

NATIONAL UNIVERSITY OF PUBLIC SERVICE
DOCTORAL SCHOOL OF MILITARY ENGINEERING

Cpt. Gávay György Viktor

**EXAMINATION AND ANALISYS OF THE WHEELED
FIGHTING VEHICLES ACCORDING TO MILITARY
EXPERINECE REQUIREMENTS OF THE LAST
DECADES**

**AUTHOR'S PRESENTATION OF DOCTORAL
DISSERTATION**

Consultant:

Dr. habil József Gyarmati eng. LtCol.(PhD)

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Formulation of the scientific problem

As a result of the task executing commitments of Hungary in the management of conflicts requiring military intervention, the Hungarian Defence Force also plays a role that requires modern vehicles. The significant modernization of Hungary's military forces and the vehicles of the Hungarian Defence Forces has recently become particularly relevant, which is a very complex issue and a several years long process.

All military forces aim at the protection of the staff and the vehicles when executing operational and tactical activities. This protection is inevitable to ensure that the military organization is able to start and execute its tasks with the necessary forces and vehicles. Securing the troops transported by fighting vehicles depends on the attributes that define the protection of the vehicle. Ensuring the criteria needed to enhance the safety is complex and in many cases raises related questions.

Vehicle development is a process that allows for the better safety of the troops by using vehicles that have better protection. When planning the vehicle development and throughout its process it cannot be left out of sight when determining the requirements (for example the Tactical Technical Requirements in case of military vehicles) that the Hungarian Defence Force needs vehicles and fighting vehicles with which it can be efficient in multiple areas of application.

Two of the application areas can be well defined:

- Protection of Hungary's territory;
- Execution of missionary tasks usually far from Hungary.

In case of territory protection tasks the geographical characteristics, circumstances important for protection fighting need to be taken into

consideration, while in case of missionary territories experience clearly shows that the direction and distance of attacks is practically undefinable.

The result of the vehicle modernization should be to have fighting vehicles that have been selected based on well-defined aspects and the needs of both application areas.

The basis of the parts of the tasks can be defined based on the following scientific problems:

- The threat of the fighting vehicles has changed in the past decades, the role of the wheeled fighting vehicles has grown. Due to these changes measuring and processing the fighting vehicles' safety requirements and their technical development is needed.
- No summary is available that would provide an overview of the characteristics and effects of the common attack weapons and the protection elements used against them for defining the direction of a possible fighting vehicle development or procurement.
- No data base is available based on which the technical characteristics defining the Tactical Technical requirements of wheeled fighting vehicles could be compared and analyzed.
- No criteria are available that would enable comparing and prioritizing the wheeled fighting vehicles, based on which the selection for the given task would be possible.
- No method is available for grouping and evaluating the wheeled fighting vehicles based on their applicability and similarity in the given application area.

The research objectives forming the basis of the dissertation

Based on the scientific problems I have defined the following research objectives:

- Getting to know the changes in the security requirements and protection abilities of the wheeled fighting vehicles and drawing conclusions based on them.
- It is worth to define a level of protection that is certainly insufficient in a given application environment today, and the lack of which might have critical effects.
- Creating a database that makes it possible to compare the attributes defining the Tactical Technical Requirements by introducing the wheeled fighting vehicles used in the last decades as well as the latest developments and by collecting the attributes influencing the protection capabilities.
- Putting together criteria that makes it possible to compare, prioritize and select the wheeled fighting vehicles.
- Identification and usage of a method that makes it possible to group and evaluate the wheeled fighting vehicles based on their suitability in the given application area

Definition of the research hypotheses

I have defined the following hypotheses during the processing of the research subject:

- I assume that the protection deficiencies arising at the application areas of the fighting vehicles during the last decades appeared as

protection requirements that have generated technical development, and this process can be summarized;

- I assume that by summarizing the attack weapons, their effects and the protection elements used in the development of the fighting vehicles, by measuring impact data and by processing scientific literature conclusions can be drawn regarding the safety of the vehicles;
- I assume that the development of the used and armored wheeled fighting vehicles can be defined by data and the collected information can be used to create a data base that can help to summarize and compare the protection capabilities of the modern wheeled fighting vehicles;
- I assume that by summarizing the attributes defining the protection criteria can be determined that makes it possible to compare the vehicles with mathematical methods in more than one decision making environment.
- I assume that a well applicable mathematical method can be identified that makes it possible to group and evaluate the wheeled fighting vehicles based on how well they fulfil the criteria typical for their usage.

