

IMPLEMENTATION OF KIRKPATRICK EVALUATION METHOD TO REDUCE THE RISK OF TECHNICAL TRAINING FAILURE AIMING AT IMPROVING ITS EFFECTIVENESS AND CONSEQUENTLY THE QUALITY OF OPERATIONAL PROCESSES - A CASE STUDY

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ABSTRACT

A brief analysis of the aviation sector publications shows the importance of aeronautical maintenance for reducing air accident rates and, consequently, the need for investments that guarantee the quality of services delivered by the workshops in this field, focusing on the element that constitutes its main component: people. In this way, developing human potential through technical training, setting, creating skills in employees, and adopting tools that ensure these training's effectiveness becomes crucial to avoid the risk of training failure and provide quality services and meet customer expectations. Kirkpatrick's model, known for involving simple questions, can be applied in different contexts as a tool for continuous improvement in training management. Some companies cannot verify the effectiveness of the training they carry out. This fact was observed in a multinational aircraft engine maintenance company, showing the need for improvement. In this sense, this study aims to demonstrate how Kirkpatrick's four levels of assessment (Reaction, Learning, Behavior, and Results) can be instituted in the technical training area of this company, showing its applicability as a tool for quality continuous improvement and training failure risk reduction. As a methodological approach, a case study was carried out through training control data, questionnaires to employees and their respective leaders, and requesting operational and quality data to obtain the necessary information. The results confirm the hypothesis that it is possible to guarantee the effectiveness of the technical training applied through the method used, demonstrating that it is effective for each of the assessment levels. The new process will improve the effectiveness of the training program and reduce the risk of training failure and, consequently, operational failure due to inadequate training. The contribution is relevant for the company studied. For the academic field, as in addition to ensuring continuous improvement for the training program, its results can serve as a basis for future studies, given the subject's importance for the quality management of organizations and the aviation sector.

Key words: Kirkpatrick Model, Technical Training, Aeronautical Maintenance

1. INTRODUCTION

In recent years, the aeronautical industry has shown exponential growth and development: currently, the airplane is the safest and fastest means of transport for long distances. Considering that aircraft maintenance is an essential component of this growing industry, it is possible to prove that this increase in demand generates more significant financial gains for the technical aspect and tremendous pressure, as the activities involve a complex organization in a limited time. Aircraft accidents occur due to a chain of events, each of which is associated with one or more causes. According to IATA [1], it is estimated that 1,795 billion passengers flew safely on about 22 million flights, with 38 aircraft accidents and 132 deaths in 2020. The safety of operations aeronautics depends heavily on maintenance processes since, according to Hobbs [2], it is estimated that twelve hours of maintenance are performed for each hour of the flight. The IATA Annual Report [3] describes that during 2008, around 15% of air accidents were caused by maintenance failures. More than half (57%) of these accidents had maintenance deficiencies as a contributing factor. Among these deficiencies are a misinterpretation of technical documentation, use of fake parts, unapproved modifications, and insufficient

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training for employees. It is essential to focus on the item that constitutes its main component (people) To decrease these numbers. The constant search for excellence makes companies in aeronautical maintenance need to invest more and more in tools to ensure the quality of their products and services, increase productivity and reduce rework. Since the beginning of humanity, the practice of passing on acquired knowledge to others to ensure survival has been seen as essential. With the passage of time and the advancement of technologies, training became necessary for the development of organizations; as Brum [4] reports, every company depends on people, and to be successful in its activities, it depends on how the organization manages to attract human potential. According to NBR ISO 10015:2001, it is recommended that employees at all levels of the company be trained to meet the organization's commitment to providing quality products, as required by the constantly changing market, whose requirements and expectations of customers increase continuously. Therefore, it is essential to invest in training and development, work to change habits and adapt to modernization, and create and improve the individuals' skills in the process. In addition, it is essential to train the workforce involved and measure the effectiveness of this training program, ensuring that it is being delivered by people who have complete mastery of the topics covered. It is equally essential to keep the program content up to date and the motivation and engagement of the trainees so that the investment and time used in these activities reflect positively on the quality of delivery of products and services.

The aircraft engine overhaul company covered by this study has a well-implemented technical training program, but it needs to improve the effectiveness evaluation process of training. A robust process for evaluating training effectiveness is necessary for an excellent technical training program to fulfill its role. A method called Kirkpatrick's Evaluation Model needs to be implemented as a continuous improvement tool in the Technical Training Area of the company being studied. The problem to be solved would be how to implement it since one of the customer's requirements is to measure the effectiveness of the training program. This company currently uses tools that allow the simple application of assessment levels (reaction). However, the lack of an effective training assessment process can result in unnecessary expenses for the company, risk of accidents, and dissatisfaction of customers regarding the non-quality of products and services. Given this context and the difficulty of guaranteeing and verifying the effectiveness of technical training, this research aims to understand and report, through a review of the scientific literature and exploratory research, the application of Kirkpatrick's four levels of assessment in the control of the effectiveness of technical training of the company, with the advantage of obtaining a criterion for continuous improvement in the process based on the results obtained. In this sense, this study will contribute to aeronautical maintenance, whose operation without adequately trained employees can result in aircraft crashes and, consequently, many deaths.

The inexistence of tools to guarantee that the training applied to the organization's employees generated positive results made it possible to prepare a project that would help the area's management. Thus, this research is justified by applying Kirkpatrick's four evaluation levels with the advantage of obtaining a continuous improvement tool in the company's Technical Training Area.

