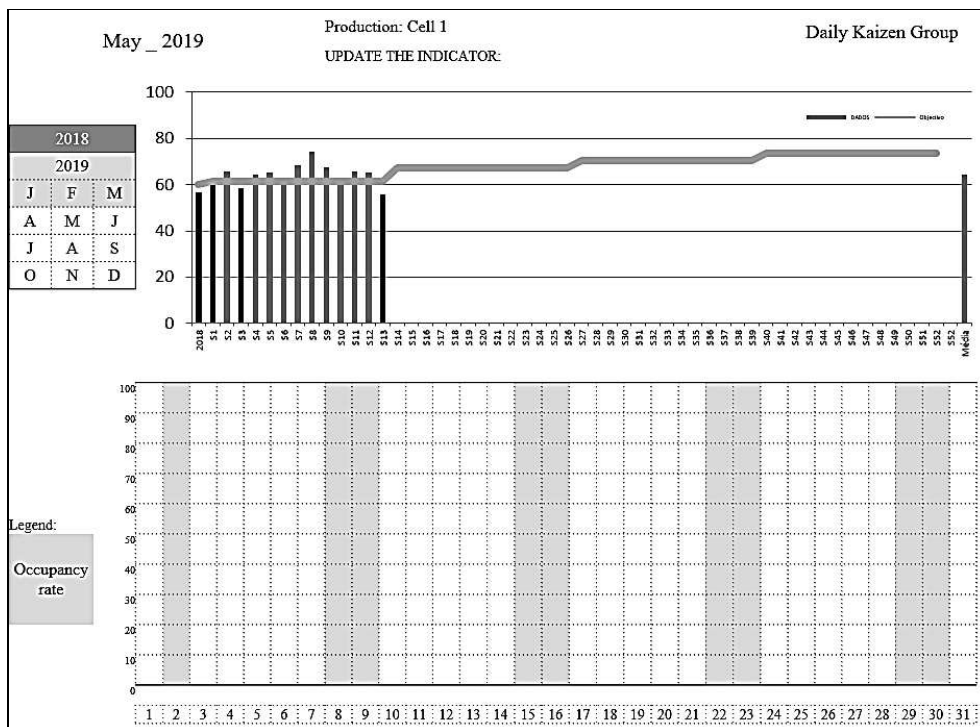


Figure 1 – Daily Occupancy Rate Control Example for Cell 1

4.2.3 Daily Kaizen

In the machining area, a “Daily Kaizen” meeting has been established, counting with the participation of the following collaborators: Machining coordinator, Planning manager, Cells manager, Times and Methods manager, and maintenance manager. This takes place every day from 9:50 a.m. to 10:00 p.m., receiving daily information from the 4 Kaizen factory cells. This meeting is performed at the beginning of the shift and will feed the relevant information for the next “operations” meeting. The example above, Fig. 1, shows the daily occupancy rate control of the cell 1.

4.2.4 Visual Management

The visual management allowed a quick indication of the productive state almost in real-time, and the data became available on the next business day. All employees from the top management to operators have important information in a simple and effective way. Graphs and data are easily perceived at 3 meters away, thus allowing easy assimilation of these.

4.2.5 PDCA (Plan-Do-Check-Act)

The PDCA tool was embedded in the Daily Kaizen panel which allowed the company to have the perception if results are within the objective. Possible proposals for improvements or needs of the sector are recorded as a plan of actions, which evolution of the work performed is daily verified by the person responsible for overcoming the problems, who, through the target objective, decisions and actions are taken when the expected results are not ok or when actions are over the established timings.

4.2.6 Gemba Walk

Gemba Walk, even unofficially implemented it was common practice to do. The Gemba Walk happens in a structured way. First, the coordinator passes with the integration of a level of kaizen daily, with the responsibility of production/responsible Lean, that whenever they sign to go to each cell, where are problems. Gemba Walk rules with the following description, as shown in Tab. 8.

Table 8 – Gemba Walk Rules

Frequency	Hierarchy	Goal
Daily	Session head	KPI (Key Performance Indicators) verification, action plan, problem solving
Weekly	Production/Quality Director	KPI (Key Performance Indicators) verification, improvement proposals
Monthly	CEO	Monitoring Projects, KPI (Key Performance Indicators) evolution verification, feedback from employees and managers

4.2.7 5S

The process was relatively easy to implement, coupled with the needed for operational improvement. All the employees got involved immediately and had clear ideas about the organization of their workstation, consequently becoming them more efficient. The simplicity of the implemented actions is inversely proportional to the gains.

4.2.8 The “5 Whys”

After the project start and with the appearance of firsts nonconformities (NC), in addition to the conventional process of their treatment, which NC is registered, it was necessary to improve the analysis of the root-causes regarding possible complex problems. A new form was created with the identification of the problems, where “5 whys” methodology is followed, trying to find the root cause of the problem. This procedure has been used two times in eight exercises.

4.2.9 Yokoten: Used to Disseminate Actions Taken in the “5Whys”

One of the tools that most catch attention was the Yokoten philosophy. “Yokoten” is a Japanese term meaning “sharing information”. It is the practice of sharing “horizontally” the information amongst the different sectors, areas, and departments of the organization, such as good ideas, important practices, and solutions to problems that can be replicated. It will take advantage of the knowledge acquired or developed bypassing them systematically horizontally, so session partners do not make mistakes or apply something wrongly already tested in another working cell. The concept is to present the problem solved through the “5 whys” from one of the working cells, who worked the problem, and after becoming aware of the real root-cause, passing the corrective actions to other manufacturing cells. These analysis and actions are implemented locally, so the potential problem does not occur again (Fig. 2 as an example).

Root Cause			
Correction and Corrective Action			
Responsible		Implementation Date	
Valuation of Implemented Action (Quality)		Closing Date	
YOKOTEN - "Share information"			
Initial Cell	C__	C__	C__
5 Whys' Leader Comments, if applicable			

Figure 2 – Root Cause Analysis – 5 Whys “YOKOTEN”

4.2.10 Brainstorming

Brainstorming is a dynamic group that is used as a problem-solving technique and to develop ideas or improvements in processes or products, fundamentally to stimulate creative thinking. In this sense, in the middle of January of 2019, a brainstorming session was held with cell coordinators, responsible for the productive sector and maintenance. From here, 24 proposals were signed, which were divided into 8 families. Most of the proposals were oriented towards the improvement of processes and seedlings reduction. At the end of the study, 71% of the proposals were implemented. The results can be seen in Tab. 9.

Table 9 – Brainstorming Results

No. Proposals to 21 January 2019	Group in families	Closed actions to 31 March 2019	Closed actions (%)
24	8	17	70.8%

4.3 1st Quarter Results

The KPI (Key Performance Indicators) were measured daily with the involvement of all the employees allowed to obtain the results described above, Tab. 9.

4.3.1 Productivity Rate

In all working cells, it was obtained an increase of work equal or higher than 6%, as can be seen in Tab. 10.

Table 10 – Productivity Rate

Productivity Rate	Average 2018	The goal for 1 st Trimester 2019 (+5%)	Results of 1 st trimester 2019
<i>Cell 1</i>	56.5%	61.5%	64.2% (+7.7%)
<i>Cell 2</i>	56.1%	61.1%	66.3% (+10.2%)
<i>Cell 3</i>	54.6%	59.6%	64.8% (+10.2%)
<i>Cell 4</i>	43.5%	48.5%	49.5% (+6.0%)
<i>Company Average</i>	52.7%	57.7%	61.2% (+8.5%)

4.3.2 Costs of Non-Quality (NQ)/Production Hours

With an increase of 30.2% hours of work in the first quarter, due to the inclusion of two new CNC machines, even with the change of the employees' schedules and the increase of occupation rate. It has led to an improvement in the Costs of Non-Quality (NQ)/Production Hours ratio, as shown in Tab. 11.

Table 11 – Costs of Non-Quality (NQ)/Production Hours

	The Year of 2018	(-10%) The goal for 1 st Trimester 2019	1st Trimester 2019 Results
<i>Cost of NQ/week (€)</i>	152.25		155.10
<i>Production Hours (h)</i>	373		486
<i>Ratio Costs of NQ/ Production Hours</i>	0.408	0.367	0.319 (-27.9%)

5 CONCLUSION

Lean tools can be rapidly and easily implemented and quickly understood by the workers. The operational results were highly positive, both in the cells occupancy rate (8.5%, see Tab. 10), which was achieved just in 3 months, as well as the considerable increase of worked hours. Consequently, the ratio of costs associated with non-quality per hour decreased significantly by 27.9% (see Tab. 11). It was created an additional motivation in the employees and very satisfying results in every production and manufacturing areas. With the implementation of Lean Tools, the occupation of the machines has increased, and the defects and their costs have decreased, so the added value grows.

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CSR Expenditure and Company Performance: Charity or Signal? Evidence from Indonesia

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ABSTRACT

Purpose: The purpose of this study are: first, to investigate CSR expenditures made by public companies in Indonesia are whether aimed at the charity, and second, whether CSR expenditure is related to the corporate's performance in the future.

Methodology/Approach: The samples are taken from 53 companies registered at the Indonesia Stock Exchange. Measurement of CSR expenditure uses monetary unit because CSR expenditure is the actual expenditure of the company. Company performance variables use ROA and CFO.

Findings: The result indicates that CSR expenditures by companies in Indonesia are aimed at charity and are not related to their future performance. In addition, the CFO is also not related to CSR expenditure. This finding indicates that the expenditure of corporate CSR in Indonesia is only limited to fulfilling corporate social responsibility to the community without expecting repayment and to fulfill applicable regulatory obligations. Thus the resulting decision is a charity decision, not a signal.

Research Limitation/implication: Sample in this study is limited to only company that reports CSR expenditure data in its annual report. The problem is that this disclosure is not mandatory in Indonesia so we cannot put all of public companies into our study. Our findings must be interpreted with this sample limitation problem.

Originality/Value of paper: Our study contributes to understanding of motives of corporation in CSR spending. Corporations that operate in Indonesia are not only local corporations. Some are foreign companies that operate in Indonesia. Even though this Indonesian-based foreign corporation has its CSR program running in Indonesia, the program actually made by its home office abroad.

While the CSR activity is used as signal in the home country, the purpose is not the same in Indonesia.

Category: Research paper

Keywords: CSR expenditures; signaling theory; charity; company performance; Indonesia

1 INTRODUCTION

The debates whether CSR activities conducted by corporates related to philanthropy (charity) or reflecting corporate performance (signals) in the future are still not reaching inclusive conclusions until now (Lev, Petrovits and Radhakrishnan, 2010; Hong, Kubik and Scheinkman, 2012; Nollet, Filis and Mitrokostas, 2016; Bose, Podder and Biswa, 2017; Danielli, Bini and Giunta, 2013; Lys, Naughton and Wang, 2015; Chen, Feldman and Tang, 2015; Rhou, Singal and Koh, 2016; Supriyadi and Tjahjadi, 2017). Neoclassical economists like Friedman (1970); Galaskiewicz (1991); Brammer and Millington (2008) are parties that do not support CSR activities. Meanwhile, Fombrun (2005); Hoopwood (2009); Brammer, Brooks and Pavalin (2006); Weber et al. (2008) are parties that support CSR activities. Friedman (1970), Galaskiewicz (1991), Brammer and Millington (2008)'s preference to not supporting CSR activities incurred by corporates is caused by the argument that, based on their functions, managers are those who are responsible for increasing the prosperity of shareholders, not running CSR activities that are supposed to run by the government.

Shifting from those who do not support, Fombrun (2005), Brammer, Brooks and Pavalin (2006), Weber et al. (2008), Hoopwood (2009) stated that there is a positive relationship between CSR activities and corporate performance. According to them, if the corporate increases its CSR activities then reports on such, the actions taken can improve the corporate's image as part of good citizenship. This will attract investors and increase the legitimacy of the corporate (Bowen, 1953; Servaes and Tamayo, 2013) and certainly have an impact on improving corporate performance in the future (signal) (Danielli, Bini and Giunta, 2013; Lys, Naughton and Wang, 2015; Rhou, Singal and Koh, 2016; Wang and Sarkis, 2017; Esteban-Sanchez, De la Cuesta-Gonzalez and Paredes-Gazquez, 2017).

In our opinion, CSR activities conducted by the corporate should not only as a signal-oriented towards material benefits but also aim to take part in thinking about the welfare of society and the environment (charity). This result is in accordance with the study conducted by Chapple and Moon (2005). They concluded that there were variations in disclosure of the corporate's CSR activities through the web between corporates in Asian countries. However, these variations failed to be explained by the stages of state development. Factors of globalization increase the adoption of CSR activities in Asian countries, yet

multinational corporates operating in Asia tend to adopt CSR activities where countries of origin operate instead of adjusting to the conditions of the country where they invest. In addition, their research findings show that in developing countries, especially Asia, CSR activities conducted by corporates are focused on charities.

Our study was motivated by a study by Danielli, Bini and Giunta (2013) and Lys, Naughton and Wang (2015). In this case, CSR expenditures referred to in our study are monetary expenditures incurred by corporates to finance CSR activities. This is consistent with the study conducted by Lys, Naughton and Wang (2015). According to them, the purpose of CSR expenditures in the beginning was to perform social actions. In this case, the corporate wants to be useful in the eyes of the community (charity). Whereas, the corporate actions to conduct CSR activities in the form of CSR expenditures are considered to be aimed at giving a signal about the corporate's future prospects (signals). To differentiate between hypotheses aimed at charity and aimed at signals, the charity hypothesis is not related to improving future performance. The improvement in corporate performance in the future is actually a management expectation and not a result of the corporate's CSR expenditures in the previous period. Conversely, the signal hypothesis, when the corporate's CSR activities in the form of CSR expenditures made by the corporate today, is a signal about the corporate performance in the future.

Our study was conducted at manufacturing corporates listed on the Indonesia Stock Exchange. In the context of developing countries, the difficulties arise in the generalization of study findings regarding CSR activities incurred by the corporates. Moreover, the limitations of the sample and the scope of the data, and then the socio-cultural and institutional differences between developed countries and developing countries according to Cai, Pan and Statman (2016), Bose, Podder and Biswas (2017) are the cause of that difficulties. Furthermore, our study aims to expand the existing literature by examining economic problems that occur in developing countries. Indonesia is a developing country as a part of the G-20 Forum membership which indicates that Indonesia is one of twenty countries with the largest economy in the world. The Indonesian capital market is one of the increasing Asian capital markets currently attracting global investment from various parts of the world (Darmadi, 2013). Since 2007, The Government of Indonesia has issued regulations regarding CSR activities of corporates through the Law on Public Corporates No. 40/2007. The regulation oversees the mandatory disclosure and reporting of CSR activities by public corporates.

According to Griffin and Prakash (2014), it is very important for corporates to choose and then decide on CSR initiatives and emphasize those choices, then combine them to stakeholder-oriented activities with an issue. This has an impact on differences in stakeholder expectations regarding prospects and evaluation of the results of CSR activities as a measurement of corporate performance (Wang et al., 2016). This study provide evidance First, CSR expenditures by Indonesia corporations have charity motive. Second, there is a correlation between CSR

expenditure and corporate performance and information about CSR expenditures delivered by the corporate is a signal to outsiders that the corporate is growing. The measurement of CSR expenditure in this study uses monetary units, as used by Lys, Naughton and Wang (2015). We estimate the assumption that the costs and benefits of CSR activities through monetary expenditures incurred by corporates are difficult to be convincingly identified, whereas the corporate's goal of disclosing more information (including CSR expenditures) is to reduce information asymmetry so that investors can assess them better (Healy and Palepu, 2000; Lech, 2012; Danielli, Bini and Giunta, 2013; Lys, Naughton and Wang, 2015; Zhang, 2016).

2 LITERATURE REVIEW AND DEVELOPMENT OF HYPOTHESES

In the USA, charitable contributions through CSR expenditures indicated by data from the Committee on Encouraging Corporate Philanthropy (2008), on average, were experiencing an increase of 5.6% in 2007. Even as quoted from Lev, Petrovits and Radhakrishnan (2010) as many as seven of the eight corporates they studied which reported losses over two decades, still had increased their charitable distribution through CSR activities. Another study by Hong, Kubik and Scheinkman (2012) concluded that corporates having excess cash flow will take the initiative to act on CSR expenditures. This action is similar to corporates doing charity which means, the initiative of monetary expenditures in the form of CSR activities is due to excess resources and then does so without expecting that the CSR expenditures will have an impact on corporate performance (Navarro, 1988; Humphrey, Lee and Shen, 2012).

Stakeholder theory explains how organizations respond to various requests from stakeholders. Based on the perspective of the theory, it is very important for corporates to achieve competitive advantages in order to ensure the sustainability of the corporation in society. CSR activity in the form of charity is one of the activities which aims as a form of the corporate's response to social demands. In addition, charitable giving through CSR activities by corporates can build the corporate's reputation in society (Aly, El-Halaby and Hussainey, 2018).

Lev, Petrovits and Radhakrishnan (2010), Nollet, Filis and Mitrokostas (2016), Bose, Podder and Biswas (2017) conducted studies on CSR activities in the form of charitable giving. Lev, Petrovits and Radhakrishnan (2010) examined the impact of corporate philanthropic activities on sales growth. In this case, there is a growth in sales by public corporates in the USA which contribute in the form of charity. Using the Granger causality test, their findings suggest that corporates contributing to charitable activities are significantly associated with increased revenues in the future. In addition, they show that increasing revenues occur only at corporates that care about consumer perceptions and assume those consumers as their importance. Moreover, their findings also document a positive relationship between the corporate's contribution to charity and customer

satisfaction. This indicates that philanthropy conducted by the corporate under certain circumstances will increase the corporate's revenue.

Bose, Podder and Biswas (2017) investigated the relationship between CSR activities in the form of charitable giving by corporates with market-based performance and institutional ownership. Using samples from banking in Bangladesh, their findings exhibited banking corporates with CSR activities through higher charity had better performance. In addition, CSR activities through charity are positively related to institutional ownership. This certainly implies that institutional owners contribute more to CSR activities through charity. This finding is certainly interesting for managers, regulators, and policymakers in countries that have similar economic and social systems.

Nollen, Filis and Mitrokostas (2016) were motivated to test the linear and non-linear correlation between CSP and CFP (accounting and market-based) using a new set of disclosure scores data from Bloomberg's Social Governance which include S&P 500 corporates. The linear correlation shows a negative and significant direction for CSP, however, non-linear models provide the opposite result between CSP and CFP. Bose, Podder and Biswas (2017) pointed that, from a stakeholder theory perspective, there is a linear correlation between charitable contributions to the performance of market-based corporates and institutional investors are reacting positively to the corporate's charitable contributions based on sample of 137 financial corporates, namely the banking industry in Bangladesh for the period of 2007-2013.

Other evidence related to the charity hypothesis, for example, according to Lys, Naughton and Wang (2015), corporates do spend CSR expenditures on ineffective activities. As the aim is to "beautify" the manager's performance and to achieve this goal, the manager will invest in his or her preferred CSR activities acting on behalf of stakeholders by carrying out CSR expenditures in the amount he or she agreed to (Bénabou and Tirole, 2010). Based on the empirical evidence above that the corporate's CSR activities done through CSR expenditures can be functioned as a charity, we propose the following hypothesis:

Ha1: The corporate's current CSR expenditures are not related to the corporate's performance in the future (charity hypothesis).

The connection between CSR expenditures and corporate performance can be explained through signaling theory. According to this theory, there is a condition where information asymmetry between the corporate and other parties outside the corporate occurred. Differences in information will set parties outside the corporate to look for information (signals) that distinguishes between good and bad performing corporates. Under these conditions, the more information reported by the corporate, the more improvement corporate can perform in the future (Healy and Palepu, 2000; Lech, 2012; Danielli, Bini and Giunta, 2013; Lys, Naughton and Wang, 2015). The use of information about CSR expenditures is an appropriate guide for examining the components of corporate CSR activities (Hilman and Keim, 2001; Carroll, 2004; Choi and Wang, 2007). The corporate's

decision to engage in CSR activities is related to corporate's signals (Mahoney et al., 2013).

Some results from previous researches reveal evidence that CSR activities are related to corporate performance in the future (Danielli, Bini and Giunta, 2013; Lys, Naughton and Wang, 2015; Chen, Feldman and Tang, 2015; Rhou, Singal and Koh, 2016; Supriyadi and Tjahjadi, 2017). For instance, research conducted by Danielli, Bini and Giunta (2013) aims to determine whether incremental information in CSR reports and annual financial statements disclosed by the corporate is a signaling strategy related to corporate performance. They suspect that the disclosure indicators in the annual report provide additional information related to corporate performance, which in this case, profitability. The corporates sampled in this study were 120 corporates in Italy. Their research results confirm that the number of CSR information indicators reported by the corporate is positively related to the profitability of the corporate.

Lys, Naughton and Wang (2015) examine the relationship between corporate expenditure on social responsibility and corporate performance. They assume that spending on corporate social responsibility is not a form of corporate charity and is also not related to improving financial performance in the future. Their research shows that there is a causal relationship that has a positive value between CSR expenditure and corporate performance in the future.

A study conducted by Rhou, Singal and Koh (2016) investigate the role of CSR awareness measured through CSR activities covered by the media to moderate the relationship between social responsibility (CSR) and corporate financial performance (CFP) in the context of restaurant industry corporates. They investigate whether CSR awareness moderates the relationship between social and financial performance. The results of their study support the idea that CSR awareness of stakeholders will influence CSR initiatives and relate to increasing corporate finance only if corporates effectively publish their CSR involvement. In short, they highlight the importance of increasing positive CSR awareness through increasing media space for socially responsible corporate activities. In addition, it also shows the importance of managing negative CSR awareness as an effort of the corporate to avoid the bad relationship between the corporate and its main stakeholders.

The corporate will voluntarily disclose information that aims to reduce the asymmetry of information between corporate management and stakeholders as a form of corporate communication. Signaling is an extension of voluntary disclosure carried out by the corporate. Signaling theory shows that corporates, in this regard as "good" citizens, convey separate CSR information and are reported independently which shows a signal of their superior commitment to CSR activities (Mahoney et al., 2013). The corporate expects that their actions aside from reducing the asymmetry of information, also to benefit from their signaling actions through CSR (Ching and Gerab, 2017). External stakeholders who are

interested in the information released by the corporate will look for additional information.

The signal hypothesis does not require the corporate to actively express its future prospects when making certain investments and CSR activities. On the contrary, it only requires that corporate CSR expenditures “gives the signal” about the corporate’s future financial prospects. This definition of signaling is consistent with several studies of dividends, where the changes in dividend have implications for the corporate’s future cash flows even though there is no intention from the corporate to convey information about future performance (Miller and Rock, 1985; John and Williams, 1985). So, it can be concluded that CSR expenditures made by corporates are thought to be related to the corporate’s performance in the future.

The benefits obtained through CSR activities which include increasing the positive image of the corporate (Brammer and Millington, 2008; Kreander, Beattie and McPhail, 2009), attracting shareholders (Wang and Qian, 2011) for example, because of CSR issues related to employee safety at mining corporates (Wang and Sarkis, 2017; Esteban-Sanchez, De la Cuesta-Gonzalez and Paredes-Gazquez, 2017; Christensen et al., 2017) and are expected to increase the corporate’s cost of capital (El Ghouli et al., 2011). To attract interest to the market, information containing signals according to Beyer et al. (2010) have two characteristics. First, relevant if used as the basis for decision making. Second, if information comes from management, the information is considered private. Based on the explanation above, we propose the following hypothesis:

Ha2: The corporate’s current CSR expenditures are related to corporate’s performance in the future (signal hypothesis).

3 METHODOLOGY

3.1 Data Collection Procedure

Information related to CSR expenditures (in Indonesian Rupiah) is obtained through the corporate’s annual report for the period of 2012-2016. We follow measurement used by Servaes and Tamayo (2013) and Lys, Naughton and Wang (2015).

Our research samples are manufacturing corporates listed on the Indonesia Stock Exchange. We use the manufacturing data because their operations have direct impacts on societies and the environment. This is consistent with the study conducted by Testa and D’Amato (2017). Corporate performance is proxied by viewing at the total return on assets (ROA) since it describes the level of management effectiveness in generating profit using existing corporate assets. Changes in future performance in this study are measured by $\Delta ROA_{i,t+1}$. Future changes in operating cash flow is cash flow operation (CFO) scaled to total

assets. Lys, Naughton and Wang (2015) argue that CFO have a better persistence level and are considered more difficult to manipulate.

3.2 Research Model

The analysis is conducted by testing whether there is a positive connection between current CSR expenditures and future corporate performance. These measurements observe changes in return on assets and operating cash flows. Different from Lys, Naughton and Wang (2015), this study does not separate economic and non- economic based CSR components. Hypotheses are tested as follows:

$$\Delta ROA_{i,t+1} = \alpha_{0a} + \alpha_{1a} CSR_{Exp_{it}} + \alpha_{2a} \Delta ROA_{it} + \alpha_{3a} \Delta ROA_{i,t+1} + \varepsilon_{1a} \quad (1)$$

$$\Delta CFO_{i,t+1} = \beta_{0a} + \beta_{1a} CSR_{Exp_{it}} + \beta_{2a} \Delta CFO_{it} + \beta_{3a} \Delta CFO_{i,t-1} + \varepsilon_{1a} \quad (2)$$

Where, $\Delta ROA_{i,t+1}$ are changes in company i performance in the future, $CSR_{Exp_{it}}$ is corporate i 's CSR expenditure in the year t , ROA_{it} are changes in company i 's performance in the year t and $\Delta CFO_{i,t+1}$ are changes in future cash flows of company i in the year $t+1$.