Research methods

I have used the following research methods in order to reach the set objectives:

- I have searched for scientific literature and publications matching the topic, organized the contained information and data, based on which I have made a comprehensive document analysis;

- Using an interference-free qualitative research approach I have carried out a content analysis based on the identified literature;
- I have participated in the development and execution of multiple shooting experiments that were closely connected to the research topic and have used the data, results and observations for the creation of this dissertation;
- I have carried out a historical summary and analysis in the subject of development and modernization of wheeled fighting vehicles;
- By using a processing research method I have carried out a quality analysis, based on which I have drawn inductive conclusions;
- I have put together criteria suitable for the comparison of the vehicles with the help of data I have collected on the attributes affecting the security of wheeled fighting vehicles;
- I have compared the vehicles with the help of a mathematical model and have drawn conclusions from the data received from the analysis.

The structure of the dissertation

In the dissertation I have introduced the chronological changes of the characteristics of wheeled fighting vehicles influencing their protection, 10 development paths based on 32 fighting vehicle types and I have compared the introduced wheeled fighting vehicles with a selected mathematical model.

In connection with the examination of the protection capabilities of wheeled fighting vehicles based on scientific literature data I have researched and determined in the first chapter that out of the tactical technical features of the APC and IFV vehicles protection, delivery capacity, mobility and firepower can be named as the most important ones.

In connection with the protection capabilities of fighting vehicles I have researched and introduced in this chapter the following points regarding wheeled fighting vehicles:

- the four main attributes influencing their protection;
- reasons for their expansion;
- possibilities for their grouping based on the namings I was to first to collect;
- threat affecting them in the past decades and the dangers occurring during military application;
- weapons and methods used for attack against them;
- changes in their protection needs.

Military experience of the 90s highlighted that the protection of fighting vehicles transporting the troops, which was still accepted in the Vietnam war, has become insufficient and this initiated the development of the protection capabilities of wheeled fighting vehicles.

Based on the data and information gained and collected through experiments, in the second chapter I have introduced:

- weapons that posed a threat to wheeled fighting vehicles in the last decade and that were used not only in conventional, all-arms fighting;
- harmful effects caused by the weapons (destruction, devastation and damage);
- STANAG 4569 document in detail out of the standards describing the protection capabilities of safety elements and fighting vehicles;
- protection possibilities against the harmful effects of weapons, the applied materials and safety elements.

Based on the collected information and data, in chapter three I have introduced the development paths of 10 fighting vehicles, based on which I have drawn conclusions regarding the changes of the Tactical Technical Requirements. The tables containing

the technical data can be found in the appendix of the dissertation and I have used the information they contain as the basis of chapter four.

Based on the collected technical data, in chapter four I have determined criteria that are suitable for comparing the introduced wheeled fighting vehicles. With the help of the criteria and a multicriteria decision model I have determined the hierarchy of the introduced wheeled fighting vehicles in two separate application areas. As a result I have confirmed that vehicles with homogeneous steel armor have disadvantages regarding their protection compared to modernized or newly developed fighting vehicles.

This comparison was carried out with the PROMETHEE method and VPS software, according to the requirements I have determined for the two separate application areas.

With the help of the GAIA method I have separated groups of the introduced fighting vehicles that have similar protection, so I have added to the information from the PROMETHEE full hierarchy.

Conclusions

In the first chapter I have examined the significant military operations of the last decades, paying special attention to data that concern the threats of the protected troop transportation vehicles.

While processing and analyzing the researched literature I have come to the conclusion that out of the attributes defining the protection, the biggest change affects security.

