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METHODOLOGICAL APPROACH INTO RESEARCHING TRAFFIC UNDER EXTRAORDINARY SECURITY CIRCUMSTANCES

ABSTRACT

The complexity of researching traffic under extraordinary conditions in order to implement a more efficient and functional traffic management strategy under both normal and irregular conditions- as well as the grey zone of when the change from normal into extraordinary traffic conditions actually occur- provides the researcher with numerous methodological problems.

Starting from the viewpoint that the field of traffic science needs an increase into the capacity of research into traffic under extraordinary conditions we have chosen to define within this article a specific methodological approach that undertakes a study into the exposure, menace, threat and risk faced by traffic systems under extraordinary conditions through utilising methods utilised by the military that allow for the possible resolution of such problems through compatible testing of both simulated and real life conditions that such systems may face.

In searching for possible applicable solutions to such demanding parametres we believe that the use of concrete information in real time and real space in order to bring about a more efficient functioning of traffic under extraordinary conditions can be achieved through the use of the analytical capacity of traffic systems information gathering attained through the usage of Uninhabited Flying Vehicles (UFVs) in monitoring road, rail and maritime traffic and transport.

KEY WORDS

Methodological approach, traffic research, extraordinary circumstances/ conditions, Uninhabited Flying Vehicles

1. INTRODUCTION

The traffic system of every European region, including Southern Eastern Europe, by ways of its complexity, volume, specificity of its individual subsystems and organisation is of great interest to the continued economic and social development of Europe; as well as the successful realisation of international state defensive alliances in the form of NATO's Partnership for Peace (PP), especially in the field of counter-terrorism whereby such systems may guarantee the continued functioning of traffic systems under all conditions.

As a fundamental integrationary factor, traffic systems must secure the activation of all potential human and material resources of a region into a useful functioning system under 'regular' traffic conditions, yet this must also be the case in times of rapid transition from 'regular' to 'extraordinary' traffic conditions. The term 'extraordinary' conditions in the functionality of traffic systems will be understood in this article to mean - natural catastrophes (earthquakes, floods and large scale fires), terrorist attacks and the outbreak of war. All other conditions will be deemed 'regular'.

Experiences up till now concerning the decisive role of traffic in 'extraordinary' circumstances, as well as the problems that arise under such conditions, have highlighted the need for continuous research into traffic systems with the goal of finding solutions that will ensure the effective functioning of traffic under all types of conditions/circumstances as well as 'extraordinary' ones.

Research into the problem of the functionality of traffic systems under extraordinary conditions, according to more recent findings, has methodologically begun to be tied to military technological research. In line with this trend, within this article, we will search for possible solutions to the problems of evaluating exposure, menace, danger and risk within traffic systems from 'extraordinary' external circumstances with a special emphasis on UAV technology. We believe that on the basis of such fortified evaluations one can go on

to plan the development and functionality of traffic systems that will eventually satisfy the demands for an effective, functioning of the system under all conditions that most states seek.

2. THE POSSIBILITIES AND THE NECESSITIES OF RESEARCHING TRAFFIC IN 'EXTRAORDINARY' CIRCUMSTANCES

Before every traffic system there stands the demand for the fast, exact, secure, elastic and safe functioning of all subsystems and elements that make up the entire system, as well as those conditions that occur in 'extraordinary' circumstances, so that in the minimal amount of time and space the system can satisfactorily function, even in times of total confusion.

The possibilities and the need to research traffic in 'extraordinary' circumstances in most segments are not reconciled with the efficiency of the functionality of traffic systems *per se*. To some extent these problems can be looked at through analysing certain methodological problems that emerge in the research as well as other approaches of research.

2.1 Some methodological problems with the research

Rapid technological and scientific developments in the field of traffic science have effected research into individual organisational, technical, technological and other innovations in the search for a more effective functioning of traffic systems under all conditions, which in turn will enable for the emergence of suitable responsible scientific prognoses into these concrete changes within the systems themselves.

There seems to be a demand for further research into the functioning of (specific) traffic systems at times of transition toward separate, smaller- as well as a return to- unique, systems. Satisfying these demands is tied to *in toto* specific characteristics of traffic systems as they are tied to the methodological problems of the research *per se*.

The traffic system of a given region, along with more modern solutions made available to its problems, is seemingly still viewed today in terms of how the infrastructural objects and transport resources of all its traffic arms can resolve their shortcomings. The fact that it causes concern in the region of South Central Europe, as in most cases, these systems are decades, and in some cases centuries, old. Because of this their ability to be activated (read function) in times of 'extraordinary' security circumstances must not be assumed automatically capable of achieving the most effective results.