4 RESULT AND DISCUSSION

4.1 Descriptive Statistics Analysis

Tab. 1 presents descriptive statistics of the regression results from (1) and (2). There are several interesting points from the two regression results. First, the minimum value of CSR expenditure is 0.00. This value of 0 cannot be interpreted that there was no CSR expenditure in that year. We can only conclude that the company did not disclose its expenditure value in the year of observation.

Table 1 – Descriptive Statistics

Information	Variables	Minimum	Maximum	Mean	Std. Deviation
Eq.1	$\Delta ROA_{i,t+1}$	-0.465	0.467	-0.002	0.084
	$CSR_{Exp_{it}}$	0.000	0.984	0.061	0.154
	ΔROA_{it}	-0.214	0.511	0.044	0.083
	$ROA_{i,t-1}$	-0.662	0.511	0.046	0.098
Eq.2	$\Delta CFO_{i,t+1}$	-1.118	2.710	-0.001	0.244
	$CSR_{Exp_{it}}$	0.000	0.984	0.061	0.154
	ΔCFO_{it}	-0.582	2.722	0.067	0.209
	$CFO_{i,t-1}$	-0.582	1.255	0.068	0.151

Another interesting result is that the minimum value of ROA is negative. This is because a sample of companies that report losses is included. On the other hand, the maximum value of ROA is quite high i.e. 0.51 while the mean is 0.05. So there is a fairly wide range between the lowest value and the highest value. We can also draw the same conclusion for the CFO data in (2).

4.2 Hypotheses Test

Tab. 2 presents the regression results between variables from the tested hypothesis.

Table 2 – Regression Result

Var	Constant Eq 1	Constant Eq 2	CSR_ Exp _{i,t} Eq 1	CSR_ Exp _{i,t} Eq 2	Δ ROA _{i,t}	ROA _{i,t-1}	Δ CFO _{i,t}	CFO _{i,t-1}
Reg Eq. 1	-0.001 (0.852)	--	0.000 (0.663)	--	0.759 (0.000)	0.090 (0.084)	--	--
Reg Eq. 2	--	0.043 (0.001)	--	0.000 (0.755)	--	--	-0.037 (0.619)	-0.942 (0.000)
Eq. 1	R ² : 46%		F-value: 89.332		p-value: 0.000			
Eq. 2	R ² : 52%		F-value: 114.501		p-value: 0.000			

Notes: ROA (return on asset) is return on asset measured by the ratio of net income to net assets; CSR_Exp (corporate social responsibility expenditure) is corporate social responsibility expenditure measured by the amount of expenditure in Indonesian currency of sample listed on the IDX; CFO is cash flow from operation; The p-value is in parantheses

In eq. 1, the p-value of CSR expenditure is not statistically significant, implying that the result supports the charity hypothesis. This findings can be justified as follows. Firstly, the average CSR expenditure is in the form of social responsibility. This support Qiu, Shaukat and Tharyan (2016). Secondly, the corporate's goals to fulfill CSR are obligations and compliance with regulation No. 40/2007, among other regulation, intended solely to obtain "operating licenses" from stakeholders and the wider community (Hackston and Milne, 1996; Walden and Schwartz, 1997). Lastly, this study does not divide the corporate's CSR expenditure as Lys, Naughton and Wang (2015) into economic and non-economic performance aspects. This is caused by the fact that not all sample corporates in our research clearly stated the separation of their CSR expenditures.

Our study on corporate performance variables (ROA) draws interesting results. In the regression eq. 1, the results show that this current year's performance affects future performance. ROA itself describes the use of corporate assets and shows management effectiveness in managing investments. In this study, if the sample corporate has a profitable "track record" and has the commitment to

social investment, the corporate will also be easier to reach customers who are willing to pay more for the green products produced (Tsai et al., 2012). According to Qiu, Shaikat and Tharyan (2016), corporates will be willing to enter into a commitment and openly express it only if they have a “way” to disclose it.

In eq. 2, the correlation between CSR expenditure with CFO variables is not statistically significant (p-value is 0.755). Simply put, the average CSR expenditures made by the corporate do not relate to the corporate’s cash flow. This finding, then, suggest that CSR expenditures incurred by corporates in Indonesia are aimed at philanthropy (Chapple and Moon, 2005) which are not directly related to corporate operations and is not even related to corporate performance (Lev, Petrovits and Radhakrishnan, 2010; Hong, Kubik and Scheinkman 2012; Nollet, Filis and Mitrokostas, 2016; Bose, Podder and Biswas, 2017).

5 CONCLUSION

Our results provide empirical evidence that corporate monetary expenditures in form of CSR by public corporates in Indonesia are more on actions aimed at charity without expecting anything in return and are not signals of the corporate’s future performance. This result is in parallel with the evidence presented by Chapple and Moon (2005), Visser (2009), Ragodo (2009), Amos (2018). The finding of our study that corporate monetary expenditures in form of CSR are not related to corporate performance can be caused by the culture of the corporate’s CSR in Indonesia not directed to improve the corporate performance. CSR activities in developing countries according to Visser (2009) are often associated with charity, for example through corporate social investment in the fields of education, health, sports development, the environment, and other community services. Ragodoo (2009) stated that most corporates have established procedures related to the allocation of funds for corporate social responsibility (CSR). This indicates the goodwill of the corporates that they are willing to help create a better social life of the society and indeed the corporate has the resources to do so. In addition, the active involvement of corporate management and community leaders in the corporate’s CSR activities is equally an important factor.

This study did not succeed in providing evidence that CSR expenditure has an effect on future corporate performance. The explanation that we might provide is as follows: First, the samples in this study are only corporates with CSR expenditures data that we can obtain. Some of the corporates we observe actually incur expenditures related to CSR but the numbers are uncertain or do not clearly show the value of the money they spend. There are still many other corporates that we did not include into the sample because of the absence of CSR expenditures figures that we could use. Second, social problems in developing countries, including Indonesia, are unique. Visser (2009) and Saleh, Zulkifli and Muhamad (2011) for example, stated that CSR activities in developing countries

are only carried out by widely known national and multinational corporates. That means, even though a corporation is financially able to perform CSR activities in form of CSR monetary expenditures but does not face the risk of being monitored by the public, then CSR monetary expenditures will be revealed differently compared to similar corporates known to the public. In addition, CSR activities in developing countries according to Visser (2009) are not formalized and are not institutionalized as in developed countries.

Furthermore, the pattern and behavior of CSR in developing countries, which are different from developed countries, are importantly required to be studied focuses particularly on developing countries. According to Amos (2018), this is due to the conventional approach to CSR in developing countries currently rooted strongly in CSR behavior in developed countries which may not be related in the context and the actual situation faced by developing countries. Lev, Petrovits and Radhakrishnan (2010), Hong, Kubik and Scheinkman (2012), Lys, Naughton and Wang (2015) and Nollet, Filis and Mitrokostas (2016), among others, use samples from developed countries. Their studies indicate that CSR expenditures is a signal of future companies' performance and shares values.

Suggestion for Further Researchers

Researches that are interested in analyzing the issue of CSR expenditures within corporate performance in the future should consider several important points. Researches on CSR expenditures in the future should be able to ensure the samples actually perform CSR expenditures that are oriented towards corporate performance or, at least, future researchers should consider separating CSR expenditures related to economic performance (signal) and non-economic performance (charity). Visser (2009) claims that the lack of comparative studies related to the nature, type, and extent of disclosure of CSR activities between developing countries and developed countries can be a consideration for researchers regarding CSR in the future. Furthermore, future studies can also be done by comparing CSR expenditures to performance among developing countries that fall into the high profile category.

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Group Creative Problem Solving: The Role of Creative Personality, Process and Creative Ability

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ABSTRACT

Purpose: Team creativity is an important factor in developing new ideas for organisations. In spite of years of creativity research, little is known about various team aspects and their affect on team creativity. This study looks at the incremental explanatory value that team creative personality and divergent thinking skill processes have on team creativity.

Methodology/Approach: Individual personality, creative personality, and divergent thinking skills were collected from 349 students at a large public university in the southeast US. These students were then randomly assigned to 105 teams where they developed a novel product. Individual attributes were averaged to create team attributes that were used to determine correlations with the product creativity. Hierarchical regression was used to evaluate incremental explanatory values for each of the independent variables.

Findings: Group creative personality adds approximately 36 percent more explanatory power than cognitive ability and traditional personality measures in predicting team creativity. Creative processes, like team divergent thinking ability, further increased the R^2 of our model from 0.54 to 0.65 demonstrating that team processes affect team creativity.

Research Limitation/implication: The task used in this study was not as complex as problems being considered by organizations. However, the results are expected to be indicative of the process used for more complex problems. It is also difficult to assign causality since correlations were used to verify some of our hypothesis.

Originality/Value of paper: This research expands the findings of team creativity by identifying factors that increase team creativity.

Category: Research paper

Keywords: innovation; creativity; group creativity; team creativity

1 INTRODUCTION

Organizations must quickly adapt in today's constantly changing, globally competitive environment. Yesterday's winning ideas are rarely valid today. Therefore, creativity and innovation have become critical to the performance, growth, and survival of organizations (Mumford, Hester and Robledo, 2011; Vnoučková, 2018). However, single individuals do not possess the creative skills and knowledge necessary to solve these complex organization problems (Reiter-Palmon, Wigert and De Vreede, 2011). Organizations have subsequently focused on teams to solve these problems (Kozlowski and Bell, 2008).

Much has been learned about the role of personality (Robert and Cheung, 2010) and individual processes (Bendickson et al., 2017) on individual creativity and yet team-level creativity remains under-researched (Amabile and Pratt, 2016; Kurtzberg and Amabile, 2001; West, 2002). One study shows that despite the calls for increased team research, little has occurred to address this issue (James and Drown, 2011). The need therefore still exists for researchers to unravel how individual traits and skills are combined with group processes to arrange the perfect cast of participants for creative problem solving teams.

The purpose of this study is address this gap in the literature by examining how individual personality and creative ability are used in a group setting to develop creative products. We base our research on Amabile's (1996) componential theory of creativity and refinement of this model (Amabile and Pratt, 2016) which states that creativity is a result of task motivation, domain-relevant knowledge, and creativity-relevant skills. We build on this componential theory by identifying the most important individual traits and abilities that contribute to group product innovation.

Our results demonstrate how team creative abilities add incremental explanatory power above that which is explained by the team's personality and cognitive ability on the development of creative products. This identification of the most dominant personality traits and creative abilities provide researchers and managers greater insight into the identification and selection of participants needed to produce creative products and ideas.

1.1 Theoretical Background

Following prior research, we define creativity as the production of high quality, original and elegant solutions to problems (Besemer and O'Quin, 1999; Christaans, 2002; Mumford and Gustafson, 1988). Mumford and his colleagues (2011a; 2011b) argued that this definition implies that creative work is the outcome of creative problem solving. From this standpoint, creativity is the outcome and creative problem solving is the process.

We base our research on Amabile's (1996) componential theory of individual creativity which claims that individuals must be motivated to use their domain-relevant skills and creative-relevant cognitive processes to produce novel products. Implied in this theory is a multiplicative model where all three key elements (motivation, domain relevant skills, and creative-relevant processes) must be present to produce creative products. We evaluate each of these three dimensions to develop theoretical support for our research.

Motivation is both a state and relatively stable trait that is related to personality (Conti, Coon and Amabile, 1996; Ruscio, Whitney and Amabile, 1998). Taggar (2002) and other creativity researchers have relied heavily on the five factor model (Costa and McCrae, 1992) to evaluate the link between personality and creativity. However, there may be other distinct creative personality attributes that add further explanation to why individuals would be motivated to engage in creative problem solving and why they would be compelled to work harder to develop a creative product. Understanding this motivation may start from understanding the link between personality and creativity.

Amabile's second component, domain-relevant skills, can be viewed as the ability of the individual to learn tasks associated with their jobs or the knowledge that a person possesses in a specific domain (Amabile, 1996). For an individual to be creative in music, knowledge about music concepts is expected.

Creative-relevant cognitive processes, the combination of cognitive ability and learned creative processes, is the final component. Individuals develop on their own, or can be trained, to develop idea generating schemas. Previous experience in solving problems also generates learned processes that can be used in future creative problem solving. However, in much of the previous innovation literature, general cognitive ability has been used as a predictor of both domain relevant skills and creative processing skills (Ree and Carretta, 1998; Taggar, 2002). This approach may have caused researchers to look specifically at creativity relevant skill attributes that are closely tied to general cognitive ability, while ignoring other creative abilities.

1.1.1 Personality and Creativity

Research and practice has shown that the right people, in the right environment, using effective social and cognitive processes, can become highly innovative teams (Paulus, Dzindolet and Kohn, 2011). This statement demonstrates that people, process, and product are all important to team creativity. We look first at which people are the "right people"?

Creative personalities have been studied among common and highly creative participants (Hoff, Carlsson and Smith, 2011) to identify personality characteristics that are associated with individuals who have high creativity scores (Eysenck, 1995; Martindale, 1989). Some of these characteristics include self-confidence, enthusiasm, hard-working, tolerance for ambiguity, risk-taking, emotional, hostile and bitter (Feist, 1998; Martindale, 1989; Mumford et al.,

1993). This wide array of descriptive characteristics has also led to contradiction in the descriptions given of creative persons (Eysenck, 1995). To analyze these characteristics, and to make sense of these contradictions, we separate these characteristics into two groups: FFM personality (Costa and McCrae, 1992) and creative personality.

The prevailing measure of personality in management literature has been based on the five factor model which identifies conscientiousness, agreeableness, neuroticism, openness to experience, and extraversion as the most prevalent stable personality traits (Costa and McCrae, 1992). At the individual level, studies using the five factor model have consistently found that creativity is positively associated with openness to experience and negatively related to conscientiousness (Batey, Chamorro-Premuzic and Furnham, 2010; Feist, 1998). Explanations for these relationships include the belief that creative people use their openness to new ideas and experiences to find ways to solve problems, and therefore generate more creative ideas. Conversely, conscientious individuals often have highly restrictive rules that may impede the problem-solving process which may cause them to never consider novel solutions. The remaining three factors, of the five factor model, have shown weaker and more varied results. Research has shown that creative people low on agreeableness (Dudek et al., 1991; Eysenck, 1995), low on extraversion (Kemp, 1981; Eysenck, 1995; Feist, 1998) and high on neuroticism (Bakker, 1991; Eysenck, 1995) are often less creative.

Team personality studies have also analyzed group elements of the five factor model (Costa and McCrae, 1992), but only a limited number of studies are available (Reiter-Palmon, Wigert and De Vreede, 2011). One study revealed a negative link between team conscientiousness and group creativity (Robert and Cheung, 2010) while a second indicated that groups with some extraverted members outperformed groups with no extraverts (Barry and Stewart, 1997).

Based on the results of individual and group personality studies, we expect that team personality attributes will be related to team creative product development. One obvious complexity added to group analysis is the necessity to determine how to measure team attributes. We will follow the lead of other creative researchers and average each personality variable across team members (Stewart, 2006). Based on these comments we propose that:

H1a.: Groups with a higher average openness to experience will produce more creative products than groups with lower average openness to experience.

H1b.: Groups with lower average conscientiousness will produce more creative products than groups with higher average conscientiousness.

H1c.: Groups with lower average neuroticism will produce more creative products than groups with higher average neuroticism.

H1d.: Groups with higher average extraversion will produce more creative products than groups with lower average extraversion.

H1e.: Groups with higher average agreeableness will produce more creative products than groups with lower average agreeableness.

Our second group of personality characteristics includes those personality attributes not included in the five factor model. A meta-analysis of creativity and personality literature found that additional factors account for some degree of individual creative performance (Feist, 1998) and that team creativity is a complex phenomenon where other personality factors affect team creativity (Baer et al., 2008). These additional factors include tolerance for ambiguity, self-confidence, intuition, resistance to closure, less conventional, driven, ambitious, hostile, and impulsive. At question is whether any of these new traits affect the development of creative products. One means of measuring these attributes is to analyze the individual's creative personality (Gough, 1979). Creative personality has been tested empirically and employees that scored higher on creative personality produced more creative work (Oldham and Cummings, 1996). We anticipate that the same processes that are present at the individual level will be identified at the group level for creative product development:

H1f.: Groups with a higher average creative personality will produce more creative products than groups with lower average creative personality.

Since most previous research has not included a measure of creative personality it is anticipated that they may have overlooked a personality dimension that may be vital to evaluating group product creativity. We propose that:

H1g.: Increased average group creative personality positively affects group product creativity above what is explained by the five-factor model of personality.

1.1.2 Creative Process

Creative problem solving cognitive processes have received much more attention at the individual level than at the group level (Reiter-Palmon, Herman and Yammarino, 2008). This is evidenced by the lack of cognitive process inclusion in a team creativity meta-analysis (Hulsheger, Anderson and Salgado, 2009). Research has potentially omitted other variables because it does not consider the complex nature of creative thought.

The production of high quality, original and elegant solutions to problems requires individuals, and groups, to develop ideas and then select those ideas which are considered to be the most creative or best fit for the situation. The process of generating creative responses is a combination of divergent thinking (Guilford, 1950; 1967), which is often referred to as ideation, and the evaluation of those ideas through convergent thinking. Based on the desire to focus on idea generation, we will focus only on divergent thinking processes.

To many people, divergent thinking has been considered a theory of originality. This is a simplified misconception based on only one dimension of the construct. Divergent thinking describes the processes that individuals use to generate new

ideas (Acar and Runco, 2011) and is a combination of cognitive processes adopted by individuals to produce many and varied ideas. During divergent thinking, individuals use learned schemas to generate ideas. General cognitive ability certainly affects divergent thinking ability since an individual must learn creative processes. However, research has shown that divergent thinking abilities can be improved by training individuals to better use effective idea generating schemas. This means that a person's divergent thinking ability may be due to factors other than just general cognitive ability. Therefore, we hypothesize that:

H2.: Groups with a higher average divergent thinking ability will produce more creative products than groups with lower average divergent thinking ability.

The Torrance Test of Creative Thinking (TTCT) is likely to be the most popular of all divergent thinking tests (Hunsaker and Callahan, 1995). The TTCT evaluates an individual's divergent thinking abilities by looking at fluency, flexibility, originality, elaboration, verbal criterion-referenced indicators, and figural criterion-referenced creativity indicators of developed products. Fluency is an evaluation of the number of non-redundant ideas, insights, problem solutions, or products generated during the creative process (Guilford, 1967; Torrance, 1966). Individuals that can produce more ideas will have a larger set of ideas to choose from when they engage in the convergent thinking process of selecting their best idea. Producing more ideas often results in producing more creative ideas. It is anticipated that an individual's ability to produce more ideas will increase their ability to produce creative products. It is also anticipated that these same processes will be present at the group level.

H2a.: Groups with higher average fluency ability will generate more creative products than groups with lower average fluency ability.

A second divergent thinking ability is flexibility which is demonstrated when different perspectives are used to develop creative ideas (Amabile, 1996). Flexibility is measured by evaluating the number of different approaches that individuals take to solve the problem (Torrance, 1995). Increased flexibility enables people to look at a problem from various angles, which can increase product creativity. Individuals that have developed the ability to look at problems from various viewpoints increase their degree of flexibility in creative problem solving and are expected to generate more creative products. Similarly, teams that have members with higher levels of flexible thinking will generate more creative group products.

H2b.: Groups with higher average flexibility in solving problems will generate more creative products than groups with lower average flexibility in solving problems.

Originality is the single dimension of divergent thinking that is often most related to the construct itself. However, originality only measures the degree to which an idea is uniquely different from ideas that would have been generated by others

(Guilford, 1967). Originality can be obtained by generating the idea or through elaboration on a previously generated idea or using flexible thinking to alter a previously generated idea. Individuals that are better at producing original ideas will generate more creative products. It is expected that the same process is true at the group level.

H2c.: Groups with higher average originality abilities will generate more creative products than groups with lower average originality abilities.

Another divergent thinking ability is elaboration which identifies an individual's ability to add details to products, ideas, or creative solutions (Torrance, 1995). Elaboration occurs after one idea has already been generated and embellishments are added to the original idea. In this manner the individual begins with the idea and then modifies it by attaching a complimentary element. The ability to elaborate allows individuals to develop more creative products. Groups are expected to use a similar process.

H2d.: Groups with higher average elaboration ability will generate more creative products than groups with lower average elaboration ability.

The TTCT also considers verbal criterion-referenced creativity indicators as contributors to divergent thinking. Responses are evaluated for richness and colourfulness of imagery, emotions/feelings, future orientation, humour, and provocative questions. Individual verbal response ability is seen as a complement to divergent thinking since the individual is relaying their idea through their verbal response. Individuals who have developed the unique ability to add layers of richness and colourfulness, or emotions, humour or future orientation will have a greater chance of having their idea evaluated as being creative. It is anticipated that these abilities apply to the group level as well.

H2e.: Groups with higher average verbal criterion-referenced creative ability will generate more creative products than groups with lower average verbal criterion-referenced creative ability.

A similar situation is expected with figural criterion-referenced creativity where responses measure the individual's resistance to premature closure, unusual visualization, movement and/or sound, richness, abstractness, storytelling, internal visual perspective, and fantasy. The elements contained in the figural responses can also contribute to other divergent thinking elements, but is predicted to add to the level of creative productivity at both the individual and group level.

H2f.: Groups with higher average figural criterion-referenced creative ability will generate more creative products than groups with lower average verbal figural-referenced creative ability.

2 METHODOLOGY

This study was conducted at a large southeastern US public university. Students were recruited from several undergraduate classes and students were informed that the study involved the evaluation of personal creativity attributes and group creative processes. In total 349 undergraduate students participated where respondents were 54% male with an average age of 22. Data collection was conducted in two phases. First, demographic data, personality assessments and divergent thinking assessments were conducted using self-report instruments. The purpose of these assessments was to determine individual characteristics that each student brought to their team. After the individual assessments were complete, the respondents were randomly assigned to groups of 3 or 4 students, which comprised 105 groups. The decision to use groups of this size is consistent with other literature which suggests that groups that are too large allow for social loafing while smaller groups do not perform as well (Mumford et al., 1993). Each group was given the task of developing a novel product in fifteen minutes and instructions were read out loud to ensure students understood the task. Groups worked together in separate areas of the classroom discussing options. After thirteen minutes, groups were told they had two minutes to finalize their discussions and choose their best answer. At the conclusion of the fifteen minutes, one person from each group recorded the group's best answer on a paper which was collected by the researchers. The purpose of the team assignment was to determine how each team used the individual attributes of each team member to develop a group idea.

2.1 Measures

Group level creativity – The dependent variable in this study is the level of product creativity. Each group was given fifteen minutes to solve a novel task (Mumford, Hester and Robledo, 2011a), to “develop a new use for aluminium foil”. Products were evaluated for novelty, resolution, and style using the Creative Product Analysis Matrix (Besemer and Treffinger, 1981). Each product was scored independently by two expert raters with extensive experience in testing and scoring performance measures for “gifted and talented” students in the State of Virginia educational system. Interrater reliability was 0.98, indicating strong agreement between raters.

Creative Personality – Gough's (1979) creative personality scale (CPS) was used to evaluate individual creative personality. The CPS is an adjective checklist comprised of 30 items (18 are associated with creative people; 12 are associated with less creative people). Scoring of the scale consists of assigning a +1 for each creative adjective checked by the respondent and a -1 for each uncreative adjective checked. Oldham and Cummings (1996) report an alpha reliability of 0.70 for this measure. The CPS is a personality checklist completed by each individual and it is not reasonable to expect there to be any substantive agreement between group members. We follow the recommendations by Chan

(1998) on aggregation using the additive model and average individual CPS scores for the group level of analysis.

Divergent thinking ability – We used the Abbreviated Torrance Test for Adults (ATTA) to evaluate divergent thinking ability. The ATTA is a shortened version of the original Torrance Test of Creative Thinking (TTCT) (Torrance, 1966) which has been widely used in creative research for over 40 years (Cramond et al., 2005). Respondents complete three activities. In task one the individual lists problems associated with a novel concept. The second and third tasks ask respondents to complete the drawing of somewhat abstract figures and title their drawings. The same raters used to evaluate the creative product were also used to rate the ATTA and interrater reliabilities for the six dimensions of the ATTA, fluency, originality, elaboration, flexibility, verbal, and figural were 0.99, 0.97, 0.97, 0.99, 0.95, and 0.97 respectively. These reliabilities are all within the normal range .95 to .99 reported in the ATTA manual (Goff and Torrance, 2002). As with the CPS, ATTA scores were averaged at the group level (Chan, 1998).

