How do Knowledge Management Practices Influence the Deployment of Lean Management: a Case Study

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Abstract

Lean has its origin in the Toyota Production System. Aiming to deliver customer value through people's respect and waste reduction, Lean advocates five principles: value specification, value stream identification, flow, pull and perfection. Knowledge management, through the process of identifying, capturing and leveraging knowledge, became a source for competitive advantage for organisations. This paper aims a contribution to a better understanding of Lean combined with Knowledge Management (KM) tools, through the study of the outcome from Lean and KM tools adoption in invoice verification process at a Portuguese shared services organisation. The study analysed how the execution time of a process depends on the operators who perform it and if operators' individual practices have an impact on the process execution time. The implementation process was surveyed through observations and statistical analysis, which identified differences in terms of practices used by operators. Statistical evidence made it clear that best practices adopted by operators have a positive impact in their execution times. Moreover, it was also important to notice that Lean and knowledge management combined practices can be useful to organisations in a digital transformation program, which will require standardisation and process automation.

Keywords:

Lean, Lean Management, Knowledge Management, Organisational Knowledge.

1. Introduction

Shared services organisations are dealing worldwide with the challenge of digitalisation, in order to shift from resource related processes to automation. To be competitive these organisations have been forced to introduce automation in their administrative processes, characterised by being massive and repetitive, so as to decrease operating costs and increase quality information and customer satisfaction.

In Europe, European Union directives want public administrations to become ready to electronic invoicing (EI) and electronic procurement (EP) by 2020. In the meantime, benchmarking between countries regarding EI/EP implementation has been carried out (Knoch 2019).

In Portugal the EI/EP will be required from 2020 on (Knoch 2019). Consequently, the Portuguese authorities defined the electronic invoicing implementation in public administration as a transformation program, which will require standardization and process automation. This program will boost the electronic invoicing adoption in Portugal both in public and private sector.

Automation will require new and stable processes and procedures. Therefore, the shift to electronic invoicing must be not only a technological change, but also a cultural and organisational one. Lean and Knowledge Management (KM) practices can help organisations to address this change in an efficient and effective way by: (1) helping in the preparation phase; (2) supporting new processes and procedures implementation; and (3) maintaining the transformation with continuous improvement actions.

The paper presents Lean and KM tools adoption in an invoice verification execution time process at a Portuguese shared services organisation. This study aims a contribution to the body of knowledge of Lean combined with Knowledge Management practices.

2. Theoretical background

2.1. Lean

John Krafcik first used the term Lean in 1988, when referring to the production of the Japanese automobile manufacturer Toyota. However, the term gained wider expression in the book *The Machine That Changed the World* by Womack et al. (1990), where the authors described the *Toyota Production System* (TPS).

Therefore, Lean has its origin in the TPS. Aiming to deliver customer value through people's respect and waste reduction, Lean advocates five principles: value specification, value stream identification, flow, pull and perfection (Womack et al. 1990).

Starting in the automotive industry, Lean then moved on to other sectors such as construction, process industry, retail and financial services (Ferreira et al. 2018). Hence, as long as there is a product or service flow that can be driven by the customer's demand, it is possible to apply Lean to any organisation (Hicks 2007).

The study performed a *gemba* walk, a Japanese word meaning '*the place where work takes place'*. The purpose was to observe and understand how people work and create value with less waste (Womack 2011), following Fuiji Cho's words, *"go and see, ask why, show respect"*.

Additionally, during the observations a waste identification was done. Lean authors defined waste as all activities that do not add value and three concepts regarding waste: *mura* (variability), *muri* (overload) and *muda* (waste) (Ferreira et al. 2018). There are seven types of waste (*muda*): over processing, waiting/delays, rework/defects, inventory, transportation, overproduction and motion (Womack and Jones 2003).

2.1. Organisational Knowledge

Davenport et al. (1998) defined knowledge as a combination of information with experience, context, interpretation and reflection. According to these authors, knowledge is different from information, and in turn, information differs from data. Knowledge can be characterised in the two domains defined by Nonaka and Takeuchi (1995) as tacit and explicit.

Tacit knowledge are clusters of skills, judgments, and intuitions that individuals possess because of their experience, even though they may not be easily described or coded (Nonaka and Takeuchi 1995). The Knowledge Research Institute (KRI) corroborates this definition of tacit knowledge, stating that it is composed of the knowledge and skills which individuals possess unconsciously (Wiig 2000). Polanyi (1996) sums up the tacit concept by affirming we know a lot more than we are able to express, which means for Cabrita (2009) that is in the tacit field that most of our knowledge resides.

