Strengthening the Safety of Track Workers Using Train Access Alert App and Management Information System

Ryu, Jeong hyeon (lead presenter)[1], Lee, Seung Min (Second Author)[2], Park, Chul (Third Author)[3]

[1] *happydays@korail.com*

[2] *railmin@korail.com*

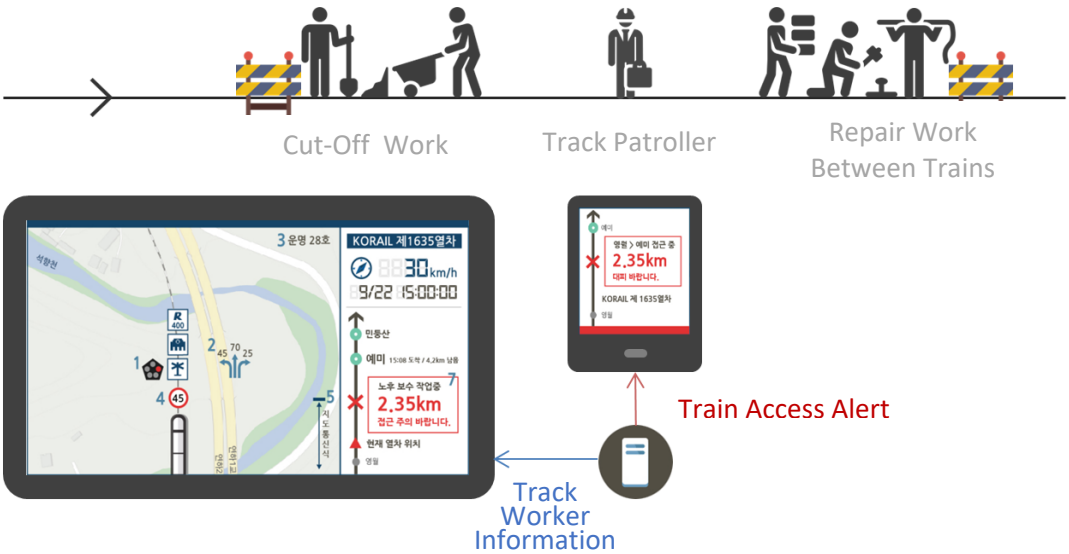
[3] *pc1127@korail.com*

*240, Jungang-ro, Dong-gu, Daejeon City, Korea Po.34618 (Email: happydays@korail.com, +82-426153810)

1. BACKGROUND.

It is a rule to carry out track maintenance work, which is essential for the safe operation, when the trains are not in operation. To ensure the safety of track workers, KORAIL makes it a rule to practice "Cut-Off Work", track work during the time trains are not running. KORAIL also tries to set aside 3.5 to 4 hours as a minimum working time by stopping train operations. However, facility inspections and emergency responses are inevitable in parallel with train operations. KORAIL makes sure track patrols should be done outside of the dangerous area during train operation hours, or take safety actions such as slowing down trains before unavoidable circumstances. Although track work or inspection performed simultaneously with train operation is very dangerous for workers.

KORAIL sets train guards to protect track workers from running trains and has developed and managed its own Train Access Alert Application to ensure train access is clearly known in advance.

