# Influence of Gender, Education, Age Group and Time in the Company on the Adoption of New Technologies and their Impact on Continuous Improvement

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*Continuous Improvement (CI) is a principle being adopted in many organizations around the world. It is present in relevant excellence models such as the Toyota Way, Shingo Model, and Lean Thinking. CI was implemented some years ago in a Public Company (Lipor) based in Porto, dedicated to municipal waste treatment, but the Covid-19 pandemic created some important challenges. The forced adoption of new technologies associated with I4.0 required important changes in the existing CI routines. This paper aims to assess the influence of gender, education, age group, and time in the company on adopting new technologies used in their IC routines. This study, based on employees' perceptions through questionnaires, shows that the CI system had, in general, a positive impact on their work and overall performance. Regarding the effect of forced teleworking caused by COVID-19 on office workers, this study shows that age, gender, education, and years in the company have an impact on the effective adoption of new technologies associated with digital transformation and Industry 4.0. The study also shows that those technologies effectively allow routines and culture of CI to be maintained when workers are forced to work remotely.*

***Keywords:*** *Continuous Improvement; Teamwork; Kaizen; Lean Production*

## 1. INTRODUCTION

The principle of continuous improvement, or seeking perfection, is present in important excellence models such as lean thinking [1], Shingo Model [2], and Toyota Way [3]. Continuous improvement assumes a more in-depth meaning in the Toyota Way model since it is one of its two main pillars is "respect for people" the other one [4]. Implementing improvements consistently is crucial in ensuring companies' and organizations' future competit–iveness and sustainability. Many leading companies worldwide lost their leading positions in the market because they failed to keep an effective continuous improvement culture. Some of them ended up closing down. An analysis of the literature regarding the imple–mentation systems to materialize the principle of CI shows that the main reason for companies to adopt it is to achieve higher customer satisfaction, increase produc–tivity and improve quality conformance [5-8]. Following the CI principle is becoming, however, a strategy not just to achieve a competitive advantage, but it is becoming more like an obligation to survive in increasingly VUCA (volatile, uncertain, complex, and ambiguous) environ–ments. The IC is all the more effective if its daily tasks have been carried out in the same way as all other routine operational tasks. Effective continuous improvement is achieved when every employee and manager contributes with improvements (even if very small) daily or at least weekly. Mike Rother puts this idea in a very nice way in his book about Toyota Kata [9] when he presents his interpretation of the Toyota's continuous improvement practices. Company leaders tend to accept the impor–tance of Continuous Improvement in the sustainable growth of the company, but very few are actually spending their time and the time of the other human resources on continuous improvement tasks. A very inte–resting metaphor, which is worth mentioning here as it fits perfectly with the culture of continuous improve–ment, was put by Abraham Lincoln (president of the USA from 1861 to 1865). "If I had six hours to chop down a tree, I'd spend the first four hours sharpening the axe". “Sharpening the axe” is a metaphor for Conti–nuous Improvement because the axe becomes a lot more efficient in the cutting operation. Unfortunately, many managers are unwilling to spend time and resources on "sharpening the axe", ignoring that the time and resources saved by the improvements pay off hand–somely. No matter how small, every small improvement slightly ele–vates the organization to a new state, with a better stan–dard, better performance, and greater com–petitiveness.

Creating and successfully implementing a system and a culture of continuous improvement is not an easy task, and there is no one right solution for every orga–nization. Nevertheless, if the principles and concepts associated with excellence models, such as Lean thin–king and the Shingo model, are pursued, companies will

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certainly be able to find their way to continuous improvement. On this path, companies will transform complicated processes into continuous process flows with standardized tasks, better job satisfaction, and provide better value for customers. Many companies adopt one of the most traditional approaches to materi–alize continuous improvement, which is essentially based on "Gemba Walks" performed by one person or a team. From the observations on "Gemba," opportunities for improvement are eventually identified, and corres–ponding actions are designed and implemented. A tra–ditionally widely used tool to help systematize work is Value Stream Mapping (VSM). This tool serves to rep–resent the current observed state of processes through the Gemba Walk [10] and to represent the desired future state in order to identify the actions required to move from the current to the future state [11]. Other app–roaches to materialize continuous improvement are also applied in different companies around the world, but probably one of the most successful ones is the Toyota approach, named Toyota Kata by Mike Rother [9].

It is difficult to define the perfect amount of time and resources that should be used for continuous imp–rovement, but for example, George Koenigsaecker [12] recommends that a few people in each company should dedicate all their time to this role. He also recommends a figure of 3% as the number of people fully dedicated to continuous improvement in any organization. Many companies, however, do not want to have people exclusively dedicated to continuous improvement; they just wish for every employee and manager to spend some of their time on these tasks every day. Citing Renata Marczak [13], “continuous improvement of processes requires appropriate thinking, teamwork, support from the managers and an organizational culture which values seeking the opportunities to introduce changes, while finding the problem should be a reason for celebration by itself”.

