TRAINING AS A KEY FACTOR IN THE CONTINUED DEVELOPMENT OF AVALANCHE RISK MANAGEMENT FOR CRITICAL INFRASTRUCTURE – A CASE STUDY FROM AUSTRIA

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ABSTRACT: Within the Avalanche Warning Service team at Austrian Federal Railways (ÖBB), 12 avalanche commissions are responsible for protecting infrastructure from the risk of avalanches during the winter months by making daily assessments, detailed analyses, and key decisions. They often have digital tools to help them nowadays, amongst other things. A digital tool will be viable over the long term if it maps the relevant process (e.g., in avalanche risk management) as realistically as possible and performs all the key tasks in the background, such as logging and communication. This then leaves scope for the more intricate elements of the process such as analyses, assessments, and decision-making. It is these aspects that are becoming more transparent and are thus coming into the spotlight as core elements and providing training and continuing professional development (CPD) in these core elements helps to hone the overall process and make it coherent. Analyses run after the end of the season and corresponding feedback meetings serve to identify potential areas for training and CPD, and corresponding steps are taken in knowledge management on this basis. If the training and CPD then build on the experience thus gained, an improvement in how the core elements is deployed can be observed over time. Using the example of Austrian Federal Railways (ÖBB), a company that deals with critical infrastructure networks in Austria, the case study highlights how training and CPD work within the ÖBB Avalanche Warning Service team, what tools are used for this purpose (scenario-based simulations, theoretical and practical training courses, etc.) and how the various avalanche risk management processes are set up. A concept for scenario-based simulations that was integrated into the training curriculum during the 2023/24 winter season is used to demonstrate how applying knowledge management rigorously allows the members of the avalanche committees to make better and more efficient use of their expertise in the core processes and how the digital tools for avalanche risk management are being adapted as a result.

KEYWORDS: Safety Management Process, Training strategy, Continuous Improvement Process, Simulation Games

1. INTRODUCTION

Perceive, assess and act' are the essential To-Dos for every avalanche commission member, regardless of whether the avalanche commissioner works at a community avalanche commission, a ski resort or critical Alpine infrastructure (Sauermoser C., 2014). ÖBB 's avalanche safety management - consolidated in the only Austria-wide avalanche warning service - operates according to these three fundamental principles. This warning service is legally integrated into a set of rules of procedure and has been equipped with innovative digital tools that handle a great deal of information, documentation and communication work, while at the same time guaranteeing that the state of the art in technology and science are incorporated into the work of the avalanche experts on a daily basis. The set of rules of procedure is defined for each individual avalanche commission in its assessment area. It contains information on the organization of the commission, its tasks, its working methods, its assessment area, the measures to be taken on the route and the rules for setting alert levels. These rules of procedure (set of rules) form the basis for the digital tools that the avalanche commissions use on a daily basis for their assessments.

2. STRUCTURE OF THE AUSTRIAL RAILWAYS AVALANCHE WARNING SERVICE

The Railway Act (Eisenbahngesetz 1957 - EisbG i.d.g.F.), which stipulates that the safety and order of operations must be guaranteed, forms the basis for all activities. The ÖBB Avalanche Warning Service was launched in 2005. Today, there are 12 ÖBB Avalanche Commissions working on the high mountain routes in Austria to obtain a daily picture of the current avalanche situation during the winter months. The ÖBB avalanche warning service consists of two levels - the central and the

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regional avalanche warning service. The central avalanche warning service is made up of avalanche experts from ÖBB's Natural Hazard Management department. The regional avalanche warning service consists of a regional avalanche expert and then the avalanche commissions defined for each region with a chairman and deputy chairman. This means that information can be exchanged quickly across all organizational levels.

2.1 Avalanche Alert Levels

Embedded in this sophisticated avalanche safety management system, the avalanche experts of ÖBB- employ a local forecasting process with defined avalanche alert levels.

Avalanche Alert Level 1 (LAS1): No restrictions of railway sections or damage are expected. Possible measures are thorough observations by the avalanche experts and a daily extended check with passing a resolution.

Avalanche Alert Level 2 (LAS2): Restrictions are possible. Due to preventive measures, no damages on trains are expected. Possible measures are speed reductions, surveillance runs and flights, temporal operational restrictions as well as artificial avalanche releases.

Avalanche Alert Level 3 (LAS3): Restrictions are expected. Damages due to avalanches are probable. It is forbidden to access or move on avalanche prone sections. Possible measures are the closing of sections, evacuations, surveillance flights as well as artificial avalanche releases.