Military experience of the 90s highlighted that the protection of fighting vehicles transporting the troops, which was still accepted in the Vietnam war, has become insufficient and this initiated the development of the protection capabilities of wheeled fighting vehicles.

In the second chapter I have introduced the weapons used in the last decades and their harmful effects in order to examine the security of wheeled fighting vehicles.

Based on the processed literature I have determined that during the correction and development of the protection capabilities of wheeled fighting vehicles, non-metallic elements became highly important in the ballistic, anti-explosion and anti-splinter protection.

As discussed in the first chapter, the technical development initiated by the new protection needs has significantly enhanced the (ballistic) protection against active weapons, especially infantry weapons and the protection against reactive weapons, such as mines, IEDs and EFPs (explosively formed penetrator), always keeping in mind the areal density of the safety elements.

In the dissertation I have examined the military operation experience of the past decades, based on which I have identified, summarized and graphically illustrated the biggest changes affecting the threat and protection of the wheeled armored vehicles.

Based on collected data backed up with experimental results I have determined that the wheeled fighting vehicles with homogeneous steel armor have insufficient ballistic protection.

Based on data of the shooting experiments as well as the existing literature it can be stated that such 5,56 mm and 7,62 mm caliber rifle rounds exist that have bigger penetration capabilities at 15 m shooting distance than the STANAG 4569 LEVEL 3 research round. This is why I do not find it sufficient to mention the STANAG 4569 2 and 3 protection levels without adding the type of the research round when determining the security of a given safety element or vehicle.

With processing the development of the vehicle types introduced in chapter three I have determined that the wheeled fighting vehicles have gone through

a significant change in the last 40 years regarding protection capabilities, mobility, transportation capacity and firepower. The changes regarding protection capabilities happened in the last 20-22 years, the effect of the experiences of the Yugoslav war and the Middle East is clear.

The third problem defined in the introduction is that there is no database available that would make it possible to compare and analyze the technical attributes and characteristics defining the Tactical Technical Requirements of the wheeled fighting vehicles.

I have drawn inductive conclusions by collecting and analyzing the technical data of a large number of wheeled fighting vehicles, with which I have put together the database serving as the basis of defining the Tactical Technical Requirements with regards to protection, mobility, transportation capacity and firepower.

With the help of the complex criteria I have put together, with a multi-aspect decision model (PROMETHEE method) I have determined the hierarchy of the introduced wheeled fighting vehicles in two separate environments (MT – area of abroad mission, and TV – homeland area defence) As a result I have confirmed that the vehicles with homogeneous steel armor have disadvantages regarding their protection compared to modernized or newly developed fighting vehicles.

The result received from the PROMETHEE method confirms the technical development of the wheeled fighting vehicles as well as the disadvantages of the vehicles that only have homogeneous steel armor. (Figure 1.)

As a final result with a multicriteria decision making model I have separated sub-groups within the group of the introduced wheeled fighting vehicles based on the quality of fulfilling the criteria typical for given application areas. (Figure 2. and 3.)