Personality – The five factor model of personality (Goldberg, 1990) was used in this study. The Mini International Personality Item Pool (Mini-IPIP) (Donnellan et al., 2006), which is a shortened version of the 50 item IPIP developed by Goldberg (1990), was used to measure the five personality factors. The alpha reliabilities for openness, conscientiousness, extraversion, agreeableness, and neuroticism in this study were 0.75, 0.67, 0.82, 0.86, and 0.70 respectively.

Cognitive ability – Cognitive ability was proxied with standardized test score averages for all participants.

2.2 Analytical Approach

Hierarchical regression analysis and correlations were used to test hypotheses. Three models were used to control for the influence of variables on creative performance. Model 1 consists of the primary controls in the study, the big five personality traits and cognitive ability. CPS was added in Model 2 and ATTA components were added in Model 3. Analyses were performed at the group level.

3 RESULTS

Tab. 1 summarizes the means, standard deviations and correlations among all variables included in this study. *Hypotheses 1a* through *1e* predicted that the average individual personality traits would be related to team creative performance. The correlations presented in Tab. 1 show that extraversion (*H1d*) is the only group personality trait that is significantly related ($r=0.217$, $p<0.05$) to total product creativity. The regression results in Tab. 2, Model 1 show that the inclusion of all five personality traits and cognitive ability have a significant R^2 of 0.18 ($p<0.01$). However, the regression coefficients for all five personality traits are not significant. Based on these results, our study shows limited support for *Hypothesis 1d* where average team extraversion is significantly related to

team creative performance. Openness to experience (*H1a*), conscientiousness (*H1b*), neuroticism (*H1c*), and agreeableness (*H1e*) are not significantly related to team creative performance.

Table 1 – Group Means, Standard Deviations, and Correlations

	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Conscientiousness	4.77	0.85														
2. Agreeableness	5.37	0.56	0.32**													
3. Neuroticism	4.56	0.71	0.22*	0.23**												
4. Openness	5.32	0.63	-0.22*	-0.04	0.01											
5. Extraversion	4.76	0.95	-0.26**	-0.15	-0.14	0.13										
6. Grade	0.12	0.54	0.14	0.02	0.17	0.00	-0.16									
7. CPS	5.26	3.24	-0.18	0.01	0.18	0.30**	0.25**	0.08								
8. Fluency	15.86	1.43	-0.27**	0.00	0.03	0.04	-0.08	0.04	0.25**							
9. Originality	16.87	1.52	0.08	-0.02	0.23**	0.04	0.07	0.23*	0.42**	0.35**						
10. Elaboration	15.78	1.51	-0.24*	-0.14	-0.22*	0.33**	0.24**	0.09	-0.05	0.33**	-0.18					
11. Flexibility	15.33	1.44	0.06	0.19*	0.02	-0.11	-0.12	0.00	-0.07	0.47**	-0.01	0.19				
12. Verbal	3.53	1.25	-0.05	-0.07	0.12	0.19*	0.28**	0.03	0.46**	0.34*	0.49**	0.09	-0.14			
13. Figural	6.95	1.80	-0.19*	-0.06	-0.14	0.29**	0.19*	-0.04	0.19	0.26**	0.15	0.53**	-0.10	0.19*		
14. Divergent Total	74.31	5.15	-0.19*	-0.03	0.00	0.23*	0.17	0.10	0.34**	0.78**	0.50**	0.59**	0.39**	0.53**	0.64**	
15. Total Creative Product	14.29	5.33	0.00	0.08	0.07	0.06	0.22*	0.13	0.30**	0.15	0.29**	0.22*	-0.06	0.39**	0.26**	0.36**

Notes: * $p < 0.05$, ** $p < 0.01$

Tab. 2 presents the results of hierarchical regression for all three models with total group creative performance as the dependent variable.

Hypothesis 1f suggested that groups with higher average creative personalities would produce more creative products than groups with lower average creative personalities. Tab.1 correlations support this claim since average team creative personality was positively and significantly related to total creative product ($r = 0.30$, $p < 0.01$). Tab. 2, Model 2 also supports *H1f* by having a positive and significant unstandardized regression coefficient ($\beta = 1.19$, $p < 0.01$) for CPS.

Hypothesis 1g stated that increased creative personality would affect group creativity above what was explained by personality. Tab. 2, Model 2 results support *H1g* by showing that adding CPS increases the explanatory power of the model (R^2 change = 0.36, $p < 0.01$).

Table 2 – Group Level Results for Total Creative Performance

Variable	Model 1 Control Variables	Model 2 Control and CPS	Model 3 Control, CPS, and ATTA
<i>Conscientiousness</i>	-0.70	-0.31	0.18
<i>Agreeableness</i>	1.22	1.13	0.96
<i>Neuroticism</i>	0.33	-0.82	-0.70
<i>Openness</i>	0.68	-0.90	-0.91
<i>Extraversion</i>	0.32	-0.60	-0.24
<i>Cognitive Ability</i>	3.94**	3.35**	3.16**
<i>CPS</i>		1.19**	0.94**
<i>Fluency</i>			1.20**
<i>Originality</i>			0.36
<i>Elaboration</i>			-0.18
<i>Flexibility</i>			-0.72*
<i>Verbal</i>			-0.02
<i>Figural</i>			0.31
<i>Model df</i>	6	7	13
<i>Model R^2</i>	0.18	0.54	0.65
<i>R^2 Change</i>	0.18**	0.36**	0.11**

Notes: Value in cells are unstandardized coefficients * $p < 0.05$, ** $p < 0.01$

Hypothesis 2 claimed that groups with higher divergent thinking abilities would produce more creative products and *Hypotheses 2a* through *2f* further defined which of the six divergent thinking abilities would affect creative product development. Tab. 1 correlations show that the team's total divergent thinking ability (*H2*) is positively and significantly related to the total creative product ($r = 0.36$, $p < 0.01$). Fluency (*H2a*) was not significantly related to the total creative product ($r = 0.15$, $p > 0.05$). Team flexibility (*H2b*) was not related to overall team creative ($r = -0.06$, $p > 0.05$). Team average originality (*H2c*) is positively and significantly related to total creative product ($r = 0.29$, $p < 0.01$). Elaboration (*H2d*) is positively and significantly related to total creative product ($r = 0.22$, $p < 0.05$). Verbal criterion-referenced divergent thinking (*H2e*) was also positively and significantly related to total creative product ($r = 0.39$, $p < 0.01$). Figural criterion-referenced divergent thinking (*H2f*) was positively and significantly related to total creative product ($r = 0.26$, $p < 0.01$).

Tab. 2, Model 3 adds further support for *H2* by having a significant unstandardized regression coefficient for at least one of the divergent thinking dimensions, and by also having a significant change in R^2 of 0.11. The only significant divergent thinking trait was flexibility which is in the opposite

direction than expected ($\beta=-0.72$, $p<0.05$). There is significant support for the claim that team's divergent thinking abilities are positively related to team creative performance. At the dimension level, there is partial support for fluency, originality, elaboration, verbal-criterion referenced, and figural-criterion referenced as predictors of team creative product development.

The results from this study show how important creative personality and creative processes are in development of creative products by a team. The results of this investigation advance team creativity research in three areas. The first contribution comes from the identification of an important personality attribute for predicting team creativity. The results of this study show that creative personality adds approximately 36 percent more explanatory power than just cognitive ability and the FFM in predicting team creativity. Most previous research has focused on using the five factor model to depict the personality attributes that are significant in team creativity. Our research supports the claim that these five dimensions are important. However, the more important personality element is creative personality. This may be related to Amabile's (1996) motivation component for creative performance. Individual's that score higher on creative personality may be more confident in their abilities to be creative and therefore less reluctant to contribute as creative team members.

A second major contribution of this research is the dissection of creative ability into creative ability components. By using a proven means of assessing individual divergent thinking ability, we were able to show that divergent thinking ability further increased the R^2 of our model from 0.54 to 0.65. The results for the six divergent thinking dimensions (fluency, originality, elaboration, flexibility, verbal and figural criterion-referenced creativity) showed that every dimension had an effect on at least one aspect of team product evaluation. This is an important outcome since most previous research only considered fluency to be a significant predictor of product creativity.

The final implication of this research comes from the design of our study. Our research design measured the team product, individual performance, and individual behaviours. We combined these measures with three separate methods of evaluation; survey studies, psychometric studies, and qualitative studies. The evaluation of creative processes and products involves the development of complex research design techniques. We believe that this study contributes to previous research by including three methods and three measures in one study.

This study has significant implications for managers. Our identification of creative personality as a key indicator of team creative performance allows human resource managers a means of identifying and hiring for the potential to perform creative work. In addition, creative personality allows managers a means of identifying which members may perform well on creative problem solving teams. Another contribution is the identification of divergent thinking skills, primarily fluency and originality, as key individual creative abilities that contribute significantly to the creative product. Finally, we have demonstrated that various creative personality and creative processes are in play when groups

are asked to develop creative products. Once defined, the manager is more capable of determining which members to include on creativity teams.

4 CONCLUSION

Based on the findings of this study, we argue that the study of a team's creative problem solving ability goes much deeper than personality, cognitive ability, and the number of ideas a team can generate. Our evaluation of divergent thinking abilities suggests that creative ability is not just a function of cognitive ability. Individuals develop creative abilities and teams use these abilities to develop ideas that can be evaluated by the group. Added to this is the idea that there are creative personality attributes that may cause some individuals to either be more creative, or at least feel like they are more creative. This may increase the individual's motivation to participate and share their ideas with the team. However, we realize that this study has limitations based on the sample and the simplicity of the creative task assigned. Future studies should try to evaluate the creative process in actual business environments. We believe this study helps identify the individual attributes that should be evaluated for these studies. It is almost a certainty that organizations will continue to use groups to solve their most important problems in the future and this research begins to uncover the attributes that leaders should consider when they choose the individuals that will perform on these teams.

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Service-Led Model for the Activation of Smart TV: Case Study in Korea

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ABSTRACT

Purpose: This study explores the characteristics of STV service to empirically examine effects of the services on adoption and usage of STV to lead sustained growth of the STV industry.

Methodology/Approach: This study employs structural equation modeling as a quantitative approach, to examine causal relationships between service characteristics and user intentions. The survey collects 212 data only from actual users of STV, who have experienced STV functions or services, in South Korea.

Findings: The results of service-oriented model based on extended Technology Acceptance Model (TAM) indicate that ‘interactivity’, ‘content quality’, and ‘simplicity’ as service characteristics influence intention to use STV.

Research Limitation/implication: First, the STV industry should establish a distribution structure that generates sufficient profits for content providers as done in Smartphone market. Second, Services of STV should be provided to allow two-way communication and to allow users to engage in active interactions with other users.

Originality/Value of paper: This study makes contributions to research on both new products and service adoption by providing richer explanations of the mechanisms acting on the actual use of STV. Given that STV is considered a key appliance for the next generation of social media and smart appliance, our findings offer new directions on how to realize high quality services in the STV industry.

Category: Research paper

Keywords: smart TV services; service-led model; extended TAM; interactivity; content quality

1 INTRODUCTION

Smart TV (STV) is changing the IT and media industry and improving consumers' lifestyle by promoting home comfort, convenience, security, and entertainment (Yu, Hong and Hwang, 2016). For example, STV can provide the consumers to access online content such as news, weather forecasts, and map, as well as to use various application services such as social networking services, games, online streaming services (e.g. YouTube) and video on demand (VOD) services (Park and Kim, 2016). Bae and Chang (2012) expected STVs will become a smart hub at home by linking smartphone, handheld devices, and computers and controlling electricity, temperature, home security, and other home entertainment systems. With these advantages, STV has become the main device of smart home, expecting rapid market growth (Bae and Chang, 2012).

Previous studies expected the STV industry to be very attractive (Park and Kim, 2016). In the U.S., BI Intelligence estimated that around 25 million STVs will be active in American households by 2016 (Hoelzel, 2014). In Korea, according to Korea Telecom, STVs account for more than 50% of the entire TV market share in 2015 (Park and Kim, 2016).

However, the actual growth of the STV industry has been relatively weak. The main reasons for this situation is that many consumers are still using the STV primarily as a substitute of a conventional TV (Grobart, 2013). In other words, because of the lack of useful and valuable services that reflect the features of STV, users do not use various services of STV fully (Yu, Hong and Hwang, 2016). STV manufacturers are trying to develop and explore the services that pull sustained growth of STV industry. These situations imply the needs to move from product oriented view to service-led model for STV industry (Vargo and Lusch, 2004).

Therefore, there is a need to examine current STV services to identify which service factors can provide differentiated values for STV service industry. The objectives of this study include; to analyze characteristics of STV services and extract the important factors different from conventional TV, to develop service-led model based on extended TAM and service factors, to give implications for activation of STV service industry based on empirical evidence.

The study results and recommendations will help to better understand the consumers' psychological and behavioral intentions about current STV services and provide strategic insights on how to realize high quality services for STV industry.

2 THEORETICAL BACKGROUNDS

2.1 Concept of Smart TV (STV)

STV services can provide more customized and interactive experience to users with a wide range of services, including high-quality telecasting contents, two-way communication, information retrieval, Internet shopping, online games, and linkages with other smart devices (Kim et al., 2012). Yu, Hong and Hwang (2016) described STV as a TV set with built-in internet access, based on operating system (OS) that not only provides the broadcasting function of conventional TV but also application stores, searching, game and SNS service. Park and Kim (2016) defined STV as smart media with OS and CPU on a digital TV platform, offering existing broadcasting, VOD, SNS, home network access, and other applications from app store. STV can display broadcast programs from traditional broadcasting channels as well as content from the Internet, so that both sources can be equally used as suppliers of information (Murschetz and Evens, 2013).

STV and smartphone as convergence devices are similar in services and functions, pursuing one source with multiple uses. However, in case of smartphone, the focus is ‘communication with others’ where users are inclined to ‘lean forward’ to actively use various applications and contents (Shin, Hwang and Choo, 2013). As a result, smartphone application ecosystem has been well established to lead the diffusion of smartphone as the main mobile device.

Whereas STV is used primarily for watching various contents, so users are inclined to ‘lean back’ (Yu, Hong and Hwang, 2016). STVs are based on wide screen and high-definition compared to smartphone devices can provide better user experience in certain services such as video streaming and gaming. However some STV manufacturers such as Samsung and LG electronics had challenges regarding software capabilities and content delivery systems to attract their consumers with these STV advantages. As such, they are seeking partnerships with movie studios, entertainment companies, and other content providers to deliver valuable contents (Shin, Hwang and Choo, 2013).

2.2 Extended Technology Acceptance Model (Extended TAM)

The technology acceptance model (TAM) has been widely applied in many previous researches to predict and explain end-user acceptance of products or services using new information technology (Davis, 1989). The TAM suggests that user acceptance has three factors: attitude toward using, behavioral intention to use, and actual use (Davis, 1989). The TAM posits that behavioral intention is influenced by two beliefs: perceived usefulness and perceived ease of use. According to TAM, beliefs in new products or services influence attitudes toward using; in turn, the attitudes generate the intention to use. This intention can lead to the actual use of new products or services (Cheng and Yeh, 2011).

The TAM has been extended and modified in various applications (Martínez-Torres et al., 2015). When applying the original TAM to new products and services that offer entertainment, such as smart phones, SNS, or mobile games, new factors are needed to reflect the hedonic value in addition to perceived usefulness and perceived ease of use.

According to the motivation model of TAM proposed by Shang, Chen and Shen (2005), perceived usefulness could serve as extrinsic motivation via the performance of an activity, whereas intrinsic motivation encompasses perceived fun, playfulness, and enjoyment. In research on the user acceptance model of hedonic information systems, Van der Heijden (2004) added perceived enjoyment to the existing TAM. Cheong and Park (2005) also used the concept of perceived enjoyment to investigate user acceptance of the mobile Internet, and Shin (2009) added perceived enjoyment to TAM to better reflect Internet protocol television (IPTV).

Given that STV is Internet connected device as well as family or group-oriented device, STV is likely to evolve as a social platform that have social influence. Social influence used in theory of planned behavior (TPB) (Ajzen, 1991) and unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003) plays an important role for user's intention or behavior to use new product or service. In social service context, most users may be conscious about what other users think about the technology service, asking their opinions and monitoring their behavior (Shin, 2009).

2.3 Conceptual Framework Based on Single-Context Theory Contextualization

This sub-section describes how TAM is modified in this paper based on STV contexts and how the antecedents of TAM are chosen and integrated to the model. This study applies single-context theory contextualization to propose the research model based on extended TAM (Hong et al., 2013). It typically starts with the identification of general theory such as TAM, and then goes through two-step process of contextualized modification to develop a conceptual model. The modification is described as follow:

First step of contextualization is editing a general model by adding or removing core constructs (Hong et al., 2013). First, with regard to the original process (perception-attitude-intention) of TAM, many TAM-related studies have removed the attitude construct to simplify the model. The present study also excludes this construct. Thus, we propose a direct effect between perception and intention. Next, as mentioned in section 2.2, perceived enjoyment and social influence are added to original TAM. Therefore, after first level of contextualization the model remains with perceived usefulness, perceived enjoyment, and social influence as core constructs and intention to use as dependent variable. According to previous research, these variables have consistent impact on innovative products or services (Bere, 2014).

Second step of contextualization is to add contextual variables as previous factors of core constructs or dependent variables. These contextual variables as external factors generally include system characteristics, service characteristics, and personal traits (Wixom and Todd, 2005). For this research, we extracted interactivity, content quality, and simplicity of the STV services as the antecedent of constructs of extended TAM. The interactivity is extracted to measure how much the consumers become to lean forward due to interaction services provided by STV. We also extracted content quality to measure the value of STV provided differentiated and valuable service. Lastly, we extracted simplicity that may be understood as a lack of complexity when they interact with STV services. Simplicity is based on the concept of perceived ease of use from TAM.

3 RESEARCH MODEL AND HYPOTHESES

This section proposes the service oriented research model and develops the hypotheses to identify antecedents of intention to use STV as shown in Fig. 1.

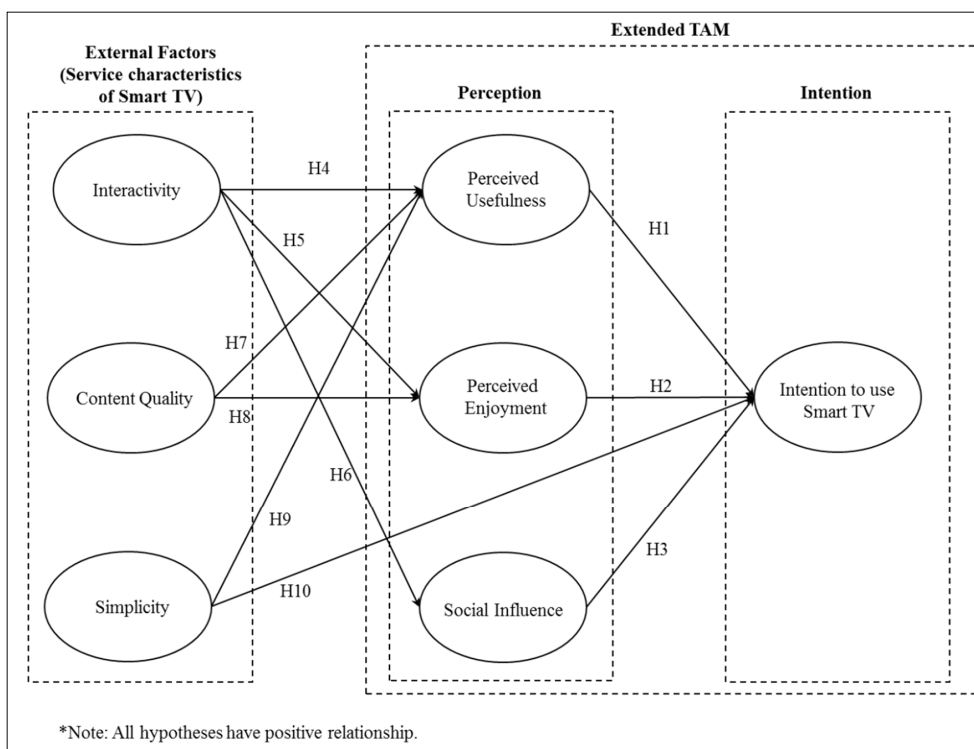


Figure 1 – Research Model

Perceived usefulness is defined by Davis (1989) as “the degree to which a person believes that using a particular system would enhance his or her job performance”. STV service may support users to reach their goals in everyday

life. Thus, we propose perceived usefulness, defining as the perception that using STV could help consumers' everyday life.

According to TAM, this variable increases the intention to use a new technology in both voluntary and mandatory contexts (Venkatesh et al., 2003). Kim and Oh (2011) also identified that when consumers have little information regarding new services, they would rely on utilitarian value derived from the services. Then perceived usefulness is strongly related to adoption intention toward new services. In research on IPTV, a context similar to that of STV, perceived usefulness had a positive relationship with intention to use IPTV (Shin, 2009). Also, Lucia-Palacios, Pérez-López and Polo-Redondo (2016) identified the positive relationship between perceived usefulness and google drive usage intention as cloud services. Hence, it can be hypothesized that perceived usefulness has a positive impact on intention to use STV.

H1: Perceived usefulness has a positive effect on intention to use STV.

High-technology appliances serve practical purposes as well as hedonic purposes (Van der Heijden, 2004). STV as a high-technology appliance can be seen as a hedonic system, as it provides entertaining contents. In the STV context, perceived enjoyment is defined as the degree to which the activity of using STV is perceived to be enjoyable and playful in its own right (Martínez-Torres et al., 2015). Perceived enjoyment is argued to be an important determinant of the intention to use when using advanced products or services for hedonic purposes (Gao, Li and Luo, 2015). Based on an analysis of mobile services (communication, online bill payment, and gaming), which are similar to the services offered by STV, Zhou (2013) proposed that people's intention to continuously use mobile services is directly influenced by the level of perceived enjoyment. In addition, research on the acceptance of IPTV, a forerunner of STV, showed that hedonic motivation is a significant predictor of the intention to use IPTV (Shin, 2009). Thus, people use STV for entertainment purposes.

H2: Perceived enjoyment has a positive effect on intention to use STV.

Social influence from other technology adoption theories such as UTAUT (Venkatesh et al., 2003) and TPB (Ajzen, 1991) is defined as the degree to which a person has the impression that others who are important to him or her believe he or she should use STV. This implies that the person's intent is influenced by others' opinions and behavior with regard to STV. In the IS perspective, intention to use mobile services is positively effected by social influence (Lucia-Palacios, Pérez-López and Polo-Redondo, 2016). In addition, some studies consistently indicate that social influence is an important factor that affects an individual's intentions or behavior (Venkatesh et al., 2003). Therefore, the following hypothesis is proposed.

H3: Social influence has a positive effect on the intention to use STV.

Interactivity can be defined as degree to which STV can allow consumers to interact with other users in real time, which is the major benefit of STV services

that conventional TV lacks (Shin, Hwang and Choo, 2013). Also, viewing content and programs on STV, the consumer may use real-time two-way communication through certain services such as chat rooms and bulletin boards. Cesar and Chorianopoulos (2009) explored how viewers interact with TV contents. They identified that viewers react emotionally to TV contents to share and discuss opinions with friends in real-time. It means that a consumer can interact with other users by accessing online in STV (Kim, Ahn and Hong, 2010). A study of American mobile internet users showed that 86% of the users share their opinions about TV programs that they are watching (Hodgkins, 2011). These interactive activities may increase positive perception about utility, sociality, and enjoyment (Shin, Hwang and Choo, 2013). Especially, viewer participating content such as game, quiz, and debate can increase not only enjoyment but also social influence.

Consumers can connect their smart device such as smartphone and handheld devices with STV. We called it 'N-Screen service' that enable users to transfer content freely among devices (Yu, Hong and Hwang, 2016). These services are possible to induce active use of STV by making users 'lean forward' to STV with diverse and personalized contents (Briel, 2012). Moreover, these advantages allow consumers to recognize that STV is useful, enjoyable, and social. Therefore, we propose the following hypotheses.

H4: Interactivity has a positive effect on performance expectancy.

H5: Interactivity has a positive effect on social influence.

H6: Interactivity has a positive effect on hedonic motivation.

In digital platforms such as STV, valuable digital content important for product or service market promotion (Yeh, 2015).

Based on the suggestion of DeLone and McLean (1992), our research employs content quality as characteristics of STV service. The concept of content quality is similar to that of information quality as defined by Lin and Lu (2000), given that information in the context of information system is often regarded as content in the context of STV.

On the basis of this concept, content quality refers to the degree to which people can access and customize the content and applications they want through STV. Apart from existing online-based content such as live programs and VOD services, STV can provide new types of online-based content for communication, information, entertainment, and commerce with wide, big, and high-definition screen (Yu, Hong and Hwan, 2016). With information technologies that is now providing various types of content and ways to customize the content, high quality of content positively affects perceived usefulness (Tsai and Chang, 2013) and it makes users more to enjoy and play with better user experience (Shin, 2009). Therefore, high content quality will have a positive impact on perceived usefulness and perceived enjoyment.