These avalanche alert levels (stipulated in the rules of procedure) can be recommended up to 48 hours in advance. First, the data and information obtained from this process are delivered in real time through information and communication channels to the relevant departments in the company. Second, these data and information form a pool of knowledge over the winter season and over the years that can be used in a variety of ways. Qualitative data analyses facilitate this process and thus help to make the activities of the ÖBB Avalanche Commissions more sustainable.

2.2 Safety Management Process

A defined safety management process based on ONR 49000:2014 was developed as the basis for knowledge management and stipulated in the rules of procedure of the ÖBB Avalanche Commissions. Among other things, it states that the ÖBB Avalanche Warning Service is responsible for the transparent, standardised assessment of the avalanche conditions and its documentation (ÖBB-Infrastruktur AG, 2023). This process, which was developed specifically on this basis, regulates the daily work of the avalanche commission and also specifies procedures to be followed in critical situations (Figure 1).

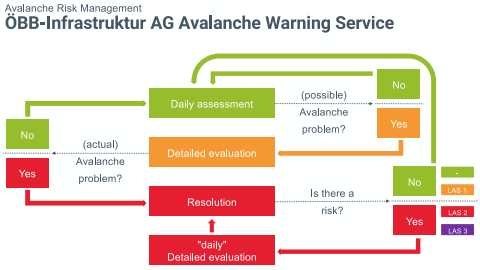

Figure 1: Safety Management Process of the ÖBB Avalanche Commissions (ÖBB-Infrastruktur AG, 2023)

A daily assessment of the snow and avalanche conditions constitutes the daily basic check, which always considers the next few days. If there is a risk of avalanche and this is relevant for the scope of the commission, then a detailed evaluation is implemented. This assessment variant is based on the problem-centric approach in avalanche assessment, a state-of-the-art methodology in avalanche assessment. As a result of this detailed assessment, a determination is made as to whether one or more avalanche problems are actually prevalent. If this is confirmed, a resolution will be passed to define packages of measures that can be implemented over the next few days. These measures are defined in ‘avalanche alert levels (LAS levels)’ in the rules of procedure for each commission and range from travelling slowly on the line to closing the line for a defined section.

3. TRAINING STRATEGY

How can the processes and the technical elements they contain be best taught to the members of the Austrian Federal Railways (ÖBB) Avalanche Commissions to put in place an effective process? Enhancing training and continuing professional development is the key to ÖBB’s organizational management A two-pronged training approach ensures a high level of knowledge and a structured application of the process. On one hand, the members of the ÖBB Avalanche Commissions have access to the training courses of the official avalanche commissions in their respective Austrian federal states, and are required to attend them every 5 years. On the other, a proprietary internal training programme was developed for the commissions, and is offered annually by the Avalanche Commissions.

This training strategy (two-pronged approach) is linked to the state of the art in avalanche risk management and always reflects the latest version of the process. The aim of the training programme is to put in place a continuous improvement process structured around the PDCA improvement cycle:

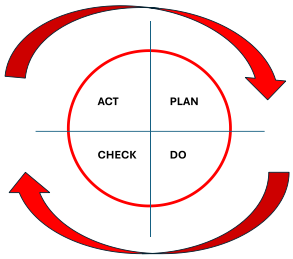

Figure 2: PDCA cycle (ÖBB, 2024)

PLAN -> Identifying issues, finding solutions and planning measures

DO -> Implementing measures, coordinating the implementation

CHECK -> Checking measures for effectiveness

ACT -> Initiating improvements, acknowledging successes (Kostka, C., 2017)

This improvement process is the basis for the different training elements that support and foster the work of the ÖBB Avalanche Commissions.

4. INTERNAL TRAINING PROGRAMME – THE CORNERSTONES

The individual training units focus on the different phases of the process (see Figure 1) and can be grouped into the following key activities of an avalanche commissioner – perceive, assess and act (Office of the Tyrolean Regional Government, 2016).

Perceive -> means the responsibility to keep an eye on the key factors that make up an avalanche risk during day-to-day work and the ability to react to changes

Assess -> the assessment process sequences the factors logically and, via an assessment process, leads to a decision on whether action is necessary or not

Act -> taking measures and continuing assessment cycles in the critical avalanche periods

Based on theses cornerstones, various elements are incorporated in the ÖBB training programme to ensure that all key activities of an avalanche commissioner are well trained.

4.1 Elements of training

The individual elements are implemented in an overall package spread out over the winter season, and thematic focuses are set in training based on the results of the CIP (Continuous Improvement Process). The following table (Table 1) illustrates the available training units and how they affect the overall process.