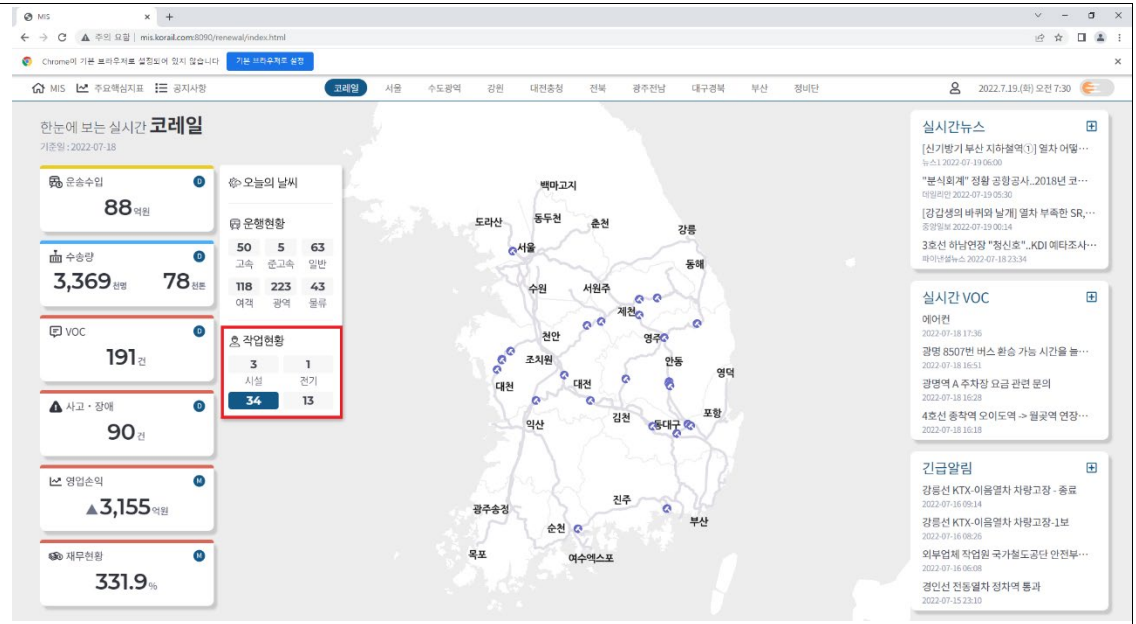


< Figure 1: Overview of Train Access Alert App >

Train guards are placed on the tracks around the track work section and secure track workers' safety by warning the workers when train. The Train Access Alert App is based on Global Positioning System(GPS) and linked with the Navigation system for train drivers on the running trains.

When conducting tasks close to the tracks, workers must hold this app and must activate it when entering a dangerous area. This Train Access Alert App is provided to all workers for any kinds of track adjacent tasks including cut-off work, track patrols, emergency repair work between trains, etc. (Train guards and subcontract workers are also provided with this app.) Based on location information from GPS system and train operation information from Centralized Traffic Control(CTC) system, the app sounds an alarm to alert the workers to the train access so that workers can evacuate to a safe place. At the same time, the Navigation system on the trains running around the work section displays the work location to warn the drivers to drive carefully.

In addition, users can check the current work status in real-time on the Management Information System(MIS) of KORAIL based on location information from the app.



< Figure 2: MIS screen showing the status of all tasks in progress >

< Figure 3: Locations of KORAIL's tasks>

<Figure 4: Locations of subcontractors' tasks >

If the user clicks the "Work Status" among the various functions of MIS, the user can see the locations of the app in all currently working sections at one sight. This function is implemented to display the locations on the map by distinguishing between track work

and electrical work, and between KORAIL's task and subcontractors' task. Users can enlarge the map and browse the detailed information including workers' affiliation, phone numbers, company names, and project names by clicking the activated work icon.

Even though such a worker safety system is in place, some problems still exist. If the worker does not hold or activate the app, they cannot notice the train access from the system and the drivers also fail to identify the work sections in advance.

KORAIL requires the workers to use the Train Access Alert App when performing every track work, but it is impossible to check if the worker does not use this app by mistake or on purpose unless directly checking the worker's usage at the site. In this case, the safety system is disabled, resulting in facing danger.

The suggestion for securing the safety of track workers described in this paper began with the following critical thoughts.

1) How to make all the workers around the tracks use the Train Access Alert App, and how to systemically check and take action when they don't use it
2) How to monitor the tasks that take place in the unapproved section or unapproved time in advance

2. OBJECTIVE

All passengers and all railway workers have the right to use and work safely. The key elements of safety can be summarized into three categories: 1) a facility that is installed and maintained safely or a facility that is designed to work safely; 2) a work manual and procedure focused on safety; 3) workers' awareness of safety first.

KORAIL implies this as safety investment, manuals and procedures, and workers' safety awareness. In order to ensure continuous safety, KORAIL concentrates on increasing consistent investment in safety, revising manuals and procedures from a focus on train operation to a focus on safety, and raising safety awareness for workers to keep their own safety.