H7: Content quality has a positive effect on perceived usefulness.

H8: Content quality has a positive effect on perceived enjoyment.

In the STV context, simplicity refers to the degree to which the various services of STV are easy to understand and to use with a remote controller (Sonnenwald, Maglaughlin and Whitton, 2001). This concept is related with usability issues such as user resistance which arises in the process of adopting new products or new services. Users will be inhibited to use new products or services if they find it requires more mental effort and time (Al-Jabri and Sohail, 2012). In mobile payment services, Mallat (2007) found that complexity caused by mobile device features such as small keypads has inhibited usability of mobile technologies.

On the contrary to complexity, simplicity of service interface allows successful implementation of communication with STV and therefore decreases the risk involved in the adoption decision (Premkumar and Roberts, 1999). Because STV services use a more complex system than conventional TV, simple interface of services may be more important for usefulness and intention to use (Abroud et al., 2015).

There is considerable amount of empirical research on relationship among ease of use as simplicity, perceived usefulness, and intention to use. Ha, Yoon and Choi (2007) identified that ease of use has positive influence on attitude to use and usefulness of mobile game under mobile broadband wireless access environment. Lee, Cheung and Chen (2007) searched that ease of use as extrinsic motivation positively influences both usefulness and behavior intention to use multimedia messaging services.

Therefore, we infer relationship among simplicity, perceived usefulness, and intention to use.

H9: Simplicity has a positive effect on Intention to use STV.

H10: Simplicity has a positive effect on perceived usefulness.

4 RESEARCH METHODOLOGY

We developed measurement items to measure the constructs and examine the research model. All measurement items were developed based on previous findings. The constructs and their measurement items are presented in Tab. 1. Each item was operationalized using a five-point Likert scale ranging from strongly disagree to strongly agree.

Table 1 – Measurement Items

Construct	Measurement item	Reference
<i>Intention to use</i>	1. I intend to continue using STV 2. I intend to use the various functions and services of STV as much as possible 3. I recommend others to use STV	Shin (2009), Shin, Hwang and Choo (2013)
<i>Perceived usefulness</i>	1. Using STV services is very useful to my life in general 2. STV is helpful to achieve my purposes in general 3. Using STV would make me more effective in my life 4. Using STV can provide useful information	Verkasalo et al. (2010), Wu and Wang (2005)
<i>Perceived enjoyment</i>	1. STV services are entertaining 2. STV services are pleasant 3. STV services are exciting	Van der Heijden (2004)
<i>Social influence</i>	1. People important to me think I should use STV 2. People like me are expected to use STV 3. People I look up to expect me to use STV	Verkasalo et al. (2010), Shin (2009)
<i>Interactivity</i>	1. Viewers have two-way communication with the content provided by STV 2. Viewers can communicate with other people viewing STV 3. Viewers can share information and content with other people	Shin, Hwang and Choo (2013)
<i>Content quality</i>	1. STV provides various information and services 2. The service and information I can get from STV are valuable 3. STV provides the services and information that I need	Shin (2009), Lin and Lu (2000)
<i>Simplicity (Perceived ease of use)</i>	1. I would find it easy to find information using STV services 2. It would be easy for me to become skillful at using STV services 3. It is easy to use STV services	Wu and Wang (2005)

We conducted a web-based survey and a paper-based survey in April 2017 and collected data only from actual users of STV, who have experienced STV functions and services, in South Korea. A total of 212 complete and valid responses were collected. For a web-based survey, we accessed STV online communities or SNS, and requested survey. For paper-based survey, we gathered random data from people on the streets.

The ratios of male to female respondents were 57.4% and 42.6%, respectively. Age groups consisted of those in their twenties (51.9%), thirties (18.9%), forties (18.9%), and fifties (10.3%). In terms of occupation, respondents were mainly undergraduate and graduate students (47.6%) and full-time company employees employed (43.4%), followed by elected public officials, self-employed individuals, and others. In terms of TV habits, among the 212 respondents surveyed, 98 (46.2%) use video-on-demand (VOD) service, 19 (8.9%) use other applications, 18 (8.5%) use STV as smart hub to control other devices, and 77 (36.4%) simply prefer to watch TV.

We assessed the level of non-response bias by comparing early and late respondents, i.e., those who replied during the first week and those who replied during the last week. According to the method proposed by Armstrong and Overton (1977), t-tests were conducted with regard to each case, showed that the early and late respondents did not differ significantly in terms of their gender, age, or occupation.

5 RESULTS

Data analysis was conducted using the structural equation modeling technique of partial least squares (PLS) with SmartPLS 2.0. PLS is primarily intended for causal-predictive analysis in situations of high complexity (Barclay, Higgins and Thompson, 1995). PLS is suitable for examining a model when it is expanded by adding new factors to an existing theoretical model to reflect circumstances connected to emerging technology with potential customers and a rapidly growing market (Henseler, Ringle and Sinkovics, 2009). Also, PLS is not as restrictive on the sample as multivariate normal data distributions, and scales may be ordinal (Chin, Marcolin and Newsted, 2003). We first assessed the validity of the measurement instrument and then tested the hypotheses.

To validate the instrument conceptually, six innovation management researchers and four R&D researchers reviewed the measurement items and examined their validity. Before statistically testing the measurement model, we checked for possible common method variance (CMV). As with all self-reported data, there is a potential for common method biases that can lead erroneous results. Harman's single-factor test was employed to examine whether a single factor accounted for a majority of the variance in the data (Podsakoff et al., 2003). The single-factor test results do not indicate that a single-factor accounts for the majority of the variance, suggesting CMV was not a serious problem.

Next, we further examined the constructs for convergent and discriminant validity. Convergent validity can be established by the following criteria: (1) the factor loadings of items should be significant and should exceed 0.7, (2) the composite reliability (CR) and Cronbach's α should exceed 0.7, and (3) the average variance extracted (AVE) of the constructs should exceed 0.50 (Fornell and Larcker, 1981). As shown in Tab. 2, the standardized path loadings of all

items were significant (t values > 1.96) and greater than 0.7. The CR and Cronbach's α for all constructs exceeded 0.7. The AVE for each construct was greater than 0.5. Therefore, the measures show good convergent validity as shown in Tab. 2.

Table 2 – Convergent Validity

Variables	Factor Loadings	AVE	CR	Cronbach's α
ITU	0.899, 0.923, 0.838	0.788	0.917	0.864
PUSE	0.858, 0.782, 0.850, 0.867	0.705	0.905	0.860
PENJ	0.933, 0.929, 0.897	0.847	0.943	0.909
SOCI	0.915, 0.928, 0.928	0.853	0.946	0.914
INT	0.894, 0.832, 0.787	0.703	0.877	0.791
CONQ	0.826, 0.915, 0.905	0.779	0.913	0.858
SIM	0.857, 0.929, 0.923	0.816	0.930	0.888

Notes: ITU – Intention to use STV, PUSE – Perceived usefulness, PENJ – Perceived enjoyment, SOCI – Social influence, INT – Interactivity, CONQ – Content quality, SIM – Simplicity

Discriminant validity is assessed using the guideline suggested by Fornell and Larcker (1981) in which the square root of AVE for each construct should exceed the correlation between that and any other construct. Tab. 3 lists the correlation matrix, with the correlations among the constructs and the square root of AVE shown diagonally. The diagonal values exceed the inter-construct correlations; hence, the result of the test of discriminant validity is acceptable.

Table 3 – Discriminant Validity

	CONQ	PENJ	ITU	SIM	PUSE	INT	SOCI
CONQ	0.883						
PENJ	0.523	0.920					
ITU	0.475	0.551	0.887				
SIM	0.296	0.378	0.408	0.903			
PUSE	0.591	0.520	0.639	0.393	0.840		
INT	0.339	0.330	0.428	0.257	0.386	0.838	
SOCI	0.408	0.438	0.607	0.315	0.517	0.311	0.924

Notes: Leading diagonal shows the squared root of AVE of each construct

With an adequate measurement model and an acceptable level of multicollinearity, we tested the hypotheses using PLS. Fig. 2 presents the results

of the PLS structural model assessment with the overall explanatory power (R^2) and estimated path coefficients. Tests of significance of all paths were performed using the bootstrap resampling procedure.

As a test of hypotheses, PUSE (coefficient ($\beta=0.33$), PENJ ($\beta=0.20$), SOCI ($\beta=0.32$), and SIM ($\beta=0.10$) have significant effects on the ITU at $p<0.01$, $p<0.05$, $p<0.01$, and $p<0.05$, respectively. Thus, *H1*, *H2*, *H3*, and *H10* are supported. INT ($\beta=0.17$), CONQ ($\beta=0.47$), and SIM ($\beta=0.21$) have significant effects on perceived usefulness at $p<0.01$. Also, CONQ ($\beta=0.47$ on PENJ, and INT ($\beta=0.31$) on SOCI are statistically significant at $p<0.01$. Therefore, *H4*, *H6*, *H7*, *H7*, and *H9* are supported. Only the path coefficients of INT to PENJ is insignificant (*H5* was rejected).

The results of the PLS analysis about the explanatory power (R^2) show that 56% of the variance in the intention to use STV was explained by the proposed research model; 43% of the variance in perceived usefulness, 30% of the variance in perceived enjoyment, and 11% of the variance in social influence was explained.

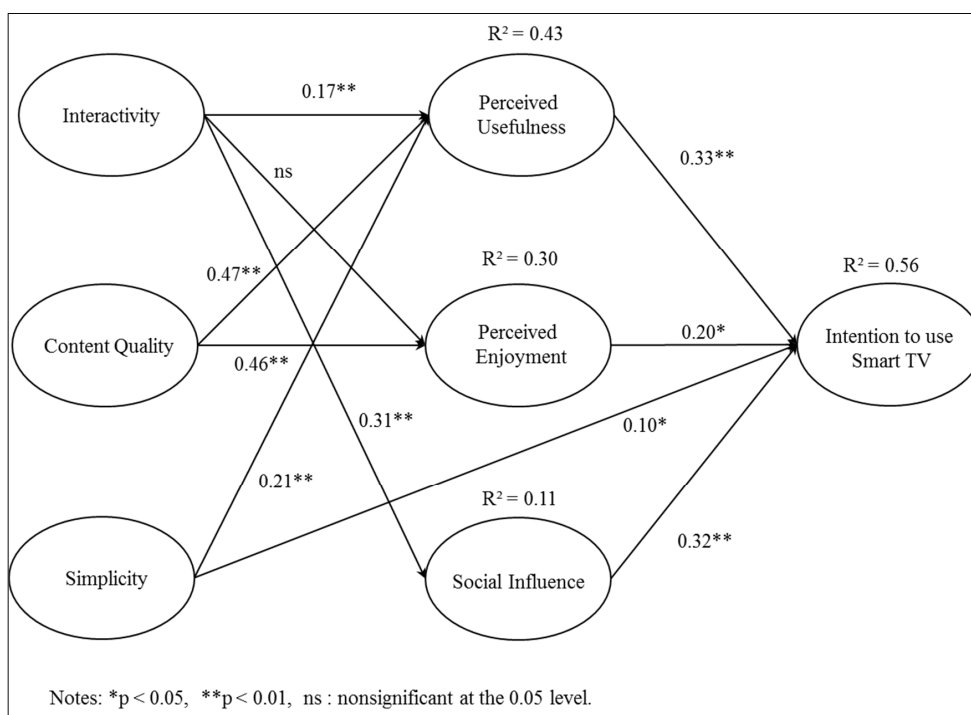


Figure 2 – Results of the Hypotheses Tests

6 DISCUSSION AND IMPLICATIONS

The goal of the study was to empirically identify importance of service for market growth of STV by understanding consumer perception and intention for use of STV services. Our results contain several important findings.

First, STV services including interactivity, high content quality, and simple service process provide relative advantages such as social, educational, informational, and commercial functions that are not offered by conventional TV (Bae and Chang, 2012). In particular, STV is likely to evolve as a social platform given its interactivity, which enables users to connect to online communities or social media. Thus, we empirically identified the service advantages offered by interactivity lead to the lean-forward use of STV due to the perception of it being more useful, enjoyable, and social than conventional TV.

Second, the main reason that current consumers make passive use of STV could be the lack of content that takes full advantage of the benefits of STV. Our study provides empirical analyses to support this point by identifying the quality of content from STV may clearly draw more users' attention and thus effectively influence users' intentions to use STV further. When considering our statistical results, content quality is more important to increase the value of STV than interactivity or simplicity in current STV context.

Third, with respect to simplicity, given that consumers lean back while watching conventional TV, it is difficult to expect consumers to actively learn complex and difficult services of STV. Therefore, a simple and intuitive service interface will allow consumers to perceive the usefulness of the various services offered by STV.

Lastly, our findings indicate that perceived usefulness, perceived enjoyment, and social influence act as key indicators of the intention to use STV. Statistical analyses supported independent variables indirectly influence the intention to use STV through these key indicators. We also conducted post-hoc analysis to statistically identify mediating effect of that perceived usefulness, perceived enjoyment, and social influence. The post-hoc results show that the effect of content quality on intention to use STV is fully mediated by perceived usefulness, while interactivity and simplicity are partially mediated by perceived usefulness. Perceived enjoyment and social influence also partially mediates the relationship between antecedents and intention to use STV. The results are consistent with earlier work that used TAM to reflect the characteristics of a hedonic system (Shin, 2009), indicating that our extended TAM is still valid when it is used to explain and predict user behavior in the STV context.

This study makes several important contributions. First, this study focuses on perspectives of service dominant logic: how customers perceive and use STV and, how STV service factors play a role in the development of customer's intention to use. This study contributes theoretical foundations to future research

on smart devices by developing service and consumer oriented research model, unlike previous research that has primarily focused on R&D side of STV.

Second, dealing with the importance of services for active and continuous use and adoption of STV, this study proposed interactivity, content quality, and simplicity as service characteristics of STV. We expanded the concept of interactivity in the STV to include constantly communicating with other users as well as interaction with the STV services. Also, the concept of content quality was expanded to cover not only simple information quality but also customized service quality about usefulness, enjoyment, and sociality that consumer expect from STV.

These key factors used in this study can be essential and meaningful factors for future research that deal with social platform or smart devices by finding the consumer service needs and understanding the psychological process for end-user acceptance and continuous use of them.

The findings of our study offer several practical implications for STV manufacturers as well as platform and content providers.

First, high quality content from various programs and applications is necessary to increase the level of usefulness, pleasure, and sociality of STV. Then, how to establish the STV ecosystem to provide high quality contents? Similar to current STV ecosystem, content of smartphone in the early stage was distributed in close platform by smartphone manufacturers and mobile service provider, so market size was not large enough to provide high quality content.

At this time, apple and android application stores gave third-party providers motivation to develop various applications to attract consumers and make profit. These application distribution channels help mobile phone market to establish successful smartphone ecosystem by releasing various high quality contents. In other words, the successful case of smartphone application markets shows that high quality contents may not arise solely from the efforts of platform companies or manufactures.

Various content providers should participate in producing high quality content. To realize such participation, the STV industry should establish a distribution structure that generates sufficient profits for content providers as done in smartphone market. As the current STV interfaces are not suitable for conducting complex work that can be performed on a personal computer, STV should focus on providing simple but necessary information and services to foster efficiency.

Second, to emphasize the differences between conventional TV and STV, interactivity should be highlighted. Services should be provided to allow two-way communication and to allow users to engage in active interactions with other users. In other words, it is important to provide interactive entertainment elements or on-demand information elements that match the main TV contents. Such advantages will attract people to use STV by giving them dynamic interactivity.

Despite its significant practical and theoretical implications, this study has some limitations. First, we only collected sample data from real users in Korea. Consumer perceptions and their influence on intention may differ from culture to culture. Moreover, because young and well-educated consumers constitute the majority of the respondents here, it is difficult to generalize the findings to all age groups. It would be useful to test the robustness of these results further by replicating the study across multiple cultures and various consumer age groups.

Second, this study was limited by the fact that the STV service is itself limited. STV is still in its infancy, and the services and applications through which consumers may sufficiently experience and perceive the merits of STV are limited. They responded to our questions after using only a few such services. As STV technology and services gets sophisticated, the perceived level of usefulness by consumers may evolve.

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Analysis of Types, Intensity, Methods and Effects of Process Innovations

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ABSTRACT

Purpose: The purpose is to provide knowledge about the intensity and types of process innovation in the business sphere, as well as the representation of entities involved in creating innovation, and about the effects of process innovation.

Methodology/Approach: Data from the statistical survey on innovation activities carried out by the Czech Statistical Office according to the Eurostat methodology were used, supplemented by some results of the own questionnaire survey. Methods of sorting, size arrangement, structure analysis, comparison, context analysis were used.

Findings: The large enterprises were significantly more active than SMEs in implementing process innovations, as well as foreign affiliates were more active than domestic enterprises. Besides typical competitive advantages of process innovation benefits the benefits in ecology, occupational safety and reduced labour demand have also proved to be numerous. Co-operation of enterprises with universities has proved to be low. The lack of skilled workers and financial resources were the main obstacles to the innovation activity of enterprises.

Research Limitation/implication: The research is focused on companies in the Czech Republic.

Originality/Value of paper: The actual contribution of the article lies in the purpose-oriented comparison of process innovations between fields of enterprise activities, especially in the area of logistics innovations, in some aspects the comparison of process-innovation activities according to the size of the company and the ownership of the company.

Category: Research paper

Keywords: innovation activity; process innovations; collaboration on innovation; effects of innovation; innovation in logistics

1 INTRODUCTION

Innovation is a prerequisite for a successful business in a highly competitive business environment (Tidd and Bessant, 2013; Veber et al, 2016). Given the growing competition, only a reduction in costs is losing momentum. On the other hand, to survive and gain a significant market position, businesses undertake innovative activities that focus on product, process or marketing and organization (Zelený, 2012). The term “process innovation” means according to the Oslo Manual (OECD, 2005) the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and / or software. The Czech Statistical Office methodology (CZSO, 2018) adds that this involves the introduction of a new or substantially improved method of production or service provision, including their distribution, storage, and the provision of business support activities such as maintenance, purchasing, accounting or information systems used. It involves a significant change in the technology, equipment or software used to improve the quality, efficiency or flexibility of production or supply activities, or to reduce the environmental burden or security risks.

Process innovations are defined in the domestic and foreign professional literature in a similar way as in the Oslo manual (OECD, 2005), while the author's point of view is emphasized. Veber et al. (2016) emphasize the introduction of technically new or significantly improved production methods, Tidd and Bessant (2013) the change the way the products are produced, services provided and delivered. Schumpeter (1987) defines the introduction of a new production process into production or type of sale or purchase. The theoretical principle of chaining innovation according to Valenta (2001) implies that the need for technological innovation is caused either by the innovation of the relevant product created by the technology or by the need to address the inefficiency of production of existing products.

In the area of process innovation, there is an urgent societal demand for green solutions, and there is a need for improved but also more cost-effective technologies and processes, as well as technologies that will help address labor shortages and improve productivity. Current directions of development of process innovations are digitization, automation, use of biotechnology and nanotechnology, use of renewable energy sources. For some products, the principles underpinning their functions are changing dramatically, which again requires the emergence of new production technologies. As stated by Mařík et al. (2016), cybernetics and artificial intelligence are key technologies for addressing systems called Industry 4.0.

Process innovations concern not only production but also logistics and support processes. Logistics innovations offer great potential benefits not only for supply flexibility but also for ecology. For example, Björklund and Forslund (2018) examined good logistics practices and suggested the classification of sustainable logistics innovations.

Creating process innovations has high demands not only on knowledge but also on research infrastructure, which can be difficult for companies to access, especially for SMEs. That is why cooperation with other companies, research institutes and universities is appropriate. Technology platforms within regions whose potential is being addressed by Urbančíková (2011) can become beneficial.

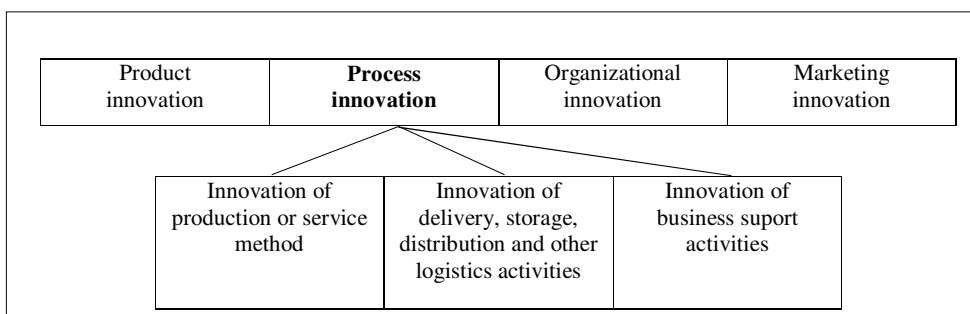
In this article specially the process innovations realized in the business sphere in the Czech Republic will be analyzed. The research will be mainly focused on comparing the relative frequencies of process innovation in selected branches of the economy, as well as on the representation of individual types of process innovation, analysis of cooperation in innovation development and identification of areas where the effects of process innovation are manifested.

2 METHODOLOGY

According to the broader concept of innovation described in the Oslo manual (OECD, 2005), we distinguish four main types of innovation: product, process, marketing and organizational. Product and process innovations are collectively called technical innovations. Marketing and organizational innovation are non-technical innovations.

2.1 Subject of the Research

Research activities are focused on innovation activities in the area of process innovations. Process innovations are divided according to CZSO (2018) into the following three groups. The first group consists of innovations in production and service delivery. The second group includes innovations in supply, storage, distribution, and other logistics activities, and finally, the third group includes innovations in business support activities (see Fig. 1).



*Figure 1 – Innovation Classification And Process Innovation Categories
(Author's Elaboration According to Classification of OECD, 2005)*

2.2 Input Data

As the basis for the analysis, the authors of the article used data collected by the Czech Statistical Office as part of a regular survey conducted according to a methodology unified across the EU in two-year cycles. Based on these data, partial sorting and purpose-oriented probes were carried out, the subject of which are process innovations. The last survey concerned the period 2014-2016 and its results were published by the Czech Statistical Office in June 2018. The results of a more recent survey dealing with innovation activities in 2017-2018 have not yet been published by the Czech Statistical Office.

The conduct of this inquiry is mandatory and coordinated by Eurostat. The Czech Statistical Office used a harmonized model questionnaire of Eurostat to collect data on business innovation activities, which the Czech Statistical Office translated into a national (brief) version of the questionnaire with several national questions. 6,638 reporting units of the business sector from selected areas of industry and services (financial and non-financial) with at least 10 employees based in the Czech Republic were addressed (CZSO, 2018). The net rate of return (number of reports used) was 85% (CZSO, 2018).

The questionnaire and the results prepared by the Czech Statistical Office in tabular form (showing mostly the shares of enterprises with the given response in %) are published in CZSO (2018) broken down by the following aspects: CR as a whole, by business ownership, by enterprise size according to number of employees, by field of business (sections by CZ-NACE) and by region of cohesion (CZ-NUTS).

The above-mentioned data source was supplemented in some investigated aspects by selected results of our own research questionnaire survey, which was carried out in 2019. In the research sample were 60 enterprises from Moravian and Silesian region of the Czech Republic

2.3 Methodology of Data Processing

The analysis carried out by the authors of this article sought answers to the following research questions:

1. What is the proportion of enterprises that have carried out a process innovation and whether these shares differ according to the ownership of the enterprise and the size of the enterprise?
2. How were individual types of process innovation and especially logistic innovations in individual sectors or branches represented?
3. In which areas did the results of process innovations show and how they differ according to the field of business?
4. Who participated in the development of the innovated processes and how does the representation of individual actors differ according to the ownership, size or field of activity of the company?

The results of the questionnaire survey of 60 MSK enterprises will be used in this article to only find answers to questions concerning the innovation strategy of enterprises, the ways of innovation development, and barriers to innovation activities.

The following methods were used for data analysis: sorting and size arrangement according to the degree of representation of innovative enterprises, according to the size of benefits, etc., comparison method, context-specific analysis along the main supply chain and in selected fields of activity.

3 RESULTS OF THE ANALYSIS

The results of the statistical survey of innovations for the period 2014-2016 show that the share of enterprises in the Czech Republic carrying out all types of innovation activities reached 46.3%. It means that the share of innovative enterprises in the Czech Republic is below the EU average.

In-house research has shown that to achieve business innovativeness, partial changes are made to a product or process that is new to the business (42.6%) than new to the market.

According to CZSO data, the process innovations addressed in this article were implemented in 27.7% of companies in 2014-2016.

3.1 Frequency Analysis of Enterprises with Process Innovation

As shown in Fig. 2, the relative frequency of process-innovating enterprises owned by foreign entities (33.6% of enterprises) is more pronounced than for enterprises with domestic owners (26.1%). The share of innovative enterprises also varies considerably according to the size of enterprises (Fig. 3). While only 23.3% of enterprises introduced process innovation in the category of small enterprises, it was more than half (57.1%) in the case of large enterprises.

