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A Study on the Cause Analysis of Human Error Accidents by Railway Job*

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Abstract

Purpose: This study investigates human error accidents in the Korean railway sector, emphasizing the need for systematic management to prevent such incidents, which can have fatal consequences, especially in driving-related jobs. **Research design, data and methodology:** This paper analyzed data from the Aviation and Railway Accident Investigation Board and the Korea Transportation Safety Authority, examining 240 human error accidents that occurred over the last five years (2018-2022). The analysis focused on accidents in the driving, facility, electric, and control fields. **Results:** The findings indicate that the majority of human error accidents stem from negligence in confirmation checks, issues with work methods, and oversight in facility maintenance. In the driving field, errors such as signal check neglect and braking failures are prevalent, while in the facility and electric fields, the main issues are maintenance delays and neglect of safety measures. **Conclusions:** The paper concludes that human error accidents are complex and multifaceted, often resulting from a high workload on engineers and systemic issues within the railway system. Future research should delve into the causal relationships of these accidents and develop targeted prevention strategies through improved work processes, education, and training.

Keywords : Railway Accident Analysis, Human Error, Accident Investigation, Root Cause, Accident Prevention

JEL Classification Code : J28, L92, R41

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1. Introduction

In the context of human behavior, ‘human error’ refers to instances where individuals act incorrectly due to misjudgment or mistakes during their daily life or social activities. In industrial sites, it is called "Human error" when an unintended result occurs due to an action that hinders the function and safety of the system by not performing the prescribed tasks assigned to the system, such as people, machines, facilities, and organizations.

KTX (Korea Train Express), a domestic high-speed railway, is a large transportation system that transports about 1,000 passengers and is a meaningful means of transportation that has brought about changes in people's work and leisure life by providing rapid mobility convenience.

Rail transportation is increasingly threatening safety due to increased errors caused by human factors in the field due to changes in the technological, social and cultural environment, the expansion of high-speed railways, and railway structural reform.

Therefore, efforts to prevent human error in railways must be continuously promoted and a fundamental analysis of the cause of the accident is essential.

In this paper, human errors by field for railway accidents over the last five years were analyzed. The aim was to assist in establishing a human error accident prevention system by analyzing human error accidents and competitive incidents across various fields.

2. Literature Review

2.1. Prior Research

In order to secure rail safety, a system that manages risk prevention and reactive behavior is very important (Yum & Gal, 2015).

The railway's work area was divided into sales, crew, vehicles, facilities, and electricity, and risk factors in the safety area, health area, and environmental areas were derived for each work area (Choi et al., 2021).

The HEAR analysis technique was used to investigate human errors in the railway sector, analyze accidents that occurred at railway operating institutions to find the root cause of human errors, and seek ways to improve them (Lee et al., 2013).

2.2. Classification System

2.2.1. Railway Accident

Article 5 of the Guidelines for Reporting and

Investigation of Railway Accidents (Type of Railway Traffic Accidents). The classification system for railway accidents is shown in Table 1(KORAIL, 2017).

Table 1: Classification of Railway Accidents

Classification	Railway Accident			
Railway Accident	Railway traffic accident	Collision accident		
		Derailment accident		
		Train fire accident		
		Other railway traffic accidents	Dangerous Goods Accident	
			Crossing accident	
			Railway traffic accident	Passenger
			Public	
			Worker	
	Railway safety accident	Railway fire accident		
		Railway facility damage accident		
Other railway safety accidents		Railway safety accident	Passenger	
			Public	
		Worker		
	Other safety accidents			
Railway quasi-accident	Railway quasi-accident			
Driving Disability	Nonstop pass, Delay in operation			
Administrative Impairment				
Railway Disaster				

Note:

1. If another railway accident is caused by one railway accident, it is classified as the first accident (However, if a collision, disconnection, or train fire accident occurs due to a railway accident other than a collision, disconnection, or train fire accident, it is classified as a collision, disconnection, or train fire accident).
 2. Where a railway accident, etc. is caused by a disaster, it shall be classified into a disaster, a railway accident, a railway quasi-accident, or a disability.
 3. If a railway-based accident or a disability is caused by a railway accident, it is classified as a railway accident.
 4. Where another driving disorder is caused by one driving disorder, it shall be classified as the first disability.
 5. Driving disability means that no casualties or property damage have occurred and has hindered the operation of the train. The operation delay is based on the delay time caused by the failure.
- The scope of railway quasi-accidents is as follows.
1. Where a train travels to an area that is not authorized to operate.
 2. Where a signal indicating progress is displayed even though the track on which the train is intended to operate is disabled: Provided, that this shall not apply to cases where control is approved for restoration and maintenance.
 3. Where a train or railway vehicle has passed a stop signal without approval.
 4. Where a train or railway vehicle has slipped into the station and station.