A good training program must always follow the company's strategic direction. As a result, evaluating and ensuring the effectiveness of planned training enables organizations to verify the alignment of content with organizational objectives, ensuring their qualifications before regulatory bodies and delivering a quality product or service to the end customer. It is expected that this work will contribute to the academic field. In addition to increasing the textual production related to the theme, its results can serve as a basis for future studies, given the subject's importance for the management of current organizations and the aviation sector. None of the researched previous studies presented information for technical training effectiveness evaluation optimization. Some of these researched papers are listed herein in section 2. The study responds to the following important research questions::

Research Question 1: What are the difficulties in showing that the training applied to a company's employees is, in fact, effective?

Research Question 2: How can Kirkpatrick's four assessment levels be used as a continuous improvement tool?

Research Question 3: What benefits and results can be obtained from using Kirkpatrick's four assessment levels?

The study aims to evaluate how Kirkpatrick's four evaluation levels (Reaction, Learning, Behavior, and Results) can be instituted and demonstrate their applicability as a continuous improvement tool in a Technical Training Area, considering the motivations and difficulties for their implementation. Focus on attaining this aim; the authors first conducted an exploratory case study verifying the company's training management process. Secondly, they presented a methodology to be developed and used to demonstrate each level of assessment according to the training process already existing in the organization. Finally, they identified and assessed the motivations, benefits, and results from the company studied to implement assessment levels as a tool for continuous improvement. The paper is structured as follows: Section 2 describes the methodology and previous Technical training effectiveness evaluation in Aeronautical Maintenance Organizations. Section 3 presents the discussion, and section 4 the conclusion. In the end, the list of references used in this paper is provided.

2. DESCRIPTION

This section presents the methodology used in conducting the study and current research about Technical Training in Aeronautical Maintenance Organizations.

2.1 Methodology

A case study was carried out in the Technical Training Area of an aeronautical engine company. This chapter presents the methodological structure used to prepare the study. The steps used in the research to implement the four Kirkpatrick assessment levels in the Technical Training Area of an aircraft engine maintenance company are shown in Fig. 1. In the first step, the authors analyzed the theoretical framework and scientific literature in order to obtain publications on the subject under study using the keywords: Kirkpatrick Model, Technical Training and Aeronautical Maintenance; In the second step, they verified the applicability of Kirkpatrick's four levels of assessment in the company's training area and the methodology used for each one, based on the tools provided by the organization. In the third step, they prepared a questionnaire to be answered by employees immediately after the training. In the fourth step, they used the Training Management System (LMS) database containing the final grade of the employees who completed each training and calculated the average. This process is performed every three months: March, June, September, and December. Aime at conducting the Behavior Assessment, they prepared two questionnaires. The first for the trainee and the second for the employee leader. It should be answered between 3 to 12 months after the training. In the fifth step, the company's quality management area provides data related to the satisfaction of some customers. This will be obtained every three months: March, June, September, and December. In the sixth step, the authors used the 5W2H tool and prepared a simple process flowchart for each of the assessment levels, defining improvement actions for technical training, if applicable. The last step was the analysis of the results obtained to verify if they are following the method proposed in this study, being used as a continuous improvement tool for the company's Technical Training Area.

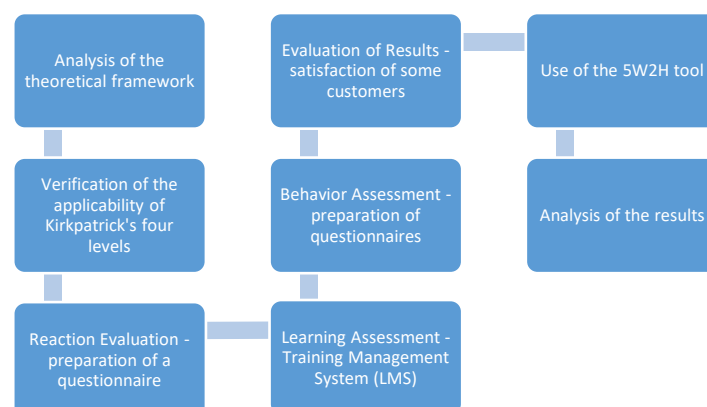


Fig. 1 – Methodology flowchart

2.2 Donald Kirkpatrick's four levels of assessment

The existing literature proposes different training evaluation models. Among them, the one that Donald L. Kirkpatrick developed in the late 1950s, called the 'Four Levels Model' or 'Kirkpatrick's Model,' stands out the most. This model lists the application of four different methods to assess aspects of training. In addition to being the best known [5] [6], it is also the most referenced in studies on training evaluation methods and the most used currently by organizations due to its low complexity and objective ideas. It gained popularity because it involved simple questions, could be applied in many contexts, and resulted in easily measurable data, aiming to assess the effectiveness of the training program [7] [8]. By analyzing the collected data, professionals working in this area can credibly show the value that training has brought to the organization. There are three main reasons for evaluating the training program: improving the program, maximizing the transfer of learning to subsequent organizational behavior and outcomes, and demonstrating the value of training to the organization [9]. Following this thought, the Four Levels Model assumes that an employee satisfied (reaction) with the training better absorbs the content taught (learning), applies this knowledge in the routine of their work area (behavior), and, consequently, improves the quality of the final product of the organization (results). The existing literature proposes different training evaluation models. Among them, the one that Donald L. Kirkpatrick developed in the late 1950s, called the 'Four Levels Model' or 'Kirkpatrick's Model' stands out the most. This model lists the application of four different methods to assess aspects of training. In addition to being the best known [5] [6], it is also the most referenced in studies on training evaluation methods and the most used currently by organizations due to its low complexity and objective ideas. It gained popularity because it involved simple questions, could be applied in many contexts, and resulted in easily measurable data, aiming to assess the effectiveness of the training program [9]. By analyzing the collected data, professionals working in this area can credibly show the value that training has brought to the organization. There are three main reasons for evaluating the training program: improving the program, maximizing the transfer of learning to subsequent organizational behavior and outcomes, and demonstrating the value of training to the organization [8]. Following this thought, the Four Levels Model assumes that an employee satisfied (reaction) with the training better absorbs the content taught (learning), applies this knowledge in the routine of their work area (behavior), and, consequently, improves the quality of the final product of the organization (results).

