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IMPROVEMENT OF THE MACHINE CONTROL PROCESS USING THE WORK STANDARDISATION CARD

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Purpose: The aim of the article was to propose the possibility of implementing a work standardisation card for a company in the passenger land transport industry – a ski lift.
Design/methodology/approach: The analysed ski lift, located in Southern Poland, should undergo daily checks on the condition of its equipment to ensure trouble-free operation. Current non-standardised operations may increase the risk of error. The proposed document, the work standardisation card, makes it possible to supervise the control and minimise the possibility of failure.
Findings: The introduction of the work standardisation card allows to increase the efficiency of the work and the analysis of the results obtained allowed to classify the most time-consuming activities.
Research limitations/implications: In order to reduce costs, as a result of failures, and to increase quality and customer satisfaction, it is proposed to introduce documents as part of the working standard.
Practical implications: Future research should focus on opportunities to further improve machine condition monitoring. The presented methodology can be applied to other activities that occur during ski lift operation, such as breakdowns.
Originality/value: The work is a useful resource for companies in the tourism and transport industry and the transport sector, due to the universality of the standards used.

Keywords: standardisation, work standardisation card, production engineering, quality engineering.

Category of the paper: research paper, case study.

1. Introduction

Belonging to the concept of Lean Manufacturing, work standardisation is about improving activities and the stability and cyclicality of the production process. It is characterised as a sum of intermediate activities that lead to a rational standardisation of repetitive solutions (Pacana, Czerwińska, 2017; MÍkva et al., 2016). It is defined as an unambiguous way of performing certain activities so that tasks can be completed without variation in terms of performance, quality, time and cost (Antosz et al., 2013).

The suitable introduction of standardisation into the production process makes it possible to prevent the occurrence of known errors during production, while at the same time eliminating the likelihood of other nonconformities affecting the process. This has the effect of reducing financial costs and saving time. Standardisation makes it possible to provide a transparent, visualised and safe working environment (Košturiak, Frolík, 2006; MÍkva et al., 2016).

A special case of railways is the ski lift, where passengers are pulled along a prepared run by means of skis or other specialised equipment, using towing devices driven by a rope (Baran, 2010; Zwolenik, Pacana, 2018). The correct functioning of the pull-out mechanism depends on regular checks, which should be carried out before the route is made available to customers. Standardisation of the activities carried out, in particular in the form of a work standardisation card, can be a significant help for employees (MÍkva et al., 2016).

The aim of the article was to develop a sample work standardisation card, taking into account its demand during control activities carried out with daily frequency. The created document was implemented in the activities preparing the ski lift machines, and the monthly results were averaged and presented in the article.

2. The concept and essence of work standardisation

A standard, which is a basis for activities improving the current state and bringing the achievement of company objectives, represents a procedure, principle or example in which the requirements are specified. Their determination should be based on facts and analysis, and they are intended to be observed and respected, with appropriate documentation. The standards must be familiar to the employees and fully understandable to them (Chan, Tay, 2018; Kurnia et al., 2018; MÍkva et al., 2016; The Productivity Press Development Team, 2010).

The standards shall apply in the case of:

- reduce variability and correct errors,
- improvement of safety,
- facilitate communication,

- need for training assistance,
- increase work discipline,
- clarify working procedures (Košturiak et al., 2010; MÍkva et al., 2016).

The essence of the standardisation of work is based on the creation of standards, i.e. schemes which will include the most effective methods of work, stabilising the process and guaranteeing that by performing certain steps, each time a product of identical quality as the target one will be obtained. The creation of standards consists of subjecting particular stages of the process to the adopted criteria (e.g. quality, efficiency) in order to evaluate their effectiveness. The obtained optimal sequence of activities is adopted as a standard which can always be improved (Chan, Tay, 2018; Imai, 2005; MÍkva et al., 2016).