On the other hand, explicit knowledge is easily documentable, transmissible and it can be expressed through flowcharts, symbols and language (Silva et al. 2003). According to Cabrita (2009), explicit knowledge is abstract and not defined in terms of each individual. Within this domain, organisational routines are included, either explicit routines in formalized procedures and practices, or implicit routines in the organisational culture (Cabrita 2009).

In this sense, organisational knowledge (OK) is present in an organisation's practices, along with its processes, norms and routines, with the focus on best practices (Davenport and Prusak 1998). For these authors, OK is a mix of experience, values, contextual information and expert insights. Therefore, it is a framework to evaluate and incorporate new information (Davenport and Prusak 1998).

Moreover, knowledge must be managed, hence knowledge management (KM). Through the process of identifying, capturing and leveraging knowledge (O'Dell and Grayson 1998) KM became an important domain and a source of competitive advantage for organisations (Nonaka and Takeuchi 1995).

2.2. Knowledge Management: Definition and strategies of knowledge identification and transferring best practices into processes

KM has several definitions (Liebowitz 1999). The study follows KRI cited by Wiig (2000, pp.12): *"Knowledge Management is the systematic, explicit, and deliberate building, renewal, and application of knowledge to maximize an enterprise's knowledge-related effectiveness and returns from its knowledge and intellectual capital assets.*"

This study applied Asian Productivity Organisation (APO) knowledge management tools. APO is an intergovernmental organisation aiming to contribute to the sustainable socioeconomic development in Asia and Pacific through enhancing productivity. This study adopted three APO KM tools: (1) **storytelling**, tacit knowledge shared through a story; (2) **communities of practice**, groups of people with a common interest, with the purpose of sharing and learning within the group; and (3) **peer assistance**, an expert person who shares insights and knowledge regarding a specific topic (Young 2010).

Regarding KM strategies, Wiig (1997) defined five strategies based on his observation of several organisations, which pursued different strategies to match internal knowledge with their culture, priorities and capacities. These five strategies are: (1) knowledge strategy as business strategy, (2) intellectual asset management strategy, (3) personal knowledge strategy, (4) knowledge creation strategy; and (5) knowledge transfer strategy.

From the list of those five strategies, this study applied **knowledge transfer strategy**. Wiig (1997) defined as a strategy which emphasises systematic approaches to knowledge sharing and best practices adoption (to the points of action where knowledge will be used to perform work). It means knowledge is used to produce work and to share best practices (Wiig 1997).

Additionally, Skyrme (2001) in his work *Knowledge Networking* identifies two directions and seven levers of knowledge often used in organisations. The first direction is to make the knowledge of an organisation profitable, by using (1) best practices among employees; and (2) developing actions, such as databases with problem-solving solutions. The second direction regards innovation, with knowledge creation within the organisation and its conversion into new processes, products or services. In this direction, the concern is to encourage creativity and improve knowledge flow in the innovation process.

From the seven levers defined by Skyrme (2001): (1) knowledge about the customer; (2) knowledge in the products and services; (3) knowledge in people; (4) knowledge in processes; (5) organisational memory; (6) knowledge in relationships; and (7) knowledge assets; the present study follows the fourth one, **knowledge in processes**. This lever involves incorporating knowledge into processes and providing specialised knowledge at its critical points.

Regarding theoretical background for knowledge management strategy, this study intersects Skyrme's (2001) knowledge transfer lever with Wiig (1997) knowledge transfer strategy, in order to identify and transfer best practices to processes, as well as incorporate knowledge and provide expertise where the work is done.

Regarding best practices and according to O'Dell and Grayson (1998), benchmarking is the process of identifying, understanding and adapting outstanding practices from organisations, whether their own (internal benchmarking) or anywhere in the world (external benchmarking). The present study performed an **internal benchmarking**. For these authors there are two approaches to identifying and implementing internal benchmarking, in order to obtain best practices: (1) by measuring performance and thus identifying best practices; and (2) by implementing knowledge management and later on measuring its impact. The study followed the first approach.

2.3. Synergies between Knowledge Management and Lean

Table 1. Synergies between Lean and KM

	Lean	Knowledge Management
Goal	Make the company more competitive (Womack et al. 1990).	Make the company more competitive (O'Dell and Grayson 1998).
Relation with products/services	Intends to improve products and services quality, by identifying waste (Womack and Jones 2003).	One strategy includes knowledge incorporation in products and services to create value (Skyrme 2001).
Relation with processes	Seeks to simplify, standardise and rationalise processes (Womack et al. 1990).	Encourages identification and sharing of best practices (Skyrme 2011).
Best practices (identification)	*Gemba* walk, where work takes place (Womack et al. 1990).	Internal and external benchmarking (O'Dell and Grayson 1998).