The Kirkpatrick Model is divided into four levels, as illustrated in Fig.2.

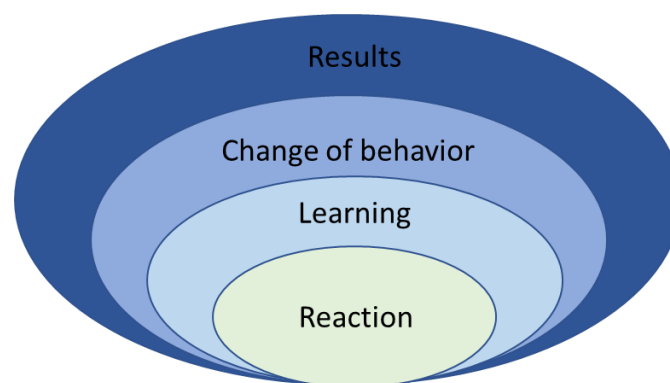


Fig. 2 – Kirkpatrick training effectiveness evaluation model

Detailed explanations on each one of the four different levels are given in this section:

2.2.1. Level 1 - Reaction

Kirkpatrick [10] states that the first level measures the workers' opinion and satisfaction with the training activity. This is the most used type of assessment due to the ease of performance and lack of experience in assessing other levels. At this level, trainees are asked if they liked the training performed. [11]. This assessment can be done using a questionnaire to measure the participants' impressions of the training, covering the content, the instructor, resources, environments, and facilities in which the training took place. The results of this evaluation can serve as a basis for decisions regarding the program, such as maintaining strengths, incorporating items suggested for improvement, extinction, or creating more types of training, among others. Reaction forms can also provide quantitative information that aids in setting performance standards for continuing training. [9] [12] [13]. Another reason to implement this level of assessment would be to certify the interest and motivation of employees who performed the training. If the reaction is adverse, they are likely not to be motivated to learn. "The positive result of a reaction evaluation is not synonymous with learning, but it can be said that a negative result reduces the possibility of it occurring." [9]. According to the author, it would be ideal for every training program to be evaluated at least at this first level since simple tools can be implemented. It is possible to improve critical items for training effectiveness. Considering the measurement of participant satisfaction.,

2.2.2. Level 2 - Learning

Since the goal of a training program is to increase knowledge, an appropriate assessment should be used to determine whether trainees have learned. Therefore, the second level corresponds to the assessment of learning, to what extent workers advanced in skills, knowledge, or attitudes after the training activity [9]. The process of acquiring knowledge can be described as the extent to which participants' attitudes change after learning, or their skills are enhanced as a result of training. At level 2, the assessment is done by verifying the participant's attitude, knowledge, or skill as a result of the training. According to Kirkpatrick [9], only by identifying one of these results is it defined that the learning occurred, and this measurement can be carried out through individual or team tests. Borghi [14], on the other hand, emphasizes that learning is, however, more challenging and consumes more time and resources than reaction assessment. An assessment of knowledge improvement and attitude changes is then suggested. In this case, the evaluator applies a test that scores knowledge, skills, and attitudes. Questions can reflect the content participants should have absorbed during the program, as is practiced in traditional school evaluations. Kirkpatrick [9] also emphasizes that when evaluating student learning, the methodology used by instructors is also evaluated. So, the result of this assessment can generate solutions to obtain improvements such as changing the approach, using new resources such as dynamics, or even replacing the instructor. Borghi [14] also emphasizes that it is essential that the training program previously determines the objectives of the covered content, the skills, and attitudes that trainees must present after the training is completed so that this level of assessment is carried out effectively.

2.2.3. Level 3 - Behavior

The Behavior Assessment indicates the extent to which training has transferred learning to the employee's workplace, promoting changes in behavior or performance. According to Truelove [15] and [7], this level determines whether changes in behavior have occurred, as expected by the training program.

Kirkpatrick [10] states that it is necessary to wait some time to apply the behavior change assessment. Thus, the participant must have had time and opportunities to practice what was learned in training and demonstrate the behavior change. As Kirkpatrick [7] highlighted, it is of utmost importance to have information about levels 1 and 2 to interpret the level 3 assessment results. Specifically, suppose a change in behavior does not occur. In that case, it is helpful to determine whether this is due to participant dissatisfaction with the program (level 1), a failure to meet the learning objectives (level 2). It can also be due to lack of behavior change due to factors beyond the program's scope, e.g., lack of desire, opportunity, support, or rewards for changing behavior. For the behavior change to occur, four conditions are necessary for the trainee: wanting to change, knowing what to do and how to do it, working in the right environment, and being rewarded for the change. The first two

requirements can be met by participating in the training program. In the third condition, the environment can be restraint, discouragement, neutrality, support, and demand. The type of environment is related to the participant's immediate superior [9]. An environment of restraint is when the boss does not encourage the participant to practice what was taught. This can be caused by an organizational culture implemented by the board. For the author, behavior change by itself does not correspond to a conclusion but to a predictive factor for organizational results improvements if found. It is then due to the learning evaluation that occurred due to the training being a determining factor for achieving the results.

