



A fuzzy-based method of assigning train managers to task types

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Abstract

Besides an employee's skill level, several personal qualities may affect the implementation of a task during job activities. Thus, it might be hypothesised that the effectiveness of railway personnel depends on the relationship between their abilities and the types of available duties. This article presents research results on the compatibility of personnel and performed duties focusing on train managers. This profession is important due to passenger safety, and there is a lower scientific interest in this job than in the case of train drivers. A complex survey has been conducted in cooperation with volunteers from the rail industry. As a result, groups of duties and personnel profiles have also been elaborated in cooperation with railway industry experts. A fuzzy logic-based method was built to classify the train managers. Then, a self-assessment was conducted as the final step; experts were asked to assess the managers' attitudes. The overall model was tested during validation. The automatised fuzzy-based method recognised 80 % of managers and indicated good clusters.

Keywords

railway, train managers, personal profiles, task types, fuzzy logic

1. Introduction

A high employee turnover characterises Poland's labour market: the change rate in 2022 was about 21%. In the railroad sector, the job change rate is lower than the average due to the specific nature of the tasks. However, the rate is significant and challenges the current management of railroad personnel. Increased turnover leads to an increased risk of human error in operational processes. A newly hired employee must be adequately prepared to perform his specific duties. Typically, such an employee may lack the necessary skills and have limited knowledge of the tasks.

Additionally, they often have not yet performed the required tasks enough times to achieve the desired quality in their work. This is apparent in his mistakes, and the longer he takes to perform his tasks. Considering various research results, the most undesirable events recorded by the rail transportation system are caused by errors and negligence of employees.

In order to avoid accidents and improve the performance of new personnel, a commonly used approach is to change and improve the training of new employees. Solutions are being sought to allow employees to acquire and develop the competencies required for their jobs more quickly and effectively. One of the answers to these needs is virtual reality (VR) technology. It allows us to replicate the work environment of operational employees faithfully.

However, there is the problem of not having enough employees. Thus, the employer cannot take personnel for tasks, taking them from a larger set of people. In addition to an employee's skill level, several personal qualities can affect the implementation of the task during job activities. Thus, the hypothesis can be made that the effectiveness of the personnel depends on the relationship between their abilities and the types of available duties.

A literature review has been conducted to find sources addressing the formulated problem. One research direction focuses on the work schedule and its influence on system safety (Roets & Folkard, 2022). The main goal is to find situations with optimised employee work schedules that minimise, for example, the operational risk. On the one hand, the workload is analysed to determine the probability of undesirable events and identify factors to reduce this likelihood. On the other hand, a risk-based approach is used to analyse the consequences of events and assess the influence of the schedule on them. However, personal abilities and qualities and their influence on the risk function are not considered, not even in analysing undesirable event occurrences (Frantasov et al., 2021).

Notable are organisational methods in the research field to improve employee performance (Haryanto et al., 2022; Liu et al., 2021). The research demonstrates a dedicated approach to personnel management, focusing primarily on training and preparation (Balakina et al., 2023). However, it does not consider the given duty's operational aspects and specific



parameters. A general view on a whole one-employee group gives the typical human reliability approach (Harrison et al., 2022) or explores stress issues (Xu et al., 2022) without discussing personal abilities despite learnt skills. Planning and work optimising methods limit the decision factors to working time (Gołębiowski, 2020), permissions related to tracks or vehicles (Jütte et al., 2011), general costs (Preis et al., 2023) or flexibility in work planning (Ludewig, 2005; Matusova & Gogolova, 2017).

Considering the gap found, the following research questions can be formulated.

1. Is it possible to identify specific groups of duty types and compatible profiles related to railway personnel?
2. Is it possible to design a method to assign personnel to the most accurate profile?
3. Do people performing duties according to their profile work more efficiently?

This article presents the research results on the compatibility between personnel and their assigned duties. There are diverse jobs in the railway industry with different responsibilities. Thus, the paper is focused on train managers, who are crucial for passenger safety and have received less scientific interest than train drivers.

Section 2 presents groups of duties and personnel profiles developed in cooperation with experts from the railway industry. Section 3 presents the fuzzy logic-based method to classify the train managers, while Section 4 describes the validation experiment of the method. The paper ends with conclusions.

2. Data and methods

2.1. Train Manager Profiles

A survey was conducted among railway workers in Poland. The questionnaire was completed by 338 people in various positions, including traffic controller, rolling stock auditor, and train manager. No personal data from people has been used or collected. During the cooperation, the railway employees were anonymous to the researchers, and the results presented to the railway company were anonymous. Therefore, an ethical commission agreement was not necessary.

The respondents completed a three-part survey. The first part included questions on various metrics, such as the respondent's job position, gender, age, and length of service; they were also asked about the duration of the shift. In the second part, respondents were asked to subjectively identify their job's primary, periodic, and episodic duties. This part was open-ended to avoid suggesting answers to the respondents. This approach aimed to obtain information on which duties employees pay special attention to and perceive as part of their daily work. The third part of the survey asked respondents about the number and causes of incidents and accidents during their service. Railway employees also listed stress factors and what gives them satisfaction at work.