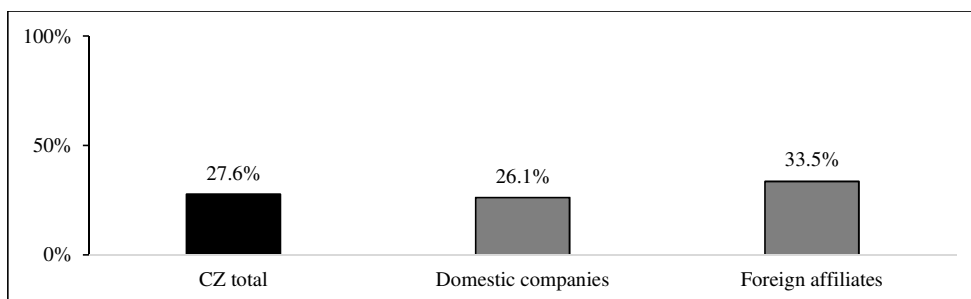


Figure 2 – The Share of Enterprises with Process Innovation in the Total Number of Enterprises – by Ownership of Enterprise (Author's Elaboration Based on Data from CZSO, 2018)

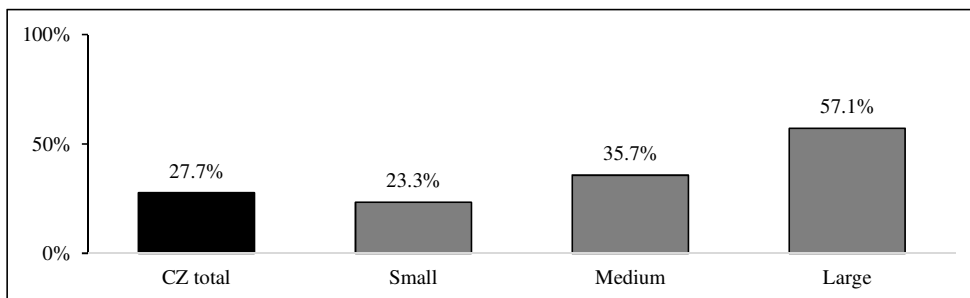


Figure 3 – The Share of Enterprises with Process Innovation in the Total Number of Enterprises – by Size of Enterprise (Author's Elaboration Based on Data from CZSO, 2018)

Fig. 4 shows the differences in the representation of enterprises with process innovation by sector of the economy and compares it with the national average. In the graph, the sectors are arranged in descending order according to the shares of enterprises with process innovation in the total number of enterprises in the sector.

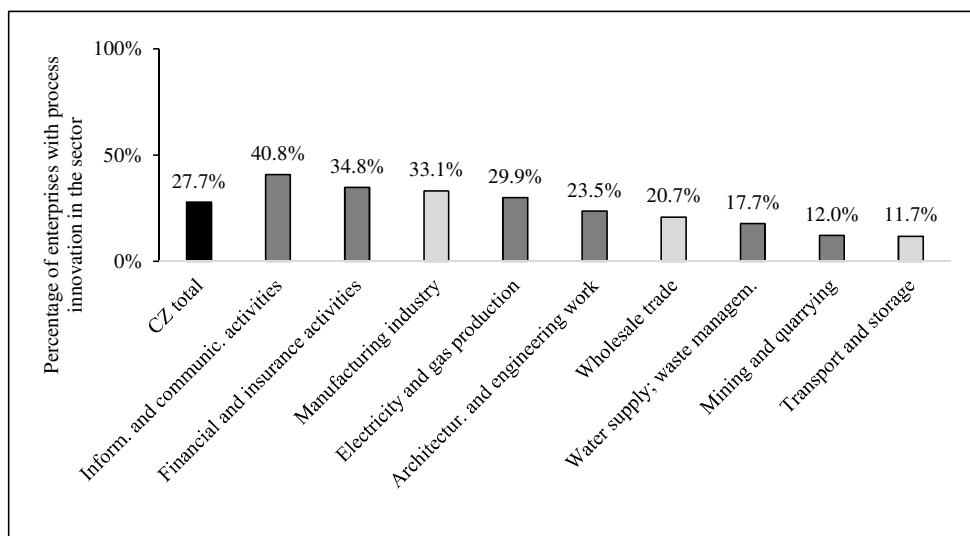


Figure 4 – Percentage of Enterprises That Have Introduced Process Innovation – by Economic Sector (Author's Elaboration Based on Data from CZSO, 2018)

According to sectors of the economy, ICT dominates, with 40.8% of enterprises in the sector implementing process innovation. This is followed by financial and insurance activities (34.8% of enterprises) and manufacturing (33.1% of enterprises). In these three sectors, the share of enterprises with process innovation significantly exceeds the national share. On the other hand, process innovation in mining and quarrying (12%) and transport and storage (11.7%)

represented the least share (deeply below the total share of process innovating enterprises in the Czech Republic).

With the data in this chart, we can more closely notice the relationship between the shares of process innovation along the main supply chain, which is made up of companies from the following three sectors: manufacturing - wholesale - transport and storage (by light colour indicated). This comparison shows a decreasing share of process innovating enterprises from manufacturing (33.1% of enterprises) through intermediary cells towards the end customer (wholesale 20.7%, transport and storage 11.7%).

Furthermore, the shares of enterprises with process innovation in individual branches of the manufacturing industry were examined in more detail. The results are shown in Fig.5, re-organized according to the size of the proportions and supplemented by comparison with the overall result for the manufacturing industry.

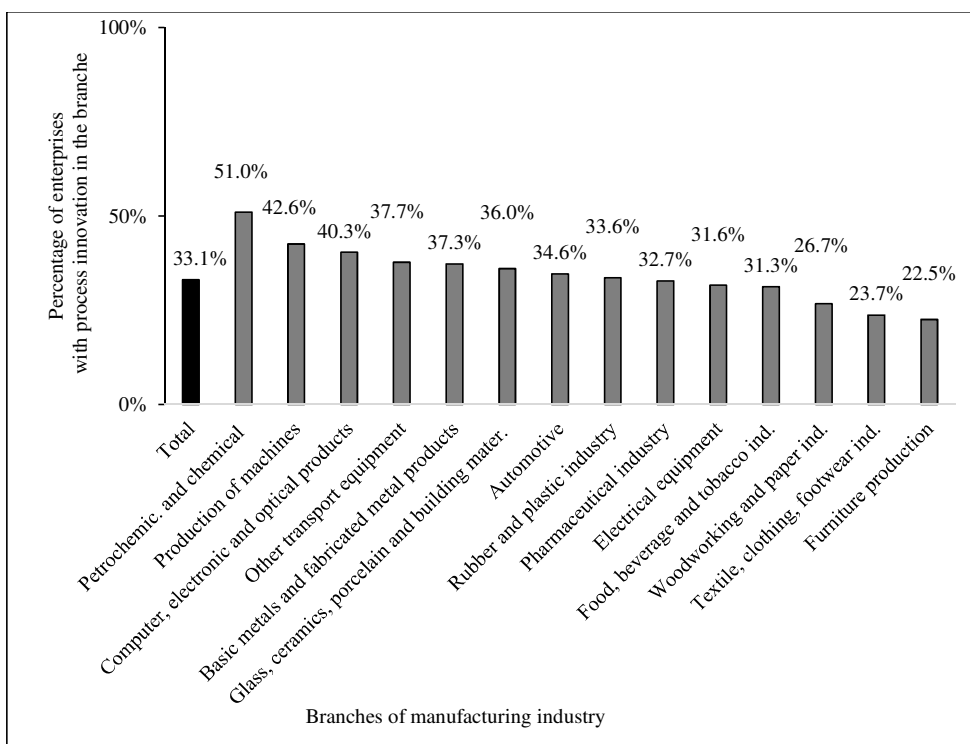


Figure 5 – Share of enterprises in particular branches of manufacturing industry, that introduced process innovation (Author's Elaboration Based on Data from CZSO, 2018)

Within the manufacturing industry, process innovations were most represented in the petrochemical and chemical industries, where more than half (51%) of the companies in this sector introduced process innovation. This is followed by the engineering industry with 42.6% of enterprises and the manufacture of

computers, electronic and optical equipment (40.3% of enterprises). In these three sectors, the share of process-innovating enterprises is significantly higher than that of the manufacturing industry as a whole. For other industries, the share of process-innovating enterprises ranged between 30 and 40% (note, for example, the automotive industry with a share of 34.6% of process-innovating enterprises), except for the woodworking, textile, clothing, leather and furniture industries, where the share of enterprises with process innovation did not reach 30% and is below the average.

3.2 Analysis by Types of Process Innovation

The relative frequencies of enterprises with different types of process innovation (broken down into process or process innovation, logistics innovation, and support activity innovation) as a percentage of enterprises that have introduced process innovation are shown in Fig. 6. Enterprises could list multiple types of process innovation and therefore the sum of relative frequencies does not give 100%.

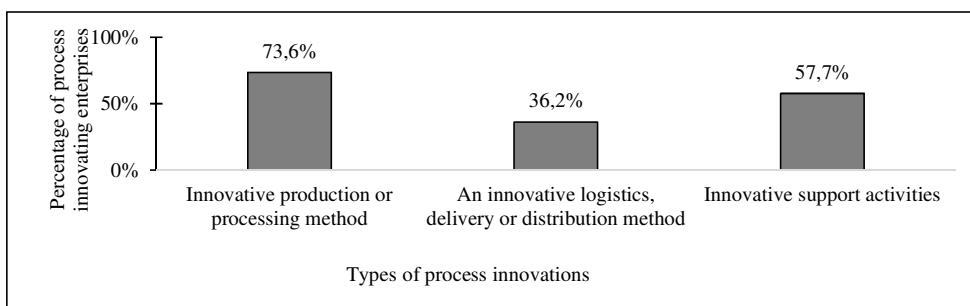


Figure 6 – Shares of Innovating Enterprises by Type of Process Innovation – CZ as a Whole (Author's Elaboration Based on Data from CZSO, 2018)

Process innovative enterprises most often experienced innovations in production or processing methods (73.6% of process innovation enterprises reported the introduction of this type of innovation), almost 60% of process innovation enterprises (57.7%) introduced innovation in support activities. Less than 40% of process innovators (36.2%) reported innovations in logistics.

The fields of activities listed in Tab. 1 were selected to analyze the representation of individual types of innovations by activity. Within the manufacturing industry the petrochemical and chemical industry (as a representant of so-called process kind of industry) and automotive (as a representant of discrete kind of industry and at the same time the industry with very high employment in the Czech Republic) were selected.

Table 1 – Percentage of Enterprises in Selected Fields of Activities (Both Innovative and Non-Innovative) by Type of Process Innovation (Author's Elaboration Based on Data from CZSO, 2018)

Field of activity	Share in the total number of enterprises in a row (both innovative and non-innovative)		
	Innovative production or processing method	An innovative logistics, delivery or distribution method	Innovative support activities
<i>CZ total</i>	20.4%	10.0%	16.0%
<i>Manufacturing industry</i>	25.8%	11.8%	17.9%
<i>Wholesale trade, except of motor vehicles and motorcycles</i>	12.9%	12.1%	11.7%
<i>Transport and storage</i>	7.1%	4.5%	7.8%
<i>Petrochemical and chemical industry</i>	43.1%	22.3%	24.3%
<i>Automotive</i>	26.2%	16.5%	22.2%
<i>Information and communication activities</i>	29.7%	7.9%	29.1%
<i>Financial and insurance activities</i>	21.8%	7.6%	29.4%

From Tab. 1 is clear that the chemical and petrochemical industry achieves more than double the share of enterprises with an innovative production or processing methods (43.1%) compared to the processing industry as a whole (which follows from the very nature of the industry). Also in the intensity of innovation in logistics methods as well as in innovation support activities the petrochemical and chemical industry outperformed the automotive industry. Information and communication, financial and insurance sectors, as well as the automotive and wholesale sectors, are characterized by a fairly balanced commitment to both core and support activities.

The authors of this article were more interested in the innovations of logistics, delivery or distribution methods, as there is great potential in this area to increase process flexibility, reduce costs and reduce environmental impacts. It was found that the share of enterprises with this type of innovation in the total number of enterprises (both innovative and non-innovative) is quite small. It ranges between 4.5% and 22.3% (in manufacturing as a whole it is only 11.8%, in wholesale 12.1%, in transport and storage only 4.5% of all enterprises).

3.3 Analysis of Process Innovation Benefits

The analysis of the benefits of process innovation was focused on:

- spectrum of benefits of process innovations (elaborated from answers to the question “What were the benefits of performed process innovations?”, where respondents could mention more areas and thus the sum of the share of enterprises does not have to give 100%; Fig. 7);
- the most important benefits of process innovation (respondents stated only the area they considered most important).

The following commentary compares the results obtained from both points of view.

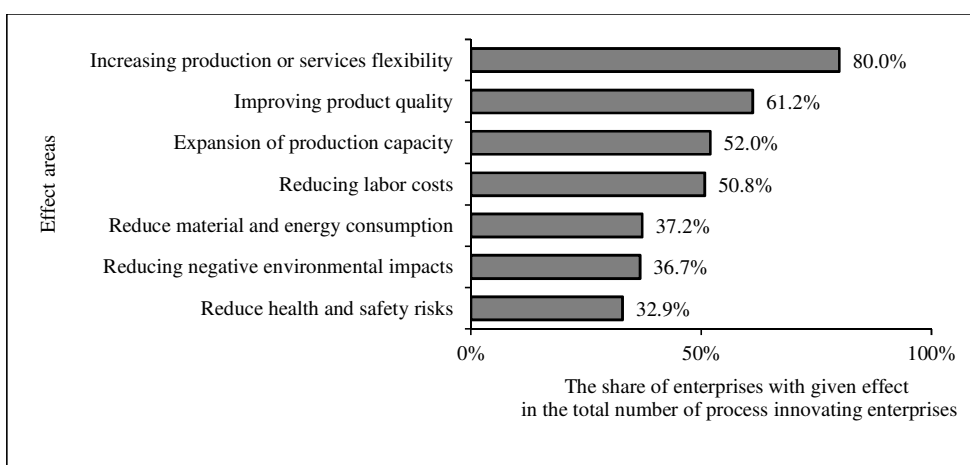


Figure 7 – Spectrum of Process Innovation Benefits (Author’s Elaboration Based on Data from CZSO, 2018)

Fig. 7 shows that process innovations often had a positive impact in several areas at the same time. High share of enterprises that have introduced process innovation have had the effects of increasing production flexibility (even 80%), increasing product quality (61.2%), increasing production capacity (52%) and reducing labor costs (50.8%). The share of companies that felt the effects of reducing material and energy consumption, reducing negative environmental impacts and reducing risks for employees is also quite significant (about a third of enterprises).

Regarding the most important effects of process innovations, all areas of effects were also represented, but with considerably greater differentiation. Due to limited extent of the paper the graph of the most important effects is not included. Increasing flexibility in production or service provision 41.5% of enterprises proved to be the most important. The largest share of enterprises with this effect was in information and communication (66.2%), financial and insurance activities (65.2%), wholesale (48.3%) and manufacturing as a whole

(34% of enterprises). Improvement of product quality, resp. the expansion of production capacity was no longer so significant. The effect of expanding production capacity was the most in companies from the automotive industry (31.5% of process innovators).

Only 10.6% of process innovating enterprises reported the decrease of labor costs as the most important effect. With these savings being most abundantly reflected in wholesale (17.1% of enterprises of process innovators in this sector) and transport and storage (14.2% of enterprises).

Effects in reducing negative impacts on the environment were mentioned as the most important by companies from the fields of energy production and distribution (21%), water supply and waste water management (16.5%), as well as from transport and storage (13.5%). In other sectors the share of enterprises with this most important effect was only up to 5%.

3.4 Analysis of Cooperation in Developing Process Innovations

When asked by the CZSO questionnaire, “Who developed the innovated processes?”, companies could list more subjects from the offer, which included the following options: on their own, in cooperation with enterprises within the corporate group, in cooperation with enterprises outside the corporate group, in collaboration with universities or research institutions, adapting the process developed by another entity, commissioning development to another enterprise, including group companies, commissioning development to a higher education institution or research institution.

It was found that representation of these particular forms varied significantly. In practice, several options are combined at the same time, and therefore the sum of the shares of the companies in each form does not give 100%. It is not possible to deduce from the results how many percent of enterprises used exclusively one form and which form it was.

The results of the analysis are summarized in one graph (Fig. 8), in which the first group presents the results for the Czech Republic as a whole. Two aspects of classification are applied to show the differences between enterprises by size according to the number of employees (small, medium, large) and by prevailing ownership (domestic enterprises, foreign affiliates).

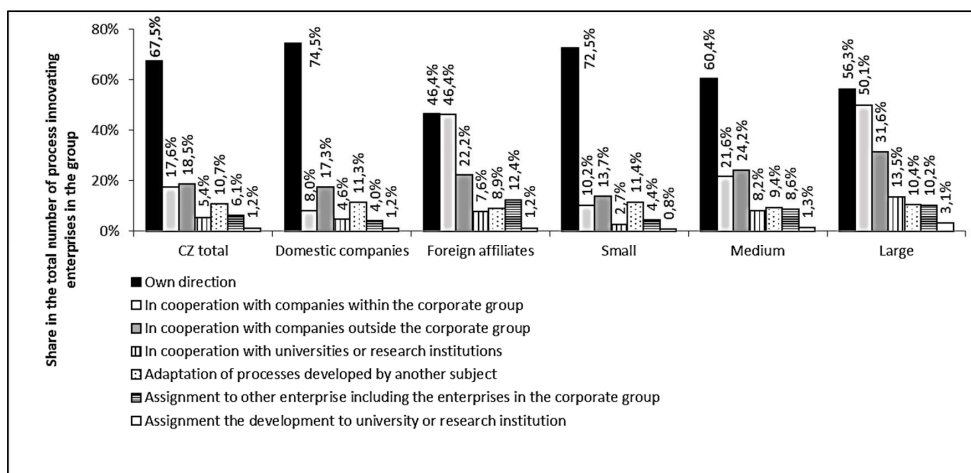


Figure 8 – Cooperation in the Development of Process Innovations According to the Size and Ownership of Enterprises (Author's Elaboration Based on Data from CZSO, 2018)

For the Czech Republic as a whole, self-directed development of process innovations prevails (this form was reported by 67.5% of the addressed enterprises that introduced process innovation). Almost 20% of enterprises (17.6%) used cooperation with other companies in the group and roughly the same share of enterprises (18.5%) used cooperation outside the corporate group. Adaptation of the process developed by another enterprise has proved to be low (10.7% of enterprises). Co-operation with research institutions or universities, or the commissioning of development directly to these organizations or other enterprises was only slightly represented (this was reported by only few percent of enterprises).

As regards the prevalence of self-directed development of process innovations the own questionnaire survey performed in 2019 led to the similar finding that the products and processes in enterprises regardless of size and ownership are developed mainly in their R&D department (75.9%).

While innovating enterprises with predominantly domestic ownership develop innovative processes predominantly on their own (74.5% of enterprises that have introduced process innovation), for foreign affiliates it is only 46.4% of enterprises. The same percentage of companies owned by foreign entities then uses cooperation with other companies within the corporate group. A smaller share of foreign enterprises (8.9%) uses adaptation of the process developed by another enterprise than domestic enterprises (11.3%).

In the development of process innovation there are also differences between categories of enterprises by size. As the size of the enterprise decreases, the share of own-account development decreases and the use of other forms of development is more pronounced in large enterprises than in small enterprises. In

adapting a process developed by another enterprise, the difference by size of the enterprise is not significant. The proportion of this form is slightly around 10% of enterprises. Ordering the development of process innovation to universities and research institutions is applied more often by large enterprises (3.1%) than medium (1.3%) and small (0.8%). This confirms the continuation of the tendency, which Spišáková (2010) stated, for example, based on her analyses of the innovation activities of Slovak and Czech companies based on Eurostat data from 2006.

4 DISCUSSION

The facts that the share of enterprises that carried out innovations of any type in the Czech Republic in the period under review is below 50% and the share of process innovators is below 30% is not very favorable. The own questionnaire research revealed that the main obstacles to the innovation activity of companies are the lack of skilled workers (61.1%) and the lack of financial resources (48.1%). However, companies are aware of the importance of innovation, which is again illustrated by the results of own research, where companies state that innovation is part of their corporate philosophy (92.6%).

The findings that large enterprises are significantly more active in this area than small and medium-sized enterprises and that foreign-owned enterprises are more active than Czech-owned enterprises are not very surprising. Regarding the intensity of innovation activities according to the sectoral structure, it may be interesting to note that the in ICT sector and in financial and insurance sector the share of process innovating enterprises was higher than in manufacturing. Placing the transport and storage sectors (with 11.7%) and wholesale (with 20.7% of enterprises) among the least process-innovating sectors may signal that their level of processes may be a brake on the development of supply chains as a whole.

The spectrum of effects of process innovation is broad and concerns not only traditional competitiveness factors (dominated by increased production flexibility, product quality and production capacity expansion), however the process innovation has led also to a reduction in labor costs in 50.8% of process innovating enterprises, contributing to addressing the urgent problem of labor shortages. It can be considered significant that the implemented process innovations had in about a third of companies positive societal impacts in reducing material and energy consumption, reducing negative environmental impacts and reducing employees' health and safety risks.

Analyses have shown that there is little cooperation in the development of process innovations, both business-to-business cooperation and, in particular, cooperation with research institutions and universities, suggesting that the knowledge potential and scientific infrastructure are not exploited.

The results obtained represent only a partial probe from the last valid survey conducted in 2016. It is necessary to respect the fact that the intensity of innovation is related to the length of innovation cycles in individual fields. For instance, in the automotive industry, the largest wave of technology and logistics innovations has taken place before the period under review, and now, for example, advanced processes in the logistics field are expanding to other sectors. The intensity of innovation is also dependent on the phases of the business cycle and the support of innovation by the state. Therefore it will be interesting to compare the results achieved with the results of the 2018 survey once they have been published.

5 CONCLUSION

For the period after 2019, further significant process changes can be expected in connection with the expansion of digitization and automation as well as the promotion of circular economy principles.

The Government of the Czech Republic has adopted an innovation strategy (RVVI, 2019) for the years 2019-2030 aimed at promoting science, research and innovation, based on the ambition to become a European innovation leader within 12 years. The innovation strategy focuses on the final production, technological solutions and knowledge-based services generating added value. The innovation strategy includes the following pillars: R&D funding and evaluation, polytechnic education, digital state, manufacturing and services, mobility and construction environment, smart marketing, intellectual property protection, smart investment, innovation and research centers, national start-up and spin -off environment. This created an innovative concept that covers national key activities across ministries, sets framework objectives and addresses strategic tools for their implementation.

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TRIZ and Lean Philosophies Applied Together in Management Activities

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ABSTRACT

Purpose: In the current market, the Portuguese industry faces strong competition from countries with substantially lower operating costs. The agri-food industry is also subject to increasing competition, both nationally and internationally. The utilization of methodologies that, in addition to continuous improvement, provide the development of creative and innovative solutions may be relevant for highlighting and differentiating between organizations. In this work, Teoriya Resheniya Izobretatelskikh Zadach and Lean Philosophies have been implemented together. Methodologies as Matrix of Ideality Matrix of Contradiction, Single Minute Exchange of Die, 5S and the Substance-Field analyses were used as complementary tools to improve the production management activities of agri-food sector. Strongly focused on the issues of time wastage and the organization and management of the filling line, the implementation of these methodologies led to a reduction of setup times, of the operators' movement and an improvement in the line's management and organization, and improve the results of 5S audits, depending on the work station. The aims of this study is the implementation of diferent methodologies, philosophies and tools to improve management activities.

Methodology/Approach: The methodology presented in this work involves using Lean and TRIZ methodologies together. Namely Matrix of Ideality, the Matrix of Contradictions, SMED, 5S and the Substance-Field Analysis, were used to optimize the management activities, in agro-food industrial sector. The methodology strongly focused on the issues of time wastage, organization and management of an filling line.

Findings: The implementation of methodologies led to a reduction of setup times by 60% to 70%, a reduction of the operators' movement during format changes by 26.2%, and an improvement in the line's management and organization by 9% to 12%, depending on the work station.

Research Limitation/implication: In the management activities, the results are not universal. Therefore, the same methodology applied in another industrial sector will present different results. Nevertheless, the application of this methodology and the tools chosen only make sense if it facilitates the management of improvements.

Originality/Value of paper: There is a need and demand for innovative solutions that lead to continuous improvement, production processes optimization and resource saving. The combination of different validated methodologies, with new concrete studies, is always in scientific and technical interest and continuously sought-after (demanded, welcome) by academic and industrial sectors.

Category: Research paper

Keywords: matrix of ideality; matrix of contradictions; SMED; 5S; substance-field analysis

1 INTRODUCTION

The agri-food sector is currently the largest industrial sector in Portugal and Europe, representing 16% of the manufacturing industry in Portugal. Nationally, it is composed of small and medium-sized enterprises, highly dispersed, employing about 114,000 workers, divided into about 11,180 organizations (Cruz, 2011; FIPA, 2016). In 2018, this sector had a turnover of around 16,952 million euros, an increase of around 3,000 million euros when compared to the year 2010 (FIPA, 2016). The detailed analysis of the agri-food industry is represented in Tab. 1, through a SWOT analysis (Gomes, 1990).

