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USING THE PROCESS FUNCTION METHOD TO ASSESS THE ORGANIZATIONAL LEVEL IN DANGEROUS GOODS TRANSPORTATION[1]

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Abstract. *As one of the most well-known methods for assessing the organizational level, the process function method represents a very effective tool for diagnosing the existing conditions and identifying what needs to be improved. The process function method can be used to evaluate the organization of business functions, organizational units, work areas work, business elements, workplaces, etc. In this paper, the process function method is applied in order to evaluate the organizational level in the dangerous goods transportation process in one of the units of the Serbian Armed Forces. Following the implementation of the methodology, the elements which should be improved to increase the existing level of the organization of dangerous goods transportation in the unit that was the subject matter of analysis were identified.*

Key words: *process function; estimation, organization; dangerous goods transportation.*

1. Introduction

Transportation is the most dynamic process nowadays, without which the life and survival of people would be unthinkable. In the world today, it cannot be imagined – not for a moment – that no transportation of goods or passengers takes

[1] *This paper is an extended and amended version of the paper entitled "Application of Process Function Method for Estimating the Level of Organization in Transporting Dangerous Goods", which was published at the conference entitled: "Security and Crisis Management – Theory and Practice, 2019".*

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place. In addition to everything positive in terms of the development of society, the development of technologies, the urbanization of cities and towns, the development of the infrastructure and industry as a whole, pose a greater danger to the safety and health of both people and the environment. In traffic, the increasing presence of goods containing dangerous substances causes a greater use of vehicles for transporting them. In order to protect ourselves against the effects of the harmful effects of hazardous substances, we are compelled to study them, analyze their impact and determine the extent of such protection. Dangerous goods transportation is particularly pronounced in the army, because handling this type of goods on a daily basis is a normal thing in that type of the environment. This fact requires that, in addition to the development of the economy, the infrastructure, the introduction of various technologies and systems, the construction of facilities in which a large number of people live or work, appropriate measures should be taken so as to protect against accidents caused by transporting dangerous goods.

The Rulebook on Dangerous Goods Transportation at the Ministry of Defense and in the Serbian Armed Forces ("Official Military Gazette", no. 8/2018) regulates dangerous goods transportation, organized by the Ministry of Defense and the Military, as well as the military forces of the other states and organizations that use the traffic infrastructure of the Republic of Serbia under a special agreement. This rulebook is harmonized with the National Law on Dangerous Goods Transportation ("Official Gazette of the Republic of Serbia", 95/2018) and the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR, 2017), the Regulations concerning the International Carriage of Dangerous Goods by Rail (RID, 2017) and the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN, 2017).

This paper is aimed at assessing the level of the organization of the work done by the person in charge of organizing the dangerous goods transportation process in one of the units of the Serbian Armed Forces. The process of solving the considered problem was carried outby the application of the process function method.

Apart from the introduction and the conclusion sections, this paper also consists of the following sections: in Section 2 of the project entitled "*Dangerous Goods in Transport*", the notion of dangerous goods, the proportion of accidents in the case of the improper handling of dangerous goods, as well as the international agreements governing dangerous goods transportation by certain transportation modes, are emphasized. *Rating the Organizational Process of Dangerous Goods Transportation by Means of the Process Function Method* is the title of Section 3, in which the process function method is described and accordingly applied to the considered problem. In the *Conclusion*, i.e. in Section 4, the results are discussed and suggestions for the improvement of the current situation are given.

2. Dangerous Goods Transportation

In order to more accurately understand potential hazards associated with working with a substance, it is necessary to know and analyze a large number of the physical and chemical properties of a substance, e.g. (Vidović *et al.*, 2019):

- the type of a danger,

- the physical state,
- viscosity,
- the boiling point,
- melting temperatures,
- density,
- the voltage of the steam,
- flammability temperature,
- auto-ignition temperature,
- the limits of explosive mixtures,
- reactivity with respect to other substances, and so on.

The term "dangerous substance" refers to the factory declared physical-chemical characteristics of a substance determined based on the recognized and corresponding criteria. From the chemistry standpoint, the above-mentioned term "dangerous substance" is not adequate in order to define such a substance; the term "hazardous substance", however, should rather be used (Jovanović *et al.*, 2010).