Based on the survey, three profiles of train managers were developed. The first is the passenger-orientated employee. A person who is open to the needs of co-workers and passengers, who easily establishes contact with the environment, who can empathise with others, who is patient, who adapts to situations as they arise, who is open to change, who builds on personal relationships, who shortens the existing distance between superior and subordinate, and who reacts quickly to problems as they arise. An adequate type of service has been developed for these characteristics, as shown in Table 1:

Table 1 Description of the preferred tasks: passenger-orientated train managers

Route	Vehicles	Co-workers	Passengers	Schedule
quiet, single route with a known level of disturbance;	modern/automated/ requiring proficiency in computer and automated systems.	lack of autonomy in action, seeking solutions from colleagues;	repeaters / people who commute daily to work / school	no need to work in a hurry;

The second group is duty-orientated. This is a person with a high knowledge of the applicable regulations, who is inflexible, orderly, follows the applicable standards and regulations, carries out assigned tasks in a meticulous and detailed manner, thoughtfully makes decisions, and builds hierarchical relationships in which the separation of superior and subordinate is clearly outlined. An adequate type of service has been developed for these characteristics, as shown in Table 2:



Table 2 Description of preferred tasks - duty-orientated train managers

Route	Vehicles	Co-workers	Passengers	Schedule
quiet, single-route	modern/automated/ requiring proficiency in computer and automated systems.	giving instructions, no group decision required;	mostly passengers of express trains, international trains	repetitive courses and routines;

The third group is the balanced type. A disciplined and orderly person looking for the optimum solution in problematic situations based on the rules in force and the opportunities present, following procedures but able to abandon them if a critical analysis of the situation shows a low level of efficiency or effectiveness in their application, open to change and challenges but maintaining a rational assessment of the situation at hand, making decisions in a considered manner but taking into account the time resources available. An appropriate service type has been developed for these characteristics, as shown in Table 3.

Table 3 Description of preferred tasks – balanced train managers

Route	Vehicles	Co-workers	Passengers	Schedule
with heavy traffic increasing the likelihood of conflicts with other trains / delays	any may be vulnerable	Dialogue, decisions made by looking for the best solution available, and the need to control colleagues resulting from	Copes with demanding passengers	high number of trips per time unit;

Another survey was then carried out in cooperation with the railway company. This time, the trainers grouped the employees according to the above criteria, who were then invited to participate in an anonymous survey dedicated to the employee group. Within a given question, respondents ranked the predefined answers from least important (in which case they assigned the number 1) to most important. Among all the questions, for six questions, a variation in responses was observed according to employee type:

1. C1. Indication of the most effective team management style (1 – least important, 5 – most important):
 - I listen to the team of conductors, and we plan activities together and hold them accountable (control) as a team,
 - I define the tasks to be performed, identify the person responsible and then hold him/her accountable for the results.
 - I define the tasks to be performed, and I identify the persons who could perform them, but first, I determine whether they agree to it, I support them in the implementation, and I supervise the correct performance of the tasks,
 - I present the team with a list of tasks to be performed and expect them to share them and determine how to perform them, and I only monitor their performance afterwards.
 - other.
2. C2. Indicate the most stressful situations (1 – least stressful, 8 – most stressful):
 - aggressive passenger,
 - need to reroute the train / relocate passengers, e.g. due to damage on the train or an accident of another train,
 - a new member of the train crew who has no professional experience,
 - a significant delay/stop on the train service,
 - sudden loss of health of one of the passengers,
 - passengers having to travel in uncomfortable conditions (e.g. out of service toilet, no air conditioning),
 - suicide on the tracks
 - other.
3. C3. Ways of dealing with stressful situations (1 – least used, 5 – most used):
 - I lock myself in a compartment to think about possible alternative actions or solutions to the problem,
 - I call a meeting of the whole train crew to identify possible courses of action,
 - make the necessary decisions quickly, as response time is of the utmost importance;
 - I wait for the situation to develop and follow the procedures,
 - other.



4. C4. What is most important in the daily work of a train manager (1 – least important, 6 – most important):
 - to know the procedures and stick to them regardless of the conditions that occur during work,
 - have a good relationship with the team and work in a pleasant atmosphere,
 - carry out repetitive journeys on the same routes with the same team,
 - operate on routes where there are no accidents and few 'difficult passengers',
 - have a well-organised team that knows its responsibilities and can react quickly in emergencies,
 - other.
5. C5. What is most important in emergencies (1 – least important, 7 – most important):
 - know the procedures and stick to them no matter what the conditions are during the work,
 - know who to call in order to be able to take quick action,
 - keep a cool head and wait for accidents to develop,
 - have a well-organised team that knows its responsibilities and can react quickly in an emergency,
 - ensure that passengers have access to basic information to keep them calm while waiting for a solution to be developed,
 - ensure that passengers have access to all information related to the emergency,
 - other.
6. C6. What makes a successful train manager (1 – least important, 6 – most important):
 - if I have a well-organised team that is cooperative and able to react quickly even in difficult emergencies,
 - if my employees feel satisfied with the performance of their daily duties and are not afraid of new professional challenges,
 - if I reach such a level of knowledge that I can/can advise other train managers with less experience/knowledge,
 - if I am paid in such a way that I am satisfied with my salary,
 - if I enjoy the respect of colleagues and company management,
 - other.