Varying social, demographic, economic, geographic and other conditions have brought society to varying levels of development, capabilities and needs via offering traffic services in the entire area of certain regions and states. This problem touches various scientific fields due to its distinctive interdisciplinary nature, which demands in turn complex research especially from the point of view that these problems occur in extenuating circumstances.

The relative high degree of motorisation and other technical-technological solutions in traffic allows the bringing of human and material goods/ /transport ever more closer to the place of the natural disaster or military (terrorist) actions as well as being able to evacuate the thoroughfares no matter what the level of need is or the surrounding conditions. However, this high degree of motorisation in large urban areas, especially amongst street vehicles, that often do not follow acceptable standards of infrastructural and regulative organisation of traffic, may even under minor irregularities in traffic conditions, e. g., street demonstrations, become factors that threaten the functionality of traffic that traffic systems must cope with; especially under extenuating circumstances.

In terms of 'extraordinary' conditions this results in the need for the research to apply the latest scientific findings, even though at the same time there remains the need for efficient attainment of knowledge and research in the face of obsolete technical, technological and organizational methods of traffic control that result from historically inherited or traditionally developed traffic systems that hold to conditions often dictated by 'current' needs. Hence, it is necessary, prior to the creation of new solutions, to avoid returning to obsolete and inherited solutions.

Such research is quite complicated especially as nowdays the predominant thought is that methodological and research practices in the field of traffic science, in terms of 'extraordinary' circumstances, is relatively underdeveloped and weighed down by traditionally subjective and objective weaknesses found primarily in its traditional methodological approach in researching this problem.

The completion of the complex nature of the optimum functioning of traffic systems under 'extraordinary' circumstances shows distinct greater variability and asks the question of whether in times of unavoidable reduction of incomplete, or totally wrong, information and poor acquaintance of the subject matter can these changes be effected? The difficulty of establishing how given traffic systems behave in times of crises can force the research to deal with numerous forms of traffic management that deal only with concrete matters that promise specific results rather than dealing solely with hypothetical situations.

The periodic occurrence of "extraordinary" circumstances must direct future research toward simulated models, whose results in many ways depend on the actual value of the model and its trueness to the original infrastructure it is modeled upon; especially when dealing with the real time terrorist actions or natural disasters. Research into such models is quite problematic given that the researcher is forced to make numerous assumptions based on the state of the model itself, as well as its surrounding circumstances, which may prove not to be based on facts, hence becoming findings based on the hypothetic.

Considering that traffic systems are exposed to the pressures of constant change and adaptation due to the demands of surrounding circumstances the general operative control of "extraordinary" traffic conditions and their possible deviations become more difficult, which hence results in the rise of entropy within the system, that in turn leads to the spontaneous collapse of the entire system. This demands a need for greater formalisation of given traffic systems, which in turn makes it less elastic to changes within the surroundings of the system and that is itself a problem in times of rapid change on the ground.

Numerous, though not enough, research into this problem is often embossed by the more generally known and accepted works that offer solutions based upon less exact scientific facts which are not optimal, and often even incorrect, and would in more concrete traffic situations be defined as being under 'extraordinary' conditions, would prove its true mark. In its complexity this work offers one of many possible approaches with a specific emphasis on the attaining of exact information in traffic management with the help of UAV technology [1].

2.2 A possible approach to research

Scientific research into the testing of the status of traffic conditions in times of 'extraordinary' circumstances, i. e., in times of war, terrorist attack or natural disasters, should include research into individual elements of exposure, menace, danger and risk to traffic systems that should be applied, for all that, to a systematic approach to finding optimal solutions to such individual problems [2].

The exposure of traffic systems to 'extraordinary' conditions can be analysed through the study of the exposure of individual elements found in Figure 1, such as: exposure of a given space to attack or disaster (ES), material-technicality of exposure (MTE), integrated traffic conditions (ITC), traffic and transport resources (TTR), demands of the users (DU), socio-economic conditions (SEC), natural resources (NR), economic power of the state (EPS), level of technical development (LTD), organisational-technological characteristics of certain traffic subsystems (OTCTS), traffic organisation of a territory (TOT), capacity of withdrawal/evacuation (CWE), level of preparedness of the traffic system with suitable equipments and resources (LPTSER), level of unification and standardisation of traffic (LUST).