Using a wrong term may erroneously direct the determination of the status of dangerous substances during the transportation process, which directly affects both the application of an appropriate recovery procedure in the case of accidents, and finally the application of the methods that are contrary to the international rules and obligations.

The term "dangerous goods" refers to a situation when a hazardous matter/substance is contained in an appropriate packaging/container or vehicle during the transportation process. , Criteria for the potential risks of hazardous substances are specifically determined for the transportation conditions (Jovanović *et al.*, 2010).

According to the Rulebook on Dangerous Goods Transportation at the Ministry of Defense and in the Serbian Armed Forces ("Official Military Gazette" no. 8/2018) and the Law on Dangerous Goods Transportation ("Official Gazette of the Republic of Serbia", no. 95/2018), dangerous goods are substances and articles forbidden from transport, i.e. those that are allowed if such transport takes place under international agreements on and regulations for dangerous goods transportation by the type of traffic (ADR, RID, ADN).

There are numerous examples of an unprofessional and negligent treatment while handling (manipulating) dangerous goods transportation, having resulted in the suffering of people and the degradation of property and the environment.

The consequences of road traffic accidents with vehicles transporting dangerous goods may also be such as to amount to a catastrophe. For example:

– In Halifax (Nova Scotia) on 6th December 1917 (Figure 1), there was a collision caused by the accident of a French ship, "Mont Blanc", and a Norwegian ship, "SS imo", in the Halifax access port and channel, which had been moving at a low speed of about 2.5 km/h. The Mont Blanc was carrying about 3.2 million pounds of picric acid and TNT for the needs of the French army in World War II. The effect of the explosion reflected in the fragments of the ship, a shock wave and a tsunami of 18 meters in height created by the explosion. The estimated temperature of the explosion was about 5000°C. a pyro-trophic cloud rose to an altitude of about 3600m. The number of the victims has never been precisely determined. It is believed that about 1600 people were killed immediately and about 400 succumbed to injuries, 9000 were injured, 1600 homes were destroyed in a series of fires and 12000 homes were damaged. The industrial

sector of the city was completely destroyed. The Halifax disaster was the unofficial start of a systematic consideration of hazardous substances (Janković, 2016).

Figure 1. The Halifax disaster in 1917; the explosion of the ship and the consequences (Janković, 2016);

- In Los Alfaques (Spain) in 1978, a fuel tank was overloaded. Due to high heat and pressure, the tank exploded and the fuel caught fire, killing 216 people (Figure 2).

Figure 2. The consequences of the tank accident on the way to Los Alfaques in 1978.

- In Okobie (a Nigerian town) on 12th July 2012, there was an explosion of road tanker gas transportation vehicles (Figure 3). A total of 121 people were killed in the accident and 75 were injured.

Figure 3. The consequences of the accident in Okobie (Nigeria) on 12th July 2012 (Janković, 2016);

- In Šabac in 1986, a railroad tank carrying ammonia (NH3) was hanging off the overpass due to the consequences of the accident. The valves were loose and the gas began to release. A favorable wind and the timely intervention of specially trained workers prevented a greater catastrophe from happening.

In order to avoid suchlike and similar situations and reduce risks to a minimum, it is necessary that all persons coming into contact with dangerous goods, or those such dangerous goods may have an impact on, should comply with the regulations and guidelines defining the manner in which dangerous goods should be handled and also the way in which they should properly trained and prepared for their work. Based on these problems, the experts of the United Nations considered giving the basic recommendations and guidelines for the international agreements on the Convention-related procedure for dangerous goods in certain transportation modes (Vidović et al., 2019; Jovanović et al., 2010; Janković, 2016; Jovanović, 2004; Petrović, 2004), as in Figure 4:

- ADR – European Agreement concerning the International Carriage of Dangerous Goods by Road;
- RID – Regulations concerning the International Carriage of Dangerous Goods by Rail;
- ICAO–TI – International Civil Aviation Organization – Technical Instructions for the Safe Transport of Dangerous Goods by Air;
- IMDG–CODE – International Maritime Dangerous Goods–Code;
- ADN – European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways.