Based on competitive factors, which include: customer, employee, production area and Kaizen, i.e. optimisation, it is possible to set appropriate standards. Standardisation works according to the concept of Lean Manufacturing, which means that its main objective is to eliminate losses. The effect of reducing or eliminating them is to limit production costs, decrease the workload of employees by excluding unnecessary activities, shorten repair time (potential failures are diagnosed earlier) and increase the efficiency of operators (Pacana et al., 2018; Kolińska, Koliński, 2013).

The work standardisation card is a document that presents the work pattern for a given workplace, so that irregularities can be detected and potential losses eliminated. It is characterised by simplicity of execution and low costs of development and introduction (Antosz et al., 2013).

Each card is individually developed by the company, adapting its scope to its own needs. Its basic elements, which may be extended, include:

- enterprise data,
- the characteristics of the workstation, including name, number, work task, type of product manufactured, cycle time,
- workstation load,
- a brief description of the workstation, including: activity diagram, activities performed, direction of production flow, and equipment,
- duration of operations, i.e., the total duration of the operations performed by the machine, the man and the intermediate operations, e.g., movement of the operator,
- description of activities, divided into:
  - basic – necessary for the production of the product, for example assembly, handling, inspection,
  - auxiliary – performed directly at the workplace, but not directly related to production, e.g. cleaning, changeover,
  - additional – occurring sporadically and irregularly, e.g. breakdowns,

- the characteristics of the operation, i.e. frequency, type of operation (Value Adding, VA or Non Value Adding, NVA) and control points,
- a description of the symbols used,
- information on the approval of the document (Antosz et al., 2013).

Due to including the type of operations on the cards, it is possible to identify the activities that create added value and those that do not create this value. During the process improvement it is necessary to aim at reducing the activities not related to the quality of the final product, remaining at the minimum required participation in the production process (Kosieradzka, Smagowicz, 2015).

The development of standardisation charters is a multi-stage solution, whereby they are gradually adapted to the situation of the company and the type of production. This starts with the selection of an area in which there is repeatability, efficient machinery and high and stable quality, while maintaining safety principles. Then comes the information campaign among the workers, during which they are made aware of the objectives and effects of the actions. This is followed by the selection of workplaces and an analysis of the current state, during which losses are identified. During the development process, it is necessary to define and describe all activities carried out and to break them down by type, followed by a measurement to determine the total cycle time. The final step is to analyse the results, verify them and make corrections in order to obtain the final work standardisation card (Antosz et al., 2013; Kolińska, Koliński, 2013; Kosieradzka, Smagowicz, 2015). A sample card template is included in Table 1.

Table 1.
Example of a work standardisation card

Company		Name and address				
WORK STANDARDISATION CARD						
Department		Position		Operation		
Assortment				Time [s]		
Workplace description [graphic]					Auxiliary equipment	
Basic operations						
No.	Description of activities	Operation time [s]			VA/NVA	Checkpoints
		Man	Machine	Transition		
TOTAL						
Ancillary and auxiliary operations						
TOTAL						

Own study based on (Furman, 2017).

The implementation of standardisation into the production process can be facilitated by carrying out all the development steps, especially during the analysis of the current state and the execution of measurements. This is due to the fact that it is in these steps that most errors

and problems become apparent, resulting from insufficient standardisation of the process, linked to non-compliance with procedures or inadequate organisation of the workplace (Antosz et al., 2013; Kolińska, Koliński, 2013; Kosieradzka, Smagowicz, 2015).

The final version of the job standardisation card is often accompanied by a graphic job description and the conclusions of the analyses. The results of the analyses are a starting point for further improvement, as they allow the selection of preventive and corrective actions (Antosz et al., 2013; Kolińska, Koliński, 2013; Kosieradzka, Smagowicz, 2015).

According to Kaizen and the 6S methodology, standardisation never ends (Nazarali et al., 2017; Singh, Singh, 2009; Szczepańska, 2012). After some time, it is necessary to reconsider the existing standards and improve them to the prevailing conditions, creating new charters. That cycle allows processes to remain stable and also reduces costs by eliminating waste (Antosz et al., 2013; Kolińska, Koliński, 2013; Kosieradzka, Smagowicz, 2015; Kwiatkowski et al., 2016; The Productivity Press Development Team, 2010).