TV					MT				
Rang	alternativa	Phi	Phi+	Phi-	Rang	alternativa	Phi	Phi+	Phi-
1	Patria AMV xp	0,2692	0,3085	0,0393	1	Patria AMV_XC360P	0,2279	0,2733	0,0454
2	Patria AMV	0,2677	0,3032	0,0355	2	Pandur_II 8x8	0,2145	0,2658	0,0513
3	Patria AMV_XC360P	0,2572	0,2977	0,0405	3	Pandur_II 6x6	0,2119	0,2755	0,0636
4	Piranha 5	0,2455	0,2908	0,0453	4	Patria AMV	0,2097	0,2687	0,0590
5	Pandur_II 8x8	0,2287	0,2799	0,0511	5	Patria AMV xp	0,2089	0,2690	0,0601
6	VBCI_I	0,2144	0,2641	0,0497	6	Piranha 5	0,2000	0,2574	0,0574
7	VBCI_II	0,2092	0,2685	0,0593	7	VBCI_I	0,1831	0,2350	0,0519
8	FNSS 8x8	0,1924	0,2285	0,0361	8	FNSS 8x8	0,1790	0,2302	0,0511
9	Boxer IFV	0,1533	0,2761	0,1228	9	VBCI_II	0,1583	0,2359	0,0776
10	Pandur_II 6x6	0,1461	0,2214	0,0753	10	VAB_II	0,1524	0,2224	0,0700
11	VAB_III	0,1388	0,2251	0,0863	11	Boxer APC	0,1392	0,2414	0,1022
12	VAB_II	0,1339	0,2087	0,0748	12	Ejder	0,1387	0,2086	0,0700
13	Ejder	0,1261	0,1880	0,0619	13	Boxer IFV	0,1211	0,2631	0,1420
14	FNSS 6x6	0,0943	0,1653	0,0710	14	VAB_III	0,1129	0,1968	0,0839
15	BTR 90	0,0717	0,2556	0,1839	15	FNSS 6x6	0,0716	0,1624	0,0908
16	Boxer APC	0,0650	0,2136	0,1486	16	Stryker DVH	0,0487	0,1718	0,1231
17	Stryker DVH	0,0047	0,1656	0,1608	17	BTR 90	0,0145	0,2363	0,2218
18	LAV25	0,0008	0,1822	0,1814	18	Fuchs_II	-0,0140	0,1540	0,1680
19	M1117 TAPV	-0,0314	0,1500	0,1814	19	LAV25	-0,0418	0,1733	0,2151
20	Fuchs_II	-0,0481	0,1618	0,2099	20	M1117 TAPV	-0,0640	0,1439	0,2079
21	BTR 82A	-0,0494	0,1963	0,2457	21	VAB NG	-0,1235	0,1467	0,2702
22	Patria XA185	-0,0800	0,1419	0,2218	22	BTR 82A	-0,1267	0,1697	0,2964
23	VAB NG	-0,1986	0,1144	0,3130	23	Piranha III	-0,1291	0,1108	0,2399
24	Fuchs_A8	-0,2040	0,1137	0,3178	24	Patria XA185	-0,1504	0,1267	0,2772
25	Piranha III	-0,2061	0,0905	0,2967	25	Fuchs_A8	-0,1695	0,1280	0,2975
26	BTR 80A	-0,2350	0,1402	0,3752	26	Pandur_I	-0,1782	0,1277	0,3059
27	Pandur_I	-0,2513	0,0906	0,3418	27	VAB_I	-0,1794	0,1328	0,3122
28	Patria XA202	-0,2673	0,0675	0,3348	28	M1117 ASV	-0,2600	0,0492	0,3092
29	VAB_I	-0,2788	0,0936	0,3724	29	Patria XA202	-0,2806	0,0838	0,3643
30	M1117 ASV	-0,3153	0,0387	0,3539	30	Fuchs_I	-0,2888	0,0696	0,3584
31	Fuchs_I	-0,3249	0,0585	0,3834	31	BTR 80	-0,2911	0,1006	0,3917
32	BTR 80	-0,3290	0,0825	0,4115	32	BTR 80A	-0,2953	0,1212	0,4165

Figure 1. Result of the vehicles comparison: a PROMETHEE II complete rankings of the TV and MT environments.