Training units	Details	Process element
Snow cover tests	Snow cover test and stratigraphy	Perceive/Advanced check
Simulation game	"Deciding" simulation game	Deciding
"Avalanche emergency" VR headset	Avalanche emergency – procedure	Avalanche Commission safety management
"Meteorology and avalanches" theory	Fundamentals of meteorology and avalanches	Perceive
RISK	"Working in the field" risk analysis	Avalanche Commission safety management
Multi-day avalanche course	Field work, theory units, simulation games	All process elements

Table 1: Details on ÖBB Avalanche Commission training (ÖBB, 2024)

The individual training elements are not only assigned to the process elements, but also to the team structure of an avalanche commission. The members of the avalanche commission (experts) are headed up by the chairperson of the avalanche commission (chairperson). New members of an avalanche commission are added to the group as candidates and receive training in line with the two-pronged approach. After these first two training units (BASIC), the candidates become full avalanche commission members (expert). Table 2 shows the training modules (as examples), depending on the development status of the commission member.

Training	Candidate	Expert	Chairperson
Basic	Introductory course (federal state-specific avalanche courses)		
Advanced		"Working in the field" module	
Practice	Avalanche emergency		
Expert CPD		"Meteorology and avalanches" module	
Chairperson CPD			"Team management" module

Table 2: Training modules by development status of ÖBB commission members, incl. examples (Source: ÖBB, 2024)

4.2 Simulation games to promote decision-making skills

As part of the training courses for the ÖBB Avalanche Commissions, it is essential to enhance all process elements, and to keep up with the state of the art, both in technology and science. It is also important to be able to make decisions and follow the workflow in doing so. Simulation games are held frequently, either working in groups or at commission level. In the winter of 2023/2024, a simulation game was held as a training unit focusing on testing participants' knowledge of meteorology and avalanches, and having them implement decisions. This training unit was held at all 12 ÖBB Avalanche Commissions, after which the results were compared. Figures 3, 4 and 5 give an impression of the simulation game.



Figure 3: Scenario for the "simulation game" training course (ÖBB, 2024)

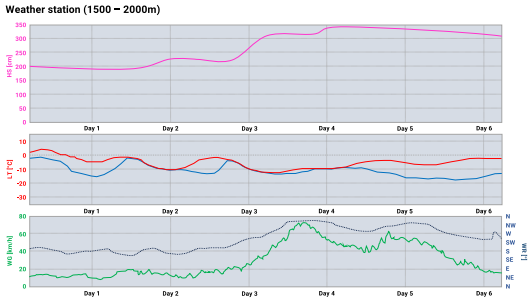

Figure 4: Scenario "weather station" for the education "simulation game" (ÖBB, 2024)

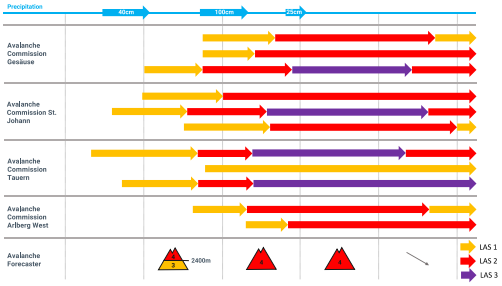

Figure 5: Results from the "simulation game" training course (ÖBB, 2024)

Figure 5 shows the results from the simulation games. Representatives from the official avalanche warning services (from the Federal States of Tyrol and Salzburg) also took part in the simulation game, and their results are also shown in Figure 5.

5. IMPLICATIONS AND OUTLOOK

Looking at the results from the simulation games, it is clear that almost all decisions on measures to be taken were made after the first period of precipitation, even though an avalanche alarm level 1 (LAS1) does not trigger any operative measures; measures at this level only apply to the avalanche commission internally. At first glance, it therefore appears that a strategic element of measure-taking – LAS 1 – is not used ideally and the lead time before measures are taken is too long. On the other hand, there is the argument that rail infrastructure engineering is very advanced, and only extreme scenarios necessitate operative measures. From the point of view of training, it would be better if all measures derived from the alarm levels were deployed correctly and at the appropriate time. In accordance with the continuous improvement process (see Figure 2), this is therefore also a key task for future training units and clearly shows how training elements are used for critical infrastructure. They are in fact deployed as holistic elements to enhance knowledge management and to evaluate the defined processes and procedures.

6. SUMMARY

Training and continuing professional development are key aspects of knowledge management in organisations, and will become increasingly important in HR management and in employee job satisfaction (Pawlowsky, 2016). For the avalanche risk management process, it is essential that process users have up-to-date knowledge, in order to firstly be able to better interpret external influences on the process and implement them

(e.g. new communication elements in an official avalanche situation report) and secondly, to be able to change and reorganise the process accordingly. As a result, in-depth training and continuing professional development are the key to sustainable business processes, not just in organisational safety management.

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