The purpose of this paper is zero the safety accidents for track workers. The methods of achieving the goal are to build a system that enables to use of the Train Access Alert App in the field and to establish a process for compelling the use of the app, monitoring it, and taking immediate action if it is vulnerable.

3. METHODS

The study is focused on the improvement of the existing system rather than the establishment of a new one for mandatory use of the app and monitoring of its use.

1) The Train Access Alert App is developed by KORAIL and is already being used at the work site, so it can alert the workers to the train access to set aside sufficient evacuation time.
2) Based on location information from the app, the Navigation system for train drivers informs the driver of the work section and requires careful driving when operating near the working area.

3) The MIS system is built to display the location of the app on a map and monitor it in real-time.
4) All track works shall be approved for their section through consultation with the station before the start of the task.

All track works shall be conducted in safety consultation with the station in charge of the work section prior to the work. The Operation Safety Agreement includes the details, time, section of the work, equipment used for the work, personnel, and safety compliance related to train operation.

When the Operation Safety Agreement is completed, the manager shall formulate a work plan and carry out tasks according to the plan. When the work began in the train operating area, information related to train operation is shared with the station. After the work is completed, the station is notified of the completion so that the train can operate normally. In particular, track patrols to inspect the track status are strictly prohibited to enter the operating lines. The patrols should be conducted along a safe passage outside of the dangerous area which is within 2 meters of the track.

If the details of the Agreement are put into the MIS system and displayed in its time and section, it is thought that the use of the Train Access Alert App is monitored because the location information of the app and details of the Agreement are linked.

When negotiating the Operation Safety Agreement, the unit of measuring work section is based on km information used for KORAIL. However, the Train Access Alert App is based on coordinated information from GPS. Thus, prior work was necessary to unify them. Civil Engineering Division in KORAIL took charge of the prior work and established the process to reflect updated information immediately when changing routes, such as new or realigned lines. Now, field workers can enter the km-based location information from the Agreement as it is and the app automatically converts them into coordinate information for GPS and displays the data on the MIS system.

Furthermore, even if the work schedule was entered, the actual start and end times of the work did not exactly match the planned time depending on the situation at the site. To solve this problem, a new process is organized. In this process, the station that approves the start of the work and is notified as soon as the work is completed is in charge of entering these milestones into the system. Also, the process determines that the location information of the app is recognized as valid information from the start to the end of the work.

That is, the work section and time entered by the manager are displayed as work schedule on the MIS system so that anyone who inquiries the information from the MIS system can recognize the scheduled work. The input of the approved start time by the station is determined as the actual start point, and the MIS system indicates the work is in normal status or offers alerts when recognizing abnormal information in work time and section according to the GPS information.

In accordance with the current status and process above, the following work procedure is set up.

1) The manager puts the project name, work section, and scheduled work time into the XROIS system when the consultation with the station about work time and section is completed.