Teamwork seems to be always present in all con–tinuous improvement practices [14]. Practically all the continuous improvement systems found in the lite–rature use teams of employees as one of the compo–nents. In general, in organizations, the value-added activities are performed by the employees, and the human factor is of vital importance in achieving good performance. The creativity and involvement of people are the fuel for the success of any organization [15]. In addition to teamwork contributing to employee invol–vement and training, several reports show that, in fact, it is also a critical success factor for continuous improve–ment projects [16]. Human factors in continuous imp–rovement are also valid in the industry 4.0 context [17].

Industry 4.0 is today´s phenomenon that cannot be ignored [18] as it is clearly transforming organizations, the economy, and our lives in society. When defining this, also called 4$^{th}$ industrial revolution, author, in general include descriptions such as:

- "Industry 4.0 or the fourth industrial revolution rep–resents embedded and connected systems erasing the boundaries between the real and the virtual factory, represented by the Cyber-Physical-System (CPS) and the Internet of Things" [19].
- The evolution of technologies is resulting in significant transformations in industries, economies, and the development strategies of governments in several countries [20];
- Industry 4.0 uses the power of new communications and information technologies, and innovation to leverage the development of manufacturing [21];
- Industry 4.0 makes full use of new technologies and the rapid development of innovative equipment to address global challenges in order to improve industry performance [22].

As happened before, we notice that in these pheno–mena of technological transformation, the human aspects of organizations are completely forgotten. The most common concepts of Industry 4.0 found in the literature are: the Internet of Things, Augment Reality, Big Data, Autonomous Robots, Cloud Computing, Additive Manufacturing, and Cyber-Physical Systems. The socio-technical nature of organizations, so well addressed by models of excellence such as the Shingo model [23] and the Toyota Way [3], is practically ig–nored by authors when referring to Industry 4.0. In some cases, they are referred to as in the work of Gaur, Solanki, & Hinchey [24] when “people” is included as one of the components of I4.0. The need to also con–sider human factors in the equation is also noted in other publications [25], [26]. In reality, some Industry 4.0 technologies could play an important role in enhancing human factors inspired by excellence models [27].

The study presented in this article took place in an own public company in the north of Portugal named Lipor. One of Lipor's main strategic lines is defined as "Towards Sustainability". The organization understands that sustainability encompasses economic, environ–mental, and social factors. On the economic side, a continuous improvement system has been developed over the years in the back office department [28]. The company's board of directors decided to extend the CI practices to the entire organization in view of the good results obtained. In line with what was said before, the whole system is centered on teamwork throughout the organization. The COVID-19 pandemic forced telework on people from indirect areas, and with it, changes had to be made in the CI routines. Teamwork routines, such as daily meetings and carrying out problem-solving, in the context of CI, changed from face-to-face to distance communication using videoconference technologies. Another relevant change was the fact that physical team boards had to be abandoned, giving way to virtual boards.

The first objective of this study is to evaluate workers' perceptions regarding the existing CI systems. The second objective is to compare the traditional CI routines in the indirect areas' teams with the new digital solutions forced by telework. The evaluations and com–parison is based on questionnaires. The main research question is "How do gender, education, age group, and time in the company influence the adoption of new technologies and their impact on CI”?

## 2. LIPOR CONTINUOUS IMPROVEMENT SYSTEM

Lipor is a public organization with responsible for waste treatment in Porto region. Every year, Lipor treats

around 500,000 tonnes of waste produced by around 1 million inhabitants of the municipalities in the Porto city region. Since 2010, when Lipor introduce in back-office area the Lean principles, the company has been deve–loping and adapting a Continuous Improvement System, based on the learnings obtained over the years. The CI system is transversal to the entire organization and developed by the Kaizen and the Natural Teams. The CI system is now quite mature, and there is a truly continuous improvement culture in the company.

Lipor is organized into several departments, and each department is composed of different Natural Teams. In this company, a Natural Team is composed of a group of workers that normally work together in the same workspace and perform different tasks in the same business process. This teams share a common team board, pursue the same team objectives, and actively contribute to the continuous improvement of their work–place and daily work activities. The coordination and support of all CI work in the company are assigned to the Kaizen Team. On the other hand, it is the responsibility of top management to define the CI strategy, objectives, and targets and to support the Kaizen Team. Another important assignment of this team is the development of continuous improvement competencies in every natural team and the awareness of all organizations to the importance of every small improvement in daily work.