2.2. The fuzzy model for the assignment of railway workers to tasks, together with models for the evaluation and classification of railway workers

The method consists of two stages. First, a questionnaire about the employee's perception of the job is carried out. This is followed by inference based on the answers given and assignment to a particular group using fuzzy models.

A Mamdani-type fuzzy modelling method was used. A minimum approach was adopted for the 'and' relationship, and a maximum approach was adopted for 'or'. Implication is based on minima, while aggregation is based on maxima. Defuzzification is centroidal.

Interviews and questionnaires led to the emergence of ratings assigned to specific responses, which also characterised the types of employees involved. For each response, the mean value within the employee category was calculated. Then, it was examined using a parametric test for two averages at a significance level of $\alpha = 0.1$ (comparing each with each) to see if a statistical conclusion could be drawn on the difference in these values. If such a difference was shown for two or three pairs, then a given response was found to be specific for one or two groups relative to the others. The given response became the assessment model's feature (and input variable).

As a result, the following responses were listed as characteristic, differentiating groups of employees:

1. C1 – Team management: I define the tasks to be performed myself; I identify the person responsible and then hold him/her accountable for the results.
2. C2 – Stress (three characteristic responses were identified, so a separate model was developed for this trait, which is the input to the total train manager model):
 - Stress: aggressive passenger
 - Stress: a new member of the train crew with no work experience
 - Stress: having to travel by passengers in uncomfortable conditions (e.g. out of service toilet, no air conditioning)



3. C3 – Coping with Stress: I convene a meeting of the entire conductor team to identify possible courses of action.
4. C4 – The most important thing in daily work is to know the procedures and stick to them, regardless of the conditions during the work.
5. C5 – The most important in an emergency is to know who to call so that you can take quick action
6. C6 – Achieving success: If I reach a level of knowledge that I can/should advise other training managers with less experience/knowledge

Membership functions were developed for the input variables with the number of points assigned for a given response on the horizontal axis. A sub-model was developed for stressful situations in the main model. Details of the stress sub-model are presented in Figures 1–4 (input and output membership functions) and Table 4 (inference rules).

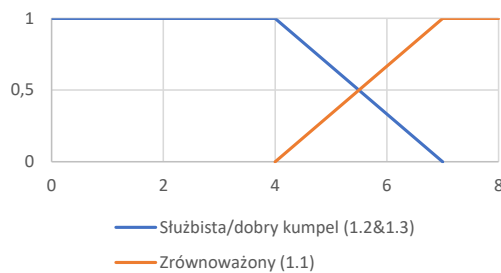


Figure 1 Membership functions for the input variable aggressive passenger of the stress submodel

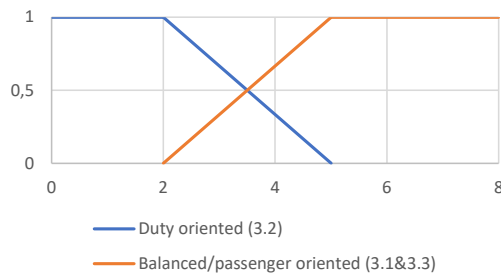


Figure 3 Membership functions for the stress sub-model input variable

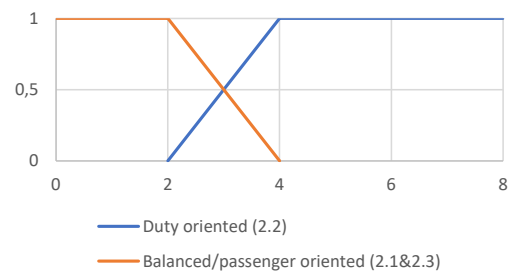


Figure 2 Membership functions for the input variable of the stress sub-model

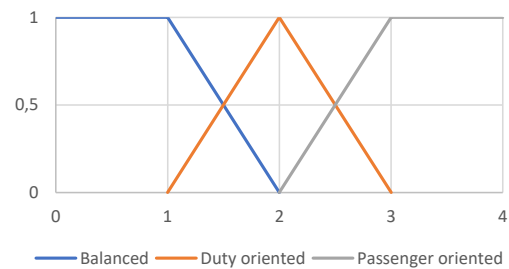


Figure 4 Membership functions for the stress sub-model output variable

Table 4 Inference rules for the stress situation model

Rule	C1	C2	C3	Type	Rule	C1	C2	C3	Type
1	1.1	2.1&3	3.1&3	1	5	1.2&3	2.1&3	3.1&3	3
2	1.1	2.1&3	3.2	1	6	1.2&3	2.1&3	3.2	2
3	1.1	2.2	3.1&3	3	7	1.2&3	2.2	3.1&3	3
4	1.1	2.2	3.2	2	8	1.2&3	2.2	3.2	2

The types of membership functions have been chosen in cooperation with experts from the rail industry. The characteristic values of these functions are the result of the survey performed. According to the elaborated classification rules, the instructors divided the employees into types and then anonymised the responses in the given category. The rounded to the integer average values were used for the characteristic point elaboration.