Figure 4. International agreements on dangerous goods transportation

3. Rating the Organizational Process of Dangerous Goods Transportation by Means of the Process Function Method

The process function method can be used to evaluate the organizational level of an entire organization or only certain organizational units, functions, and so forth. According to (Erić, D., 2000), the term 'process functions' implies the activities necessary for the successful completion of the entire task at all workplace levels in an organization. There are 10 basic phases of the process functions (Pamučar, 2013; Lukovac *et al.*, 2018; Lukovac *et al.*, 2015; Savić *et al.*, 2017; Tomić, 2019) that appear in the work process, as in Table 1.

Table 1. An overview of the process functions with tags and the meaning

Name of the function	Index	Meaning
Recording	Rec	Covering all business developments in the organization
Informing	Inf	Delivering data and information to all workplaces in the organization
Controlling	Con	Comparison of the activities performed with pre-set benchmarks, standards and guidelines
Analysis	An	Disassembling, comparing and concluding on the causes of deviations
Deciding	De	Re-intervening on developments in the existing processes and shaping future processes

Planning	Pl	Providing the necessary elements to execute decisions
Synchronization	Sy	Combining and directing individual efforts into a total effort
Organizing	Org	Finding and designing appropriate organizational procedures and performing work tasks
Performance	Per	Concrete execution of tasks in all workplaces in the organization
Command	Co	Assigning tasks to subordinate units and authorities.

In this paper, the activities performed by the person in charge of organizing the dangerous goods transportation process in one of the units of the Serbian Armed Forces are analyzed, as in Table 2.

Table 2. The jobs analyzed

Index	Jobs
01	Determining the availability of the drivers capable of transporting dangerous goods
02	Determining the availability of the vehicles intended for dangerous goods transportation
03	Consulting with the safety advisor on dangerous goods transportation
04	Developing an engagement plan
05	Preparing the driver to complete the task
06	Controlling the equipment that a dangerous goods transportation vehicle must have
07	Controlling the driver and the vehicle documentation
08	Checking the knowledge of the procedure in the event of a failure or a traffic accident
09	Communicating occupational safety and health, environmental and fire safety measures when performing the task
10	Tracking the completion of the task
11	Submission of reports within prescribed deadlines

The listed tasks are performed within the individual work areas by the process functions. Given the fact that not every job has to contain all the process functions, it is necessary to determine their connection with the process function, which is determined by entering a “+” sign into the “The connection between the jobs and the process functions” table where the sum of such “+” signs represents the sum of the frequencies (F) (Table 3) for the job containing one of the process functions. If a job contains no process functions, a “-” sign is entered into the table.

Table 3. The connection between the jobs and the process functions

Jobs	Process function										F
	Rec	Inf	Con	An	De	Pl	Sy	Org	Per	Co	
01	+	+	+	+	+	+	+	+	+	+	10
02	+	+	+	+	+	+	+	+	+	+	10
03	+	+	+	+	+	+	+	+	+	+	10
04	+	+	+	+	+	+	+	+	+	+	10
05	+	+	+	+	+	+	+	+	+	+	10
06	+	+	+	+	+	+	+	+	+	+	10
07	+	+	+	+	+	+	+	+	+	+	10
08	+	+	+	+	+	+	+	+	+	+	10
09	+	+	+	+	+	+	+	+	+	+	10
10	+	+	+	+	+	+	+	+	+	+	10
11	+	+	+	+	+	+	+	+	+	+	10

Not all jobs have the same importance. Some are more significant, whereas others are less significant; it is necessary to perform their weighting. The weighting is performed by selecting one of the weights on a scale from 0 to 5, according to the criteria accounted for in Table 4.

Table 4. The weighting criteria

Weight	Criterion
5	The execution of the jobs is necessary, without which no business would be possible
4	The execution of the jobs has a big impact on the overall business
3	The execution of the jobs affects the economy of the business
2	A failure to do the job causes a deficiency in business, but business is nonetheless possible
1	The execution of the jobs affects the integrity of business
0	The execution of the jobs is unnecessary

The process functions are weighted according to the same criteria, because not all of them have the same importance for the job. The selected job weights, as well as the process function weights, are a result of a survey conducted with the person performing these tasks in the Serbian Military Unit that was the subject matter of this analysis. The weighting of the jobs and the process functions was performed by multiplying the selected job weights by the selected process function weights, and the resulting products are the theoretical weights for the jobs by process function, or for the process functions by job, as given in Table 5.