Following the synergies above identified, this study presents Lean and KM tools adoption in an invoice verification process at a Portuguese shared services organisation. The research questions of this study are:

1. Does the execution time of a process depend on the operators who perform it? If so, to what extent does it occur?
2. Do operators' individual practices have an impact on the process execution time?

The research methodology adopted in this study was Case-Study.

3. Case Study Analysis

3.1. Research introduction

This study was conducted in a shared services organisation in Portugal. This organisation required anonymity, hence it is identified as A. The business activity of organisation A is to provide shared services in finance, human resources, information technology and purchasing.

In organisation A, the study was carried out in a finance shared services department. After analysing the strategy of this department (aligned with the strategic plan of the organisation), it was possible to infer that organisation A seeks to achieve its operational excellence by increasing the efficiency and effectiveness of its processes.

In this sense and since knowledge management strategy has to be aligned with the organisation's strategy (Wiig 1997), the authors of this study have identified (as mentioned above) that the KM strategy of organisation A is a **knowledge transfer strategy** - sharing knowledge and incorporating best practices into the processes.

Nowadays, the finance shared services department of A is delivering one hundred and four financial processes to their customers, so one process-focus had to be chosen for the purpose of this study. In this case the decision model Analytic Hierarchy Process (AHP) was applied to evaluate all processes according to the following three criteria: (1) volume of annual requests; (2) level of tacit knowledge; and (3) department's level of expertise.

When AHP is applied, a score is given in order to make a comparison pairwise between criteria. In that sense, the scores given were based on the organisation's strategic plan and as a result of a meeting with the department coordinator and the knowledge management team.

The result of application AHP was the selection of **invoice verification** process, which represents 45 % of the total volume of all processes delivered by the finance shared services department.

Regarding the invoice verification process, a digital transformation program is going on in organisation A, aiming to, the automation of this process, by posting invoices automatically and removing manual steps. In order to do so and before automation, the organisation had to realise the importance of the invoice verification process standardisation, as well as all the related procedures and practices.

Subsequently, a team was formed to start an internal benchmarking, following the first approach of O'Dell and Grayson (1998) by measuring performance and thus identifying best practices. Hence, a direct observation through Lean *gemba* was done on the department resources in charge of posting the invoices (known as operators). The goal was to analyse (1) how operators carried out the invoice verification process; (2) which procedures/practices they used; and (3) to quantify the process execution time of each operator.

In order to evaluate if the practices identified have an impact on the execution times of the invoice verification process, an analysis of variance was performed based on the times collected from each operator, through One-Way-ANOVA. Additionally, a Fisher Least-Significant-Difference (LSD) test was performed and a ranking was made with each operator's process execution time, to verify among operators, the main execution time differences.

3.2. Research sampling and protocol

In organisation A, the invoice verification process has four activities: (1) **analysis**, to understand the customer's order; (2) **verification**, to check all data received; (3) **posting**, to register the invoice in the software; and (4) **response**, to answer the customer's order.

The invoices are received in the finance shared services department through customers' orders. Since these orders may include several invoices, causing a high variability in the number of invoices between different customers' orders, single invoices, rather than customer's orders, were chosen in the collection of execution times.

To carry out this study, 19 samples were collected, each representing an operator. In total, there are 21 operators responsible for posting invoices in this finance shared services department of organisation A, therefore this analysis represents 90,5 % of the operators universe.

Each sample consisted of 20 observations, which means 20-invoice execution times, obtaining a total 380 observations (19x20). The strength of the sample size was confirmed, after performing the One-Way-ANOVA, given the statistical power desired ($1-\beta = 0{,}99$).

As invoices do not have the same degree of difficulty, it was necessary to classify invoices into 'family of products'. In order to do so, two degrees of difficulty, based on organisation criteria, were defined: (1) invoices considered "easier"; and (2) invoices considered "difficult".

For the sampling it was only considered 20 'easier' invoices. In each observation the execution time of each process activity (analysis, verification, posting and response) was recorded as well as the corresponding total execution time of the invoice. For the collection of times, a technique of continuous timekeeping was used, by means of the following materials: a mobile chronometer of continuous reading and a timesheet for observations. To record the operator's practices, a template sheet was used.

The software used in this study for sample data analysis was *statistica.* For the One-Way-ANOVA test it was considered a 5 % level of significance. The collected execution times are represented per each operator in the next graphic BoxPlot in figure 1. The BoxPlot (figure 1) gives a visual perception of how operators' process execution time differs between each operator, in terms of variability and median. This perception already shows that might exist different practices influencing the process execution time.

In figure 2, through a brief visual analysis it is possible to verify that the data presents a huge variability ($\sigma^2 = 21568$). The times do not follow a normal distribution, presenting an average of 289 seconds. Thus, 48 seconds was the lowest value and 970 seconds was the highest one.