3. Improvement of the ski lift condition control process using the work standardisation card

The subject of analysis was the W-1 ski lift located at the Cieniawa-Ski ski station, of plate lift type. The horizontal length of the ski lift route is 310 m, the slope length is 314.33 m, and the difference in levels is 52 m, giving an average slope of 16.9%. The maximum speed of the ski lift is 2.5 m/s. The operating capacity is 400 persons/hour and the maximum theoretical capacity is 720 persons/hour. There are two types of stations: on the lower platform there is a drive-winding station with hydraulic tensioning, and on the upper platform there is a winding station. Both stations are load-bearing welded steel structures attached to the foundation. On the hoist route, there are 6 intermediate supports in the form of steel poles equipped with 2-bolt batteries and 2-bolt batteries with a pressure pulley. Towing devices are single person telescopic plates, and their number is 50 (+2 spare) (Cieniawa-Ski ski station, 2022).

The operation of the ski lift is managed from the control room located at the ski lift driving station in such a way as to ensure good visibility of the route. In the control room, there is a control panel with operational buttons, control lights, electrical indicators, a STOP safety button and the main switch of the ski lift, as well as a cabinet with electrical equipment and fuses. To maintain safety, STOP switches are located on each platform and are used in case a passenger falls on the route or the automatic switches do not work due to a rope derailment, the passenger crosses the uncoupling zone, improper winding of the rope of the towing devices or faults in the operation of the lift mechanism (Cieniawa-Ski ski station, 2022). The mechanism in the control room is shown in Figure 1.

Figure 1. Control panel of a ski lift. Own study based on (Cieniawa-Ski ski station, 2022).

Responsibilities of the ski station staff include daily inspection of the condition of the ski lift. The established procedure, written in the form of a flow chart, requires checking the lift mechanism, towing devices and the condition of the route supports (Cieniawa-Ski ski station, 2022). Figure 2 shows a flow chart of the inspection process for the condition of the lift and machinery.