Table 1 – SWOT Analysis in the Agri-Food Industry

<i>Strengths</i>	<i>Weaknesses</i>
• Largest industrial sector in Portugal and Europe • Highly diversified sector	• Consisting mainly of small and medium-sized enterprises • Necessity of certification • Lack of negotiating capacity in relation to distribution • Lack of specialization
<i>Opportunities</i>	<i>Threats</i>
• Customer proximity • Turnover growth	• Raw material price growth • Decrease in consumption • Competition

In European terms, in 2017 the agri-food industry had a turnover of around EUR 1,089 billion, employing about 4.25 million workers in about 289,000 organizations. As a highly diversified industry, its turnover is divided several specific sectors, such as dairy products, drinks, fats and oils, bakery and farinaceous products, besides others (FoodDrink, 2017). The division of turnover by all sectors at European level is shown in Fig. 1.

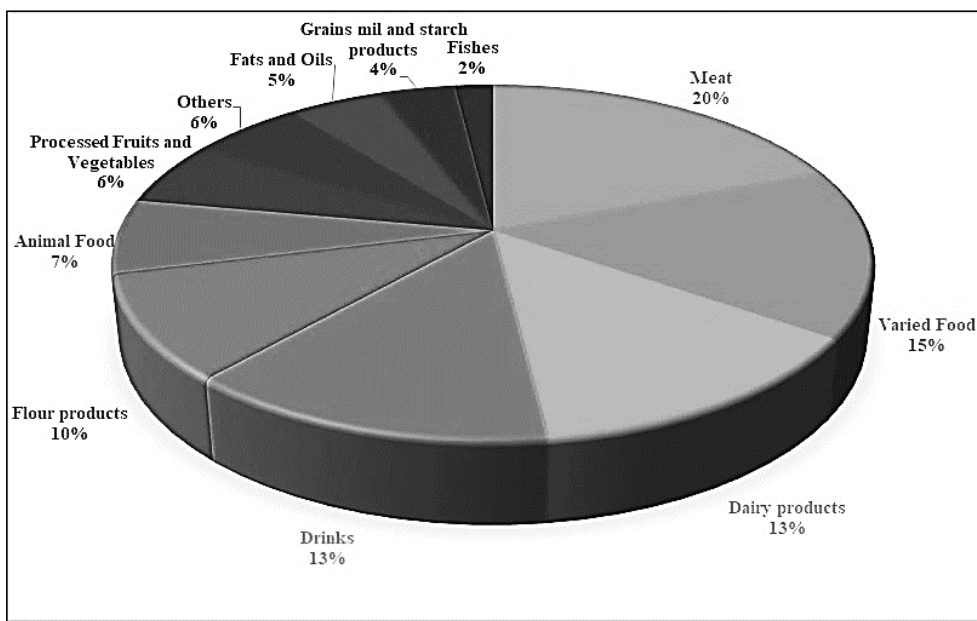


Figure 1 – Division of Turnover by Food Sector at European Level

In this work a methodology was developed to reduce waste present in a can filling line, aided by the use of TRIZ methodologies and Lean analytical tools identifying the improvements and implementation of solutions. In this way, several activities were defined and carried out in a logical order.

1.1 Lean Philosophy

In the early twentieth century, Henry Ford introduced mass-production techniques in automobile manufacturing, by changing the standard of handicraft manufacturing into serial production. The production method has changed from small workshops with highly skilled workers into large work areas with specialized, high-cost equipment, reducing the need for manpower. Increasing the complexity of the processes resulted in a greater supply of products which, in turn, led to stock accumulation and increased process times, increasing customer response time and customer complaints. Coupled with the new industry processes implemented by Henry Ford, customer expectations grew rapidly, requiring greater final product customization, reduced process times, better quality, and lower prices. To respond to customer demands, the industry, notably the

Japanese, led by Toyota, has redesigned the rules of industrial management (Pinto, 2008).

The Toyota Production Systems (TPS) originated the concept of Lean. Created in 1940 by engineer Taiichi Ohno. The TPS was developed as a philosophy oriented to the efficient satisfaction of the customer needs and expectations, based on the desire to produce through a continuous flow that did not depend on mass production to be efficient. What is currently referred to as Lean thinking is an extension of Toyota's production system. The comparison between the mass production techniques developed by Ford and the Lean production developed by Ohno is presented in Tab. 2 (Melton, 2005).

Table 2 – Comparison between Mass Production Systems and Lean Production

	Mass production	Lean Production
<i>Base</i>	Henry Ford	Toyota
<i>Workers – design</i>	Semi-skilled workers	Team of multi-skilled workers
<i>Workers – production</i>	Unskilled or semi-skilled workers	Team of multi-skilled workers
<i>Equipment</i>	Expensive equipment with a single purpose	Manual and automatic systems capable of producing large volumes and variety
<i>Production method</i>	Large volume of standardized products	To produce what the customer ordered
<i>Organizational Philosophy</i>	Hierarchical - management takes responsibility	Value flow using appropriate levels of power
<i>Philosophy</i>	Search for “sufficient”	Search for perfection

1.2 Triz Philosophy

The increasing need to increase quality, lower costs and, at the same time, remain competitive, leads organizations to aim for process improvements that result in efficiency gains. However, improvements in existing technology are no longer enough, and a radical increase in the resource efficiency use is needed (Flumerfelt, Kahlen and Alves, 2017). To this purpose, companies focus on innovation as a means of survival, resulting in inventions that solve problems in an efficient, effective and creative way (Savransky, 2000). It was for this purpose that Genrich Altshuller, engineer and Soviet inventor, developed the TRIZ methodology (Altshuller, 1999). TRIZ, acronym of Teoriya Resheniya Izobretatelskikh Zadach, is equivalent to Inventive Problem Solving Theory. This methodology is characterized by the use methodologies in order to generate creative ideas in the process of product development and problem solving.

TRIZ began to be developed by Genrich Saulovich Altshuller in 1946, through the study of more than one and a half million patents {85,6 years; 8 h/day, 10 min/patent} from different areas, in order to search for alternatives to the methods of creative solutions then available. Altshuller's analysis of the patents and the solutions described in their application revealed the existence of five inventive levels, leading to the conclusion that the inventive value of different inventions is not the same. The five inventive levels are represented in Tab. 3 (Navas, 2013).

Table 3 – Five Inventive Levels

Level	Description	Patents
1	Routine solutions using methodologies known in the field	30%
2	Minor fixes on existing systems, using methods known in the area	45%
3	Significant improvements that solve contradictions in systems of a specific area branch	20%
4	Solutions based on the application of new scientific principles	4%
5	Innovative solutions based on untapped scientific discoveries	1%

Solution development may follow different procedures, depending on its inventive level (Flumerfelt, Kahlen and Alves, 2017):

- Conventional improvement of existing systems (level 1 and 2);
- New procedures with existing operating principles (level 2 and 3);
- Creation of a new system with new operating principles (levels 4 and 5).

TRIZ has as main objective to assist in the projects of levels 3 and 4, where general engineering solutions do not produce the desired results (Navas, 2013). From Altshuller's point of view, level 1 and level 5 projects are ignored since, respectively, they are not innovative and require a high level of knowledge (Terninko, Zusman and Zlotin, 1998).

TRIZ introduced a methodology that circumvents the idea that the most significant methods for solving technical problems would be unique for each engineering area (Srinivasan and Kraslawski, 2006). This methodology, illustrated in Fig. 2, generalizes specific problems to identify examples of solutions that may be particularized into specific solutions for each problem.

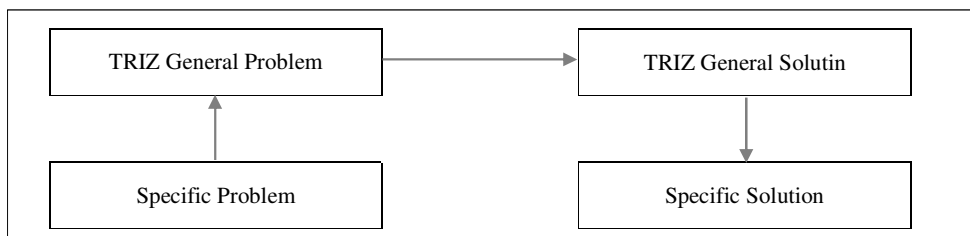


Figure 2 – TRIZ Implementation Methodology

2 METHODOLOGY

The development of this work was performed in a can filling line of 33 cl and 37.5 cl, having the filling capacity of 60,000 cans per hour. The line is composed of 9 main machines (Sandiães, 2017).

The presence of 2 types of packaging machines (Hi-Cone and OCME VEGA) and a packer (OCME TH) allows the line to be extremely versatile, allowing the production of 10 different final product formats.

The machines that make up this line are:

1. Depalletizer: puts the empty cans in the line, which are supplied in pallets of 23 rows.
2. Filler, harrower and level 1 inspector: fills the beer/coolant cans, which are then closed on the harvester and inspected at level 1 inspector.
3. Pasteurizer: heat the product to 70°C in order to eliminate microorganisms. It increases the life of the product and ensures that it is safe for consumption.
4. Daters and level 2 inspector: marks the cans with expiration date and lot. After dating, the cans go to the level 2 inspector.
5. Hi-Cone Packer: Pack the cans with Hi-Cone film.
6. VEGA OCME wrapping machine: packs cans with retractable film.
7. OCME TH Packer: packs loose packs or cans with carton and retractable film.
8. Palletizer: palletizes the packs packaged/packaged in half-pallet and whole pallet.
9. Wrapping and labeling of pallets: involves the pallets with transparent retractable film, and these are then labeled, through the pallet labeler.

The final product formats of the fill line 94 are as follows:

- 37.5cl can - Pack 24 of loose can;
- 37.5cl can - Pack 24 (Pack 8 x 3);

- 33cl can- Pack 24 (Pack 6 Hi-Cone x 4);
- 33cl can- Pack 24 of loose can with cardboard;
- 33cl can- Pack 24 of loose can;
- 33cl can- Pack 18 with cardboard;
- 33cl can- Pack 12;
- 33cl can- Pack 24 (Pack 6 x 4) with cardboard;
- 33cl can- Pack 6;
- 33cl can- Pack 6 Hi-Cone.

The first phase of the study focused on the analysis of the filling process, including equipment stops, set-up times, sequence of activities performed during the various setups and all the fundamental concepts and activities associated with the can filling process in the line.

In the initial analysis a Pareto diagram was performed with the total stop times of each equipment. Defining 3 aspects to be addressed in the study to be carried out, followed the identification of the critical points to be improved (Fonseca and Domingues, 2018). In order to identify the priority parameters of the line to be developed and improved, a brainstorming was conducted with a heterogeneous group of factory workers, including the filling head, engineering chief, engineering trainees and line operators. Based on this brainstorming was built the Matrix of Ideality. The “Setups” and “Costs” were identified as the most relevant parameters for a possible improvement in the value of ideality.

In order to complement the parameters chosen in the previous step, the parameters were adapted to the Contradictions Matrix, a TRIZ tool that allows the selection of inventive and innovative principles that best suit the problems in question. From the implementation of this methodology resulted as methods of improvement the Prior Action and Continuity of Useful Action, both of which are reviewed in the application of the Lean tool, SMED – Single Minute Exchange of Die.

Prior to the application of SMED, it was necessary to carry out a prior analysis of the types of setup, due to the existence of a large amount of them. For this, the average duration times and the frequency of each were considered. Defining the 3 types of setup to be improved, the SMED methodology was implemented.

To standardize the setups and reduce the variation between shifts, several operator support documents were developed, such as format change manuals, checklists, and work instructions.

Another of the points to be addressed was the organization and management of the line. For this, the Lean 5S methodology was used. Through a 5S audit and using a checklist, several critical points were identified.

In order to determine the methods for solving the identified problems, another TRIZ methodology, called Substance-Field Analysis, was used, which, through 7 general solutions, allows the development of specific solutions for each problem.

3 RESULTS AND DISCUSSION

Prior to any proposed improvements, it was imperative to carry out an initial situation analysis of line stops. Based on the data collected, a Pareto diagram was developed (see Fig. 3), which allows an easy visualization of the most important problems of the filling line, leading to a prioritization of the most relevant.

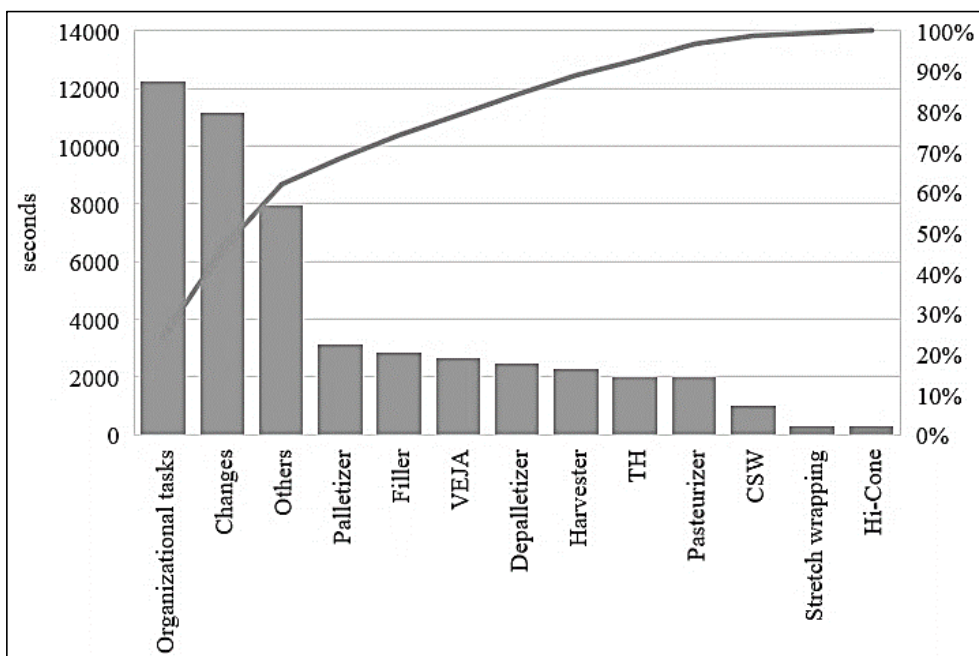


Figure 3 – Pareto Diagram of the Line 94 Filling Stops

Observing the Pareto diagram (Fig. 3), it can be seen that this does not follow the rule called 80/20, where 20% of the stop types give 80% of the total stop time. In this case, 20% of the stop types originate only between 46.27% and 62.03% of downtime. From another point of view, 80% of the total stop time of the line is caused by 46.15% of the stop types.

It is noted that there is no concentration of the total stop time in a small number of stop types, so it is necessary to define a point that balances the two parameters. The following stopping causes were defined as follows: organizational tasks, which correspond to stops due to other departments, such as logistics, quality, syrup and manufacturing, and tasks related to the organization and management of the line; product/format exchanges; other stops, which represent line stops due to unspecified machines. These three types of stops make up 23% of all stopping

causes and give rise to 62% of the total stopping time. Due to the nature of the stopping type, this is, other departments influence, the topic of organizational tasks was addressed with limitations, being restricted only to the topic of organization and management of the filling line department.

Tab. 4 presents the Matrix of Ideality that allowed the identification of interactions between requirements and distinguish positive and negative effects. Through the analysis of the Matrix of Ideality (Tab. 4) it was possible to determine the value of System Ideality through Matrix Contradictions and Engineering parameters.

Table 4 – Ideality Matrix

Parameters		1	2	3	4	5	6	7	8
1	Productivity							-	-
2	Setups	-				-	-	-	-
3	Versatility		+			-		-	-
4	Reliability	+					+	+	-
5	Automation	+			+		+	-	+
6	Availability	+			+			+	-
7	Maintenance	+			+		+		-
8	Costs		-	-	-	-	-	-	

The engineering parameter that presented the greatest number of contradictions in the Ideality Matrix was “Time wastage”. The principles associated with the parameter “Waste of time” were identified, and it was possible to identify which of these are possible solutions to the problem in question: “Prior action” and “Continuity of a useful action”. The 2 principles are related, and can be applied together through a Lean tool, SMED. Tab. 5 shows the results obtained in the improvement of setup times after SMED application in the 3 different setups.

Table 5 – Time Improvements Achieved through the SMED Application

	Initial Setup [min]	Final Setup [min]	Improvement [%]
<i>Product Exchange (Refrigerant)</i>	66.1	27.0	59.1
<i>Product Exchange (Beer)</i>	19.7	6.0	69.5
<i>Format Exchange (Hs Mp For P12p)</i>	89.3	35.9	59.8

Tab. 6 shows the results obtained through the application of SMED, in the improvements related to operator movements. It is possible to observe a considerable reduction in the movements, a reduction that is directly related to a reduction in equipment downtime (see Tab. 6).

Table 6 – Improvements Related to Movements Obtained through the SMED Application

	Initial [m]	Final [m]	Improvements [%]
<i>Movements</i>	116.8	86.2	26.2

One of the focal points in the filling line was the organization and management of the work space, evidenced by the Pareto diagram shown in Fig. 3. The Lean 5S methodology was applied, which focuses on the organization of the work place and the standardization of processes, with the objective of simplifying the stations and reducing waste. For that, a checklist was prepared with elements of all 5S senses (*Seiri, Seiton, Seiso, Seiketsu* and *Shitsuke*) on a total of 20 questions and five evaluation criteria (from 0 to 4) were defined. The maximum pontuation for the checklist was 80 points which correspond to the total percentage (100%). The audits were standardized and performed before and after the implementation of the improvements. and the results are presented in Tab. 7.

Table 7 – Improvements Achieved through the Implementation of 5S

	Initial Audit [%]	Final Audit [%]	Improvement [%]
<i>Station 1</i>	80	93	11.6
<i>Station 2</i>	85	91	9.3
<i>Station 3</i>	74	89	12.0
<i>Station 4</i>	80	94	11.8

4 CONCLUSIONS

From the initial analysis of the Pareto diagram, it was verified that of the equipment stop times, the ones with the greatest influence on the total standby time of the line were:

- Organizational tasks, which correspond to tasks related to the organization of the line and activities performed by others departments, external to the filling department, such as logistics and quality;
- Exchanges, which correspond to line stops resulting from changes in format and product;

- Other stops, representing stops due to failure of conveyors and machines not specified.

These three stop types give rise to 62% of the line stop time.

From the implementation of LEAN and TRIZ methodology resulted as methods of improvement the Prior Action and Continuity of Useful Action, both of which are reviewed in the application of a Lean tool, called SMED.

The SMED methodology was implemented. Following a specific methodology, 3 changes of formats were improved, obtaining reductions of setup times of 60% to 70%, depending on the setup, and reductions of the operators' movements of 26.2%, only for the 3rd setup analyzed.

To standardize the setups and reduce the variation between shifts, several operator support documents were developed, such as format change manuals, checklists, and work instructions.

The Lean 5S methodology was used and the following solutions were obtained:

- Organization of the visual management panels on the worktable of the filler, keeping only the information essential to the proper functioning of the workstation. Organization of the worktables of the other stations of the line;
- Insertion of records of compliance in the worksheets of all the jobs;
- Placement of cleaning stations along the filling line;
- Organization and labeling of the place of storage of the packaging pieces of format;
- Placement of storage shelf with circular supports in the wrapping machine.

The application of the solutions allowed an improvement in the results of 5S audits by 9% to 12%, depending on the job.

It is concluded that after the solutions were applied, it is essential to follow them, monitoring the associated parameters and maintaining the demand for continuous improvement, avoiding stagnation in terms of process improvement.

The use of Lean and TRIZ methodologies was essential for the identification and resolution of problems present in the line, promoting the reduction and elimination of waste through innovative solutions. However, the future success of the application of these tools depends on the motivation of the workers and their willingness to improve and break their routines.

It is important to note that, during the study, several difficulties and barriers to the application of the TRIZ and SMED methodologies emerged, fortified by the resistance to change by the operators and the factory manager. However, the application of these tools proved to be beneficial both in terms of productivity

and efficiency of the line as well as in motivational terms, allowing a constant evolution of trust and motivation that, in turn, has promoted an environment conducive to improvements and the argumentation of solutions to the critical problems in workplaces.

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Lean Six Sigma Approach to Improve the Production Process in the Mould Industry: a Case Study

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ABSTRACT

Purpose: The purpose of this article is to explore the optimization of internal process is assumed as a critical factor to be capable of answering to the moulds industries. Consequently, it has been considered essential to adopt high-valued methodologies to support tooling industry in order to achieve global competitive advantages. For that purpose, this work aims to apply LEAN principles and techniques to support mould design and manufacturing processes.

Methodology/Approach: The methodology used was based on PDCA/DMAIC, with the following stages: Define, Measure, Analyze, Improve and Control. For each stages was taken some of Lean Six Sigma techniques, such as Continuous Improvement, Value Stream Mapping, Pareto analysis and Overall Equipment Effectiveness.

Findings: This study results was revealed that there are many areas on the organizations in the Mould Industry, when they utilize otimizations tools obtain hugt successes. With the Pareto analysis was carried out to show that events that contributes the most to the stops. The results were: unavailability of the operator (16.4%), programming the machine (14.4%) and tool exchange (12.4%) In the case of this Mould Industry study was obtained for the CNC machines studies, with the implementation of Lean Six Sigma tools as obtained a improvement about 20% of global OEE.

Research Limitation/implication: This research was revealed that there the moulds are Project unique and difficult to analyze. Moreover, this paper reports that the approach LEAN Six Sigma is very interesting for the continuous improvement of processes and profitability of moulds industry.

Originality/Value of paper: This research highlight areas of future research using of quality management methods and Lean Six Sigma tools to analyse and

optimize production in the moulds industry. Therefore this research It is considered to promote and adopt high-valued methodologies to support tooling industry in order to achieve global competitive advantages.

Category: Case study

Keywords: mould; Lean Six Sigma; VSM; Pareto diagram; OEE

1 INTRODUCTION

Most injection mould manufacturers in Portugal are generally characterized by their high technological standards, high engineering knowledge and high performance in terms of overall mould quality and customer service. However, the injection mould industry has faced several challenges posed by globalization (ISTMA World, 2007). This create a set of threats, promoting competitiveness, and compels companies to be more efficient, by seeking new opportunities for innovation and for market and also with the improvement and effectiveness on yours internal processes.

The production process of injection moulds has several difficulties to overtake namely the uniqueness of each mould, the simultaneous production of myriad components from several moulds and recurrent mould design changes asked by the customer (Jorge and Peças, 2018). However, these companies have a challenge to remain at the level of excellence by responding to an increasingly demanding market in terms of mould complexity, ever shorter delivery times and a continuing and growing environmental concern, together with waste minimization. The challenge listed above result in the need to reduce waste and time without added value, where maximizing the use of high technology resources is relevant and differentiating (WEF, 2016; Henriques and Peças, 2012; Wongwiwat, Bohez and Pisuchpen, 2013). This complexity manufacturing results in a very unstable and dynamic process flows and, as such, waste in the mould production chain is difficult to identify and assess. For overtake this difficulty this paper presents the results of a research aiming to understand the applicability of Lean tools to the mould making industry. The underlying principle at continuous improvement is it guided towards the efficiency of the global process (Jorge and Peças, 2018).

One objective of this study regarding the applicability of Lean tools to the mould industry is keep the information available and disseminated. If possible that information must be available in Knowledge database. The process of knowledge management results from the need to survive in a world dominated by innovation, and the need for its management is based on the creation of value (Santos et al., 2019). So, databases might be a solution to promote creation of value and scientific production (Figueiredo and Pereira, 2017).

Due to the increased competitiveness, the mould makers are under huge pressure in order to reduce their costs and provide products of higher quality in shorter

lead times. This is possible if they improve their performance. Lean manufacturing can be used by manufacturing organizations to achieve these and obtain a competitive advantage over their rivals (Belekoukias, Garza-Reyes and Kumar, 2014; Garza-Reyes et al., 2012; Womack and Jones, 2003). This competitiveness is obtained by increasing efficiency and decreasing costs through the elimination of non-value added steps and inefficiencies in the production process (Sohal and Egglestone, 1994; Garza-Reyes et al., 2012). Lean was first introduced by Womack and Jones (1990) in their book “The Machine That Changed the World”, which describes the Toyota production system (TPS) (Womack, Jones and Roos, 1990; Alaskari et al., 2012).