### 2.1 Kaizen Team

The Kaizen team is composed of three members: one member of top management, one member with operational experience, and another with administrative experience. Only one of the elements is full-time in continuous improvement activities. The board of direc–tors assigned this team to deploy the continuous improvement culture to all organizations. The kaizen team was reorganized in 2016 because the team board realized that it was necessary to continue putting energy into the CI systems; otherwise, it tends to gradually reduce the improved speed and ultimately stagnate. Having someone in the company with that responsibility and being accountable for the results was the decision made. Furthermore, the Kaizen team is responsible for defining the company's CI strategy, defining the truth north or the direction to follow, carrying out CI audits, and monitoring and supervising the CI activities in the entire organization. The Kaizen team members are responsible for training and mentoring the natural team members whether they carry out production, admi–nistrative or intellectual work.

### 2.2 Natural Teams

As mentioned before, a Natural Team comprises a group of workers that usually work together in the same workspace and perform different tasks in the same business process. These teams share a common team board, pursue the same team objectives, and actively contribute to the continuous improvement of their workplace and daily work activities.

Being part of the audit team, the natural team leaders (Pivot) participate in audit preparation meetings, regular meetings, and kaizen team training. Each Natural team has a "Kaizen Pivot", the person chosen to interact with the Kaizen team. This person has motivation, skills, and knowledge in continuous improvement.

### 2.3 Process Design

Process design is one crucial activity in Lipor CI sys–tem. Each year, natural teams must analyze and review the most important processes in their responsibility. Using the VSM tool, the process owner and the process team members, with the presence of the kaizen team, identify problems and improvement opportunities, and then they draw a VSM of the desired state of the process. There are also defined improvement indicators and goals to quantify the improvement obtained.

### 2.4 Solving problems Projects

Solving Problems Projects are developed to resolve a problem or develop a specific improvement project. A specific team is created, which includes the process leader and elements of the natural teams involved directly and indirectly in the process. Usually, solving problems projects are created after a deep analysis of the Quality Matrix. This is a tool that every natural team uses in their regular work. In this matrix, the errors/occurrences detected in the various tasks of a given process are identified according to their origin or intervenient. From the analysis is possible to realize if it is an occasional or frequent error/occurrence. In the case of being frequent, a solving problem project is initiated. Any new project team that is created frequently requires training on problem-solving methodology always provided by Kaizen Team, which in some cases may be represented in the Project Team. For each project, a project board is created with a section to monitor the key performance indicators and another with infor–mation concerning the important details of the project.

### 2.5 Kaizen Events

Daily Kaizen is one of Lipor's CI events, playing a very important role in the life and management of the natural teams. Each natural team has a daily meeting to visualize the assignment of tasks and management of priorities, monitor the evolution of key performance indicators, and identify problems to be solved. In this sense teams, and boards provide transparency about the team's perfor–mance and create a platform for team's development.

Daily meeting is an important team event in CI System. All operational teams are stimulated and moti–vated to hold a small meeting every day in front of the team board so that its members become aware of the evolution of the team's performance and the distance to the objectives. In this meeting, it is also expected to identify problems to be solved and suggestions on ways to solve them.

Another important event is the kaizen team meeting with the leaders of the operational teams. This event occurs once a month. In this meeting, the Kaizen team and the leaders of the operational teams (Pivots) analyze and adapt the company's action plan, update the

performance indicators and the problems of the operational teams, and take action to solve the existing problems. This is a moment to share best practices and to present the results of solving problems projects.

Kaizen Team Audits were another practice imple–amented in LIPOR CI System. The audits are oriented to a specific topic according to improvement priorities. The priority can be defined for example in the imple–mentation status of the physical 5S, the IT 5S, or even in process improvement. Every year an external audit is carried out by a consultant with the purpose of obtaining an external evaluation of the entire existing CI system. Based on the results of this audit, the company defines new goals for the following year.

## 3. METHODOLOGY APPLIED IN THIS STUDY

The methodology applied in this study regarding the evaluation of the existing CI system was based on one questionnaire applied to production and office workers.

The questionnaire was designed to understand their perception of the most features of the Lipors' Conti–nuous Improvement System. The 12 questions of the questionnaire can be seen in Figure 1. This questi–onnaire was delivered digitally to 135 of 182 emplo–yees, resulting in a total of 62 valid responses. It was not successfully delivered to the remaining 47 emplo–yees. In order to reach as many people as possible, 10 paper questionnaires were delivered.

