As can be seen in Table 4, the reduction of the OCRA index is linked to a two-fold effect: on the one hand, the reduction in the number of actions achieved (Ae) through the simplification of the actions carried out by the installation of the rotating top and the cylinders, these allow the product to move without any effort; on the other hand, the increase in technical reference actions (Ar) through the reduction of applied efforts and an improved posture of the left arm. Once the OCRA indexes have been calculated, these can be classified in the different risk zones depending on their value (see Table 5).

Table 5. Criteria for risk assessment with the OCRA index

Zone	OCRA index	Risk level
Green	≤ 2.2	Without risk
Yellow	2.2 < Index ≤ 3.5	Low risk
Red	> 3.5	High risk

A summary of the results obtained is shown in Figure 2, where the horizontal line represents the limit of the green zone (without risk). Above this limit, in the yellow and red zones, risk mitigation activities are required, or in the worst cases, it is necessary to redesign activities and workstations.

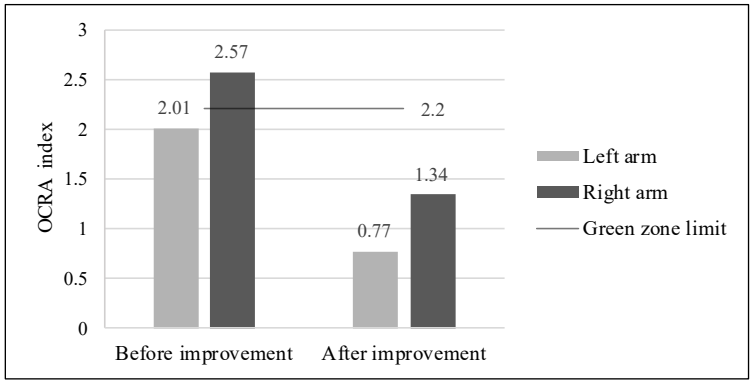

Figure 2. OCRA indexes in both scenarios

Concluding, the improvement project introduced also had beneficial effects on the level of ergonomics. The modifications launched had an impact in various aspects:

- A reduction of the elementary actions performed by each arm during the working cycle, which is more noticeable for the left arm. A handling reduction implicates the possibility of performing moves with the most comfortable arm that, since it is less tired, it also absorbs activities that could be deferred to the left arm.
- Effort reduction due to the introduction of the rotating system.
- An improvement in the posture coefficient, mainly related to the pronation of the elbow which, with the rotating plane now can be avoided.

Therefore, and as in the first case, an improvement activity launched for productive purposes has produced a benefit to the health of workers.

5. Concluding Remarks

The present study considers the possibility of obtaining safety improvements enabled by the application of a production management system; in this case, the lean approach developed by Toyota. In particular, this article aimed to determine whether an application of lean manufacturing techniques had beneficial effects not only on productivity performance but also on the health and safety of workers.

The literature review analysis has shown conflicting views regarding the effect of lean thinking on the health and safety of workers. Various authors, mainly from the operations management area, believe that the application of lean manufacturing practices can improve the working conditions of the employees; other authors, primarily from the area of industrial sociology and health areas, believe that there may exist adverse effects related to lean.

The empirical analyses presented through the case study in Company SFT, have demonstrated a positive effect on health and safety as a result of the lean improvement activities; however, the results cannot be considered statistically significant to draw more general conclusions. This paper is particularly interesting since the implementation of a lean improvement project has enabled the transition from a traditional lubrication method to a minimal lubrication method, and it has allowed an improvement of the 4% of the global efficiency index (OEE) with a payback of investment of four months. Additionally, the analysis carried in the second improvement project with a lean perspective of the post-painting defects has led to a complete redefinition of the workstation with a focus on maximizing the value-added activities carried out by the operator. More specifically, the root causes analyses have permitted the introduction of simple but effective modifications, and the participation of workers has enabled the balance of the workload between the different control stations operating at the same line. Thus, both lean applications have led to remarkable benefits regarding the risk exposure and ergonomics of the workers involved.

An analysis of this scale requires an in-depth knowledge of both lean thinking and safety in the workplace, understood as requirements and risk assessment techniques. This study encountered a limitation since already completed projects were used, making it difficult in some situations to obtain information with a very high degree of accuracy. Hence, a future research direction could be the follow-up of a lean improvement project to understand its effects on the level of security for employees before, during and after its implementation. Moreover, it should be considered that the whole analysis was limited to the manufacturing sector. Therefore, there are several research opportunities in other areas, such as construction, healthcare, etc. that could be reviewed according to their specific regulatory requirements.

In other words, lean manufacturing offers a range of practices and tools that need to be used in the right way and at the right time; the balance in the use of these tools is not established a priori but should be determined on a case-by-case basis depending on the company's vision and specific characteristics. In contrast, the application of these instruments without having grasped the lean philosophy and without adapting them to each case will hardly allow the achievement of effective results.

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