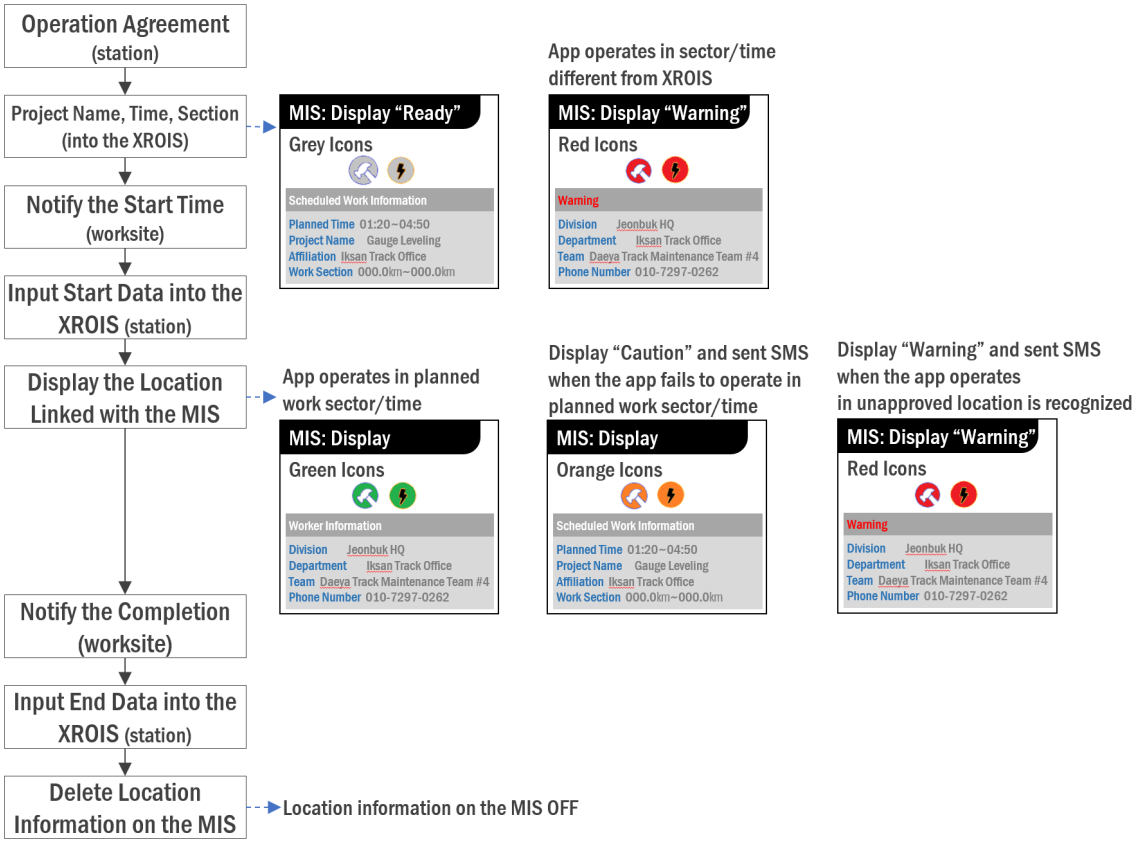
** XROIS stands for "neXt generation Railroad Operating Information System" which is KORAIL's own system.*

2) The MIS displays work time and section from the XROIS as scheduled location and time by the unit of a day, so the manager can check the planned work on the map.
3) When the scheduled work time is reached, the worker notifies the station of the start of the work. The station approves the worker to start the task and clicks the "Scheduled Work Information" tab and enters the data into the XROIS system.
4) As soon as the start time is put in the XROIS, the MIS changes its display.

- Display "Normal" if the location information of the Train Access Alert App is recognized in the planned section.
- Display "Caution" if the location information is not recognized even after the work is started. Send warning messages to the task manager and the safety manager via SMS.

5) When the work is completed and all workers withdraw from the site, the task manager notifies the station of the completion.
6) The station puts the completion information into the XROIS.
7) The MIS stops displaying the location of completed work.
8) If the recognized location information from the app is different from the time and section that the station has approved, the MIS considers it as an "Unapproved Work" and displays "Caution" and sends warning messages. These messages go to the phone number of the safety manager and the app holder.
9) The safety manager checks the site immediately upon receiving the warning message and takes necessary safety measures.

The following is a schematic diagram of this supplementary procedure in order.



< Figure 5: Diagram of improvement on the inquiry of work status by linking the Train Access Alert App and the MIS system >

KORAIL's safety HQ is planning the improvement of the work procedure and is now in its designing stage collaborating with KORAIL's IT Operation Center. The system development and testing will be completed by the end of 2022 and will be expanded to all divisions in KORAIL by 2023 through a pilot operation.

This procedure is implemented to be automated by minimizing system input and focused on ensuring the safety of track workers so that all related parties including on-site workers, managers, safety managers, and train drivers can share status information and take safety measures.

Still, the following additional systemic tasks are required to track workers and stations, but the improvement tries to simplify the way of inputting the data to minimize the burden on workers.

1) The task manager must input additional information including the date, section, and name of the work into the XROIS system after the consultation with the station that has been processed through documents/phone calls in the past is completed.
2) The station must input additional information including the start/end time of the work into the XROIS system after the work was approved and notified of its completion. To simplify this step, the system needs to be developed so that the station can pick the task and hit the start/end button with one simple click.