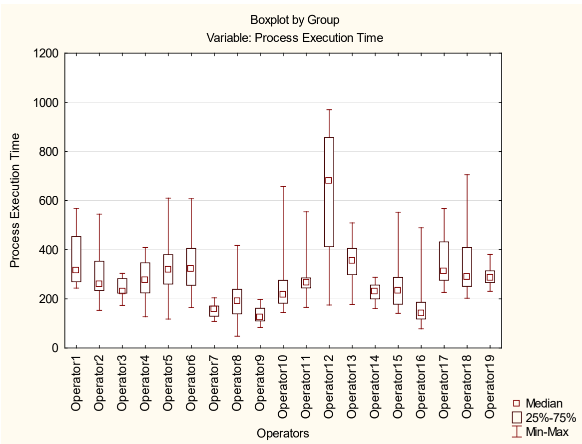

Figure 1- BoxPlot of process execution time

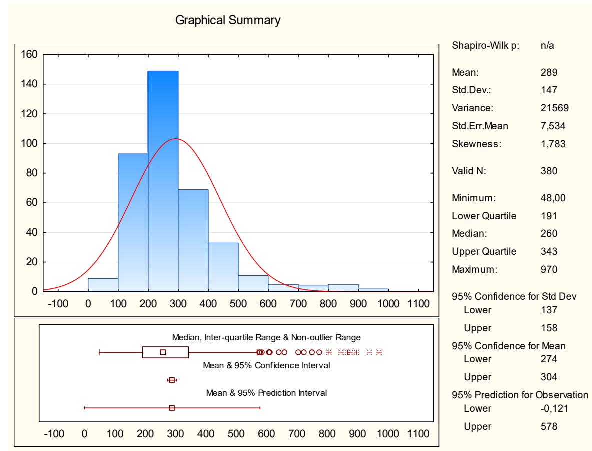

Figure 2- Statistical description of observations

3.3. Lean and Knowledge Management

Along with invoice verification process execution time measurement, a Lean *gemba* walk combined with knowledge management storytelling was performed. The *gemba* had the purpose to make a visual analysis of the operators' work, where they executed the process and related procedures (known as individual practices). Through storytelling the operators had the opportunity to share their problems and perceptions regarding process procedures wastes. Briefly, the following practices were listed regarding the invoice verification process:

- Template with standard-answers, to support the forth invoice verification process activity ("response"). This practice consists of copying the answer from a template and replicate it in the customer's order response box, avoiding the constant and repeated use of the same type of answers. Each of the operators who adopted this practice, had their own answers template. Therefore, there was not a unique and standard template in finance shared services department. The *template standard-answers* practice, also avoids misspelling errors in customers' orders;
- Cross check information between the accounting posting file with historical data already posted in accounts payable accounting records;
- Use of the keyboard command "ctrl+c" and "ctrl+v", instead of constantly introducing the exact same information;
- Decrease the number of open windows. This practice avoids time wasting when the operator is jumping from window to window, searching for information.

Additionally, wastes were identified:

- Each operator had their own file with posting accounting information;
- Two files that supported the posting activity were out of date;
- The operators who used the template standard-answers, had a file with incomplete information.

3.4. Assumptions for the application of the One-Way-ANOVA test

The one way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the means of two or more independent (unrelated) groups (Montgomery & Runger, 2003), so for the application of the One-Way-ANOVA test it is necessary to verify the following assumptions:

- Normality of the residuals;
- Variance homogeneity of the residuals; and
- Independence of the observations.

Thus, through the *statistica* software, it was possible to verify if the residuals would be normally distributed using the graph of the probabilities of the normal distribution. The graph of figure 3 shows that the residues do not appear as normally distributed, since their distribution does not resemble a line. As such, we can conclude that the times collected with the metric used, do not meet the necessary conditions for the application of the One-Way-ANOVA test.