5. Where the train is driven to the section where the operation of the train is suspended and construction or repair work is performed.
6. When rail damage or track distortion outside the allowable range of maintenance occurs that interferes with safe operation.
7. Where a fault occurs in the wheel, axle, axle bearing, etc. of a railway vehicle that interferes with safe operation.
8. Where dangerous substances under Article 45 of the Enforcement Decree of the Railway Safety Act (hereinafter referred to as the "Decree") or hazardous substances under Article 78 (1) are leaked from a railway vehicle.
9. Anything that is equivalent to quasi-accidents under subparagraphs 1 through 8 of railway and may lead to a railway accident.

2.2.2. Dangerous Events

Dangerous events refer to unauthorized operation, misrepresentation of progress signals, violation of stop signals, vehicle clouds outside the station, train operation of working sections, vehicle de-line, safety failure of safety equipment, safety failure of vehicles, leakage of dangerous goods, and other dangerous events. Table 2 shows the classification system of dangerous events.

Table 2: Classification of Dangerous Events

Classification		Dangerous Event	
Driving disability	Dangerous event	It refers to the occurrence of a situation that is likely to develop into a railway accident	
	Delayed operation	Vehicle disengagement	The wheels of a railway car derailed and derailed
		Vehicle damage	Railway vehicle damaged by collision or contact
		Vehicle fire	A fire breaks out on a train or vehicle
		Train separation	Separation of connections between railway vehicles regardless of train construction work during train operation
		Vehicle Roll	When a train or railway vehicle rolls from station to station
		Violation of regulations	When dealing with violations of regulations, such as signals, obstruction of traffic, entry into the second line, or violation of the stationary position, etc.
		Track fault	Disruption of train operation due to defects such as failure, damage, and deformation of track facilities or obstacles on the track
		Sudden disability	Defects such as failure, damage, and deformation of electrical equipment, or power supply failure such as power failure or voltage drop due to external shock or contact with foreign substances, which interferes with train operation
		Signal disturbance	Defects such as failure and deformation of the signal security system interfere with train operation
Vehicle failure	Failure of a railway vehicle hinders train operation		
Obstruction of the train	Interference with train operation by deliberately interfering with train operation, such as railway occupation, etc.		
Other Disabilities	Disability not applicable to each subparagraph		

Note: The scope of driving disabilities is as follows(Article 2, No. 13 of the Act).

1. Passing a stop without prior approval from the control.
2. Operation delays according to the following categories:
 - Provided, That the operation delays caused by other railway accidents or operational disabilities shall be excluded.
 - A. High-speed trains and electric trains: 20 minutes or longer

B. Regular passenger train: More than 30 minutes

C. Freight trains and other trains: 60 minutes or longer

The types of delayed operations are as follows.

1. Vehicle derailment: In the case where the wheels of a railway vehicle are derailed due to off-track.
2. Vehicle damage: When a railway vehicle is damaged by collision or contact.
3. Vehicle fire: When a fire occurs in a train or railway vehicle.
4. Train separation: Where the connection between railway vehicles constituting the train is separated regardless of the construction work of the train during the train operation.
5. Vehicle cloud: Where a train or railway vehicle rolls outside a station (including a signal station, signal station, simple station, and base) where a train or railway vehicle parks or stops.
6. Violation of regulations: Where a violation of regulations, such as a violation of the handling of signals or obstruction, entry of a second line, violation of the stop position, etc., interferes with the operation of the train.
7. Track disturbance: Where a defect such as failure, damage, deformation, etc. of a track facility or an obstacle on the track interferes with the operation of the train.
8. Power supply disability: Power supply problems such as power outages or voltage drops caused by defects such as breakdown, damage, deformation, etc. of electrical equipment, external shocks, or contact with foreign substances interfere with train operation.
9. Signal failure: Where a defect such as failure, damage, deformation, etc. of the signal security device interferes with the operation of the train.
10. Vehicle failure: Where the failure of a railway vehicle interferes with the operation of the train.
11. Interference with trains: Where the operation of trains is deliberately obstructed, such as the occupation of tracks, etc., which interferes with the operation of trains.
12. Other disabilities: Disabilities not falling under any of the above. The types of management disorders are as follows.
 1. Disabilities not falling under delayed operation among disabilities referred to in subparagraphs 1 through 6 of Article 7.
 2. Quality defect: In the case where a train operation line (road, trajectory, construction, tram line, signal, communication, etc.) is disrupted due to a material defect, construction failure, negligence of responsibility, etc. in the business section managed by a person other than the public company, and damage occurs.
 3. Other disabilities: Disabilities not falling under any of the above.