The safety manager or task manager should monitor the MIS system from time to time to ensure proper usage of the Train Access Alert App and whether there is any unauthorized work even though text notification is received through SMS.

When this system improvement is done, the task managers and the safety managers can verify whether the Train Access Alert App is working normally or if the tasks from the app are approved. Also, the workers not holding or activating the app must be detected immediately, so the app will be compulsory for all tasks.

However, the following factors are should be additionally considered to utilize the system in all sections.

1) This can be used efficiently in single-track or double-track sections, but its effectiveness can be lowered in those sections where numerous tracks are installed in the same area. As for major stations, more than 10 tracks are installed within the station area, but train access on all tracks is recognized and alerted due to the error range of the GPS. In this case, train access unrelated to the location of the actual worker will be alerted as well.
2) As for pre-negotiated works, the task manager can enter the information of the scheduled work section and time, but it may be difficult to enter the schedule into the system when urgent inspection or maintenance work is carried out due to force majeure. In this case, the subject who is in charge of inputting the data may be changed. Considering these various cases, clear criteria should be set up to prevent the omission of data input.
3) It is impossible to detect unauthorized work if the app is not activated while performing the work. Unauthorized work without pre-negotiation is a serious violation that causes major accidents. In order to prevent such violations from occurring, continuous efforts are required to change all workers' safety awareness through compliance with rules and activations of a safety culture. Also, all the violations should be severely punished.

4. RESULTS

Once the system has been completely built and operated, the workers of all approved tasks must use the Train Access Alert App. If they don't carry this app by mistake or on purpose, the MIS displays the warning sign indicating that the worker is not using the app upon approval of the work. This sign is monitored by all employees including managers or traffic controllers, and even the CEO. In addition, when an unauthorized work site is monitored, the managers and safety managers are immediately notified through SMS and they must take safety measures.

Unauthorized(Unapproved) work can also be detected immediately if the worker holds the app. There may be cases when the worker carries out the tasks without the app, but in this case, the worker will be given the strongest penalty if caught.

A system for monitoring work status by linking the Operation Safety Agreement, the Train Access Alert App, and the MIS system are currently under development by KORAIL. It is scheduled to be implemented in 2023.

KORAIL plans to continuously discover and improve additional supplementation by monitoring the results of the pilot and actual operation.

5. CONCLUSION

In order to secure the track workers' safety from train operation, the most fundamental solution is to stop the trains during working hours. In fact, if significant track maintenance work is urgently needed, train operation is suspended to carry out the tasks. However, it is impossible to suspend usual track patrols or simple tasks. In Korea, it is more difficult to secure adequate working hours due to the frequent train service. Nevertheless, KORAIL is striving to spare sufficient 3.5 to 4 hours of working hours by arranging the timetables in the early morning.

It is necessary to share the train operating information with track workers and to secure enough time for safety measures when conducting track patrols or urgent cut-off work between trains. To supplement former methods of information systems via wireless communication with the stations, KORAIL developed their own Train Access Alert App and is managing it.

Nonetheless, some of the workers are still not using the app due to urgent work or carelessness, and such mistakes may lead to large casualties.

Therefore, to protect the track workers from trains, an effective method was required to monitor whether the app was used at the authorized work site and to supplement this when not in use. It is also very important to make sure that the actual work is carried out at the approved location and time, even if the worker uses the app. This is because most accidents between workers and trains are at unapproved locations and times.

KORAIL is pushing to improve the procedure that minimizes the burden of additional data input by employees while developing the Train Access Alert App from simply notifying to mandatory to use it. This improvement includes confirming and complementing safety measures to recognize train access is properly implemented. Moreover, KORAIL tries to enable the procedure to check unapproved works to eliminate situations in which workers and trains face a danger that could lead to a major accident.

The safety of train operations, the safety of train passengers, and the safety of train workers are absolutely important values and key elements to be kept.

KORAIL will continue to strive for safety as its top priority and expects unwavering cooperation with all railway organizations to maintain safety as an absolute value.

Keywords: track worker safety, MIS, GPS, train access alert app