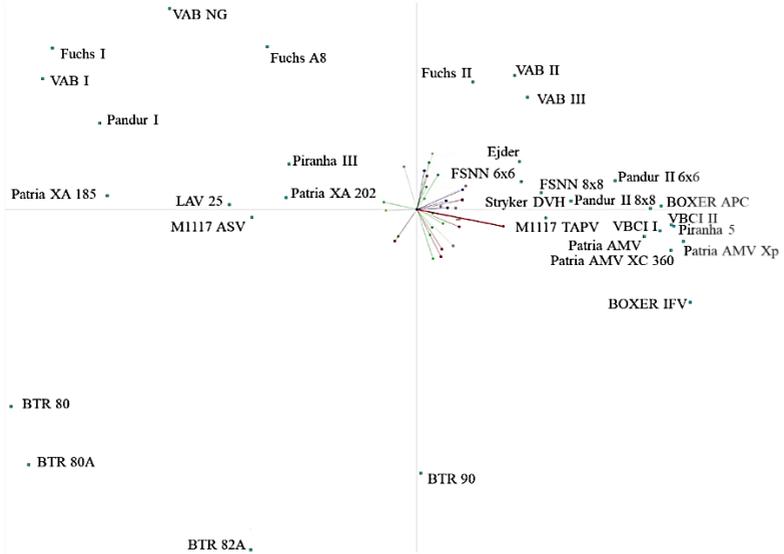


Figure 2. Representing alternatives and criteria at GAIA plane of TV enviroment

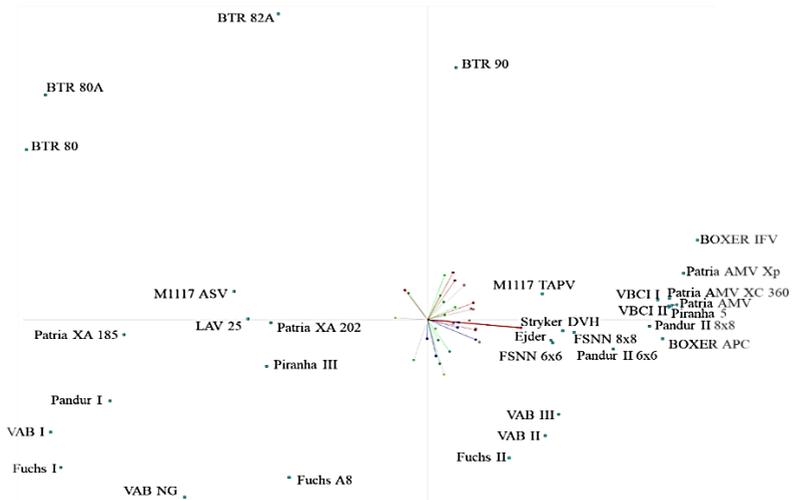


Figure 3. Representing alternatives and criteria at GAIA plane of MT enviroment

Scientific Findings

1.

I have examined the military operation experience of the past decades, based on which I have identified, summarized and graphically illustrated the biggest changes affecting the threat and protection of the wheeled armored vehicles.

2.

Based on data collected from scientific literature sources as well as my own experimental results, I have determined that due to the armor penetration capability of the 5,56 mm and 7,62 mm caliber AP rifle and machine gun rounds, in case of a 90° impact angle the ballistic protection of the wheeled fighting vehicles with homogeneous steel armor is not sufficient.

3.

I have analyzed development path types of the ten wheeled fighting vehicles used in the last half century and based on their technical data and features I have identified changes that occurred in the Tactical Technical Requirements regarding protection, transportation capacity, mobility and firepower.

4.

I have determined the hierarchy of the introduced wheeled fighting vehicles in two different application areas with the help of a multicriteria decision model, and as a result I have confirmed with the criteria used in the examination that vehicles with homogeneous steel armor have disadvantages regarding their protection compared to modernized or newly developed fighting vehicles.

5.

I have identified and applied a multicriteria decision model and with it I have separated sub-groups within the group of the introduced wheeled fighting vehicles based on the quality of fulfilling the criteria typical for given application areas.

Recommendations

I recommend to apply the subject and results of the dissertation in the following fields within the organizations of the Hungarian Defence Forces and the Ministry of Defence, as well as at the Faculty of Military Sciences and Officer Training of the National University of Public Service and the NCO Academy:

- the dissertation provides structure for the descriptions of the passive protection of the wheeled fighting vehicles and so serves as a basis for specialists of this field for further research;
- the contents of the dissertation can be applied in the area of military research and development;
- I find studying and applying the dissertation useful during the preparation of the troops selected for military operations, especially missionary operations;
- the dissertation can serve as a basis for updating educational materials on topics regarding wheeled fighting vehicles for institutions with military education;
- the subject of the dissertation and the information it contains can serve as a basis for formulating tactical, technical requirements when managing military vehicle procurements or planning the modernization of the applied vehicles.