Nowadays, the optimization of internal process is assumed as a critical factor to be capable of answering to the high-tech industries, namely the automotive and aeronautics industries. Therefore all companies are confronted with constant changes in the markets for this the management processes that should be proactively applied (Araújo et al., 2019). Currently, the rapid change in global market imposes faster mould design and manufacturing in order to reduce the time-to-market, along with higher quality, greater efficiency and lower costs. Consequently, it has been considered essential to adopt high-valued methodologies to support tooling industry in order to achieve global competitive advantages. For that purpose, this work aims to apply Lean principles and techniques to support mould design and manufacturing processes. The injection mould is a high precision tool responsible for the production of most plastic parts used everywhere. Its main purpose is to replicate the desired geometry of the final plastic part by transforming molten plastic into its final shape and dimensional details. Thus, these tools are custom designed and built. Taken in to account these specific characteristics of moulds sector (Engineering & Tooling), namely the design and manufacturing of unique and unrepeatable tools through a job shop production environment, significant adjustments were introduced in order to adapt some of traditional Lean techniques, such as Value Stream Mapping (VSM) and Overall Equipment Effectiveness (OEE), to this sector.

2 LEAN MANUFACTURING

Lean manufacturing is a management approach to make organizations more competitive by increasing efficiency and decreasing their costs and providing products of higher quality in shorter lead times e.g. promote the elimination of non-value added steps and inefficiencies in the process (Garza-Reyes et al., 2012). It is associated to the continuous improvement since that requires constant improvement of its practices (Marodin and Saurin, 2013). The major challenge to industry applying lean manufacturing is to implement a culture that will create and sustain long-standing commitment in the organization (Prakash and Sunil Kumar, 2011). To maintain the culture of continuous improvement we can use the PDCA cycle or a Kaizen what is methodology for a systematic approach that

focuses on customer needs, oriented to the process and encourages the participation and proactivity of all collaborates (Glover et al., 2011).

As Ohno (1988) refers, the products delivery between the supplier and the customer's order should be studied, and the wastes identified should be eliminated in order to reduce deadline of delivery. The original seven common wastes in an industrial environment that were identified (Ohno, 1988) are:

- *Defects;*
- *Inventory;*
- *Motion;*
- *Over processing;*
- *Over production;*
- *Transportation;*
- *Waiting periods.*

The Human talent is an additional waste more recently been pointed out as important and, should therefore, has been considered in the list (Liker and Meier, 2006). So, in addition to this, other types of waste can still be identified, namely; Waste of materials, Energy and Water; Pollution and Time.

The authors Womack and Jones (1996) referred Lean thinking as the “way to specify value, line up value creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively”. Five Lean principles were introduced to address the various challenges that occur within and between business units from the differences in business culture and management thought process. The Lean principles (Womack and Jones, 1996) are:

1. Define value from the customer;
2. Identify the value stream mapping;
3. Establish a continuous flow;
4. Implement pull system production;
5. Continuously search for perfection.

These principles (Fig. 1) have the goal to establish a perfect value stream by continuously identifying, and eliminating activities considered waste and focus on activities that create value.

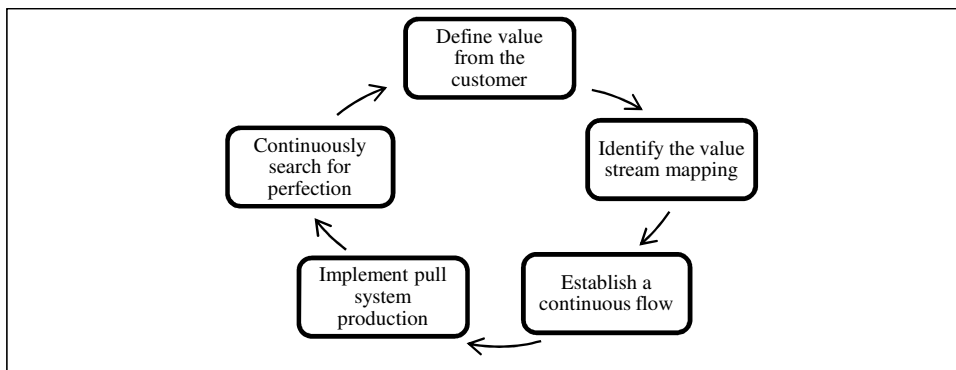


Figure 1 – Lean Principles

Lean Manufacturing is a concept used in production systems through continuous improvement, elimination of waste and non-value-added operations by using a series tools and techniques (Manzouri et al., 2014; Thangarajoo and Smith, 2015). Lean was first introduced by Womack, Jones and Roos (1990) in their book “The Machine That Changed the World”, which describes the Toyota production system (TPS). Womack and Jones (2003) describes Lean as: “*The most powerful tool available for creating value while eliminating waste in any organization*”.

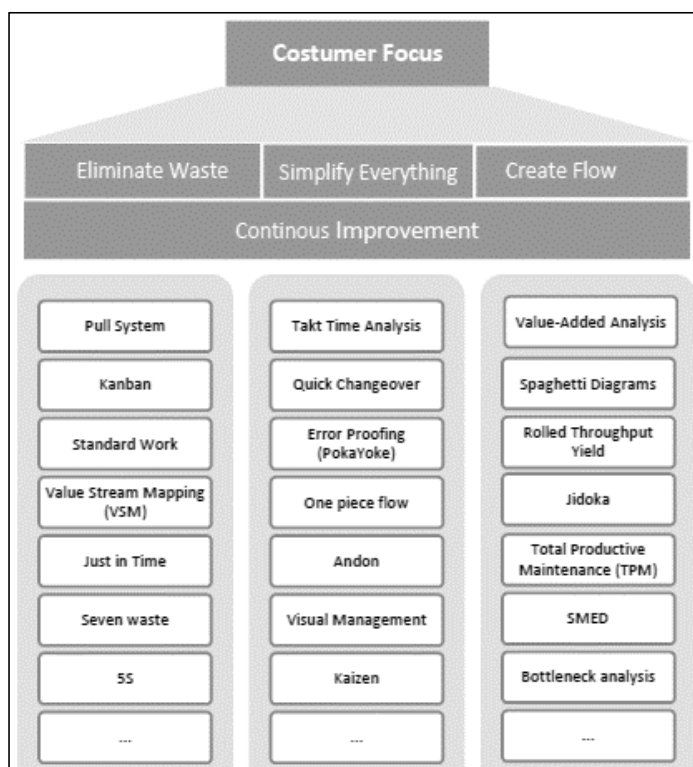


Figure 2 – Lean Tools

The fundamental principles of Lean are visualization and “go and see” (Liker, 2004). These principles have been leading in the development of tools and techniques to achieve the target of continuous improvement (Fig. 2). There are many Lean techniques and tools design for waste reduction which can be applied to promote efficient material flows, shorten lead-time, and minimal waste of time (Araújo et al., 2019; Rother and Shook, 2003; Rother, 2010).

The mainly tools used in this research to obtain waste were: Kaizen/Continuous Improvement, Seven Basic Tools of Quality, 5S Methodology, Value Stream Mapping (VSM), and Overall Equipment Effectiveness (OEE).

2.1 Kaizen/Continuous Improvement

This signifies improving continuously in a short space of time or at low cost, supported by a team brought together to achieve goals. This tool have the same base of PDCA cycle, the quality management (Defeo and Juran, 2016). Kaizen is based on the principle that everything can be improved. Kaizen cycle for continuous improvement have seven steps that should be repeated on an ongoing basis, with new solutions, when appropriate, or with new problems. This seven steps are:

1. Get employees involved;
2. Find problems and potential opportunities;
3. Request creative solutions;
4. Test the solution;
5. Analyze the results;
6. Standardize;
7. Repeat these steps.

2.2 Seven Basic Tools of Quality

The Seven Quality Tools are simple statistical tools used for solving quality problems e.g. are used to find out root causes and eliminates them, thus the manufacturing process can be improved. These tools were either developed by the Quality Gurus such as Deming, Ishikawa and Juran. These are the most useful and simple to use. Kaoru has stated “that these seven tools can be used to solve 95 percent of all problems”. The Seven Quality Tools used are; Check Sheets/Check List; Pareto Diagram; Ishikawa (Cause & Effect) Diagram; Histogram; Control Charts; Scatter Diagrams and Graphs (Ishikawa, 1986; (Ishikawa, 1991; Magar and Shinde, 2014).

2.3 5S Methodology

The 5S is a systematic technique used by organizations for workplace organization promoting its efficiency and decreasing the waste and consequently increasing the quality and productivity through an organized environment (Ghodrati and Zulkifli, 2013). The 5S methodology has 5 phases which use five Japanese words:

1. Seiri/Sort (organize);
2. Seiton/Set in order (create order);
3. Seiso/Shine (cleanliness);
4. Seiketsu/Standardize (standardized cleaning);
5. Shitsuke/Sustain (discipline).

It is known that 5S techniques support the Organization's objectives to achieve continuous improvement and higher performance and, consequently, promotes a positive impact on organizational performance.

2.4 Value Stream Mapping (VSM)

VSM it allows the visual representation of all company processes, making the process analysis simple and intuitive, from the client request till the final delivery of products. VSM is a powerful tool to support continuous improvement and to decide and design improvement overall effectiveness of the process. The VSM has with objectives (Costa et al., 2012) the follows:

1. Make the current process visible;
2. Facilitate the identification of problems and opportunities for improvement;
3. Establish a reference for evaluating impacts of improvement actions;
4. Establish a working basis for the creation of an improved state of the process.

According to Hines and Rich (1997) associated it to seven waste are the seven value stream mapping tools, as indicated below:

1. Process activity mapping Industrial engineering;
2. Supply chain response matrix Time compression/logistics;
3. Production variety funnel Operations management;
4. Quality filter mapping New tool;
5. Demand amplification mapping Systems dynamics;
6. Decision point analysis Efficient consumer response/logistics;
7. Physical structure mapping.

2.5 Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) is a Key Performance Indicators (KPIs) and a metric for evaluating the progress of Total Productive Maintenance (TPM). This is obtained with cumulative measure of three separate factors: availability, performance and quality. Together they can provide, with a good measure, of how well your plant is producing (Ayatollahi et al., 2013; Dutta and Dutta, 2016; 2017; Puvanasvaran, Teoh and Tay, 2013). OEE can be improved through analysis of the six big losses, and according to Tajiri and Gotoh (1992) the relationship between OEE and losses depends on equipment availability, their performance rates and the quality of the product. These authors classified major losses into six groups, where the breakdown losses, setup and adjustment losses are downtime losses and contribute to determine a true value for the availability of a machine. The losses including minor stoppage and reduced speed losses and are known as speed losses. They are contribute to measure of performance rate of a given machine. Finally, rework and yield losses are defined as quality losses to determine the quality rate for the equipment.

In summary, it can be considered that: the availability factor measures the total time that the system is not operating; the performance rate measures the ratio of the actual operating speed of the equipment as compared to its ideal speed and the quality factor measures the proportion of defective production to the total production volume (Jonsson and Lesshammar, 1999).

3 METHODOLOGY/EXPERIMENTAL PROCEDURE

This study was carried out in a mould maker located at Marinha Grande using a direct observation on the shop floor to see in firsthand the production process.

The data collection was conducted in the field by following one particular mould component that was deemed most important to the mould manufacturing, the core, and time were measured between and within all stages of it is manufacturing process, from the steel acquisition to the mould try-out. All the data gathered allowed to build one VSM – Value Stream Mapping, where different events were evaluated, namely:

1. *Setup* (or change-over): Fix the piece, Center the piece, Program, Exchange of die, Move or turn the mould, amongst others tasks;
2. *Wait*: Machine failure, Wait for the program, Wait for information, Wait for the availability of the crane, Search for tools, Unavailability of the operator, amongst others waits;
3. *Others*: Transporting piece, Examine, Clean piece, etc.

The different waiting time between steps, in Setup or in turn off have been analyzed, by histogram chart, to verify the reason of this waste. Regarding the

different stoppage events, a detailed analysis through Pareto diagram was also performed in order to identify the main factors for stoppage.

Parallel to this study, the overall performance of automated equipment's, Machining Centers (CNC), of the company industrial park was analyzed through the Overall Equipment Effectiveness (OEE) assessment. The OEE can establish a working basis for the creation of an improved state of the process with propose of implementation of Lean tools to improve production performance.

In this study has also used a hybrid concept based on continuous improvement of PCDA/DMAIC (Mishra and Sharma, 2014). It is considered that DMAIC is an evolution of PDCA where it started to use statistical tools with analytical power. It is important to reinforce that each step taken, supported by the PDCA/DMAIC cycle, is continuously repeated until perfection is reached. This instrument consists of several activities to achieve a certain improvement, based on the purpose of making processes clearer and more agile (Imai, 1997).

Data processing is done by PDCA/DMAIC cycle (Indrawati and Ridwansyah, 2015). The first stage is identification of production waste during production of moulds parts. In the Measure phase, Pareto diagram is used to determine the critical wastes. Measurement of waste was carried out by qualitative assessment. Then root cause analysis is done to evaluate several factors causing waste. In the improve phase, alternative solution are given to reduce production waste and improve production performance.

The five phases presented in the Fig. 3 follow the DMAIC methodology with the corresponding objectives and the potential tools that can be used.

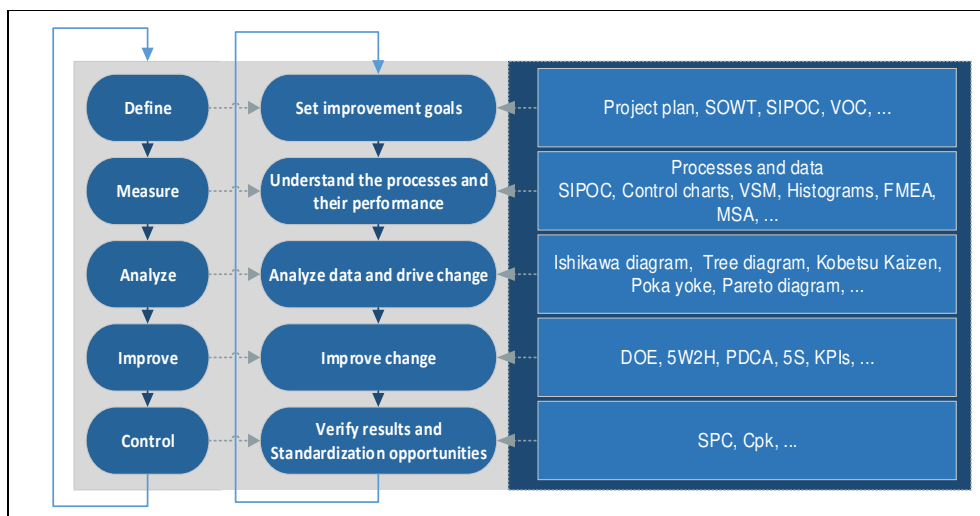


Figure 3 – Improvement Process – Potential Tools

4 RESULTS AND DISCUSSION

The main results are following.

4.1 Value Stream Mapping (VSM)

The gathered data, thorough continuous observation of mould's core, allows to building of the VSM type illustrated in Fig. 4. Based on that, it is possible to observe that the lead time is 12 weeks, which corresponds to approximately 164h of Cycle time (OCT), 23h related to Change-over (C/O), totaling in average of 60% availability time. One can also concluded that rework was 29 hours and the total number of hours that the core was remained stopped between the various stages of manufacture was 201 hours.

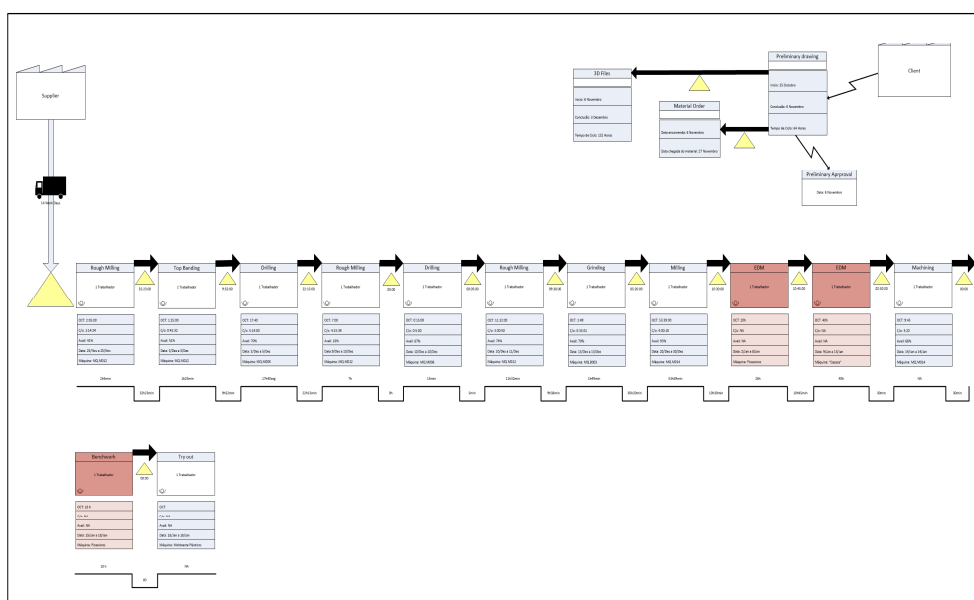


Figure 4 – Overview of the VSM Aspect Generated

4.2 Waste Analysis

With an analysis of the various types of stoppages, it can be observed that the milling process was the one that exhibits a larger timeout (40%), which is expected since it is the most time-consuming stage (see Fig. 5).

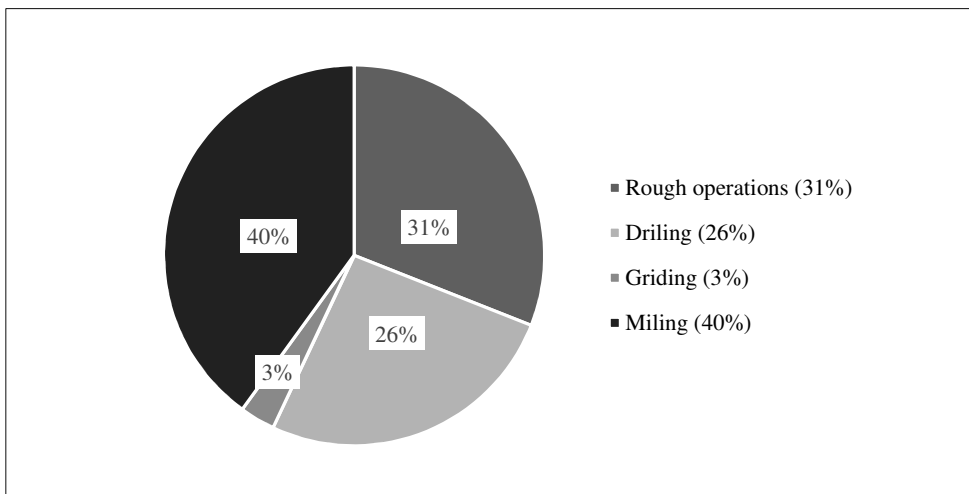


Figure 5 – Stoppages by Sectors

The time values between the various manufacturing stages, is present in Figure 6 in which the core has been stopped without any intervention of any kind. It is important to highlight that for the calculation of the stoppage time, was considered 5 days of manufacturing with a daily load of 20 hours.

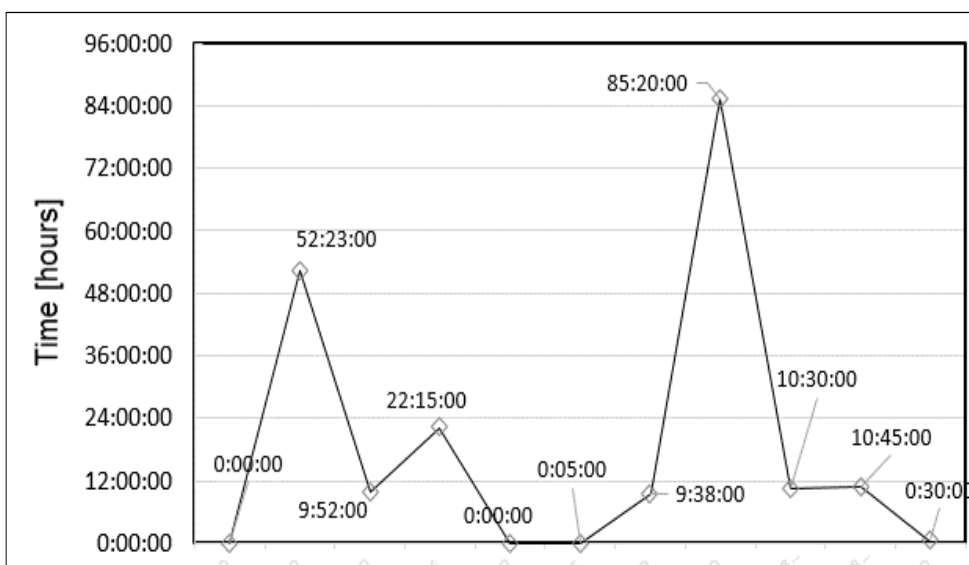


Figure 6 – Waiting Time between Steps

Pareto analysis was carried out to show that events that contributes the most to the stops. The results were: unavailability of the operator (16.4%), programming the machine (14.4%) and tool exchange (12.4%) (see Fig. 7).

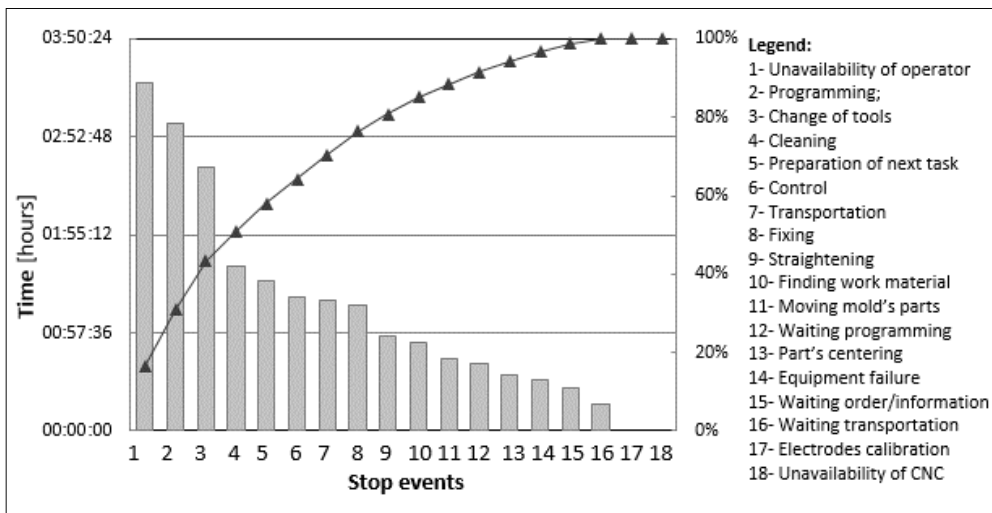


Figure 7 – Contribution of the Different Stoppage Events

Machine states have been recorded. The state of: machine running; machine stop; or machine in Setup were analyzed by histogram to verify the reason for this waste (see Fig. 8).

About the global of analyzed machines it is verified that about 42.9% of the machines with state “running” is below the machines with “average state of machine running” (46.9%). With the same tendency, machine state setup average is 14.5%, and have been recorded 47.6% of the machines with state “machine in setup” above this value. That suggest unbalance production.

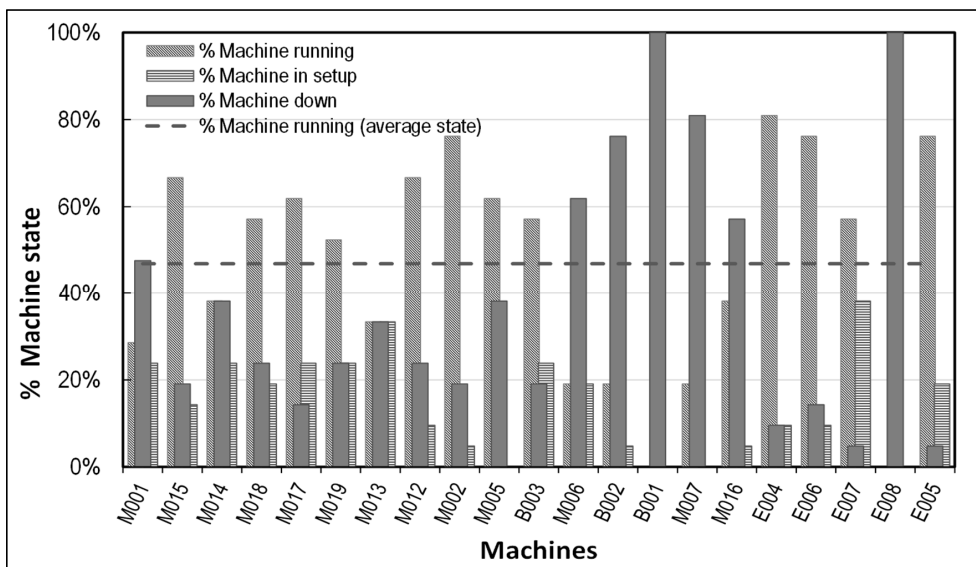


Figure 8 – Machine States

One of the problems detected is related to incorrect task planning. Therefore, the work planning method should be analysed in order to reduce waiting times, operating time, setup time and for this can improve the planning tasks with an enterprise resource planning (ERP) system.