In order to evaluate the impact of telework forced by COVID-19 on Continuous Improvement routines and performance, a questionnaire was applied in 2021 to workers and managers (see Figure 2) only from indirect areas with 12 questions resulting in a total of 86 valid responses obtained. Regarding the characterization of the sample, Table 1 shows the number of people per gender, education level, age group, and time in the company.

In all questionnaires, questions were to be answered using a Likert scale with the following possible answers: strongly disagree, disagree, neither agree nor disagree, agree, strongly agree.

**Table 1. Characterization of the sample**

| | |
|---|---|
| Gender | 47 female and 39 male |
| Education | 16 with secondary school<br>70 with university degree |
| Age groups | 11 up to 30 years old<br>26 from 31 to 40 years old<br>40 from 41 to 50 years old<br>9 over 51 years old |
| Time in the company | 30 up to 10 years<br>33 from 11 to 20 years<br>23 over 21 years |

For the statistical tests, the t-Student test for two independent samples (assuming unequal variances), t, and the one-way ANOVA test for more than two independent samples, F, were performed.

## 4. RESULTS

Figure 1 shows responses with a clearly positive trend in employees' perceptions of the company's CI system. These are the results obtained from only 62 valid answers out of 182 possible ones, so we cannot claim that the remaining 120 workers share the same perception patterns. Workers well accept continuous improvement routines and practices as, on average, 84% of responses were either 'agree' or 'strongly agree'. Additionally, 92% of the respondents considered it important to be involved in improving their team's processes. The major perceived difficulty of the workers points out to waste identification, since question "Q10 – I can easily identify the "MUDA" (waste) in my Daily Work" was the one with a lower quotation, and only 70% of the respondents relate with it. However, this question is not directly related to the worker's perception of the CI system, but rather is an individual skill important for maintaining CI.

In an attempt to involve the respondents in a closer articulation and clarify their perception regarding the CI system, they were asked to give feedback and explain some of their responses to particular items. The following extracts give the accounts of four workers regarding the kaizen team and CI system in general: "*I think we could still get more knowledge and support from the kaizen team*"; "*The Kaizen at Lipor is extremely focused on quantity, getting numbers and does not help in the evaluation of work's quality*"; "*It is necessary to focus on what is fundamental and to minimize the investment of time in bureaucratic processes*"; "*Very well! You're doing a good job!*".

The Covid-19 pandemic crisis brought a major transformation worldwide and presented unprecedented challenges in the dynamic of our society. Small businesses paused, health services are confronting several difficulties, and the world of work changed. Lipor's management established a range of measures to protect our teams and contribute to the containment of the disease, moreover, lockdown measures have sud–denly forced employees to telework, making them work far from their conventional workplace.

In this context, our teams had to adjust their CI and team routines to a new work environment and practices. Information and communication technologies, such as Microsoft Teams, were essential to bring closer teams that started working from home.

Among others, the Daily Kaizen started to be held via videoconference, and the team adopted a digital Kanban board replacing the physical one. The Kaizen team, whenever necessary, supports and monitors the other teams and tracks the ongoing actions using distance communication tools, yet a monthly meeting for the whole team was scheduled. Moreover, it was found necessary to establish a biweekly meeting with the support team and the Natural team's pivot to strengthen relationships since team members are more distant. The improvement projects, namely process design, are still carried out in person, complying with all the safety rules stipulated by DGS.

To investigate and understand how workers have responded to the adoption of information and commu–nication technologies to maintain teamwork, as well as the realization of kaizen routines in telework, a survey was designed and sent to the team members.