2.2.4. Level 4 - Results

This level verifies how the training positively affected the business results. According to Kirkpatrick [7], it is the most important, significant, and challenging to carry out since it verifies whether the training met its objectives and organizational needs. Buriak & Ayars [6] state the same when they point out that this assessment represents the highest level of complexity in the model. It assesses the measurement of organizational effectiveness, and its implementation is generally beyond the scope of most assessors due to the lack of data available. Despite highlighting this complexity, Kirkpatrick [7] does not provide many techniques for its performance. It suggests going down one or two levels to assess changes in behavior, learning, or both, even proposing to use as a basis a positive result of satisfaction questionnaires. Other models for this assessment are also proposed in the literature, although most are based on Kirkpatrick. The high costs of collecting and interpreting data at this level, the lack of clear and direct methods for measuring results and comparing them with the formative action mean that few companies use this method of evaluation [11]. A long-term perspective is also needed, making it challenging to establish unambiguous cause-and-effect relationships. Outcome measures generally refer to the entire organization or a department; therefore, it is not easy to identify the effects in just one individual or a specific group. Kirkpatrick [9] discusses that there are results that cannot be measured in a monetary way, such as leadership, motivation, time management, decision making, or change management, which is one of the criticisms of this model. Furthermore, it is difficult to state that only training was responsible for increasing a result in the organization since this statement could only be made if the environment or market conditions were maintained, which does not happen. According to Aragón [15], evaluating the results means finding out what changes have taken place in organizations due to employee participation in training programs. Evaluators can then consider the effects of the training results by issues such as increasing productivity, reducing costs, improving quality, increasing sales, or gaining new customers. Notably, the link between training and these outcomes is often unclear, and training may be just one of many possible causes. According to Borghi [14], the answers found by evaluating the training results must be consistent with the expectations of the training program developers. In the case of quality-related training, information on the number of units of a product was not rejected in the months following the completion of training with this objective, for example should be expected by the company's senior management.

2.3 Application of training in aeronautical maintenance

Zamprognio [16] emphasizes that aeronautical maintenance means conserving and preserving the aircraft in airworthy conditions. Thus, aircraft maintenance and inspection work is a complex process that requires several tasks, specific knowledge, and procedures to ensure that the delivery is made with quality. It becomes essential to invest in training programs to qualify and develop employees who perform essential functions. According to the FAA [17], the purpose of a repair station's initial and recurring training program is to ensure that employees perform maintenance, inspection, preventive maintenance, and assigned tasks. Each repair station's training program should be based on its operation, and consideration should be given to its size, ratings, maintenance tasks associated with positions, and its employees' experience and skill levels. In addition, the training requirements for each employee are based on the tasks associated with their position. Therefore, each repair station must develop procedures to determine the training that each function requires. In Brazil, among the responsibilities related to the training of aviation professionals, according to Art. 8 of Law 11.182, of September 27, 2005 (Law for the Creation of ANAC), the agency is responsible for adopting the necessary measures to serve the public interest and develop and promote civil aviation. The agency also regulates and supervises air services, aeronautical products and processes, the formation, and the training of specialized personnel. In the specific case of aviation, problems related to the training of specialized personnel can expose

society as a whole to unsafe conditions. For example, a flight mechanic who performs maintenance on an aircraft having forged his training for the employer or the aviation authority will be acting without the proper training. In this way, the relationship of trust in the state's performance, thus, is based on the ability of regulators to promote a coherent performance given the values and norms expected by society [18]. Training indicators are measures that reflect an operational and less strategic reality. These measures were highly valued and used in the Training and Development Centers, and for Corporate Universities can also be helpful, but they are not essential for their functioning. Indicators that reflect the company's financial reality, such as the ratio of costs to operating profit and total employees, are required to justify training courses. Index of employees in training programs: This indicator shows the proportion of employees who participated in the training compared to the total number of employees in the organization. Thus, as Palmeira [13] discussed above, such an index may show a situation where access to training is restricted to a few employees [19].

2.4 Quality and Sustainability

Rickard, G., & Johansson, P. [20] presented a conceptual model that considers stakeholder-oriented management's practical and theoretical implications in pursuit of organizational sustainability. The model explains the actual behavior of organizations and the distinction between organizational and global sustainability. Pereira et al. [21] stated that sustainability is related to the needs of stakeholders and the degree to which the hidden needs are met and that the different stakeholders can change as well as the needs of the stakeholders. It implies that the meaning of sustainability also has become dynamic. Lagrosen, Y. and Lagrosen, S. [22] conducted a case study in an innovative manufacturing company based on interviews with employees focusing on their perception regarding quality and sustainability and document studies and observation. The analysis revealed identified dimensions, and the framework that integrates is suggested to be useful for companies. Fundin et al. [23] gathered extensive data during a workshop process by a collaborative brainstorming workshop and an appreciative inquiry with researchers and practitioners about the theme of sustainable development. The process identified aspects in the field and practice that need to be preserved. Deleryd, M. and Fundin, A. [24] stated that additional quality management models that complement current approaches are needed to manage current, fast-changing environments successfully. The authors propose a generic model for sustainable development based on sequential Delphi studies that support all organizations on their pathway towards sustainable organizational success. Martin et al. [25] proposed a framework centered around the notion of quality-in-use that incorporates two dimensions for understanding quality; form, which covers the constructive or predefined dimension, and scope, which covers the single actor or multi-interested parties' dimension. Carnerud et al. [26] conducted a study that applied data mining and content analysis to the digital archives of eight scientific journals, covering 12,000 research paper abstracts in almost 40 years. The findings show that sustainability came onto the literary scene in 1996 and has become an increasingly popular research area. Vandenbrande, W., W. [27] presented a framework that allows companies to advance sustainability using quality management. The author considered the company's maturity level, which allowed the sustainability movement to spread out widely and fast. The author presented a new definition of sustainability that can be used as a starting point for developing quality.

