

A Study on the New Aptitude Test Items for the Safety Critical Workers: Focused on Stress Tolerance under Emergency and Solitary Driving Situation

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Abstract

The main purpose of this study is to highlight the importance and validity of introduction of stress-concerned aptitude items for the safety critical workers, corresponding to the radical environmental change in railway industry. To attain this purpose, the author performed a brief literature survey, and scrutinized the western practice in detail. Then, the necessity of introduction of stress-related aptitude items was suggested, based on the statistics resulted from a survey which has been once performed for experts and drivers. The final conclusion is that the present selection system through which the safety critical workers are being staffed, without any rigorous screening mechanisms cannot but have some limitations. So, an overall restructuring for aptitude management system needs to be done in order for us to advance to the position of upper-class railway country.

Key words : *Aptitude management, Stressors, Coping with time pressure and emergency, Safety-critical worker*

1. Introduction

Since the catastrophe of Daegu subway big fire in the year of 2003, an incident ever unheard of happened lately. It was a kind of near miss error that a subway train with hundreds of passengers onboard ran backwards about 200 meters upon a complaint from a passenger who missed a stop. Even though there were no actual losses or damages both in physical and in economic aspects, it was an incident enough to give us a notable lesson in the respect that it might have incurred an unrecoverable fatal accident.

The safety-critical workers performing their everyday routine tasks such as driving, dispatching or rolling stocks inspection in the railway industry are inclined to be vulnerable to many kinds of human errors caused by diverse stressors. Despite the radical advancement in railway technology and safety systems, it may be undeniable that the degree of complexity in railway systems, the number of passengers, and the level of responsibility for safety are ever increasing. With these irresistible environmental changes, the global trend of gradual downsizing in human

resources (e.g. one-man operation driving system) being implemented by the name of cost-cutting and technological advancement is believed to be a plausible factor which causes a high level of stress for the safety-critical workers.

The main purpose of this study is to highlight the new aptitude test items having been adopted in the most western countries for the purpose of enhancing competencies necessary for coping with stress under time pressure, emergency, or solitary working situation.

2. Retrospect on Stress, Human Error, and Performance

Stress in its negative sense implies an imbalance between the demands of the environment and the capacity of the individual to cope, or that the individual's expectations exceed what is offered by the environment. In order to evaluate the consequences of stress, the individual's ability to evaluate and cope with the situation must also be taken into account.

If a stress situation cannot be controlled, negative reactions arise such as discontent, worry, fear, frustration, and a lack of pleasure or motivation at work.

There are numerous factors and situations which can cause stress at work and some of the most common are

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Table 1. Result of Factor Analysis and Reliability Test-Job Stressors