3. Research Methods and Materials

Based on the contents of the railway accident analysis report and statistical data from the Aviation and Railway Accident Investigation Board and the Korea Transportation Safety Authority, 240 human error accidents in the last five years (2018-2022) were analyzed.

4. Results and Discussion

4.1. Total Number of Accidents Over the Last Five Years

Railway accidents caused by human errors over the last five years have been classified according to their characteristics, and the results are as shown in Table 3.

Table 3: Classification of Dangerous Events

Sortation	Number of occurrences
Year	
2018	42
2019	74
2020	50
2021	47
2022	27
Field	
Business	28
Driving	131
Facilities	19
Electric	4
Control	4
Business + Driving	32
Business + Facilities	3
Driving + Facilities	18
Facilities + Control	1
Cause	
Management disability (violation of regulations)	149
Management Failure (Other)	17
Management disability (Tracks disability)	1
Management failure (Signal failure)	1
Management failure (vehicle disconnection)	14
Management failure (vehicle damage)	2
A non-stop passage	6
Delayed operation (violation of regulations)	19
Delayed operation (other)	20
Delayed operation (Tracks disability)	1
Railway quasi-accidents	2
Railway quasi-accidents (Other dangerous events)	2
Railway quasi-accidents (Stop signal violation operation)	6

4.2. Annual Number of Accidents by Field

4.2.1. Business Field

The business field is in charge of ticket handling for passengers and transferring work stations for the construction of trains, and signal handling for the operation of trains in station. Most of the risk factors for human factor accidents were negligence of confirmation, problems with work methods, and risk factors for negligence of confirmation of facilities (see Table 4).

Table 4: Number of Accidents by Year in the Business Field (63 cases)

Sortation	Number of occurrences by year				
	2018	2019	2020	2021	2022
Business field					
Business	7	8	6	5	2
Business + Driving	3	4	11	10	3
Business + Facilities	0	2	0	1	0
Cause					
Management disability (violation of regulations)	6	8	16	13	2
Management Failure (Other)	0	0	0	0	1
Management failure (vehicle disconnection)	4	2	0	0	0
Management failure (vehicle damage)	0	1	0	0	0
A non-stop passage	0	0	0	1	1
Delayed operation (violation of regulations)	0	3	1	0	0
Railway quasi-accidents (Other dangerous events)	0	0	0	1	1
Railway quasi-accidents (Stop signal violation operation)	0	0	0	1	1

4.2.2. Driving Field

The Driving field is in charge of driving trains and is in charge of vehicle operation by operating trains such as starting and stopping according to signals set for safe and comfortable travel for passengers. Most of the risk factors for human factor accidents were risk factors such as passing a stop station or missing a stop location due to signal check neglect and braking failure related to running beforehand (see Table 5).

Table 5: Number of Accidents by Year in the Driving Field (181 cases)

Sortation	Number of occurrences by year				
	2018	2019	2020	2021	2022
Driving field					
Driving	21	51	27	15	17
Business + Driving	3	4	11	10	4
Driving + Facilities	4	3	3	7	1
Cause					
Management disability (violation of regulations)	19	33	36	24	7
Management Failure (Other)	2	3	1	0	5
Management disability (Tracks disability)	0	3	0	0	0
Delayed operation (violation of regulations)	1	0	0	0	0
Delayed operation (other)	0	0	0	4	2
Railway quasi-accidents	1	9	2	2	1
Railway quasi-accidents (Stop signal violation operation)	5	9	2	1	3
Railway quasi-accidents (Other dangerous events)	0	1	0	1	4

4.2.3. Facilities Field

In the facility field, the roadbed required to operate the train is piled up, gravel and sleeper are laid on it, and rails are installed, while gravel is supplemented to prevent the vehicle from being derailed during train operation and replacement of sleeper rails. Most of the risk factors for human error accidents were maintenance delays, problems with work methods, and risk factors for neglect of measures against facilities (see Table 6).