Sometimes, membership functions are combined for two types of employees. This results in close average values and a positive result from the parametric test on the equality of two means. A team of scientists and experts from the rail industry has developed the inference rules presented in Table 4.

The same approach has been used for the overall model. The types of functions have been chosen by cooperation between scientists and experts from the rail industry. The characteristic values of these functions also result from the same survey conducted by volunteer train managers.

There are six input variables and one output variable. Their membership functions are presented in Figures 5–11. The 144 inference rules are shown in Tables 5 and Table 6.

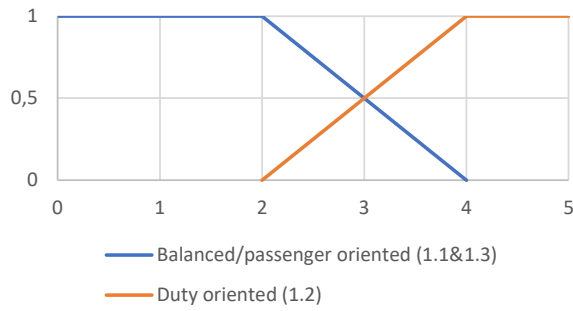


Figure 5 Membership functions for input variable C1 – Team management: I define the tasks to be performed myself; I identify the person responsible and then hold him/her accountable for the results.

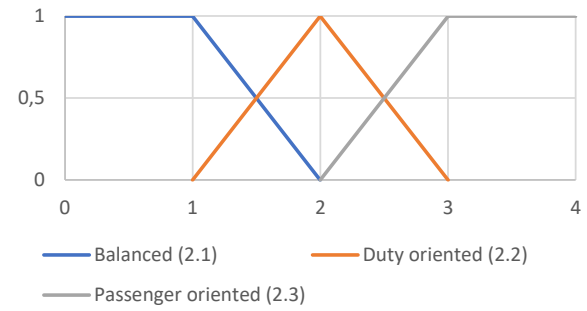


Figure 6 Membership functions for input variable C2 – Stress

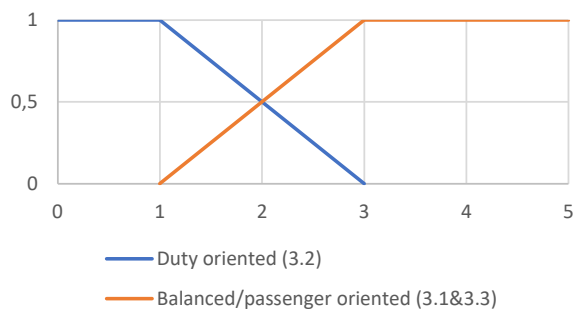


Figure 7 Membership functions for input variable C3 – dealing with stress: I convene a meeting of the entire conductor team to identify possible courses of action.

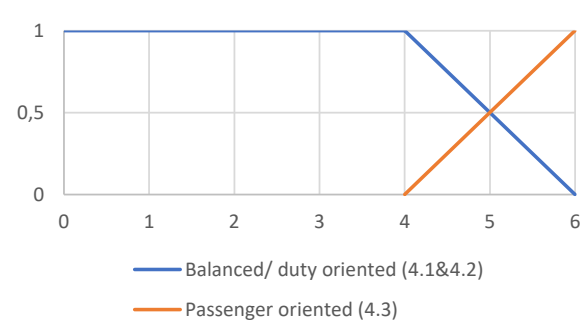


Figure 8 Membership functions for input variable C4 – The most important in daily work: know the procedures and stick to them, whatever the conditions during the work

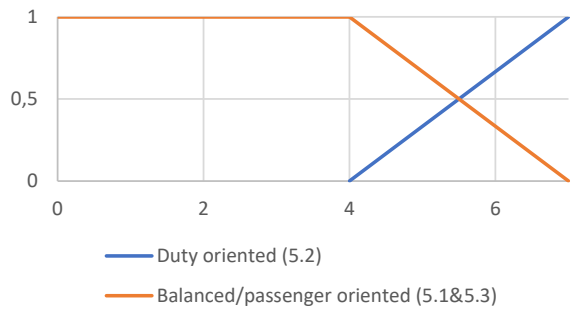


Figure 9 Membership functions for input variable C5 – The most important in an emergency: Know who to call so you can take quick action