Menace to traffic systems in "extraordinary" conditions can be studied through the analysis of the menace of individual elements in Figure 2, such as: mar-

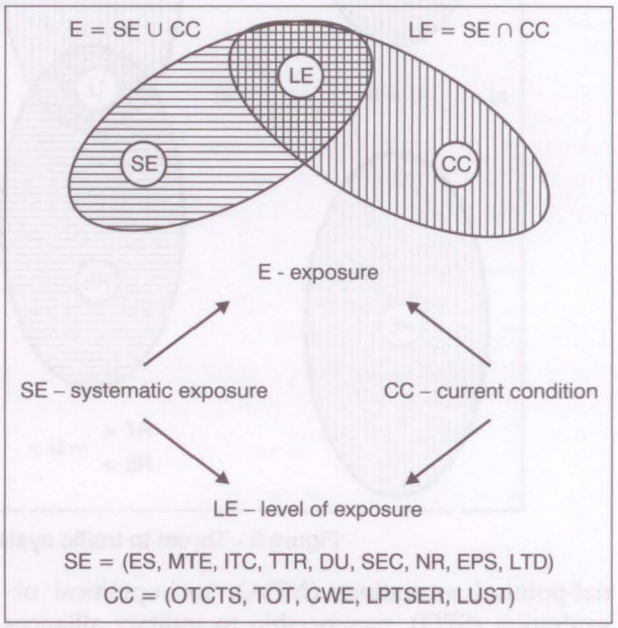

Figure 1 - The exposure of traffic systems to 'extraordinary' conditions

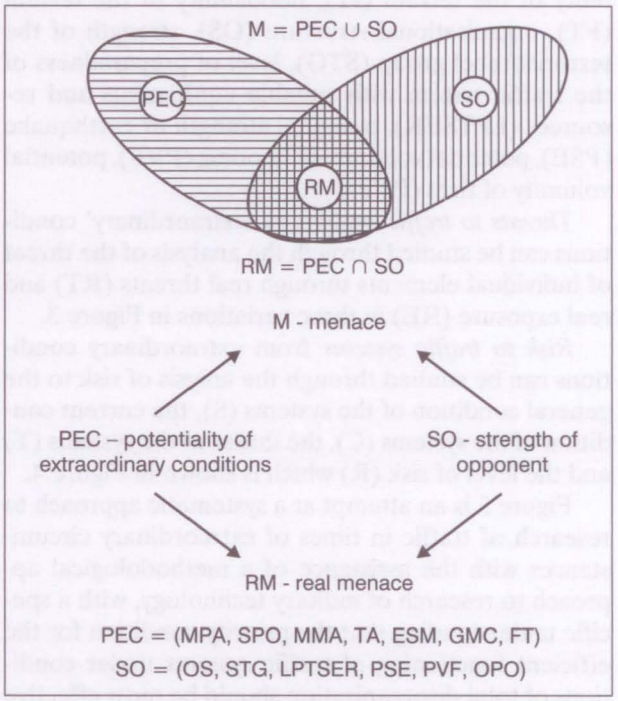

Figure 2 - The menace to traffic systems due to "extraordinary" conditions

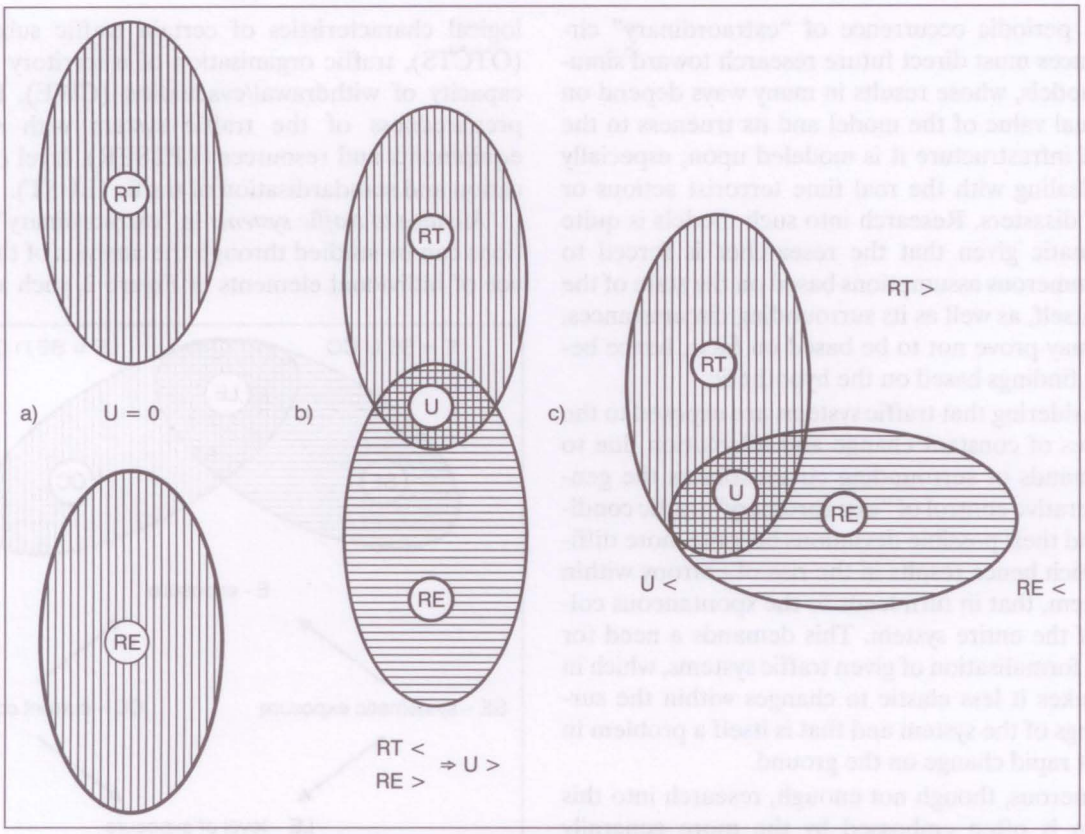

Figure 3 - Threat to traffic systems from extraordinary conditions

tial-political aspirations (MPA), socio-political organisation (SPO), membership to military alliances (MMA), territorial aspirations (TA), econmic power of state (EPS), geo-military conditions (GMC), instability of the terrain (IT), floodability of the terrain (FT), organisational structure (OS), strength of the terrorist/rebel group (STG), level of preparedness of the traffic system with suitable equipments and resources (LPTSER), potential strength of earthquake (PSE), potential volumity of flooding (PVF), potential volumity of fires (PVF).

Threats to traffic systems in 'extraordinary' conditions can be studied through the analysis of the threat of individual elements through real threats (RT) and real exposure (RE) in three variations in Figure 3.

Risk to traffic systems from extraordinary conditions can be studied through the anlysis of risk to the general condition of the systems (S), the current condition of the systems (C), the threat to the systems (T) and the level of risk (R) which is shown in Figure 4.