The practical applicability of the research findings

I find the dissertation results applicable in practice according to the following:

- the compiled databases are applicable in practice during training and education;

- the dissertation summarizes the protection development of the wheeled fighting vehicles with passive elements, which can be applied as educational material in the military middle and higher education;
- the information on safety elements summarized in the dissertation can be effectively applied for the protection development of military vehicles;
- the method for the comparative analysis of the wheeled fighting vehicles can be effectively applied in vehicle procurement processes for selection or classification.

The publications of the author regarding the dissertation

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- Gávay György, Gyarmati József, Kalácska Gábor, Sebők István, Szakál Zoltán - Lövedék páncéllemezen történő áthaladás

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Professional CV of PhD student György Viktor Gávay

The candidate has earned his high school diploma and car mechanic qualification in 1997 at the Széchenyi István High School and Vocational High School in Pécs, and a year after he has also earned his technician diploma at the same institution.

From end of 1998 he started working as a car mechanic and from November 2000 he started his conscription service as a driver.

In 2002 he applied for and got admitted to the armored and motor vehicle technology specialty of the Bolyai János College Faculty of Military

Engineering. Because of his scholastic records and dedication he received multiple recognitions and rewards. In 2005 he took the second place in his section at the National Conference of Scientific Students' Associations. His subject was the development of the cooling system of BTR fighting vehicles, where he also performed independent tests at Ócsa Military Training Base. His work was also acknowledged by the commander as well as the head of the armored and motor vehicle technology branch of MHÖLTP. In 2006 he received the military service sign for flood-control.

The candidate received his bachelor's degree in 2006 at the armored and motor vehicle technology specialty of the Bolyai János College Faculty of Military Engineering.

He fulfilled his first assignment as an officer between 2006-2010 at Pápa Air Base in the position of platoon commander of the Logistic company repair platoon. From 2010 he started his educational career at the Zrínyi Miklós University of National Defence as a technical tutor and also educated the pupils as an NKH registered instructor of the Bolyai Driving School.

In 2011 the nominee got admitted to the safety engineer Msc course of the predecessor institution and gained his qualification as a certified safety engineer at the National University of Public Service Safety Engineering MA specialty of security defense system analysis. The topic of his thesis was the research of the riot control shields, the basis of which was a measurement series carried out with high speed camera tests. The measurement data was also acknowledged by the specialists of the Rapid Response Unit.

In 2013 the candidate got admitted to the correspondence course of the Doctoral School of Military Engineering, where he received his absolutorium in 2015.

Next to his educational tasks and studies he was constantly involved in research and other military activities.

As a consultant for the research papers of the Conference of Scientific Students' Associations his students regularly finished at top three in their sections.

From 2013 he was member of the military engineering research society and analyzed the material quality changes of the damaged armor plates in cooperation with the teachers of the Szent István University of Gödöllő.

In 2016 the nominee researched the movement of splinters resulting from the punching of armor plates at the then existing experimental shooting station of the Hungarian Defence Forces VGH.

In 2017 he won a scholarship as part of the New National Excellence Program, where he researched the application of military vehicles in public services.

From 2012 to 2016 he was helping the work of the faculty leadership as a member of the Faculty Council of the Faculty of Military Sciences and Officer Training.

In 2016 he took part in the Temporary Security Border Fence task, after which he represented the Faculty of Military Sciences and Officer Training at the Slovak Shield high-visibility multinational exercise.

In 2018 he took part in the Erasmus program at the University of Defence in Brno in the Czech Republic.

The quality of the scientific work of the candidate is also reflected by the 30 citations and nr 3 Hirsch Index score he received for his 23 publications before submitting his application for the Phd degree process, which also includes an internationally proofread scientific article that was published abroad. As a result of the above the number of his publication points is 30,7, which is significantly more than the minimal requirements of the Doctoral School.