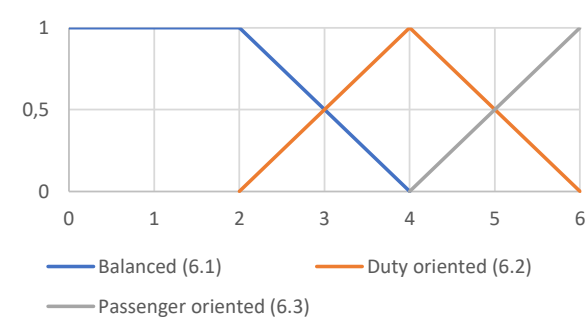


Figure 10 Membership functions for input variable C6 – Achieving success: if I reach a level of knowledge that I can/should advise other train managers with less experience/knowledge

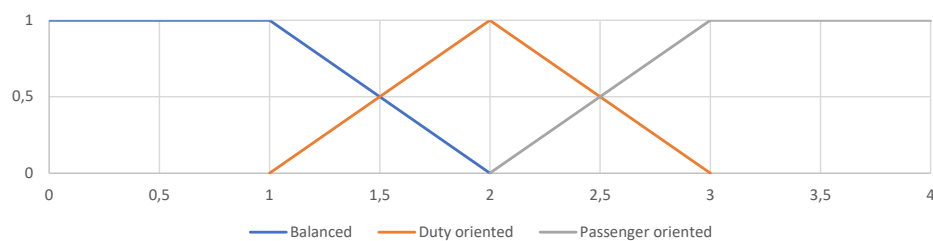


Figure 11 Membership functions for the output variable of the evaluation of the train driver category



Table 5 Inference rules 1–100 for the model for assigning categories to a train driver