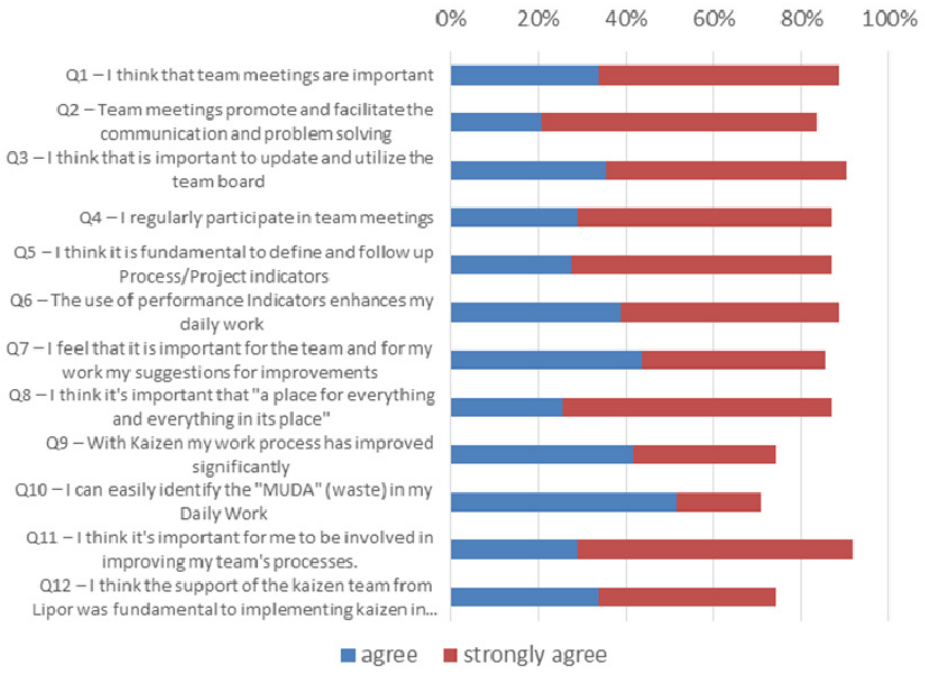


**Figure 1. Percentage of "Agree" and "Strong agree" answers obtained from the questionnaires applied to production and office workers.**

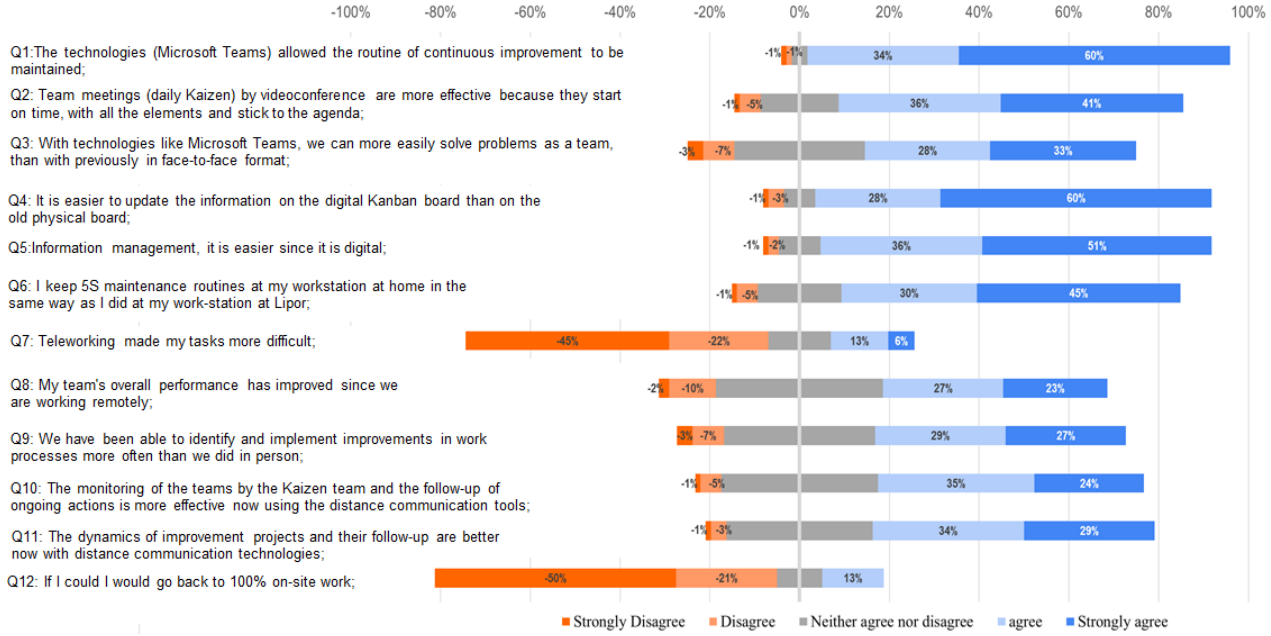


**Figure 2. Results regarding the impact of telework on CI performance.**

The results are summarized in **Error! Reference source not found.**2 and demon–strate that teamwork and CI routines were not only possible to maintain with employees in telework, but also the efficiency of some, such as Daily Kaizen, was improved. Q1, Q2, Q4, and Q5 had very positive feed–back, with 94% of the inquired recognizing the impor–tant role of information technologies in the maintenance of CI routines. Updating, managing, and monitoring information has become easier since it is digital (87% agreed), and 88% of the respondents found it easier to use the digital Kanban board. Moreover, 73% declared to keep 5S routines in their workplace at home, and 56% assumed that they have been able to identify and implement improvements in work processes more often than before. Although most respondents found the adaptations to distance communication technologies beneficial, 12% of the employees expressed that telework worsens team's overall performance, and 19% found that telework made their tasks more difficult.