SMED methodology can be implemented to reduce the setup time. With this implementation it is intended to improve some factors, namely: reduction lead time and increased capacity; increase of quality and less process variability; increased flexibility to meet client demands; and better utilization of your workforce and lower manufacturing cost.

4.3 Overall Equipment Effectiveness (OEE)

The assessment of OEE was performed for machining centers during a 9 hour shift for six equipment's. Regarding OEE calculation, the following factors were considered:

- *Availability*: Production Time versus Programmed Time;
- *Performance*: Real Production versus Ideal Production;
- *Quality*: Total Conforming Parts versus Total Produced Parts.

Thus, the results obtained for the automated equipments' Machining Centers (CNC), is show in the Tab. 1, where it can be observed that the availability factor is the main problem.

Table 1 – OEE of CNC Machines – Above and Before

CNC machines	Availability	Effectiveness	Quality rate	OEE
<i>Above improvement continuos program</i>				
1	26%	89%	87%	20.1%
2	38%	100%	98%	37.2%
3	97%	97%	100%	94.1%
4	40%	85%	92%	31.3%
5	73%	95%	100%	69.4%
6	50%	88%	100%	44.0%
<i>Before improvement continuos program</i>				
1	48%	93%	89%	39.7%
2	68%	100%	98%	66.6%
3	98%	97%	100%	95.1%
4	62%	95%	97%	57.1%
5	88%	98%	100%	86.2%
6	80%	96%	100%	76.8%

The key performance indicators OEE was calculated on CNC Machines at the beginning of the study and a global OEE of CNC Machines about 50% was obtained. This was followed by the implementation of a (basic) continuous improvement program using Lean Six Sigma tools such as: 5S methodology, SMED methodology; Visual Management and Standard Work. Before a pre-implementation, the OEE was recalculated. An improvement of each machine's OEE was achieved and the Global OEE improved by about 20%.

5 CONCLUSIONS

The results attained highlight the great potential of the proposed framework to achieve mould production improvements, with consequent time earnings for the entire mould fabrication process, since it illustrates where the problems are (such as higher change overs and waiting time).

Notwithstanding, the data sample collected is very small, and it is therefore appropriate to complement this study, so that one can extrapolate the results obtained in order to sustain improvement actions to reduce, for instance, waiting time.

At the same time, and since the unavailability of resources is identified as the most important cause of waiting time, one considers especially important to create a planning support tools that mitigate all the waiting factors.

Implementation of lean manufacturing tools and practices in the mould industry can bring many benefits, such as reducing waste and creating the value-added products to customers.

This paper provides positive evidence regarding the effects that Lean tools and techniques have on the performance of organizations. This research offers to the mould industries, a better understanding of the relationship between the Lean strategy/ management and the performance of their operations.

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The Main Benefits of the Implementation of the Quality Management System in Higher Education Institutions in Angola

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ABSTRACT

Purpose: The aim of this study is to obtain a diagnosis regarding the implementation of QMS (Quality Management System) according to ISO 9001 in Higher Education Institutions (HEIs) of Angola.

Methodology/Approach: The research was conducted through a questionnaire proposed to survey selected 55 institutions. Fifty completed questionnaires were received, representing the sample of this work. The statistical analysis SPSS version 22.0 for Windows was used for the treatment of the data.

Findings: The results of the study show that of the 50 Angolan HEIs surveyed, only 20% of them have the Quality Management System implemented. As main benefits of the implementation of the QMS in HEIs of Angola, we can highlight: Improvement of the quality of teaching; Improvement of student satisfaction; Improvement of confidence of students and other stakeholders; Improvement in student assessment; Improvement of teacher competences.

Research Limitation/implication: The main limitation of the study lies in the fact that of the 50 Angolan HEIs referred, only 20% of them have the Quality Management System implemented, which shows that there is still much work to be done in this area.

Originality/Value of paper: Higher education in Angola has had an evolution in terms of demand and access. Due to the quantitative development of higher education in Angola, it is necessary to be accompanied by qualitative growth, which implies the reinforcement of the need for quality management.

Category: Research paper

Keywords: organization context; higher education; ISO 9001; quality planning and organizational processes

1 INTRODUCTION

The continuous development of quality management in organizations was driven on the one hand by competition and on the other hand by growing requirements of the customers (Weckenmann, Akkasoglu and Werner, 2015). In recent years, quality management in Higher Education Institutions (HEIs) in Angola has been the subject of increasing interest motivated by the impact on their performance. The implementation and certification of the Quality Management System (QMS) are nowadays indispensable to any institution because it is seen as a differentiating flag for the institutions of the sector. However, quality is still questioned, and inefficiency of management is identified as a result of bottlenecks in funding, curricula, faculty, and student bodies.

The adoption of a QMS by organizations represents, even in the case of public organizations, a strategic decision that can help improve their overall performance and provide a solid foundation for sustainable development initiatives. On the other hand, risk-based thinking enables organizations to determine the factors likely to cause deviations in their processes and QMS from planned results, implement preventive controls to minimize negative effects, and maximize the opportunities that emerge. In this sense, the implementation of a QMS should seek to instil the principles of quality in the organizational processes according to ISO 9001:2015, of which we highlight: Customer focus; Leadership; Commitment of people; Improvement. The implementation of the QMS in the functional structure of public organizations is now supported by specific initiatives and models such as the Common Assessment Framework (CAF), European Foundation for Quality Management (EFQM), and International Organization for Standardization (ISO) standards, which represent important methodological support. These benchmarks for the implementation of QMS tend to emphasize the importance of the role of the clients in the definition of strategic objectives, the minimization of errors, and bet on the continuous improvement of the processes of supply of products and services. Its current relevance also stems from the fact that efficiency in resource management (including human resources) and customer capture have become central factors in the survival of public organizations, especially in a context of greater competitiveness between educational institutions and simultaneously, the successive budget cuts that Angola is experiencing (Veiga, 2014). In the last decades of the twentieth century, the Angolan government, regardless of its ideological tendency, encountered structural problems stemming from ineffective Higher Education. The transformations that occurred in Higher Education in Angola during the last decade had, as a consequence, the modernization, and administrative reform that the government started to take in order to improve the subsystem, conducted for the effectiveness, efficiency, and quality of the services they provided. In view of this situation, we note the concern of the Angolan State regarding the need to improve the quality of higher education. For this reason, the use of the QMS as a possible way to find the desired quality is invoked. Thus, higher education should develop the potential of each individual and provide

graduates with the necessary knowledge and skills that promote individual development to be successful in their professions. According to the last President of the Republic of Angola, José Eduardo dos Santos (ANGOP, 2008):

“We must make an evaluation of the implementation of the programs for the reform of the education system and the subsystem of Higher Education to detect the shortcomings and correct them and define the instruments for the materialization of the guidelines emanating from the Government program approved by the voters with a view to improve the quality of teaching, the working conditions of teachers and the management of educational establishments at all levels.”

According to Adão do Nascimento, “despite the successes achieved over the years, since the proclamation of national independence, improving quality and expanding the network of institutions of the subsystem of Higher Education is an imperative that is put to the Angolan State” (SEES, 2005). Thus, education is the most determining sector for the future of society. This importance increases with the level of development of the country or the region, in particular because competitiveness requires higher levels of qualification, which are not possible to achieve without the teaching-learning systems being able to meet the needs of the community in quantity and quality (Pires, 2012). The reform and modernization of Higher Education in Angola also depends on the competence and motivation of teachers and researchers. However, the number of teaching and research professionals has often not accompanied the increase in the number of students, which exacerbates the already felt capacity pressure (SEES, 2007). Better working conditions, including transparent and fair recruitment procedures, better initial and continuing professional development, and better recognition and reward of excellence in teaching and research are essential if Angola is to produce, attract, and academic staff you need.

The objective of this work is to highlight the main advantages of the implementation and certification of the QMS in higher education in Angola, its performance and the efficient use of resources for the training of students and the provision of services to the community.

2 THEORETICAL FRAMEWORK

2.1 The Quality Concept

In a market economy, each organization is competing with others providing the same product. This principle is valid independent of the type of offer, including material goods as well as immaterial services or their combination (Weckenmann, Akkasoglu and Werner, 2015). Although quality management has become a notorious issue since the early 1980s, it is not a modern invention. We can tell the story of quality in many ways. A large number of scholars agree that the concept or philosophy of quality has long existed, disagreeing only with some

that the concept of quality has existed for hundreds of years, and others speak for thousands of years (António and Teixeira, 2009). Quality Management as a management field is rich with research on different aspects and theories, empirical data from the field and theoretical elaborations. Some of its fundamental aspects are well defined and established through well-known and widely used international management standards such as ISO 9001 and ISO 14001 (Santos, Mendes and Barbosa, 2011). Nowadays, organizations without quality do not survive (Araújo et al., 2019; Santos and Milán, 2013; Santos, Murmura and Bravi, 2019). Hence, there are many organizations that integrate QMS with other Management Systems, namely with Environmental Management System (EMS) and Occupational Health and Safety Management System (OH&SMS) among others (Carvalho, Santos and Gonçalves, 2018; Santos, Rebelo and Santos, 2017; Ribeiro et al., 2017) seeking to optimize human, material and financial resources (Zgodavová, Zolotova and Roznik, 2011; Costa et al., 2019). These are sustainable organizations. Thus, ISO 9001 is applied in different kinds of organizations all over the world (Ingason, 2015; Santos et al., 2008). It is necessary to build an organisational culture for quality. In general, organisational culture is understood through the deeply embedded values and beliefs shared in an organization. Every organisation has a unique culture. It is almost impossible to achieve excellence unless a suitable culture of quality has been introduced because culture is the driving force of quality. Organisational culture represents an organisation's experiences that have accumulated over the history of the organisation (Zgodavova, Hudec and Palfy, 2017; Araújo et al., 2019). The measurement culture has grown in education, both in education policies and in the practice of schools and teachers (Rodriguez-Mantilla, Fernandez-Diaz and Carrascosa, 2019). Thus, the ISO 9001 implementation in organizations reduces the cost of poor quality (Lee, To and Yu, 2009; Santos and Barbosa, 2006) and increases the organization's chances of gaining work in the private or public sector through the creation of better internal management systems and service quality improvement (McAdam and Canning, 2001; Murmura and Bravi, 2017; Marques et al., 2018). The benefits of implementing the QMS were analysed by several authors, among others (Santos et al., 1996; Santos and Milan, 2013; Fonseca and Domingues, 2018; Bravi, Murmura and Santos, 2019). Among the higher benefits to institutions highlighted by that authors are, namely, the improvement of the institution's image, the introduction of clear procedures for quality, awareness of quality, clarification of responsibilities, reorganization, and improvement of efficiency. It also occurs the return on investment (Santos, Costa and Leal, 2012; Batista and Santos, 2015).

According to the French association for standardization, quoted by (Fey and Gogue, 1983) "the quality of a product or a service is its ability to meet the needs of users". The American Society for Quality (ASQ), quoted by (Kotler and Keller 2006) stats that "quality is the totality of attributes and characteristics of a product or service that affect its ability to meet stated or implied needs". ISO 9000:2015 (IPQ, 2015a) defines "quality as the degree of satisfaction of requirements given by a set of intrinsic characteristics". In the twentieth century,

the greatest importance attributed to quality led to the investigation, formulation, and publication of various definitions for the concept, highlighting such illustrious authors as Joseph Juran, Philip Crosby, Walter Shewhart, Edwards Deming and Kaoru Ishikawa (António and Teixeira, 2009). Today, many organizations are “searching” for excellence, but not many organizations have been able to achieve this goal, seemingly because management does not have a profound understanding what it really means to be excellent (Dahlgaard-Park and Dahlgaard, 2007). To improve services and to achieve quality and excellence, ideas and a good education system are described in (Santos et al., 2018; Santos et al., 2019).

2.2 The Concept of Quality in Higher Education

Understanding the politics of education reform is crucial to assess the challenges facing the SDG (Sustainable Development Goals) of quality education (Bruns, Macdonald and Schneider, 2019). The aim of all educational systems, nowadays, is to provide quality education (Sánchez, Lupión and González, 2017). Implementation of Quality Management Systems in educational organisations is a fact in many countries. Therefore, it is necessary to obtain evidence of the improvements and changes that the centres have because of the implementation (Rodríguez-Mantilla, Fernandez-Diaz and Carrascosa, 2019). The term “quality” has been used in the most diverse fields of knowledge, including the educational one, although there are substantial differences in its conceptualization, that is, there is no universal definition. The universal is the recognition of quality, both in products and services, as a decisive factor for the development of organizations, in an increasingly competitive world. In the educational context, definitions of the term “quality” focus on various aspects such as customer satisfaction, management, and administration of educational institutions, availability of human, financial and infrastructural resources, since they contribute to the successful accomplishment of the functions of IES (Pires, 2012). For António and Teixeira (2009), in the case of higher education, an integrative approach to the term quality, expressed in its trans versatility with respect to the provision of institutions, is recurrent. To gauge the quality of the university presupposes a global approach to the functions of the university, which results, on the one hand, from the interconnections between them and, on the other, from the articulations of these functions with the other dimensions that make up the organization. With the implementation of a QMS in HEIs in Angola, based on ISO 9001:2015 (IPQ, 2015b), it is intended to make management more efficient, with impact on academic training, financial resources management, and human resources. With this implementation, we intend to continuously improve the quality of both the training offer and the services provided to the academic community. It can also be an important support for Institutional Marketing, for the external recognition that certification can bring, besides being a differentiating factor and influencing the attractiveness and notoriety of HEIs for teaching of recognized quality.

3 METHODOLOGY

The impact evaluation of the implementation of ISO 9001 Standards in Angolan HEIs was conducted using a questionnaire. Fifty-five Angolan HEIs were selected from the 73 existing ones, which are part of the Statistical Yearbook of the Ministry of Higher Education, corresponding to 75% of the total (guaranteeing coverage of public and private HEIs). The questionnaire was sent by email. Fifty completed questionnaires were received, representing the sample of this work, representing a percentage of questionnaires answered and received about 91%. From this sample, the AMOSTRAL database was built to support our work.

Table 1 – Main Questions of the Questionnaire

Group of questions	
<i>I° Group</i>	What is your role in the Institution?
	What is the educational system in which the institution is inserted?
	Does the Institution have the QMS implemented?
<i>II° Group</i>	Do you know the advantages of implementing QMS in HEIs?
	What is the benchmark you used as a basis for implementing the QMS in your HEIs?
	Is the system implemented in every institution or only part of it?
	Which sectors of the institution where the QMS is implemented?

For the treatment of the data, the statistical analysis SPSS (Statistical Package for the Social Sciences) version 22.0 for Windows was used.

4 RESULTS

A total of 50 Angolan HEIs leaders participated in this study. The majority were male (70%), $n=35$) whereas the female gender was represented by 30% ($n=15$) according to Fig. 1. Of the 50 Angolan HEIs surveyed, only 20% of them have the Quality Management System implemented, as can be seen in Fig. 1. We know this is little, but this is the Angolan reality.

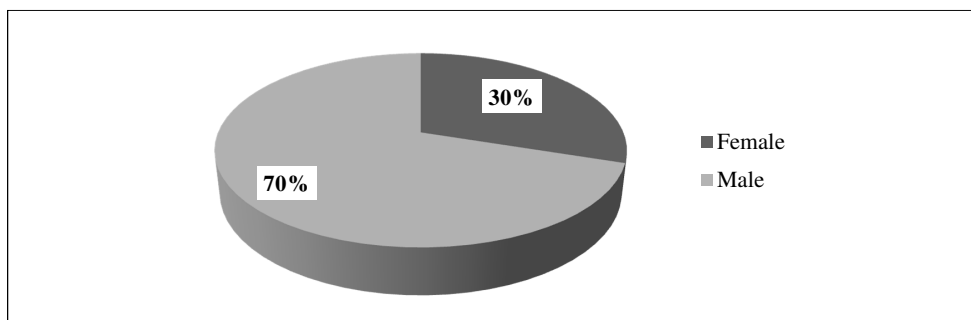


Figure 1 – Participants in the Survey about QMS

According to Fig. 2, the main reason for the non-implementation of the QMS is financial incapacity. Other reasons are: “a little institutional interest and availability of time”. If organizations are more organized, then they will have more time to devote to problem-solving and quality improvement. It is a matter of organization.

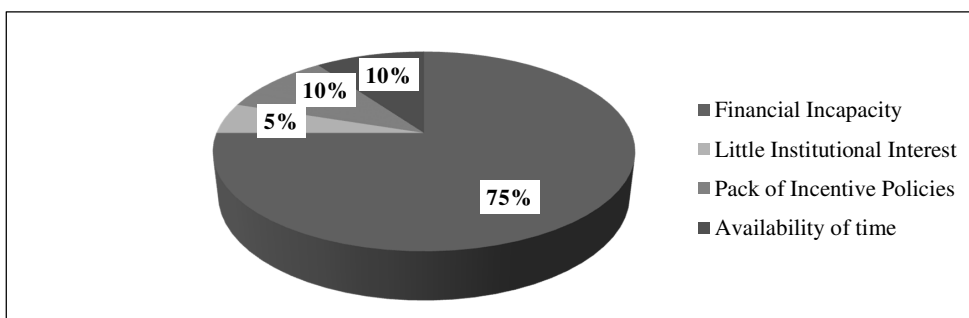


Figure 2 – Main Reasons for Non-Implementation of the QMS in HEIs

The respondents state that the implementation of the QMS was according ISO 9001, as can be seen in Fig. 3. Although there are other referential for implementing QMS, ISO 9001 is the most widely adopted.

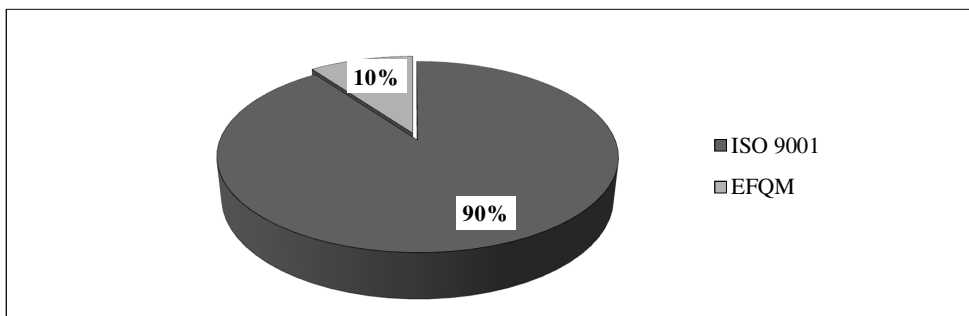


Figure 3 – The Referential More Used for the Implementation of the QMS in Angolan HEIs

The difference of opinion between the respondents with Rector/Vice-Rectors and those with the functions of Director are all statistically significant, and those with a Director role are more in agreement with the statements related to the implementation of the QMS (see Tab. 2 and Fig. 4). Most statistical tests begin by identifying a null hypothesis. The null hypothesis for pattern analysis tools essentially states, that there is no spatial pattern among the features, or among the values associated with the features, in the study area. Said another way: the expected pattern is just one of the many possible versions of complete spatial randomness. The Z score is a test of statistical significance that helps you decide whether or not to reject the null hypothesis. The p-value is the probability that you have falsely rejected the null hypothesis. When a hypothesis test in statistics is performed, a p-value helps you determine the significance of the results. Z scores are measures of standard deviation and in Tab. 2 is decimal number. The 3 asterisks refer to person p of SPSS (Statistical Package for the Social Sciences), that is, when $p < 0.001$ the result is less.

Regarding the representativeness of the ‘Rectors’ and ‘Directors’ opinions, according to Tab. 2, it can be highlighted that it is important for Directors and Rectors to implement QMS. The Directors and the Rectors agree that it is important that higher education institutions in Angola implement the QMS (ANGOP, 2016).

Table 2 – Representativeness of Opinions Regarding the Implementation of the QMS between Rectors and Directors

	Rectors		Directors		Z ³
	M ¹	DP ²	M	DP	
<i>1. It is important that higher education institutions in Angola implement the quality management system.</i>	5.21	1.48	6.97	0.17	-6.298***
<i>2. All Angolan higher education institutions must have a certified quality management system in place.</i>	4.50	1.40	6.75	0.44	-5.770***
<i>3. The Ministry of Higher Education of Angola must create a legislative decree that obliges higher education institutions to implement the quality management system.</i>	4.50	1.34	6.67	0.48	-5.448***
<i>4. Quality management enables higher education institutions to improve the quality of teaching.</i>	4.50	1.45	6.86	0.35	-6.016***

	Rectors		Directors		Z ³
	M ¹	DP ²	M	DP	
<i>5. One of the main objectives of the implementation of quality management in higher education institutions has to do with student satisfaction.</i>	4.79	1.48	6.81	0.40	-5.626***
<i>6. The confidence of students and other stakeholders in higher education is established and maintained through effective quality assurance activities.</i>	3.36	1.01	6.11	0.82	-5.584***
<i>7. Institutional self-knowledge is the starting point for effective quality assurance.</i>	4.79	1.93	6.94	0.23	-6.051***
<i>8. Students' evaluation is one of the most important elements of their training course in higher education.</i>	3.93	1.38	6.42	0.69	-5.410***
<i>9. It is important that teachers of higher education institutions in Angola have the complete knowledge and understanding of the area they teach.</i>	4.21	1.25	6.08	0.81	-4.781***
<i>10. Teachers represent the most important learning resource for most students in higher education institutions in Angola.</i>	4.57	1.50	6.89	0.32	-6.112***

Notes: ***p≤0.001; M¹ – Average; DP² – Standard Deviation; Z³ – Statistically significant difference; p – decimal number; the 3 asterisks refer to person p (SPSS)

As main benefits of the implementation of the QMS in HEIs of Angola, it can be highlighted: Improvement the quality of teaching; Improvement of student satisfaction; Improvement of confidence of students and other stakeholders; Promotion of institutional self-knowledge for quality assurance; Improvement in student assessment; Improvement of teacher competences; Teachers as the most crucial resource of learning. Thus, according to Tab. 2, there are many work to do regarding improvement education in HEIs of Angola.

Fig. 4 shows the representativeness of opinions of Directors and Rectors. Directors deal more closely with the problems of teaching quality and organization. Thus, they have a more precise idea than that of the Rectors. These have to deal with other types of significant problems.

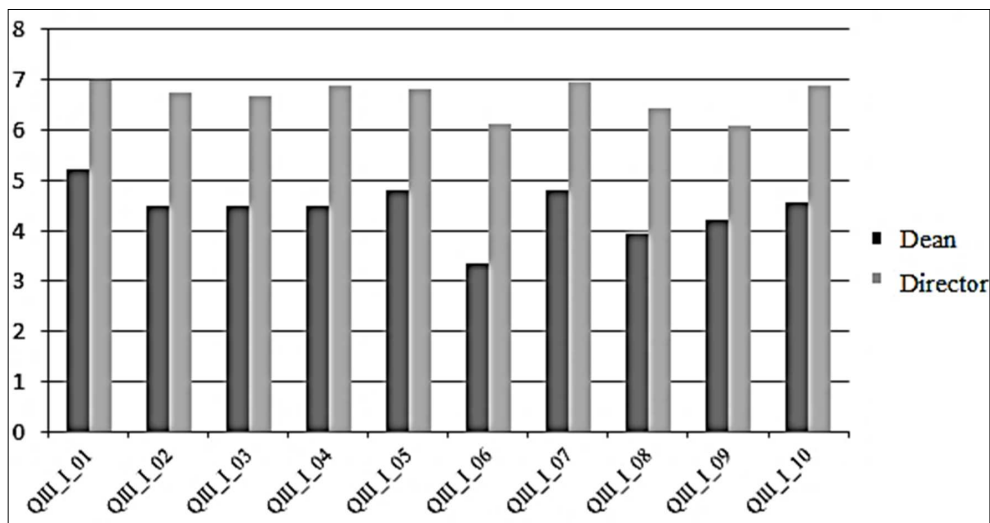


Figure 4 – Representativeness of the Views of the Implementation of the QMS between Rectors and Directors

When directors agree to implement QMS in their organizations, sooner or later, it will happen. This is the hope of many Angolans for a better education system.

5 CONCLUSION

Higher education in Angola has grown quantitatively over the last years. Still now there is a need to start looking for qualitative growth, which will imply the introduction of practices related to quality. Thus, the key to quality begins with changing the mindset of managers through knowledge, commitment, communication, and involvement. Nevertheless, it is necessary, in addition to changing the management mindset, a radical change in the mentality of all who are involved with the organization. The need arises for all members of the organization to work towards the same goal, towards the satisfaction of their clients, which in the specific case of Angolan HEIs are their students.

The results of the survey of Angolan HEIs show that most respondents are aware of the advantages of implementing the QMS, which is a significant step towards achieving it. It was found that the majority of the respondents who answered the questionnaire were the Directors to the detriment of the Rectors; on the other hand, it was concluded that one of the main reasons for not implementing the QMS is limited in the scarce financial resources that institutions have. Finally, it can be concluded that the Angolan HEIs recognize the advantages and are interested in the implementation of a QMS but have as main limitation the financial reasons, because the implementation of a QMS has high costs.

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