Items	Stressors				
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
	Anxiety of Accident/Error	Time Pressure	Psychological Burnout	Physical	One-Man Operation
1. Feel a strain from individual judgment and responsibility in case of solitary driving.	.700	.397	.106	.198	.320
2. Feel unsafe on account of responsibility and disadvantage received in case of accident.	.687	.346	.125	.245	.358
3. Feel fatigue from multiple judgment and instruction from authority in case of emergency.	.686	.290	.401	.161	.098
4. Feel much burden from loaded training and education for coping with failures of systems.	.586	.207	.437	.222	.178
5. Feel stressful at the dumps of complaints from customers.	.575	.197	.213	.414	.206
6. Feel psychological resistance on listening to redundant directions from manager.	.567	.090	.493	.244	.182
7. Feel a strain incurred by wrong operation of machines or tools.	.548	.339	.328	.217	.283
1. Feel pressure on timely shift.	.212	.847	.181	.123	.130
2. Feel tension on showing up at the office and on duty on time.	.105	.838	.147	.139	.099
3. Feel tension coming from a conflict between timeliness and passenger's safety.	.290	.741	.248	.324	.111
4. Feel pressure from responsibility on fast problem-solving under emergency.	.310	.660	.230	.271	.146
5. Feel unsafe on account of the chance of casualty and error.	.496	.650	.194	.166	.122
1. Feel unsafe on account of tunnel's isolated environment.	.136	.138	.727	.224	.108
2. Feel difficulty in learning and adapting to new knowledge based on system change or improvement.	.350	.222	.688	.167	.214
3. Feel an obscure anxiety on solitary driving.	.302	.447	.626	.157	.214
4. Feel fatigue from routine multiple judgment and concentration.	.317	.369	.593	.294	.297
5. Feel stress from excessive communication.	.188	.275	.545	.499	.163
1. Feel a sense of destruction of biorhythm on account of continual shift.	.472	.188	.150	.669	.099
2. Feel pressure from the needs of evacuation(e.g. urine)	.470	.137	.177	.658	.241
3. Feel burden from strengthened physical checks.	.163	.431	.230	.610	.163
4. Feel fatigue from excessive utilization of specific parts of body.	.079	.227	.410	.592	.316
5. Feel pressure from overcoming drowsiness.	.407	.189	.397	.515	.157
6. Feel fatigue from poor working environment.	.117	.430	.389	.514	.268
1. Feel stress from rail and station facilities unfit for solitary driving.	.184	.174	.138	.168	.845
2. Feel stress from cabin layout unfit for solitary driving.	.179	.055	.260	.205	.785
3. Feel unsafe from insufficient monitoring system at boarding area.	.428	.219	.167	.160	.668
KMO and Bartlett Test	.954 (p-value=.000)				
Bartlett' Sphericity (%)	72.37				
Reliability (Cronbach's Alpha)	.921	.915	.884	.886	.846

(source: Shin & Song, 2011)[5]

difficult social relationships, problems with the organization, poor career opportunities, strenuous physical conditions, excessive workloads and time pressure, demands that are too low (under-stimulation), little decision-making opportunity, no stimulation, lack of control and an inability to exert influence on the job.

When it comes to the monitoring of complex technical

systems, any insecurity when confronted by unforeseen operational conditions can be a common cause of stress. This insecurity can arise from a lack of knowledge about how to manage a situation or the absence of feedback on whether measures that have been taken are correct or not(Kecklund etals, 1999) [1].

A reason for why performance is often impaired by

stress is that, under favorable conditions, many people are able to deal with moderate levels of stress by mobilizing extra (mental) resources and focusing themselves on the task (Hockey, Wastell & Sauer, 1998; Schönflug, 1983, Meijman, 1997) [2-4].

According to a relevant study (Shin & Song, 2011)[5] once performed by the author for the safety critical workers of Korean railway industry, it was found that they were all suffering from lots of stressors. This study started with a pre-interview in order to find out specific stressors, physical and psychological. Then, based on the result of interview, questionnaire containing 26 items on stressors was made and sent to the hundreds of participants¹.

When the factor analysis for the 212 drivers was performed, it was shown that 5 factors were grouped as statistically distinctive (Table 1).

Among the 5 factors, two latter factors, that is, physical stressor (factor 4) and one-man operation stressor (factor 5) seem to be ones beyond rational control since they are factors coming from external, irresistible physiological reason or environmental characteristics.

For example, when a driver feels natural and physiological needs such as urine, evacuation, or drowsiness, unfortunately there is no way to overcome those needs except for just enduring it or taking private easy method in his cabin, and taking pills in case of drowsiness. They are just irresistible needs out of mind-control or mental mechanism. Therefore the stress caused by or from these factors has nothing to do with inborn aptitude or acquired traits followed by learning and training.

On the other hand, first three factors are stressors concerned with psychology and mentality of drivers. And as shown on the table, majority of detailed items are the psychological stressors coming from or concerned with time pressure, emergency, and solitary driving situation.

For example, among the detailed items belonging to factor 1 (anxiety of accident or error), the item number 1 (feel a strain from individual judgment and responsibility in case of solitary driving.) and the item number 3 (feel fatigue from multiple judgment and instruction from authority in case of emergency.) are concerned with solitary driving and emergency, respectively.