Rule	C1	C2	C3	C4	C5	C6	Type	Rule	C1	C2	C3	C4	C5	C6	Type
1	1.1&3	2.1	3.1&3	4.1&2	5.1&3	6.1	1	51	1.1&3	2.3	3.1&3	4.1&2	5.1&3	6.3	3
2	1.1&3	2.1	3.1&3	4.1&2	5.1&3	6.2	1	52	1.1&3	2.3	3.1&3	4.1&2	5.2	6.1	1
3	1.1&3	2.1	3.1&3	4.1&2	5.1&3	6.3	1	53	1.1&3	2.3	3.1&3	4.1&2	5.2	6.2	2
4	1.1&3	2.1	3.1&3	4.1&2	5.2	6.1	1	54	1.1&3	2.3	3.1&3	4.1&2	5.2	6.3	3
5	1.1&3	2.1	3.1&3	4.1&2	5.2	6.2	2	55	1.1&3	2.3	3.1&3	4.3	5.1&3	6.1	3
6	1.1&3	2.1	3.1&3	4.1&2	5.2	6.3	1	56	1.1&3	2.3	3.1&3	4.3	5.1&3	6.2	3
7	1.1&3	2.1	3.1&3	4.3	5.1&3	6.1	1	57	1.1&3	2.3	3.1&3	4.3	5.1&3	6.3	3
8	1.1&3	2.1	3.1&3	4.3	5.1&3	6.2	3	58	1.1&3	2.3	3.1&3	4.3	5.2	6.1	3
9	1.1&3	2.1	3.1&3	4.3	5.1&3	6.3	3	59	1.1&3	2.3	3.1&3	4.3	5.2	6.2	3
10	1.1&3	2.1	3.1&3	4.3	5.2	6.1	1	60	1.1&3	2.3	3.1&3	4.3	5.2	6.3	3
11	1.1&3	2.1	3.1&3	4.3	5.2	6.2	2	61	1.1&3	2.3	3.2	4.1&2	5.1&3	6.1	1
12	1.1&3	2.1	3.1&3	4.3	5.2	6.3	3	62	1.1&3	2.3	3.2	4.1&2	5.1&3	6.2	2
13	1.1&3	2.1	3.2	4.1&2	5.1&3	6.1	1	63	1.1&3	2.3	3.2	4.1&2	5.1&3	6.3	3
14	1.1&3	2.1	3.2	4.1&2	5.1&3	6.2	2	64	1.1&3	2.3	3.2	4.1&2	5.2	6.1	2
15	1.1&3	2.1	3.2	4.1&2	5.1&3	6.3	3	65	1.1&3	2.3	3.2	4.1&2	5.2	6.2	2
16	1.1&3	2.1	3.2	4.1&2	5.2	6.1	1	66	1.1&3	2.3	3.2	4.1&2	5.2	6.3	2
17	1.1&3	2.1	3.2	4.1&2	5.2	6.2	2	67	1.1&3	2.3	3.2	4.3	5.1&3	6.1	3
18	1.1&3	2.1	3.2	4.1&2	5.2	6.3	2	68	1.1&3	2.3	3.2	4.3	5.1&3	6.2	3
19	1.1&3	2.1	3.2	4.3	5.1&3	6.1	1	69	1.1&3	2.3	3.2	4.3	5.1&3	6.3	3
20	1.1&3	2.1	3.2	4.3	5.1&3	6.2	2	70	1.1&3	2.3	3.2	4.3	5.2	6.1	3
21	1.1&3	2.1	3.2	4.3	5.1&3	6.3	3	71	1.1&3	2.3	3.2	4.3	5.2	6.2	2
22	1.1&3	2.1	3.2	4.3	5.2	6.1	1	72	1.1&3	2.3	3.2	4.3	5.2	6.3	3
23	1.1&3	2.1	3.2	4.3	5.2	6.2	2	73	1.2	2.1	3.1&3	4.1&2	5.1&3	6.1	1
24	1.1&3	2.1	3.2	4.3	5.2	6.3	3	74	1.2	2.1	3.1&3	4.1&2	5.1&3	6.2	2
25	1.1&3	2.2	3.1&3	4.1&2	5.1&3	6.1	1	75	1.2	2.1	3.1&3	4.1&2	5.1&3	6.3	1
26	1.1&3	2.2	3.1&3	4.1&2	5.1&3	6.2	2	76	1.2	2.1	3.1&3	4.1&2	5.2	6.1	1
27	1.1&3	2.2	3.1&3	4.1&2	5.1&3	6.3	3	77	1.2	2.1	3.1&3	4.1&2	5.2	6.2	2
28	1.1&3	2.2	3.1&3	4.1&2	5.2	6.1	2	78	1.2	2.1	3.1&3	4.1&2	5.2	6.3	2
29	1.1&3	2.2	3.1&3	4.1&2	5.2	6.2	2	79	1.2	2.1	3.1&3	4.3	5.1&3	6.1	1
30	1.1&3	2.2	3.1&3	4.1&2	5.2	6.3	2	80	1.2	2.1	3.1&3	4.3	5.1&3	6.2	2
31	1.1&3	2.2	3.1&3	4.3	5.1&3	6.1	3	81	1.2	2.1	3.1&3	4.3	5.1&3	6.3	3
32	1.1&3	2.2	3.1&3	4.3	5.1&3	6.2	2	82	1.2	2.1	3.1&3	4.3	5.2	6.1	1
33	1.1&3	2.2	3.1&3	4.3	5.1&3	6.3	3	83	1.2	2.1	3.1&3	4.3	5.2	6.2	2
34	1.1&3	2.2	3.1&3	4.3	5.2	6.1	2	84	1.2	2.1	3.1&3	4.3	5.2	6.3	3
35	1.1&3	2.2	3.1&3	4.3	5.2	6.2	2	85	1.2	2.1	3.2	4.1&2	5.1&3	6.1	1
36	1.1&3	2.2	3.1&3	4.3	5.2	6.3	3	86	1.2	2.1	3.2	4.1&2	5.1&3	6.2	2
37	1.1&3	2.2	3.2	4.1&2	5.1&3	6.1	2	87	1.2	2.1	3.2	4.1&2	5.1&3	6.3	2
38	1.1&3	2.2	3.2	4.1&2	5.1&3	6.2	2	88	1.2	2.1	3.2	4.1&2	5.2	6.1	2
39	1.1&3	2.2	3.2	4.1&2	5.1&3	6.3	2	89	1.2	2.1	3.2	4.1&2	5.2	6.2	2
40	1.1&3	2.2	3.2	4.1&2	5.2	6.1	2	90	1.2	2.1	3.2	4.1&2	5.2	6.3	2
41	1.1&3	2.2	3.2	4.1&2	5.2	6.2	2	91	1.2	2.1	3.2	4.3	5.1&3	6.1	1
42	1.1&3	2.2	3.2	4.1&2	5.2	6.3	2	92	1.2	2.1	3.2	4.3	5.1&3	6.2	2
43	1.1&3	2.2	3.2	4.3	5.1&3	6.1	2	93	1.2	2.1	3.2	4.3	5.1&3	6.3	3
44	1.1&3	2.2	3.2	4.3	5.1&3	6.2	2	94	1.2	2.1	3.2	4.3	5.2	6.1	2
45	1.1&3	2.2	3.2	4.3	5.1&3	6.3	3	95	1.2	2.1	3.2	4.3	5.2	6.2	2
46	1.1&3	2.2	3.2	4.3	5.2	6.1	2	96	1.2	2.1	3.2	4.3	5.2	6.3	2
47	1.1&3	2.2	3.2	4.3	5.2	6.2	2	97	1.2	2.2	3.1&3	4.1&2	5.1&3	6.1	2
48	1.1&3	2.2	3.2	4.3	5.2	6.3	2	98	1.2	2.2	3.1&3	4.1&2	5.1&3	6.2	2
49	1.1&3	2.3	3.1&3	4.1&2	5.1&3	6.1	1	99	1.2	2.2	3.1&3	4.1&2	5.1&3	6.3	2
50	1.1&3	2.3	3.1&3	4.1&2	5.1&3	6.2	3	100	1.2	2.2	3.1&3	4.1&2	5.2	6.1	2