Regarding the effectiveness of the Kaizen team in assisting natural teams (Q10), 59% of the respondents agree that the kaizen teamwork is more effective at a distance. Similar results were observed regarding the dynamics of improvement projects, where 63% of the respondents considered that they had improved, and only 4% disagreed.

Information and communication tools played an important role in the adaptation of employees to teleworking triggered by the COVID-19 pandemic

crisis. Although some disadvantages are associated with remote teamwork practices, digital tools are eliminating them and, in some cases, have contributed so positively to this transformation that some practices may be maintained in the future.

Regarding the research question "How does gender, education, age group, and time in the company influence the adoption of new technologies and their impact on CI", some statistical analysis was performed and the results are presented in the next paragraph.

Regarding gender, considering the answers to question Q1 (*The technologies (Microsoft Teams) allowed the routine of continuous improvement to be maintained*), the obtained differences are statistically significant ($t(63)=2.020$, $p<0.05$). On average, women are assumed to be able to maintain continuous improvement routines easier than men. A similar result was obtained to question Q10 (*The monitoring of the teams by the Kaizen team and the follow-up of ongoing actions is more effective now using the distance communication tools*) ($t(74)=1.903$, $p<0.05$). As in Q1 female workers are more effective in being monitored by the Kaizen team when working from home.

Regarding the education level, the statistically relevant difference ($t(21)=2.628$, $p<0.01$) was obtained only in question Q12 (*If I could, I would go back to 100% on-site work*). Although neither group wanted to go back to 100% on-site work, people without a university degree are apparently more inclined to go back to 100% on-site work (mean = 2.875).

In terms of age groups, statistical differences were found ($F(3, 82)=2.931$, $p<0.05$)) in the answers to question Q6 (*I keep 5S maintenance routines at my workstation at home in the same way as I did at my workstation at Lipor*). The age group from 31 to 40 years old has more difficulty keeping 5S maintenance routines working from home. Statistical difference ($F(2, 83)=4.052$, $p<0.01$)) was also found in the answers given by people from different age groups to question Q12 (*If I could, I would go back to 100% on-site work*). The willingness to return to work on-site is higher in older workers, as seen in Table 2.

**Table 2. Summary of statistics from question Q12**

| *Age* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <31 | 11 | 14 | 1.2727 | 0.4182 |
| 31-40 | 26 | 47 | 1.8077 | 1.2015 |
| 41-50 | 40 | 88 | 2.2 | 1.7538 |
| >50 | 9 | 28 | 3.1111 | 3.3611 |

Finally, regarding the effect of time working in the company, statistical differences were found in 4 questions. The answers to question Q1 (*The technologies (Microsoft Teams) allowed the routine of continuous improvement to be maintained*), showed that workers with less time in the company (up to 10 years) were more able to keep continuous improvement routines in telework than the others working already in the company for longer periods ($F(2, 83)=3.935$, $p<0.05$)). Similar results were obtained in question Q4 (*It is easier to update the information on the digital Kanban board than on the old physical board*) ($F(2, 83)=6.377$, $p<0.01$)). The group of people working in the company between 11 and 20 years, although with a high mean value, 4.4 out of 5, showed a lower score in that question than the people working in the company for less than 11 years and people working in the company more than 20 years. The newer people in the company showed better scores in question Q5 (*Information management, it is easier since it is digital*) with a statistical difference ($F(2, 83)=2.184$, $p<0.05$)).

**Table 3. Summary of statistics from question Q12**

| *Years in the company* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| <10 | 30 | 39 | 1.3 | 0.3552 |
| 11-20 | 33 | 77 | 2.3333 | 2.0417 |
| >21 | 23 | 61 | 2.6522 | 2.0553 |

Finally, in Q12 (*If I could, I would go back to 100% on-site work*), it is clear the difference ($F(2, 83)=9.567$, $p<0.001$)) between the answer given by newer people in the company (see mean values shown in Table 3).

## 5. CONCLUSION

This paper presents a picture of the current routines and practices with CI of Lipor. CI implies organizational changes, a lot of daily work, and years of practice, so its sustainability depends on the management and workers' commitment. Data shows that the company's workers well received the implemented CI routines and practices since more than 80% of the survey's respondents gave positive feedback. Being part of the team's process improvement and the use of team boards are important motivators to work with CI. The survey also highlighted the relevance of participation in team's events such as daily meetings, resulting in improvement in communi–cation and problem-solving, along with monitoring the teams' performance indicators. It appears that the focus of the Kaizen Team on quantity and performance rather than the quality of the work and the use of shop-floor tools that do not fit so well in the office are some of the negative aspects of the CI systems developed at Lipor.