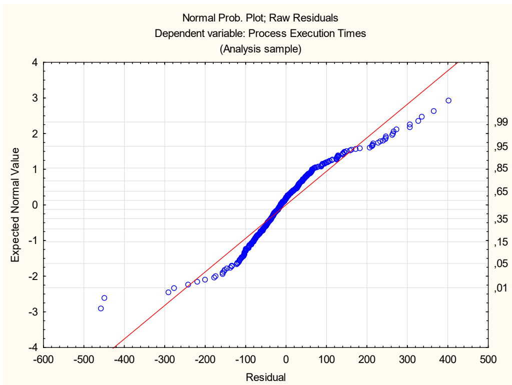

Figure 3 - Normality of the residuals

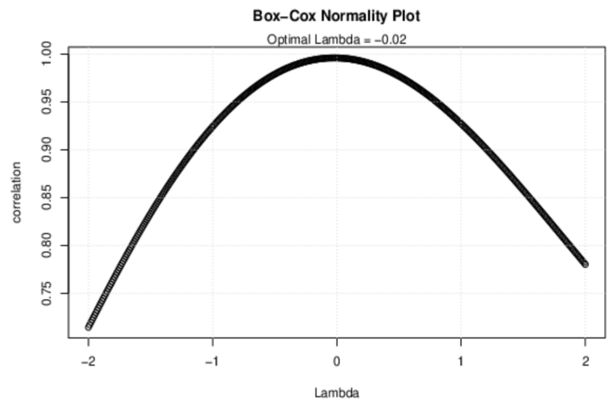

Figure 4- Lambda value to perform data transformation

When the assumption of normality is infringed, it is suggested to perform a transformation, that is, to analyse the data in a different metric (Montgomery and Runger 2003). To perform this transformation, was used the Box-Cox method (Box and Cox 2017). This method allows to determine transformation parameters so that the variance is constant and that the normality of the data is satisfied (Pereira and Requeijo 2008). When, in the Box-Cox transformation, a $\lambda \cong 0$ is obtained, as in the case of the graph of figure 4, a logarithmic transformation is necessary (Box and Cox 2017). The processed data are presented in the following histogram in figure 5.

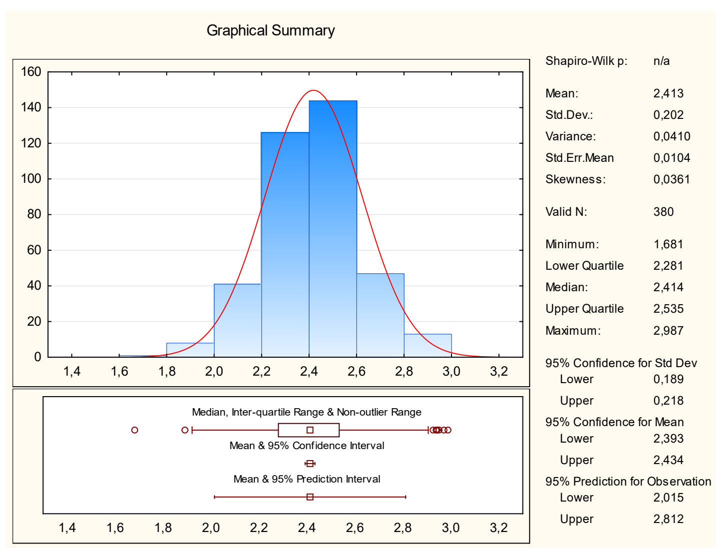

Figure 5 - Statistical description of processed data

The assumption of residuals normality for the execution times was then tested after the logarithmic transformation, obtaining the following graph of normality probability distribution in figure 6. As it can be evaluated, the distribution of the data resembles a straight line. Therefore, can be concluded that the residuals, after the logarithmic transformation suggested by the Box-Cox method, fulfil the assumption of normality (Box and Cox 2017).
The next step was to assess the homogeneity of the residuals variance. This was done by analysing the residuals chart in terms of the expected values (Montgomery and Runger 2003). Through a graph visual analysis in figure 7, was

possible to verify that there was no special structure in the data distribution. Hence, the variance homogeneity assumption was confirmed.