Table 5. The theoretical weighting of the jobs by process function

Jobs		Process function										∑
		Rec	Inf	Con	An	De	Pl	Sy	Org	Per	Co	
		Weight										
Index	Weight	3	3	5	5	5	5	4	5	5	5	
01	**5**	15	15	25	25	25	25	20	25	25	25	225
02	**5**	15	15	25	25	25	25	20	25	25	25	225
03	**5**	15	15	25	25	25	25	20	25	25	25	225
04	**5**	15	15	25	25	25	25	20	25	25	25	225
05	**4**	12	12	20	20	20	20	16	20	20	20	180
06	**4**	12	12	20	20	20	20	16	20	20	20	180
07	**5**	15	15	25	25	25	25	20	25	25	25	225
08	**4**	12	12	20	20	20	20	16	20	20	20	180
09	**5**	15	15	25	25	25	25	20	25	25	25	225
10	**5**	15	15	25	25	25	25	20	25	25	25	225
11	**4**	12	12	20	20	20	20	16	20	20	20	180
∑		153	153	255	255	255	255	204	255	255	255	2295

The next step implies the evaluation of the jobs by process functions, with the rating from 1 to 5, according to the criteria for determining the ratings based on the observed organizational attitude in the observed workplace, as shown in Table 6.

Table 6. The job evaluation criteria

Rating	Criterion
1	The jobs are not done
2	The jobs are done occasionally
3	The jobs are not done on employees' own initiative, but upon order
4	The jobs are done according to the instructions received from the superiors
5	The jobs are done according to the organizational regulations

The job ratings by process function are shown in Table 7 and they are also a result of the survey conducted with the person performing the tasks that were the subject matter of this analysis.

Table 7. The job ratings

Jobs	Process function									
	Rec	Inf	Con	An	De	Pl	Sy	Org	Per	Co
01	3	3	3	3	5	5	4	5	5	5
02	3	3	3	3	5	5	4	5	5	5
03	4	3	4	4	5	5	4	5	5	5
04	5	5	4	3	5	4	4	5	5	5
05	5	5	4	4	5	5	4	5	5	5
06	3	3	3	4	5	5	4	5	5	5
07	5	3	5	3	5	5	4	5	5	5
08	3	3	5	3	5	5	4	5	5	5
09	5	5	5	5	5	5	5	5	5	5
10	5	3	5	5	5	5	5	5	5	5
11	3	5	5	4	5	5	5	5	5	5

After the job evaluation by process functions, the calculation of the actual job weights (P_s) is performed by using Equation 1:

$$P_s = \frac{P_p \times O}{S_o} \tag{1}$$

where

- P_p – the required (theoretical) weighting of the job,
- O – the job evaluation by process functions,
- S_o – the rating scale (5).

The actual job weights are shown in Table 8.

Table 8. The actual jobs weights

Jobs	Process function										Σ
	Rec	Inf	Con	An	De	Pl	Sy	Org	Per	Co	
01	9	9	15	15	25	25	16	25	25	25	189
02	9	9	15	15	25	25	16	25	25	25	189
03	12	9	20	20	25	25	16	25	25	25	202
04	15	15	20	15	25	20	16	25	25	25	201
05	12	12	16	16	20	20	12.8	20	20	20	168.8
06	7.2	7.2	12	16	20	20	12.8	20	20	20	155.2
07	15	9	25	15	25	25	16	25	25	25	205
08	7.2	7.2	20	12	20	20	12.8	20	20	20	159.2
09	15	15	25	25	25	25	20	25	25	25	225
10	15	9	25	25	25	25	20	25	25	25	219
11	7.2	12	20	16	20	20	16	20	20	20	171.2
Σ	123.6	113.4	213	190	255	250	174.4	255	255	255	2084.4

The next step in applying this method implies the calculation of the average job ratings (O) by using Equation 2:

$$O=\frac{\sum P_s}{\sum P_p}\times S_o \tag{2}$$

The average job ratings are shown in Table 9.