Table 6 Inference rules 81–144 for the model for assigning categories to a train driver

Rule	C1	C2	C3	C4	C5	C6	Type	Rule	C1	C2	C3	C4	C5	C6	Type
101	1.2	2.2	3.1&3	4.1&2	5.2	6.2	2	123	1.2	2.3	3.1&3	4.1&2	5.1&3	6.3	3
102	1.2	2.2	3.1&3	4.1&2	5.2	6.3	2	124	1.2	2.3	3.1&3	4.1&2	5.2	6.1	2
103	1.2	2.2	3.1&3	4.3	5.1&3	6.1	2	125	1.2	2.3	3.1&3	4.1&2	5.2	6.2	2
104	1.2	2.2	3.1&3	4.3	5.1&3	6.2	2	126	1.2	2.3	3.1&3	4.1&2	5.2	6.3	3
105	1.2	2.2	3.1&3	4.3	5.1&3	6.3	3	127	1.2	2.3	3.1&3	4.3	5.1&3	6.1	3
106	1.2	2.2	3.1&3	4.3	5.2	6.1	2	128	1.2	2.3	3.1&3	4.3	5.1&3	6.2	3
107	1.2	2.2	3.1&3	4.3	5.2	6.2	2	129	1.2	2.3	3.1&3	4.3	5.1&3	6.3	3
108	1.2	2.2	3.1&3	4.3	5.2	6.3	2	130	1.2	2.3	3.1&3	4.3	5.2	6.1	3
109	1.2	2.2	3.2	4.1&2	5.1&3	6.1	2	131	1.2	2.3	3.1&3	4.3	5.2	6.2	2
110	1.2	2.2	3.2	4.1&2	5.1&3	6.2	2	132	1.2	2.3	3.1&3	4.3	5.2	6.3	3
111	1.2	2.2	3.2	4.1&2	5.1&3	6.3	2	133	1.2	2.3	3.2	4.1&2	5.1&3	6.1	2
112	1.2	2.2	3.2	4.1&2	5.2	6.1	2	134	1.2	2.3	3.2	4.1&2	5.1&3	6.2	2
113	1.2	2.2	3.2	4.1&2	5.2	6.2	2	135	1.2	2.3	3.2	4.1&2	5.1&3	6.3	3
114	1.2	2.2	3.2	4.1&2	5.2	6.3	2	136	1.2	2.3	3.2	4.1&2	5.2	6.1	2
115	1.2	2.2	3.2	4.3	5.1&3	6.1	2	137	1.2	2.3	3.2	4.1&2	5.2	6.2	2
116	1.2	2.2	3.2	4.3	5.1&3	6.2	2	138	1.2	2.3	3.2	4.1&2	5.2	6.3	2
117	1.2	2.2	3.2	4.3	5.1&3	6.3	2	139	1.2	2.3	3.2	4.3	5.1&3	6.1	3
118	1.2	2.2	3.2	4.3	5.2	6.1	2	140	1.2	2.3	3.2	4.3	5.1&3	6.2	2
119	1.2	2.2	3.2	4.3	5.2	6.2	2	141	1.2	2.3	3.2	4.3	5.1&3	6.3	3
120	1.2	2.2	3.2	4.3	5.2	6.3	2	142	1.2	2.3	3.2	4.3	5.2	6.1	2
121	1.2	2.3	3.1&3	4.1&2	5.1&3	6.1	1	143	1.2	2.3	3.2	4.3	5.2	6.2	2
122	1.2	2.3	3.1&3	4.1&2	5.1&3	6.2	2	144	1.2	2.3	3.2	4.3	5.2	6.3	3

As a result, values from 0 to 4 are obtained (Figure 11). Some margin is left to interpret the results by experts for the range from 1.0–1.5 (a mixture of balanced and duty-orientated) and for the range 2.5–3.0 (a mixture of passenger-orientated and duty-orientated). In the other cases:

- 0 to 1 – balanced,
- 1.5 to 2.5 – duty-orientated,
- 3.0 to 4.0 – passenger-orientated.

3. Results and Validation

To validate the method, a sample of people was given a questionnaire as a data source for the models assigning staff categories (as described earlier). A second part of the questionnaire was prepared, in which they were asked to give answers characterising the services (self-assessment). It was done according to the description placed in Tables 1–3.

A section on the level of errors and shortcomings within the service followed this. For each question, the respondent could give one of four answers: agree, possibly, disagree, or not applicable.

- I sometimes lack time to fulfil all my duties,
- It bothers me when I have to finish tasks after work,
- I can cope with situations where I have delayed the train,
- I would prefer a different way of managing the team to which I belong,
- I usually find working with people (passengers or co-workers) difficult.

The results were analysed in three steps. First, an employee category was assigned according to the method. Then, a team of scientists and experts determined from the answers in the second part of the questionnaire which types of tasks the employee performed on the job (the team did not know at the time which category was assigned according to the method). In the final step, the team evaluated the third part of the questionnaire and determined whether the employee had indicated significant difficulties in the tasks that he or she performed. After this, the database was merged. The occurrence of



significant errors on the job was assigned if the train manager indicated a response of at least 'possibly' for at least four questions or agreed on at least two questions.