The results also show the importance of the kaizen team role. The level of support given by the kaizen team is vital to the success of the CI effort. There is an awareness that keeping the CI system working and giving results requires energy, time, and everyone's involvement, but despite this, it seems that the gains made are worth it for the results in terms of performance, job satisfaction, and motivation.

The main conclusions regarding the impact of telework, forced by COVID-19, on the CI performance are based on a representative sample of 86 valid answers. The conclusions are: (1) the meetings are more effective through videoconference because they start on time and with all the elements (77% agree or strongly agree) probably because they are working fundamen–tally "in front of the PC", and there is no reasons for delays. The fact that "Microsoft Teams" warns that someone has started the meeting also promotes punc–tuality. (2) The team's routines did not suffer big changes (94% agree or strongly agree), given that they were already performing back office operations, allowing a “smooth” transition to telework. The fact that the organization has all the necessary technological

tools also facilitated this transition. (3) Information Management (87% agree or strongly agree) and updating team boards (88% agree or strongly agree) has become easier with digital boards, as the work tasks and team board updating are performed in the same space, the personal computer. (4) Distance work did not change the team's performance; however, it made the task more complicated (67%). Team's tasks are equally performed by using a greater number of working hours, maybe because of the more difficult interaction between team members and the team leader.

Regarding the research question, there were differences in how different groups perceived the use of new communication and information platforms in telework. Female workers showed more ability to keep continuous improvement routines in telework and maintain good communication levels with the kaizen team. Workers with less time in the company could also keep continuous improvement routines in telework. The workers with a university degree were less interested in returning to 100% on-site work. Results also showed that people are less reluctant to go back to 100% on-site work as they are older. A similar result was obtained for people working longer in the company. The group of people working for the company for 11 and 20 years is apparently less confident in keeping the digital kanban board updated than the previous physical version.

The most interesting learning from this study is that digital transformation, commonly associated with Industry 4.0, can also allow effective remote teamwork as well as maintaining continuous improvement tasks and culture in a very successful way.

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## REFERENCES

[1] Womack, J. and D. Jones. Lean thinking: Banish Waste and Create Wealth in Your Corporation. New York: Fee Press, 1996.

[2] Shingo Institute. The Shingo Model, 2020. https://shingo.org/shingo-model/ (accessed Jun. 08, 2020).

[3] Liker, J. Toyota Way: 14 Management Principles from the World's Greatest Manufacturer. McGraw-Hill Education, 2004.

[4] Toyota_Europe. The Toyota Way: our values and way of working, 2019. https://www.toyota-europe.com/world-of-toyota/this-is-toyota/the-toyota-way (accessed Jan. 20, 2020).

[5] Readman, J. and J. Bessant. What challenges lie ahead for improvement programmes in the UK? Lessons from the CINet Continuous Improvement Survey 2003. Int. J. Technol. Manag. vol. 37, no. 3–4. pp. 290–305. 2007. doi:10.1504/IJTM.2007.012264.

[6] Magjuka, R. J. Survey: Self-managed teams achieve continuous improvement best. Natl. Product. Rev. vol. 11, no. 1. pp. 51–57. 1991. doi: 10.1002/npr.4040110107.

[7] Albors, J. and J. L. Hervás. CI practice in Spain: Its role as a strategic tool for the firm. Empirical evidence from the CINet survey analysis. Int. J. Technol. Manag. vol. 37, no. 3–4. pp. 332–347. 2007. doi: 10.1504/IJTM.2007.012267.

[8] Scott, B. S., A. E. Wilcock, and V. Kanetkar. A survey of structured continuous improvement programs in the Canadian food sector. Food Control. vol. 20, no. 3. pp. 209–217. 2009. doi: 10.1016/j.foodcont.2008.04.008.

[9] Rother, M. Toyota KATA. McGraw-Hill Education - Europe, 2010.

[10] Tyagi, S., A. Choudhary, X. Cai, and K. Yang. Value stream mapping to reduce the lead-time of a product development process. Int. J. Prod. Econ. 2015. doi: 10.1016/j.ijpe.2014.11.002.

[11] Rother, M., J. Shook. Learning to see: Value stream mapping to add value and eliminate muda. 1999.

[12] Koenigsaecker, G. Leading the lean enterprise transformation. New York: Productivity Press, 2009.

[13] Brajer-Marczak, R. Employee engagement in continuous improvement of processes. Management. vol. 18, no. 2. pp. 88–103. 2014. doi: 10.2478/manment-2014-0044.

[14] Sanchez-ruiz, L. and B. Blanco. Business , Management and Economics How Do Companies Implement Process Management? The Case of Cantabrian Companies. vol. 2, no. 1. pp. 1–9. 2016.