Table 9. The average job ratings

Jobs	$\sum P_s$	$\sum P_p$	O
01	189	225	4.20
02	189	225	4.20
03	202	225	4.49
04	201	225	4.47
05	168.8	180	4.69
06	155.2	180	4.31
07	205	225	4.56
08	159.2	180	4.42
09	225	225	5.00
10	219	225	4.87
11	171.2	180	4.76
Total	2084.4	2295	**4.54**

Analogously to Equation 2, the average ratings of the process functions (O_{pf}), which are shown in Table 10, are calculated by using the weights given in Tables 5 and 8.

Table 10. The average ratings of the process functions

Process function	$\sum P_s$	$\sum P_p$	O_{pf}
Recording	123.6	153	4.04
Informing	113.4	153	3.71
Controlling	213	255	4.18
Analysis	190	255	3.73
Deciding	255	255	5.00
Planning	250	255	4.90
Synchronization	174.4	204	4.27
Organizing	255	255	5.00
Performance	255	255	5.00
Command	255	255	5.00
Total	2084.4	2295	**4.54**

Based on the average job and process function ratings, the jobs (Table 11) and the process functions are ranked, as in Table 12.

Table 11. The job ranks

Rank	Job index	Weights	O
1.	09	5	5.00
2.	10	5	4.87
3.	11	4	4.76
4.	05	4	4.69
5.	07	5	4.56
6.	03	5	4.49
7.	04	5	4.47
8.	08	4	4.42
9.	06	4	4.31
10.	01	5	4.20
10.	02	5	4.20

Table 12. The process function ranks

Rank	Process function	Weights	O_{pf}
1.	Deciding	5	5.00
1.	Organizing	5	5.00
1.	Performance	5	5.00
1.	Command	5	5.00
2.	Planning	5	4.90
3.	Synchronization	4	4.27
4.	Controlling	5	4.18
5.	Recording	3	4.04
6.	Analysis	5	3.73
7.	Informing	3	3.71

4. Conclusions

Average job evaluation is an assessment of the organizational level in a particular workplace. Accordingly, based on the value of the average job rating (4.54) obtained in this research study, it can be concluded that it is characteristic of the organizational level that the execution of jobs does not entirely base on organizational regulations, but also on the instructions received from superiors. This especially applies to the jobs rated lower than the average job rating; in this case, these are the following jobs:

- 01 – Determining the availability of the drivers capable of transporting dangerous goods,
- 02 – Determining the availability of the vehicles intended for dangerous goods transportation,
- 06 – Controlling the equipment that a dangerous goods transportation vehicle must have,
- 08 – Checking the knowledge of the procedure in the event of a failure or a traffic accident,
- 04 – Developing an engagement plan, and

- 03 – Consulting with the safety advisor on dangerous goods transportation.

Based on the average process function rating, we came to know the process functions that need to be upgraded. This primarily applies to those process functions that are rated lower than the average (4.54); so, in this specific case of ours, the improvement measures should focus on the process functions of:

- Synchronization,
- Controlling,
- Recording,
- Analysis, and
- Informing.

The good and the bad sides of the organizational level can also be seen from the analysis of the relationship between the assigned weights and the calculated ratings. According to the analysis carried out, it is also possible to see which process functions and jobs need to be paid greater attention to, which primarily applies to those process functions and jobs that are assigned high weights and have low average ratings. From this point of view, the jobs marked "01", "02", "03" and "04" are interesting, as well as the "Controlling" and "Analysis" process functions.

Given the fact that the jobs marked "01", "02", "03" and "04", as well as the "Controlling" and "Analysis" process functions, were identified as the weaknesses in both cases, the measures for the improvement of the existing situation should first focus on improving these jobs and process functions.

However, it is necessary to emphasize that the results of this analysis should be critically viewed in order for a more appropriate analysis of the observed problem to be performed and that the opinions of a larger number of persons (or groups of experts) involved in the subject-matter problem should be considered.

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