The results of the experiment performed are shown in Table 7. In this part, 41 volunteers working as train managers participated. The respondents were not the same as in the previous survey,

Table 7 Validation of the method

Category – Method score	Description of tasks according to the self-assessment	Are there any significant errors/defects in the performance of tasks on the job?	Should there be any failures according to the method,	Result
Passenger-orientated	Passenger-orientated	No.	No.	Correct.
Passenger-orientated	Passenger-orientated	No.	No.	Correct.
Passenger-orientated	Duty-orientated	yes,	yes,	Correct.
Passenger-orientated	Passenger-orientated	yes,	No.	Not correct.
Passenger-orientated	Balanced	No.	yes,	Not correct.
Duty-orientated	Passenger-orientated	yes,	yes,	Correct.
Duty-orientated	Duty-orientated	No.	No.	Correct.
Duty-orientated	Duty-orientated	No.	No.	Correct.
Duty-orientated	Balanced	yes,	yes,	Correct.
Balanced	Duty-orientated	yes,	yes,	Correct.
Duty-orientated	Balanced	yes,	yes,	Correct.
Balanced	Passenger-orientated	No.	yes,	Not correct.
Balanced	Balanced	No.	No.	Correct.
Balanced	Balanced	No.	No.	Correct.
Passenger-orientated	Balanced	yes,	yes,	Correct.
Duty-orientated	Balanced	yes,	yes,	Correct.
Balanced	Balanced	yes,	No.	Not correct.
Passenger-orientated	Passenger-orientated	No.	No.	Correct.
Passenger-orientated	Passenger-orientated	No.	No.	Correct.
Passenger-orientated	Balanced	yes,	yes,	Correct.
Passenger-orientated	Duty-orientated	yes,	yes,	Correct.
Passenger-orientated	Passenger-orientated	No.	No.	Correct.
Passenger-orientated	Balanced	yes,	yes,	Correct.
Passenger-orientated	Balanced	yes,	yes,	Correct.
Balanced	Balanced	No.	No.	Correct.
Duty-orientated	Passenger-orientated	No.	yes,	Not correct.
Duty-orientated	Passenger-orientated	yes,	yes,	Correct.
Duty-orientated	Duty-orientated	yes,	yes,	Correct.
Duty-orientated	Duty-orientated	No.	No.	Correct.
Duty-orientated	Balanced	yes,	yes,	Correct.
Passenger-orientated	Passenger-orientated	No.	No.	Correct.
Duty-orientated	Duty-orientated	No.	No.	Correct.
Duty-orientated	Duty-orientated	yes,	No.	Not correct.
Duty-orientated	Duty-orientated	No.	No.	Correct.
Duty-orientated	Duty-orientated	No.	No.	Correct.
Balanced	Balanced	No.	No.	Correct.
Balanced	Balanced	No.	No.	Correct.
Duty-orientated	Duty-orientated	yes,	No.	Not correct.
Balanced	Balanced	yes,	No.	Not correct.
Balanced	Balanced	No.	No.	Correct.
Balanced	Balanced	No.	No.	Correct.

Of 41 volunteers, 17 were women and 24 men. The youngest volunteer was 34 years old, and the oldest was 56 years old. The first column of Table 7 shows the train manager category of the volunteers according to the presented method. The second column presents the real job description they do. The third column informs if the personnel have regular difficulties in the job. The next column indicates whether there should be difficulties based on discrepancies between the category resulting from the model and the description of the survey participants. Finally, the last column shows if there is a correlation between the model and the real data.

Five out of 41 participants were incorrectly evaluated. Their category seems correct, but significant difficulties occur during the job performance. On the other hand, 3 of the 41 volunteers had no match, but no significant difficulties were noted at the same time. It means that 80.5% of analysed train managers have been assigned to groups correctly (Results: Correct – 33 persons), 7.3 % have been assigned incorrectly (they should have no difficulties, but they have) (Results: not correct – Difficulty: yes – 3 persons) and the remaining 12.2 % (Results: not correct – Difficulty: no – 5 persons) should have difficulties according to the model, but they do not have.



4. Conclusions

The paper aimed to show that personal qualities may influence personnel performance regarding employee tasks. A large-scale survey has been performed to identify the train manager categories. The final validation experiment with 41 people shows that the model worked correctly for 80.5%. It also means that a proper assignment of tasks influences the scale of difficulties during job duties. Answering the research questions, it is possible to prepare a combination of profiles and duty types, and the people who are properly assigned have fewer difficulties in their daily jobs.

In the experiment, 7.3% of participants were identified as not properly assigned according to the model, and they had, in fact, significant difficulties in their daily jobs. At the same time, 12.2% of the participants were also identified as not properly assigned, but they had no significant job problems. However, the experiment should be confirmed in additional research.

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