And among the detailed items belonging to factor 2

(time pressure), the item number 1 (feel pressure on timely shift.), the item number 2 (feel tension on showing up at the office and on duty on time.), and the item number 4 (feel pressure from responsibility on fast problem-solving under emergency.) are all concerned with time pressure.

More, among the detailed items belonging to factor 3 (psychological burnout), the item number 3 (feel an obscure anxiety on solitary driving.) is concerned with solitary driving.

In addition to these types of direct stressors caused by solitary driving, time pressure, or emergency, the item number 2 (feel unsafe on account of responsibility and disadvantage received in case of accident.) of factor 1 and the item number 5 (feel unsafe on account of the chance of casualty and error.) of factor 2 are the stressors indirectly concerned with emergency which drivers are anticipating the chance of incidents in advance.

When we consider the fact that the individual's ability to evaluate and cope with the situation is differential person to person (Han, 2003; Lee, 2006; Chung, 2009)[6-8], this results suggest that it would be not only so necessary to recruit and select human resources having competency needed to cope with stress itself, stress under emergency situation, and stress coming from solitary driving situation, but also necessary to educate, and train them in order to improve their competency to cope with stress².

For this reason, most of the western countries including railway-advanced ones have already adopted this competency items into their practice. So, it may deserve to depict the western cases in detail.

3. The Practice of Western Countries

The practice of western countries can be summarized as Table 2 (Shin, 2009)[10]. As shown in the table, western countries take account of the competency for coping with stress under diverse situations as an indispensable caliber for the safety critical workers, and this perspective is reflected into their aptitude management system. This aptitude management practice can be divided into two phases: one is to acquire new workers, and another is to build up the ability to cope with stress for their present workers.

¹Items used for my previous research were based on a pre-interview with several incumbents working as drivers or dispatchers. Despite this intention, this article is thought to invariably have some limitation in that items were solely dependent on the responses of drivers or dispatchers that time. It would have been more desirable if other opinions or perspectives from external groups such as railway-related specialists or academic researchers were included.

²Some people thrive on stressful situations, while others are overwhelmed by them. Focused on this theme, lots of studies have been performed. Most literatures suppose that every people are different in terms of their ability to handle stress, and there exist individual difference variables moderating the relationship between potential stressors and experienced stress. At least four variables ? perception, job experience, social support, and personality ? have been found to be relevant moderators up to now (Robbins & Judge, 2009)[9].

Table 2. The Western Practices on Aptitude Management

Country	Stages and Items		Job Type		
			Driver	Dispatcher	Rolling Stocks
Austria	Selection	Handling Stress	Ability to withstand work stress	Ability to withstand work stress	Ability to withstand work stress
	OJT (On the job Training)	Handling Emergency	Action in case of faults	Handle unusual events	—
Belgium	Selection	Handling Stress	Management of a task under temporal stress	—	—
Denmark	Selection	Handling Stress	—	Work under pressure	—
		Solitary Working	Attitude towards working alone	—	—
Finland	Selection	Handling Stress	Ability to work under stress	—	—
Germany	OJT	Handling Stress	Behavioral skills for coping with stress and conflicts	—	—
Luxembourg	Selection	Handling Emergency	Behavior in the tension moments	Behavior in the tension moments	Behavior in the tension moments
Netherland	Regular Aptitude Test	Solitary Working	Aptitude to solitary work	Aptitude to solitary work	Aptitude to solitary work
Spain	Selection	Handling Stress	Capacity to withstand work stress	—	—
Norway	Selection	Handling Stress	Stress tolerance	Stress coping	—
		Handling Emergency	—	Work under pressure	—
	Selection	Solitary Working	—	Cope with conflicts	—
		Solitary Working	—	Work independently	Work independently
Switzerland	OJT	Handling Stress	Coping with stress	—	—
		Handling Emergency	—	Handle abnormal operational situations	—
		Solitary Working	—	—	The ability to work independently and take decisions
Estonia	Selection	Handling Stress	Ability to work under stress	—	—
England	Selection	Handling Stress	Tolerance of stress	Not found	Not found
		Solitary Working	Tolerance of working alone		
France	Selection	Overall Personality including Stress Tolerance	Overall Personality including Stress Tolerance	Overall Personality including Stress Tolerance	Overall Personality including Stress Tolerance