3. DISCUSSION

During the case study conducted in the company's facilities, after defining the research questions, based on the literature review, the tools available in the organization for the applicability of each of the Kirkpatrick assessment levels were verified. Different application methods were devised for each level of assessment and the individual actions to be taken based on the results obtained. Subsequently, the authors verified the context of the place where the study was carried out before and after the application of these assessments as a tool for continuous improvement. This study was carried out in an aircraft engine maintenance company with approximately 2,000 employees. Maintenance is performed on about 500 engines per year, having customers worldwide and being considered a reference in its segment. The application of Kirkpatrick's four levels of assessment was carried out in the area that controls the technical training of employees. The area is responsible for administering more than 50 different training courses to improve employees' technical knowledge and performance in their activities, applying an average of 30,000 hours of training per year. As it is a Technical

Training Area, which directly impacts the quality of the products and services delivered, this area belongs to quality management. Regarding the reaction evaluation, a questionnaire was applied to the trainees. The final grades of employees for each training were evaluated for the learning assessment. Two types of questionnaires were applied for the evaluation of behavior. The first was for the trainee, and the other was directed to his leadership. Finally, for the evaluation of results, data related to customer satisfaction were requested for quality management. In all the questionnaires applied, we used a semi-structured script formulated from the literature review. Such applications result in graphics containing information relevant to the theme proposed in this work. It aimed to highlight the possibility of applying the four assessment levels as a tool for continuous improvement and the main motivations, benefits, and results obtained by the Training Area. The training management processes consist of planning, making available, implementing, demonstrating, and measuring the effectiveness of technical training and its respective program content, ensuring that trained people, called training instructors, deliver them. The order of activities can be seen in Fig.3.

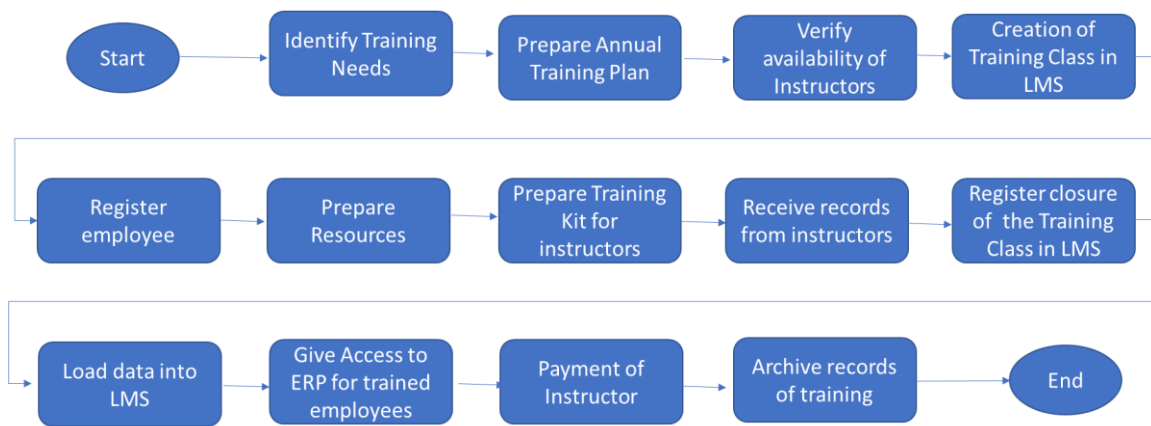


Fig. 3 – Order of Activities in the Training Process

In the flowchart, the first activity performed by the training area is named "*Identify Training Needs*". It is crucial since assessing training needs and the resources available to meet those needs forms the first step in developing and delivering effective training in the company. Defining the company's needs and what employees need is a crucial step to get employees engaged. In the second activity, named "*Prepare Annual Training Plan*" the training area defines meeting training needs. A training plan is prepared and revised at regular intervals to ensure that it is functioning correctly, the training is being completed, and that it is effective. At this point, strategies and methods are discussed to address factors related to learners and organizations, trainers and facilitators, and the environment that may impact training efforts. The training plan will cover the appropriate training that the employees need to have and schedule for each one. An LMS is used to track who has completed what training and when. In the third activity, named "*Verify availability of Instructors*," the training area identifies capable and qualified instructors to deliver the required training. In the fourth activity, named "*Creation of Training Class in LMS*," the training area uses a learning management system (LMS). It is a software application used to assign, deliver, track, and report on training. In the fifth activity, named "*Register employee*," the training area assigns the training to employees, and once it is completed, the employees can log in and see the list of training they have been assigned. The learning management systems include notification systems that send emails to the workers when new assignments are made, or due dates are approaching. In the sixth and seventh activities, named "*Prepare Resources*" and "*Prepare Training Kit for instructors*," the training area defines the form in which the training will be delivered. It may be classroom instruction; practice opportunities such as role-playing exercises, focus groups, case studies, or small group assignments; on-the-job skills-based training; the delivery of paper-based hand-outs for individual reading and study; the completion of e-learning modules on a computer; a combination of some or all of these; or more. If the training includes an on-the-job skills-based component, the employees are informed on how to demonstrate competence. In this step, the employee is informed in advance that he will attend the training to work it into their schedules and complete any necessary pre-training preparation. In this step, the workers' supervisor is