[15] Moica, S., C. Veres Harea, and L. Marian. Effects of Suggestion System on Continuous Improvement: A Case Study, 2019, doi: 10.1109/IEEM.2018.8607804.

[16] Morales, S., A. Valles, J. García-Alcaraz, and E. Martinez. DETERMINATION OF THE CRITICAL SUCCESS FACTORS OF CONTINUOUS IMPROVEMENT PROJECTS. Int. J. Ind. Eng. vol. special is. pp. 471–480. Sep. 2008.

[17] Stadnicka, D., P. Litwin, and D. Antonelli. Human factor in industry of the future - Knowledge acquisition and motivation. FME Trans. vol. 47, no. 4. 2019. doi: 10.5937/fmet1904823S.

[18] Pinheiro, P., G. D. Putnik, A. Castro, H. Castro, R. D. B. Fontana, and F. Romero. Industry 4.0 and industrial revolutions: An assessment based on complexity. FME Trans. vol. 47, no. 4. 2019. doi: 10.5937/fmet1904831P.

[19] Roland Berger. The digital transformation of industry - How important is it? Who are the winners? What must be done?, Munique, 2015.

[20] Schwab, K. The Fourth Industrial Revolution: what it means and how to respond. World Econ. Forum. 2016.

[21] Kagermann, W. Wahlster, and J. Helbig. Recommendations for implementing the strategic initiative INDUSTRIE 4.0, 2013.

[22] Wang, S., J. Wan, D. Li, C. Zhang. Implementing Smart Factory of Industrie 4.0: An Outlook. Int. J.

Distrib. Sens. Networks. vol. 2016. 2016. doi: 10.1155/2016/3159805.

[23] Plenert, G. J. Discover excellence: an overview of the Shingo model and its guiding principles. New York: CRC Press, 2017.

[24] Gaur, L., A. Solanki, and M. Hinchey. Industry 4.0 - Managing Digital Transformation Using Disruptive Technologies, 1st ed. 2021.

[25] Bednar, P. M. and C. Welch. Socio-Technical Perspectives on Smart Working: Creating Meaningful and Sustainable Systems. Inf. Syst. Front. vol. 22, no. 2. 2020. doi: 10.1007/s10796-019-09921-1.

[26] Sony, M. and S. Naik. Industry 4.0 integration with socio-technical systems theory: A systematic review and proposed theoretical model. Technol. Soc. vol. 61. 2020. doi: 10.1016/j.techsoc.2020. 101248.

[27] Pereira, A. C., J. Dinis-Carvalho, A. C. Alves, and P. Arezes. How Industry 4.0 Can Enhance Lean Practices. FME Trans. 2019. doi: 10.5937/fmet 1904810P.

[28] Monteiro, M. F. J. R., C. C. L. Pacheco, J. Dinis-Carvalho, and F. C. Paiva. Implementing lean office: A successful case in public sector. FME Trans. vol. 43, no. 4. pp. 303–310. 2015. doi: 10.5937/fmet1504303M.

## УТИЦАЈ ПОЛА, ОБРАЗОВАЊА, СТАРОСНЕ ГРУПЕ И ВРЕМЕНА У КОМПАНИЈИ НА УСВАЈАЊЕ НОВИХ ТЕХНОЛОГИЈА И ЊИХОВ УТИЦАЈ НА КОНТИНУИРАНО УНАПРЕЂЕЊЕ

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Континуирано побољшање (КП) је принцип који се усваја у многим организацијама широм света и присутан је у релевантним моделима изврсности као што су Тојота Пут, Шинго модел и Lean Thinking. КП је имплементиран пре неколико година у јавном предузећу (Липор) са седиштем у Порту, посве–ћеном третману комуналног отпада, међутим пан–демија Ковид-19 је произвела неке важне изазове. Принудно усвајање нових технологија повезаних са Индустријом 4.0 захтевало је важне промене у постојећим КП рутинама.

Циљ овог рада је да се процени утицај пола, образовања, старосне групе и времена у компанији на усвајање нових технологија које се користе у овим КП рутинама. Ова студија, заснована на перцепцији запослених кроз упитнике, показује да је систем КП, генерално гледано, пози–тивно утицао на њихов рад и укупни учинак. Што се тиче ефекта форсираног рада на даљину изазваног Ковидом-19 на канцеларијске раднике, резултати ове студије показују да старост, пол, образовање и године у компанији утичу на ефективно усвајање нових технологија повезаних са дигиталном трансформацијом и Индустријом 4.0. Студија такође показује да су те технологије ефикасне у омогућавању одржавања рутина и културе КП када су радници принуђени да раде на даљину.