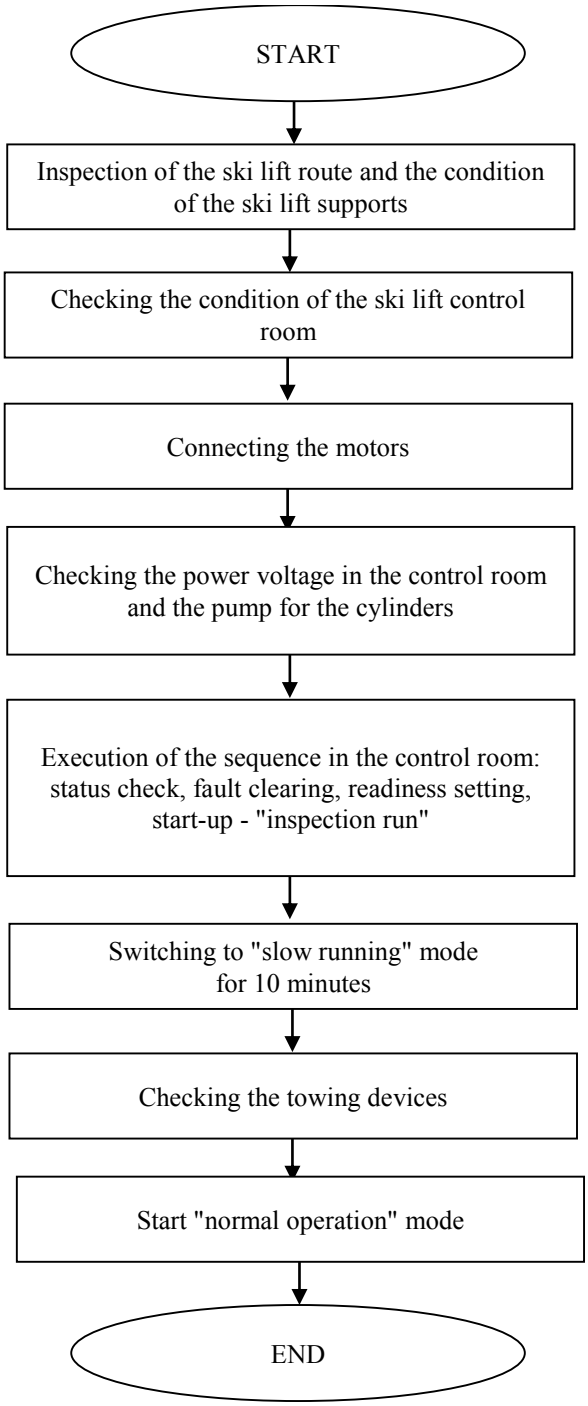


Figure 2. Block diagram of the ski lift control course. Own study based on (Cieniawa-Ski ski station, 2022).

The inspection takes place before the operating hours of the ski station and takes about 60 minutes. In addition, the inspection are tasked with the weekly lubrication of the bearings located at the drive-winding station and winding stations, in order to avoid potential failures.

This stage is necessary for the proper functioning of the machinery as it enables to minimize the occurrence of breakdowns. Analyzing the data from five seasons – because only during that time the ski station is in use – it should be noted that none of the occurring unplanned stoppages

negatively influenced the work of the ski lift, meaning that they could be quickly neutralized. Failures are presented in the graph in Figure 3.