informed, rooms for training are reserved, necessary supplies and logistics. In the eighth activity, the training area receives training records from instructors. In the ninth activity, the register closure of the Training Class in LMS and then load data into LMS. In the tenth activity, the training area gives access to ERP for trained employees, and finally, the last step archives training records. At this point, the training area tracks the training plan and ensures all employees complete the appropriate modules. Considering that the reaction evaluation has been applied in the company but manually, the need to optimize the process was initially identified. A functional flowchart was developed to identify bottlenecks and waste, as illustrated in Fig 3. Waste such as excessive processing, long waiting times between operations, and many documents to be completed was identified. An online questionnaire was designed to carry out the effectiveness assessments to facilitate its application. The 5W2H tool was initially prepared to map each activity. The new online questionnaire was organized according to data obtained in the current literature to measure the opinion and degree of satisfaction of employees who carried out the training. This questionnaire aims to analyze the trainee's perception of the knowledge acquired, available material, room infrastructure, content, instructor methodology, etc. In order to reduce the waste identified in the previous process and speed up the assessment, all instructors were instructed to provide to the students the link to the questionnaire at the end of the training. This questionnaire was developed using software used by the company, which generates automated metrics and has a database for collecting the responses sent. It needs to be filled out online by the trainees. Therefore, the new and changed process is shown in Fig. 4. The new process will improve the effectiveness of the training program and reduce the risk of training failure and, consequently, operational failure due to inadequate training.



Fig. 4 – Order of Activities in the Training Process – Changed process

The new steps in the process were added to the flowchart, as shown in Fig 4. Reaction, learning, behavior, and results evaluations were added to the initial flowchart. Receiving regular employee feedback gives a good idea if it is working as it should and how it is being received. For job-specific training, monitoring productivity before and after training through improved sales targets or increased production and improvement of quality is the way of measuring efficacy. As the company grows and based on the feedback received, the training plan is modified and expanded and training optimized. Items 3.1 to 3.4 show the application of Kirkpatrick's four levels of assessment in the studied company.

3.1 - Application of Level 1 - Reaction

The authors initially identified the need to optimize the process in the company. The reaction evaluation had already been applied in the company but manually. For this, a functional flowchart was developed in order to identify bottlenecks and waste. After finding the need for automation and identifying waste such as excessive processing, long waiting times between operations, and a large number of documents to be archived, an online questionnaire was designed to carry out the effectiveness assessments to facilitate its application. The new

questionnaire was organized according to data obtained in the current literature to measure the opinion and degree of satisfaction of employees who attended the training. This questionnaire analyzes the trainee's perception of the knowledge acquired, available material, room infrastructure, content, instructor methodology, etc. With the results generated by the software, it was possible to analyze the average grades in each question for all training offered, and metrics were generated for each of the relevant items in a reaction evaluation: learning, satisfaction, content, punctuality, communication, mastery and infrastructure. Fig 5 shows an example of the grades of some training applied in the company.

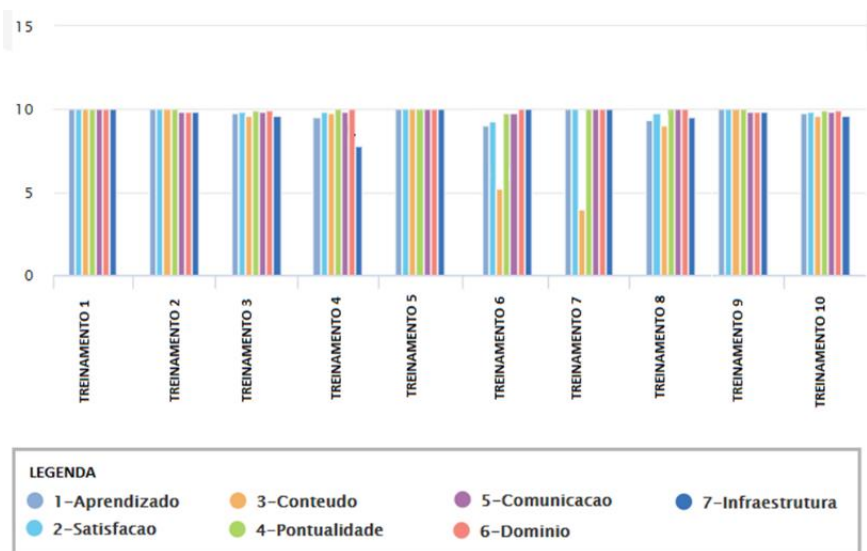


Fig. 5 – Example of the grades

3.2 - Application of Level 2 - Learning

The authors decided to perform the learning evaluation using tools already being used in the Training Area. In this sense, the method used to measure the effectiveness of training in this level of the evaluation was the application of tests at the end of each training, whose objective would be to verify whether the training program is effective by evaluating the level of learning employees.



Fig. 5 – Example of evaluation

Fig. 5 shows the average score of the 21 employees was 66.90, so after data analysis, the representative of the training area needed to investigate opportunities for improvement in the learning assessment. After investigations, a meeting was held with the instructors responsible for reviewing the content of the training and identifying possibilities to make it more understandable for employees.