Table 6: Number of Accidents by Year in the Facilities Field (41 cases)

Sortation	Number of occurrences by year				
	2018	2019	2020	2021	2022
Facilities field					
Facilities	7	3	3	5	1
Business + Facilities	0	2	0	1	0
Driving + Facilities	4	3	3	7	1
Facilities + Control	0	0	0	1	0
Cause					
Management disability (violation of regulations)	5	3	5	11	0
Management Failure (Other)	1	1	1	0	1
Management disability (Tracks disability)	4	3	0	0	0
Delayed operation (violation of regulations)	1	0	0	0	0
Delayed operation (other)	0	1	0	1	0
Railway quasi-accidents	0	0	0	2	0
Railway quasi-accidents (Stop signal violation operation)	0	0	0	0	1

4.2.4. Electric field

It is in charge of repairing electrical equipment for passenger guidance, such as electric equipment necessary to operate trains in the electric field and lighting in station. It is in charge of repairing subway equipment for moving electric locomotives and signal equipment communication equipment for train operation. Most of the risk factors for human error accidents were problems with work methods and risk factors for neglect of measures against facilities (see Table 7).

Table 7: Number of Accidents by Year in the Electric Field (4 cases)

Sortation	Number of occurrences by year				
	2018	2019	2020	2021	2022
Electric field					
Electric	0	2	0	1	1
Cause					
Management Failure (Other)	0	1	0	0	0
Management disability (Tracks disability)	0	0	0	1	0
Management failure (Signal failure)	0	0	0	0	1
Delayed operation (other)	0	1	0	0	0

4.2.5. Control field

In the control field, the operation coordination according to the train operation plan is carried out, and is in charge of monitoring, control, and control of trains. Most of the risk factors for human error accidents were caused by neglect of work and lack of action(see Table 8).

Table 8: Number of Accidents by Year in the Control Field (5 cases)

Sortation	Number of occurrences by year				
	2018	2019	2020	2021	2022
Control field					
Control	0	1	0	2	1
Facilities + Control	0	0	0	1	0
Cause					
Management disability (violation of regulations)	0	1	0	2	0
Management Failure (Other)	0	0	0	0	1
Railway quasi-accidents	0	0	0	1	0

4.3. Consideration

Human error accidents can only be prevented by systematic management using various methods. Human error accidents can occur anywhere in human life, and in particular, accidents in driving jobs can cause fatal secondary accidents. Among them, railway drivers are exposed to railway accidents caused by human errors, and it can be said that it is a phenomenon caused by a high proportion of work on engineers. In other words, it can be seen from the accident prevention measures that the railway engineer "did not occur even if there was only pointing and repetition." Behind the scenes, however, various factors of the entire railway system must be considered when investigating human error accidents, as railway accidents may occur due to mistakes caused by engineering, such as vehicles, facilities, signal designers, managers, and

supervisors.

Human error refers to human behavior that appears as wrong decisions or actions in situations where safety accidents occur due to reduced work processing ability or poor efficiency. This may lead to repetitive mistakes, and depending on the degree of satisfaction, it may affect the safety of the human-machine system. In a study by the Aviation and Railway Accident Investigation Board, careless behavior, manipulation errors, and violation of regulations were found as the causes of human errors in railway accidents, which are interpreted as complex and diverse causes related to the limitations of workers, organizational, and work factors. Human errors include complex and diverse actions that can occur at various stages of work (Kim, 2020).

Reason (1990) defines a human error as a case in which a set of mental or physical activities planned and executed by humans did not reach the intended outcome, and refers to this failure as a result of another cause, not an accidental event (Reason, 1990).

5. Conclusions

The main and potential risk sources for human error accidents are derived from various causes, so the analysis of the causal relationship of the impact will be dealt with in future research. For safety management of railways, problems in the facility part of the accident risk factors should be reflected in the railway technology standards, and problems in human error should be referred to below.

First, there are facilities as a factor that causes unsafe behavior. In addition to the principle, operation, arrangement method, and arrangement condition of the facility, the importance of the machine should be systematically or mechanically installed with security devices that may appear through simulation.

Second, there should be no workplace environment and corporate climate that tolerate unsafe behavior. In particular, in railway transportation, unsafe behavior is directly linked to accidents, and the size of accidents may be larger than other accidents, which must be improved.

Third, with a firm belief in safety and a mindset that safety is the top priority, management should continue to observe whether safety budgets or safety education and training for employees are actually being implemented, and if there is a lack, measures must be taken to improve.

Fourth, in the event of an accident, it is necessary to seriously discuss issues across positions or fields, discuss intensive improvement directions, and make efforts to eradicate unsafe behavior.

Most human error accidents in the railway sector are problems with negligence and work methods, and in

particular, most accidents in the driving sector are accidents that fail to properly brake due to neglect of forerunners and pointing and repetition. In future research projects, the causes of human error accidents should be analyzed by work process to derive risk factors of work order or work method so that they can be prevented through system construction, education, and training.

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