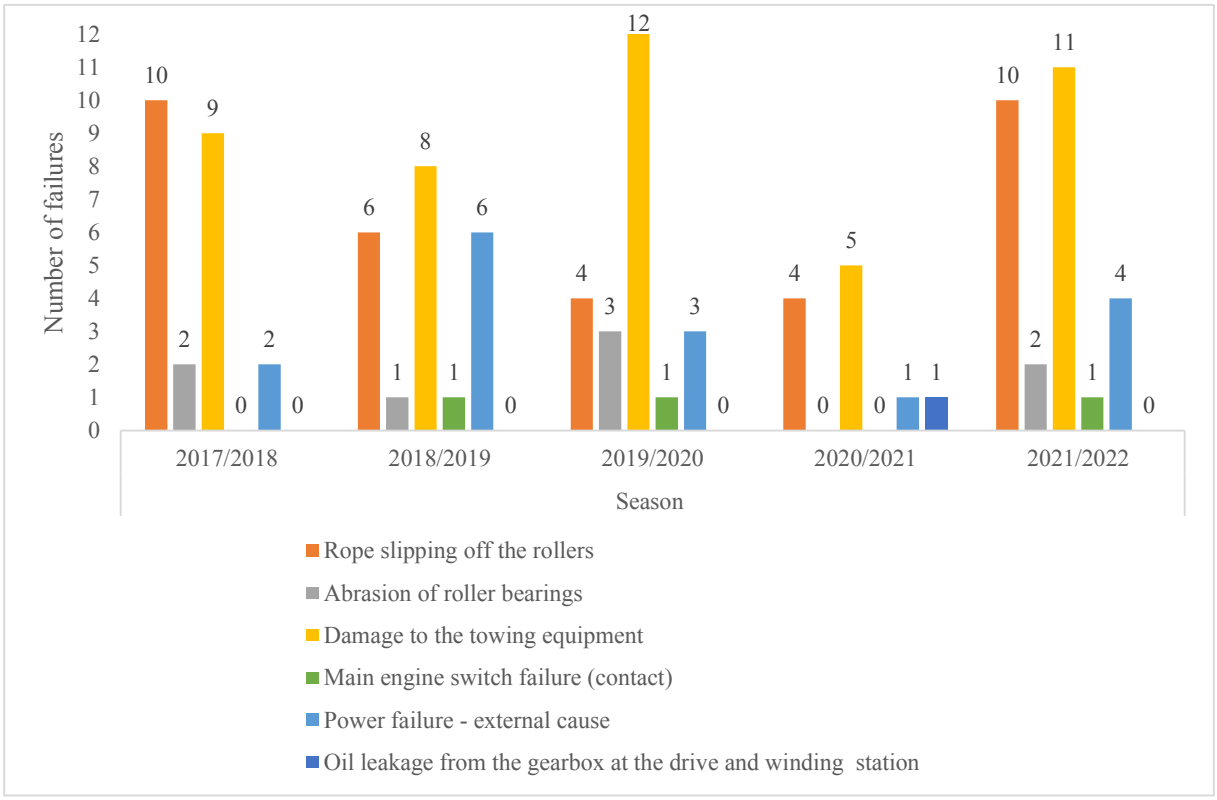


Figure 3. The most important failures that occur at the ski station and their frequency. Own study based on (Cieniawa-Ski ski station, 2022).

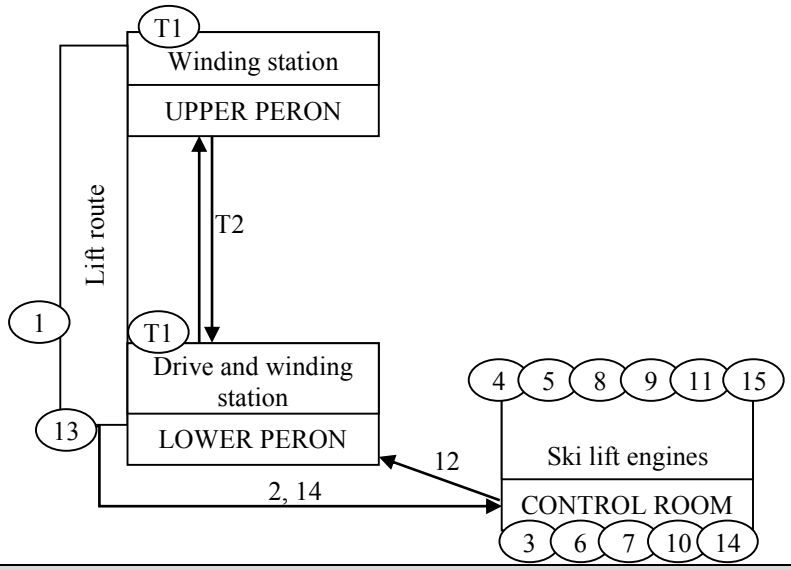
In case of slipping of the rope from the rollers and wearing out of their bearings, damage to the towing devices (orbs) and a problem with the main motor switch - the failure can be quickly repaired. Most of these problems are caused by weather conditions, since inaccurate checking of the ski lift route for accumulated snow leads to failures of the rope or the cable winch. Power cuts, however, are out of the company's control, but they occur occasionally and are acceptable. The most serious malfunction was, coinciding with the exceptionally short 2020/21 season, an oil leak from a box at the drive-winding station (lower platform), which had the potential to disrupt the operation of the machinery; the fault was rectified during a ski station shutdown caused by restrictions related to the SARS-CoV-2 pandemic.

In the case of the lift inspection according to the official instruction, no standardised procedure was developed – the activities performed were recorded, but not adequately. A work sheet template was developed for this purpose, which could serve to minimise potential errors occurring during inspection and also prevent potential failures.

Prior to the analysis, the time of each operation was measured. Research was carried out in a monthly cycle, averaging the results obtained. During the observations, no malfunctions that would prevent the lift from operating or other impediments to the control process were found. Using the previously identified activities, they were then divided into primary and secondary activities. The second category includes activities that preventively reduce the risk of failure.

Finally, the control components were detailed and additional elements were distinguished, resulting in 15 basic activities and 2 weekly activities, which were completed on the work sheet in Table 2.