3.3 - Application of Level 3 - Behavior Assessment

The items established to help verify this level of assessment were questionnaires answered by the trainees and their respective leaders. In these questionnaires, the authors sought to identify whether there were behavioral changes months after the training was conducted and whether the knowledge acquired (learning assessment) was resistant to time. For the execution of the idea and other levels, the 5W2H of this operation was carried out, defining objectives and the people responsible for carrying out each step. For employees, the questions are equivalent to a self-assessment, containing items related to the contribution of training to their workplace, if any mistakes were made after the training, if behavioral changes were noticed and if the employee feels encouraged after completing the training. The same questions were prepared for the leadership but aimed at the leader's perception of the trained employee. The questionnaires were prepared in the same software used for the reaction evaluation; for this reason, data and graphs related to each item could also be generated. The criterion chosen to verify whether the evaluation results show that the training was effective was an average score of 70, on a scale between 0 and 100. Suppose the scores for one or more items related to Work Area, Acquired Knowledge, or Behavioral Changes are lower to 70. In that case, it is necessary to investigate whether the training is, in fact, applicable to the area of the evaluated employee or if a content update is necessary to comply with the requirements of the area.

3.4 - Application of Level 4 - Results

For the evaluation of results, it was considered that the company's results do not reflect the training effectiveness only. Information about external customers' satisfaction in the first months of 2021 was obtained. In this sense, the authors sought to observe customers' perceptions about items such as quality of delivery of products, quality of available technical documentation, TAT (turnaround time/ delivery time), customer support, and support of the engineering team. Customers could rate each item on a scale of 0 to 5, where one means "very dissatisfied," three means "neutral," and five means "very satisfied." The result can be seen in Fig. 5.

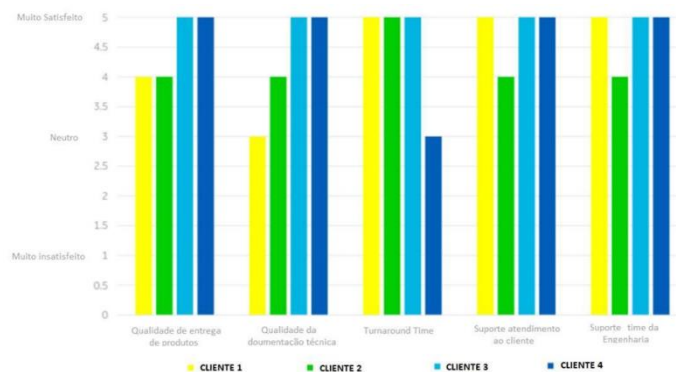


Fig. 5 – Example of satisfaction of external customers

Thus, after accessing and analyzing the data obtained every three months, the training area checked if it was necessary to take any action. If the score is below 3, it was investigated which item is critical in the eyes of the customers and the possibility of this being improved through technical training, either by reviewing the content of some existing training or developing new programmatic content. The objective is to ensure that in the coming months, this evaluation has better results.

4. CONCLUSION

The target of the study was to create a method to verify the effectiveness of technical training in the aircraft engine maintenance company through the inclusion and application of Kirkpatrick's four levels of assessment as part of the Technical Training Area process. The initial process map was revised to add Kirkpatrick's four levels of assessment. This contributes to the previous findings of other researchers presented in the section literature review since none of them presented a method to apply Kirkpatrick's four levels of assessment to an aircraft engine maintenance company. This paper aimed at completing this gap by proposing and describing a method to apply Kirkpatrick's four levels by proposing a changed process that could optimize quality, safety, and sustainability. The study was conducted within the facilities of a jet engine overhaul shop, and the result can be generalized to other aviation and non-aviation maintenance shops. The implications are relevant since the proposed changes in the training processes can avoid operational failures and catastrophic accidents caused by a lack of adequate training.

In response to the first question: *What are the difficulties in showing that the training applied to a company's employees is, in fact, effective?* It can be considered that the difficulty in showing the effectiveness of technical training is found in the numerous existing processes in the sector and the few resources available that could serve as an aid to verifying the effectiveness of the training. It is also worth noting that the performance of an organization takes into account many other factors in addition to training. It means that a positive result, such as gains from new customers or increased profits, is linked to the different segments of the company and not only to the realization of technical training. Therefore, showing the effectiveness of technical training becomes a complicating factor for many companies, and therefore, the use of the Kirkpatrick Model is suggested.

In response to the second question: *How can Kirkpatrick's four levels of assessment be used as a continuous improvement tool?* it can be observed that for the use of each assessment level as a continuous improvement tool, it is essential that the resources available in the organization are verified. In addition, the use of quality methodologies and tools such as 5W2H and flowcharts allow the process to be idealized. The data obtained to be analyzed thoroughly, ensuring that if the final result of each assessment level is below expectations, these reflect on actions by the Technical Training Area, thus promoting continuous improvement in this area.

In response to the third question: *What benefits and results can be obtained from using Kirkpatrick's four assessment levels?* After applying each level of assessment and obtaining the data, it is clear that each reflects different results. As this result is below the stipulated minimum score, it is possible to promote actions to improve the aspects identified as below average. Thus, with the application of each level, it is possible to verify possible weaknesses in items such as room infrastructure, quality of materials available, communication and methodologies used by instructors, trainees' satisfaction and learning with the participation in training, application of acquired technical knowledge on the desktop, among others.

In short, it can be stated based on this study that the benefits and results obtained with the use of Kirkpatrick's four levels of assessment are vital for the studied organization since it was focused on the weaknesses in critical points in the training program. During the case study, an opportunity was identified to improve level 3 of assessment (behavior) in a specific way for each type of training. As a suggestion for future studies, in addition to continuing the tools used to obtain the results of this level of assessment, it is also recommended to develop more specific questions for the questionnaires according to the syllabus of the technical training carried out. In the case of technical training with practical applications, it is suggested that the instructor conduct the behavior assessment in the employee's work area, before and after the training, where the degree of knowledge acquired after the training can be better evaluated.