(source : Atkins, 2002)[11]

Even if there exists some distinction in the aptitude items adopted and terminology entitled, by country and by job type, they can be divided into 3 kinds of competency: 1) ability to cope with stress, 2) tolerance of working alone, and, 3) ability to cope with stress under emergency.

Considering western examples based on the table, several implications can be found. First, most western countries recognize the ability to withstand work stress, to cope with emergency (or time pressure), and to work alone, as

an important aptitude factor necessary for maintaining safety and performing their job effectively. Main reason for this can be inferred from the fact that the previous aptitude items can have some limitations in covering today's radical changes of social and railway-concerned task environment.

Second, the competency for coping with stress is found to be more important one to the driver than other two jobs – dispatching and rolling stocks.

Table 3. The Results of Survey on Stress-Related Items

Items	Expert	Driver
1. Cope and judge under time pressure	6.42	5.78
2. Knowledge of safety	6.29	5.35
3. Stress tolerance	6.14	5.24
4. Working alone	6.00	5.40
5. Observance of procedures and rules	6.00	5.38
6. Knowledge of technology	5.86	5.42
7. Night eyesight	5.71	4.84
8. Communication	5.27	4.29
9. Processing of conflicting Information	5.29	4.78
10. Eyesight for moving object	5.29	4.89
11. Interviews by psychologist	5.14	4.64
12. Meet customers	5.00	4.69
13. Relationship with others	4.86	4.69
14. Interpretation and language	4.27	3.85
15. Presentation	3.86	3.85

(The figures are the mean scores at a 7 scale.)
(source: Shin, 2009)[10]

Third, in case of rolling stocks worker, the number of countries which are adopting stress-concerned items is relatively small. However, five countries are still adopting stress-concerned items as the important aptitude factors. What is noteworthy is that the competency of solitary working is being adopted among three countries. When we consider the fact that the rolling stocks worker used to go by the name of 'one man dispatcher,' it might make sense that the ability to work independently would be a must for them.

On the other hand, the ability to cope with emergency is considered as more critical caliber to the dispatcher in spite of its low frequency comparing to the ability to cope with stress. This result is thought to be based on the job process followed in case of emergency.

When an emergent incident happens, and as soon as the dispatcher in charge of the incident receives a report on this, he should manage to judge and deliver effective directions in the shortest time to the driver on the site, who in turn, takes a proper action for minimizing a loss or damage of the incident, based on a communication with that dispatcher. Seen from this job process, the deep insight and effective judgment of dispatcher is a decisive determinant in successful settlement of an incident.

4. Implications

As described above, the aptitude management system

focused on the stressors and the competency to handle them is so common among western countries. Then, the main concern to us is what and how to adapt it to Korean situation. For this purpose, the author once performed a survey in order to depict the opinions of three groups – railway experts, drivers, and dispatchers, respectively [10]. In this study, the author completed a questionnaire containing diverse western aptitude items having never been applied to Korean safety critical workers.

As shown in the Table 3, the ability to cope under time pressure, the tolerance of stress, and the aptitude for working alone resulted to receive relatively higher scores at large than other items for three groups. In case of our country, nevertheless, the stress-related items are not still adopted, since when it comes to aptitude management we have ever only followed Japanese model from the start. Considering both the western practices and the survey results on stress-related aptitude items for the safety critical workers, it would be desirable to put these stress-related items into the present aptitude system through systematic research as early as possible.

5. Conclusion

The main purpose of this study is to highlight the importance and validity of introduction of stress-concerned aptitude items corresponding to the radical environmental change in railway industry, for the safety critical workers.