Table 2.
Developed standard operation card for the ski lift

WORK STANDARDISATION CARD			
Lift	W-1	Employee	XYZ
Workplace description [graphic]		Auxiliary equipment	
		- protective clothing, - gloves, - operating manual - sets of spanners (flat and socket spanners), - set of screwdrivers, - bearing grease	

Basic operations

No.	Description of activities	Operation time [min.]			VA/NVA
		Man	Machine	Transition	
1	Inspection of the lift route and condition of the route supports	15	-	10	VA
2	Moving to the lift control room	1	-	1	NVA
3	Checking the condition of the lift control room	5	-	-	VA
4	Connecting the engines	2	-	-	VA
5	Switching of engines from idle to ready for operation	-	2	-	VA
6	Control voltage in control room and pump to actuators	5	-	1	VA
7	Pressure equalization to the correct level	-	5	-	VA
8	Manual execution of the engine sequence: - status check, - fault clearing, - readiness setting, - start-up - "test run".	5	-	-	VA
9	Change to "inspection run" mode	-	5	-	VA
10	Checking the correct behaviour of the machine	3	-	1	VA
11	in the control room	-	10	-	VA
12	Change to "slow running" mode	-	-	2	NVA
13	Moving an employee to the lower platform	10	-	-	VA
14	Checking the towing devices on the lift route	-	-	2	NVA
15	Activation of "normal driving" mode	-	1	-	VA
TOTAL		**46**	**23**	**15**	

Cont. table 2

Preventive actions [weekly]					
T1	Lubrication of bearings in the drive-winding station and winding station	30			VA
T2	Moving from the station			10	NVA
TOTAL		**30**	**-**	**10**	

Own study based on (Cieniawa-Ski ski station, 2022).

By analysing the results obtained, most of the inspection time is devoted to checking the condition of the lift, including the route supports (activity 1) as well as the towing devices (activity 13). Any failure affecting this part will result in an automatic stop of the mechanism and risks posing a danger to the participants.

The activities that take place in the ski lift control room, located next to the lower platform, at the drive-winding station, are extremely important. All the activities related to the ski lift engines, marked 3-11 and 14-15, i.e. checking the condition, correct execution of the engine sequence or consideration of the driving mode order, affect the correct operation of the station during the working day. Breakdowns that would have caused an interruption in service did not occur during the period in question; the documentation shows that they are extremely rare. The preventive measures taken by the employees really support the smooth and smooth operation of the ski lift.

The card also notes the weekly activities that are part of the necessary maintenance. Ensuring that lubrication is carried out on the bearings located at the drive-winding station and winding station (lower and upper platforms, one after the other), significantly extends the life of the parts. Consequently, the mechanism operates for a greater number of man-hours, resulting in reduced expenditure.

By introducing standardisation in the form of a charter, it is possible to systematise activities and, consequently, to improve the process. The information provided makes it possible to implement preventive and corrective actions, which will contribute to reducing the occurrence of failures, minimising machine operating costs and increasing customer satisfaction.

4. Conclusions

Through standardisation, it is possible to provide a clear, visualised and safe working environment. The feedback from its execution makes it possible to determine schemes that include the most efficient working methods. With these, it is possible to achieve a stable process that guarantees the desired product, which meets the defined standards.

The article analyses the course of cyclic control of a ski lift. Due to the care of the ski station employees, the number of failures that occur during the season is small, but it is possible to achieve a lower number. The problem is the lack of a standardized document according to which

the inspection was to be carried out - the current procedure and its record is not efficient because it is not performed according to the agreed standard. The actions to date allow for a lack of information flow between staff and those responsible for removing failures.

The aim of the study was to develop a work standardisation card to standardise the activities during the inspection of the machine operation and the condition of the ski lift. The created document was based on the results of tests of activities carried out by workers in a certain period of time. The card obtained allowed to standardize the activities of the staff during the inspection, and the results allowed determining the average time of realization of the activities. The result is a standardised procedure, thanks to which it is possible to minimise the occurrence of failures resulting from human error.

The effect of the presented actions is the possibility to reduce the risk of failure, which contributes to the improvement of machine operation and provision of services of a high level of quality, compliant with customer requirements, translating into an increase in process efficiency and reduction of expenses on its implementation.

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