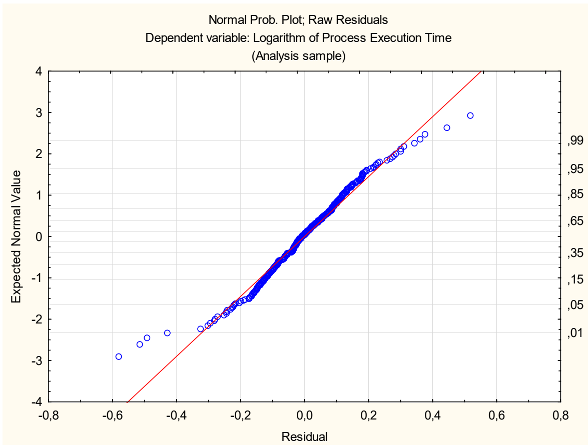

Figure 6- Residuals normality after logarithmic transformation

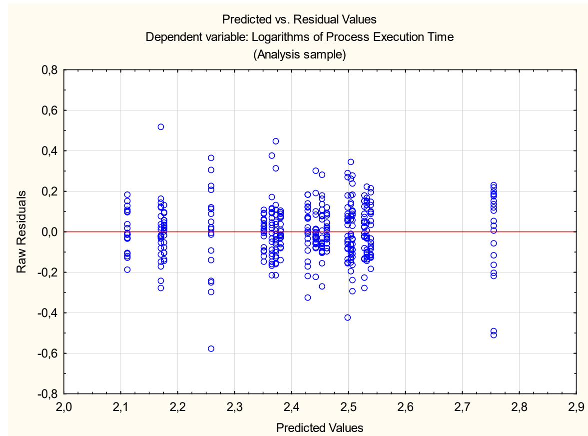

Figure 7-Homogeneity of the residuals after logarithmic transformation

3.5. One-Way-ANOVA (fixed effects) and Fisher Least-Significant-Difference Test

To test whether or not there are significant differences between execution times, it was formulated the following null hypothesis and alternative hypothesis:

$$H_0: \tau_{operator1} = \tau_{operator2} = \tau_{operator3} = \cdots = \tau_{operator19} = 0$$

$$H_1: \tau_i \neq 0, \text{ for at least one operator } i$$

In which τ_i is equal to the parameter of the effect of the operator *i,* in the invoices execution time. Therefore, figure 8 presents the output obtained in *statistica* software.

Effect	Univariate Results for Each DV (espap_stat) Sigma-restricted parameterization Effective hypothesis decomposition Degr. of Freedom	SS	MS	F	p
Intercept	1	2212,999	2212,999	114568,1	0,00
collaborators	18	8,567	0,476	24,6	0,00
Error	361	6,973	0,019		
Total	379	15,540			

Figure 8- One-Way-ANOVA test result

For an α = 5%, and because ρ <0,05, the null hypothesis is rejected, therefore it was possible to affirm that there were statistical significant differences between the execution time of each operator. Hence, invoice verification execution time is dependent on the operator who performs it.

Still, this data analysis of variance does not indicate who are the top and the worst time performers. In that sense, an Fisher LSD test was performed in order to make an operators' performance ranking (Montgomery and Runger 2003). Hence, for an α = 5%, the following Fisher LSD test result was obtained. The performance ranking results, based on the records in figure 9 shows that the operators 7 and 9 are the two best top performers whereas operator 12 and operator 17 are the worst time performers.

LSD test; variable
logarithms of process execution times
Probabilities for Post Hoc Tests
Error: Between MS = ,01932, df = 361,00

	collaborators	{1} 2,5331	{2} 2,4546	{3} 2,3812	{4} 2,4286	{5} 2,4991	{6} 2,5082	{7} 2,1773	{8} 2,2599	{9} 2,1119	{10} 2,3732	{11} 2,4435	{12} 2,7561	{13} 2,5283	{14} 2,3514	{15} 2,3662	{16} 2,1714	{17} 2,5394	{18} 2,5047	**{19} 2,4633**
1	collaborator1		0,075	0,001	0,018	0,440	0,571	0,000	0,000	0,000	0,000	0,042	0,000	0,914	0,000	0,000	0,000	0,886	0,519	0,113
2	collaborator2	0,075		0,096	0,554	0,312	0,224	0,000	0,000	0,000	0,065	0,800	0,000	0,094	0,019	0,045	0,000	0,055	0,255	0,843
3	collaborator3	0,001	0,096		0,282	0,008	0,004	0,000	0,006	0,000	0,854	0,158	0,000	0,001	0,498	0,733	0,000	0,000	0,005	0,063
4	collaborator4	0,018	0,554	0,282		0,109	0,071	0,000	0,000	0,000	0,208	0,735	0,000	0,024	0,080	0,157	0,000	0,012	0,084	0,430
5	collaborator5	0,440	0,312	0,008	0,109		0,836	0,000	0,000	0,000	0,004	0,206	0,000	0,507	0,001	0,003	0,000	0,360	0,899	0,416
6	collaborator6	0,571	0,224	0,004	0,071	0,836		0,000	0,000	0,000	0,002	0,142	0,000	0,647	0,000	0,001	0,000	0,478	0,937	0,308
7	collaborator7	0,000	0,000	0,000	0,000	0,000	0,000		0,061	0,138	0,000	0,000	0,000	0,000	0,000	0,000	0,894	0,000	0,000	0,000
8	collaborator8	0,000	0,000	0,006	0,000	0,000	0,000	0,061		0,001	0,010	0,000	0,000	0,000	0,038	0,016	0,045	0,000	0,000	0,000
9	collaborator9	0,000	0,000	0,000	0,000	0,000	0,000	0,138	0,001		0,000	0,000	0,000	0,000	0,000	0,000	0,176	0,000	0,000	0,000
10	collaborator10	0,000	0,065	0,854	0,208	0,004	0,002	0,000	0,010	0,000		0,111	0,000	0,000	0,621	0,874	0,000	0,000	0,003	0,041
11	collaborator11	0,042	0,800	0,158	0,735	0,206	0,142	0,000	0,000	0,000	0,111		0,000	0,054	0,037	0,080	0,000	0,030	0,164	0,651
12	collaborator12	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000		0,000	0,000	0,000	0,000	0,000	0,000	0,000
13	collaborator13	0,914	0,094	0,001	0,024	0,507	0,647	0,000	0,000	0,000	0,000	0,054	0,000		0,000	0,000	0,000	0,802	0,591	0,140
14	collaborator14	0,000	0,019	0,498	0,080	0,001	0,000	0,000	0,038	0,000	0,621	0,037	0,000	0,000		0,737	0,000	0,000	0,001	0,011
15	collaborator15	0,000	0,045	0,733	0,157	0,003	0,001	0,000	0,016	0,000	0,874	0,080	0,000	0,000	0,737		0,000	0,000	0,002	0,028
16	collaborator16	0,000	0,000	0,000	0,000	0,000	0,000	0,894	0,045	0,176	0,000	0,000	0,000	0,000	0,000	0,000		0,000	0,000	0,000
17	collaborator17	0,886	0,055	0,000	0,012	0,360	0,478	0,000	0,000	0,000	0,000	0,030	0,000	0,802	0,000	0,000	0,000		0,431	0,084
18	collaborator18	0,519	0,255	0,005	0,084	0,899	0,937	0,000	0,000	0,000	0,003	0,164	0,000	0,591	0,001	0,002	0,000	0,431		0,347
19	collaborator19	0,113	0,843	0,063	0,430	0,416	0,308	0,000	0,000	0,000	0,041	0,651	0,000	0,140	0,011	0,028	0,000	0,084	0,347	