Based on literature, case, and empirical survey, the author suggested the necessity of introducing and reflecting stress-related aptitude items into our aptitude management system for the safety critical workers. At this point, there comes up a more structural in-depth issue, so called the topic of governance. As far as the railway industry espouses the public interests first, the government-initiated railway management policy would be desirable. However, the mission of railway in this turbulent environment like today seems being enforced to be dual: profit- and nonprofit-oriented at the same time.

When it comes down to the topic of customer satisfaction, safety and financial efficiency, the indispensable direction of railway management would be put to authority delegation to the localized operational organizations rather than centralization by government. The rationale is that the flexibility for adopting stress-related items into practice on time would go together with the operational autonomy followed by delegation.

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(Appendix) Questionnaire Sample used for the Study

Following descriptions were provided to depict your specific stressors you are liable to suffer during performing your duty as a driver. Please, check on the number you may think would be most plausible to your situation or yourself.

Factor	Description	Strongly Disagree	Moderately Disagree	Medium	Moderately Agree	Strongly Agree
Physical / Emotional	1. Feel pressure on timely shift.	1	2	3	4	5
	2. Feel unsafe on account of the chance of casualty and error.	1	2	3	4	5
	3. Feel tension on showing up at the office and on duty on time.	1	2	3	4	5
	4. Feel tension coming from a conflict between timeliness and passenger's safety.	1	2	3	4	5
	5. Feel pressure from responsibility on fast problem-solving under emergency.	1	2	3	4	5
	6. Feel burden from strengthened physical checks.	1	2	3	4	5
	7. Feel fatigue from excessive utilization of specific parts of body.	1	2	3	4	5
	8. Feel pressure from the needs of evacuation(e.g. urine)	1	2	3	4	5
	9. Feel a sense of destruction of biorhythm on account of continual regular shift.	1	2	3	4	5
	10. Feel stress from excessive communication.	1	2	3	4	5
	11. Feel pressure from overcoming drowsiness.	1	2	3	4	5
	12. Feel unsafe on account of tunnel's isolated environment.	1	2	3	4	5
	13. Feel an obscure anxiety on solitary driving.	1	2	3	4	5
	14. Feel fatigue from routine multiple judgment and concentration.	1	2	3	4	5
Work environment	1. Feel fatigue from poor working environment.	1	2	3	4	5
	2. Feel a strain incurred by wrong operation of machines or tools.	1	2	3	4	5
	3. Feel difficulty in learning and adapting to new knowledge based on system change or improvement.	1	2	3	4	5
	4. Feel much burden from loaded training and education for coping with failures of systems.	1	2	3	4	5
	5. Feel stress from cabin layout unfit for solitary driving.	1	2	3	4	5
	6. Feel unsafe from the rail system and platform structure unfit for a solitary driving.	1	2	3	4	5
	7. Feel unsafe from insufficient monitoring system at boarding area.	1	2	3	4	5
	8. Feel fatigue from multiple judgment and instruction from authority in case of emergency.	1	2	3	4	5
Work system	1. Feel unsafe on account of responsibility and disadvantage received in case of accident.	1	2	3	4	5
	2. Feel a strain from individual judgment and responsibility in case of solitary driving.	1	2	3	4	5
	3. Feel psychological resistance on listening to redundant directions from manager.	1	2	3	4	5
	4. Feel stressful from multiple judgment and on the directions from above in case of emergency	1	2	3	4	5
	5. Feel lots of stress from handling temperature and broadcasting in addition to driving.	1	2	3	4	5
	6. Feel stressful at the dumps of complaints from customers.	1	2	3	4	5
	7. Feel pressure from the time schedule coming first than my private life.	1	2	3	4	5
	8. Feel burden from driving a long time in a solitary driving situation.	1	2	3	4	5
	9. Feel anxious from the lack of proper manual and education needed for solitary driving.	1	2	3	4	5
	10. Feel a lot of pressure from the rules dominating all my tasks.	1	2	3	4	5