1. REFERENCES:

- [1] IATA. International Air Transport Association. IATA releases 2020 safety report, details airline safety performance. Iata, 2021. Disponível em: <<https://www.iata.org/en/pressroom/pr/2021-03-25-01/>>. Acesso em: 10 de abr. de 2021.
- [2] HOBBS, Alan. An overview of human factor in aviation maintenance. Report no. AR-208-055. Australian Transport Safety Bureau. Australia, 2008.
- [3] IATA. International Air Transport Association. Annual Report, 2009. Disponível em: <<https://www.iata.org/contentassets/c81222d96c9a4e0bb4ff6ced0126f0bb/iataannualreport2009.pdf>>. Acesso em: 03 de mar. de 2021.
- [4] BRUM, Melissa. A influência do comportamento humano dentro das organizações. Revista Pós-graduação: Desafios Contemporâneos, cachoeirinhas, v.2, n. 3, 2015.
- [5] PHILLIPS, J. Handbook of training evaluation and measurement methods. 2 ed, Houston: Gulf Publishing Company, 1991.
- [6] BURIAM, Susan E. and AYARS, Candace L. Evaluation of a drug and alcohol safety education program in aviation using interrupted time series and the Kirkpatrick framework. Massachusetts, 2019.
- [7] KIRKPATRICK, Donald L. Evaluación de acciones formativas: Los cuatro niveles. Gestión 2000, 2007.
- [8] KIRKPATRICK, Jim & KIRKPATRICK, Wendy. An Introduction to the New World Kirkpatrick Model. Geórgia, 2019.
- [9] KIRKPATRICK, Donald L. & KIRKPATRICK, J. D. Como avaliar programas de treinamento de equipes: os quatro níveis. Tradução José Henrique Lamensdorf; revisão técnica Klalter Fontana. Rio de Janeiro: Senac Rio, 2010
- [10] KIRKPATRICK, Donald L. Evaluating Training Programs: The Four Levels, Berrett-Koehler, San Francisco, CA, 1994.
- [11] PLANT, R.A. and RYAN, R.J. Training Evaluation: A Procedure for Validating an Organizations Investment in Training, Journal of European Industrial Training, 1992.
- [12] MARINELLI, Marcos. Educação Corporativa: um estudo sobre modelos de avaliação de programas. Fortaleza: Editora UFC, 2007.
- [13] PALMEIRA, C. Avaliação de Resultados em Educação Corporativa. In: RAMAL, A. (Org.) Educação corporativa: como implementar projetos de aprendizagem nas organizações. Rio de Janeiro: LTC – Livros Técnicos e Científicos Editora Ltda., 2012
- [14] BORGHI, Layla. Avaliação de resultados do treinamento: uma análise das metodologias disponíveis e sua aplicação em empresas brasileiras. Rio de Janeiro, 2008.
- [15] ARAGÓN-Sánchez, A., Barba-Aragón, I., & Sanz-Valle, R. Effects of training on business results. The International Journal of Human Resource Management, 2003.

- [16] ZAMPROGNO, C. Gestão e desenvolvimento em fatores humanos na segurança de voo: estudo na manutenção aeronáutica. Dissertação (Pós-graduação em Ciência, Tecnologia e Sociedade) – Universidade Federal de São Carlos, 2011.
- [17] FAA (2005). Repair Station Training Program. Disponível em: <https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_145-10.pdf>. Acesso em: 02 de mar. de 2021.
- [18] MACEDO, Gabriel. A regulação sobre os treinamentos na aviação civil: assimetria de informação e o uso de blockchain como alternativa para os registros educacionais. Semantic Scholar, 2019.
- [19] ASSIS, Marcelo Tadeu. Indicadores de Gestão de Recursos Humanos: Usando indicadores demográficos, financeiros e de processos na gestão do Capital Humano. Rio de Janeiro, Qualitymark, 2009.
- .
- [20] RICKARD GARVARE & PETER JOHANSSON (2010). Management for sustainability – A stakeholder theory, Total Quality Management & Business Excellence, 21:7, 737-744, DOI: 10.1080/14783363.2010.483095
- [21] PEREIRA, J.C; LEITE, F.F., GARCIA, C.N. AND JESUS, G.M.O. (2017). Risk assessment of quality management system failure via analytic hierarchy process and the effects on organisational sustainability. Int. J. Quality and Innovation, Vol. 3, Nos. 2/3/4,
- [22] LAGROSEN, Y., LAGROSEN, S. (2019). Creating a culture for sustainability and quality – a lean-inspired way of working, Total Quality Management & Business Excellence, DOI: 10.1080/14783363.2019.1575199
- [23] FUNDIN, A., LILJA, J., LAGROSEN, Y, BERGQUIST B. (2020). QUALITY 2030: quality management for the future, Total Quality Management & Business Excellence, DOI: 10.1080/14783363.2020.1863778
- [24] DELERYD, M., FUNDIN, A. (2020). Towards societal satisfaction in the fifth generation of quality – the sustainability model, Total Quality Management & Business Excellence, DOI: 10.1080/14783363.2020.1864214.
- [25] MARTIN, J., ELG, M., GREMYR, I. (2020). The Many Meanings of Quality: Towards a Definition in Support of Sustainable Operations, Total Quality Management & Business Excellence, DOI: 10.1080/14783363.2020.1844564
- [26] CARNERUD, D., MÅRTENSSON, A., AHLIN, K., & SLUMPI, T. P. (2020). On the inclusion of sustainability and digitalization in quality management – an overview from past to present, Total Quality Management & Business Excellence, DOI: 10.1080/14783363.2020.1848422
- [27] VANDENBRANDE, W.W. (2021) Quality for a sustainable future, Total Quality Management & Business Excellence, 32:5-6, 467-475, DOI: 10.1080/14783363.2019.1588724