Figure 9- Serialization of the operators according to their performance

3.6. Sampling size verification through the *statistical power* desired

The statistical power is the probability of rejecting the null hypothesis, when the alternative hypothesis is true (1-β) (Pereira and Requeijo 2008). Therefore, *statistical power analysis* command was used to determine whether the sample size and the effect size, which the study intended to study, leaded to a test power 'lower than' or 'higher than'.

The value established in the study was 99 % (1-β = 0,99). When the power result is lower than desired, it means it is necessary to increase the size of the sample to determine the desired effect with the desired statistical power (Montgomery and Runger 2003).

In order to calculate the size effect, it was used *eta-squared* (Cohen 1988), according to the above One-Way-ANOVA test data:

$$\eta^2 = \frac{SS_{effect}}{SS_{total}} = \frac{8,567}{15,540} = 0,551$$

The result obtained means 55,1 % of the time variance is due to the operator effect and according to Cohen's scale this value is considered a "large effect" (Cohen 1998). Additionally, for the strength of the sample, the *power analysis* command was used and the value of the variables introduced: (1) number of groups [19]; (2) number of samples observation [20]; (3) level of significance [0,05]; and (4) effect size [0,551].

	Value
Number of Groups	19,0000
Group Sample Size (N)	20,0000
RMSSE	0,5510
Noncentrality Parameter (Delta)	109,2964
Type I Error Rate (Alpha)	0,0500
Effect Df	18,0000
Error Df	361,0000
Critical Value of F	1,6325
Power	1,0000

Figure 10- power analysis command output

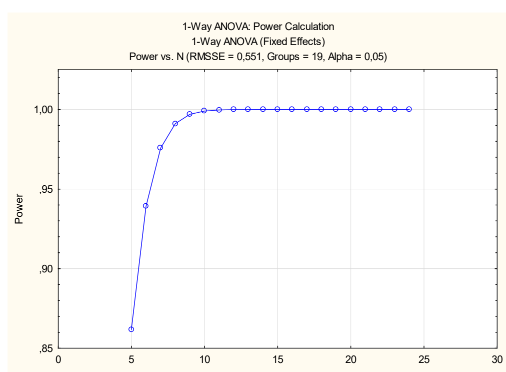

Figure 11- operational curve

For the sample size of the present study, with an α = 5 % and desired effect of 55,1 %, the result, shown in figure 10, was (1-β=**1**). Hence, it is higher than the statistical power defined at the beginning (1-β=0,99). Furthermore, the minimum sample size required for a statistical power of 0,99 and for a desired effect of 55,1 %, is close to 10 (figure 11). This means that, the study sampling size defined (20 observations) satisfies the required statistical power, the level of significance and the effect size.

3.7. Process Parameterisation

The invoice verification current execution time was also parameterized for further actions. In Box-Cox analysis, it was confirmed that the logarithm of the process execution time was normally distributed, therefore the authors decided to verify if the times followed a log-normal distribution, using the following hypothesis tests:

$$H_0: The\ collected\ data\ approach\ to\ a\ distribution\ log-normal$$
$$H_1: The\ collected\ data\ do\ not\ approach\ to\ a\ distribuição\ log-normal$$

To perform the test, the authors used the *statistica* command "Distribution Fitting" and had the following output (figure 12).

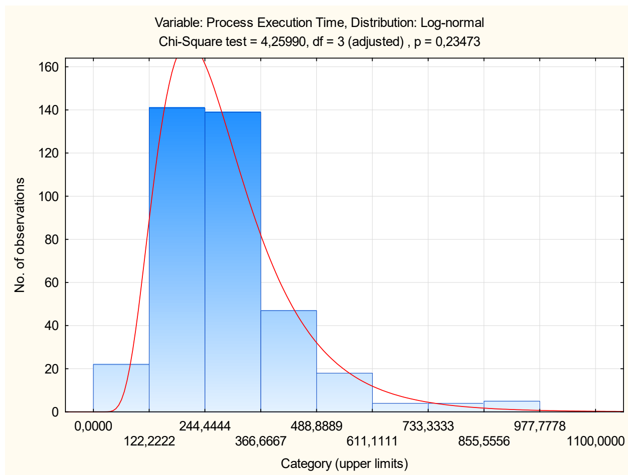

Figure 12- Fit of data to a log-normal distribution

As *p-value=0,23473* is higher than $\alpha = 0{,}05$, the null hypothesis is not rejected, so it was possible to conclude that the times follow a log-normal distribution, with the following parameters: $\mu = 289{,}027\ seconds$ and $\sigma^2 = 21568{,}834$.

4. Cross Case Study Analysis

4.1. Does the execution time of a process depend on the operators who perform it? If so, to what extent does it occur?

The One-Way-ANOVA test allowed to know if there were any significant differences in the process execution times among the operators. It was proved that the invoice verification execution time depends on the operator who performs it. This effect is responsible for about 55 % of the process execution time's variance.

The fact that there are significant differences in the process execution times among the operators was an important evidence for the present study. If no significant differences existed, the different practices identified in the *gemba* walk and storytelling would not be relevant or even characterised as good practices, in other words, those practices would not be worth sharing.

The *gemba* walk, supported by visual analysis and storytelling, did not only identify best practices, but also allowed to understand operators' motivation. Some referred to be driven by quality, hence for them the execution time was not their first priority, as long as the quality of the process was assured. Others were driven by time performance with no focus on process quality.

4.2. Do operators' individual practices have an impact on the process execution time?

The Fisher LSD test allowed to ranked operators in top and worst time performance. It was confirmed that operator 9 and operator 7 are the best time performers and operator 12 and operator 17 the worst time performers. In fact, operators 9 and 7, the two top time performers, are applying all the practices identified in the Lean *gemba* and KM storytelling. Operators 12 and 17 (the two worst time performers) are not applying these practices. This validates that the practices identified in *gemba* are in fact good practices.

So, the study may conclude that good practices and their adoption in this invoice verification process have a positive impact on the execution time.

5. Conclusions

The study surveyed a finance shared services department through observations based on Lean *gemba* and waste identification combined with knowledge management tool, storytelling and KM approach internal benchmarketing. These tools were fundamental to identify the different practices adopted among the operators and the wastes in the process procedures.

Statistical analysis were made with the support of *statistica* software, namely One-Way-ANOVA test, which led to the conclusion that the process execution time is dependent on the operator who performs it, producing an effect of approximately 55 % in the variability of the process execution time. Hence, through the Fisher LSD test interception with the practices identified in the *gemba* and storytelling, it was proved that operators' individual practices impact their process time performance.

Also, the Fisher LSD test allowed to understand where the significant differences among the operators' execution times were, and cross check with their current practices. Top performers were applying the same practices identified in the *gemba* and worst performers were not. This validated those practices as good practices, since it was proved they have a positive impact on the process time performance.

Moreover, the lean and knowledge management tools allowed the identification of wastes through storytelling and visual analysis of the process procedure and their elimination via communities of practices and peer assistance. In this sense, it was proved that the combination of lean and knowledge management tools can be useful to organisations, such as organisation A, in a digital transformation program, by enabling the required standardisation, process automation and continuous improvement actions.

Additionally, the study converged to the organisation knowledge management strategy, "Identification and share of best practices", and consequently to the organisational business strategy of improving their operational performance. However, for the time being it is not possible to measure those contributions.

For future studies it would be interesting to implement the mentoring knowledge management tool. Not only to share the good practices identified among the operators in the *gemba,* but also to understand the impact of sharing these best practices and to analyse how the log-normal distribution parameters of execution times will react.

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