Figure 5 is an attempt at a systematic approach to research of traffic in times of extraordinary circumstances with the assistance of a methodological approach to research of military technology, with a specific understanding that the priority condition for the efficient functioning of traffic systems under conditions of total disorganisation should be most effective under conditions of terrorist attack or during times of war.

A systematic approach to reseach into the functioning of traffic systems under the influence of extraordinary circumstances can be realised through an analysis of inter-relational actions and influential relations of specific elements within the traffic system under review (Figure 5), such as: (1) preparedness of the traffic system for its efficient functioning under extraordinary conditions; (2) interdependence of research with elements of military technology (MT) and

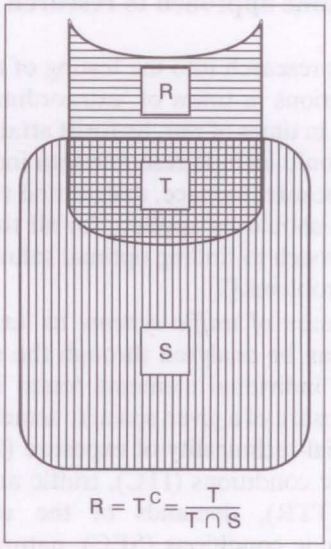

Figure 4 - Risk to traffic systems from extraordinary conditions

elements of traffic and transport science (TT) currently available; (3) interdependence of research into elements of military technology (MT) and technical-technological development of traffic and transport (DTT); (4) interdependence of research into elements of military technology (MT) and elements of organisational and economic development (OED); (5) interdependence of research into elements of operational-tactical demands (OTD) in conjunction with MT-TT-OED conditions faced in such circumstances; (6) interdependence of research into elements of operational-tactical demands (OTD) in conjunction with MT-DTT-OED conditions faced in such circumstances; (7) interdependence of research into elements of operational-tactical demands (OTD) in conjunction with MT-TT-DTT conditions faced in such circumstances; (8) interdependence of research into elements of operational-tactical demands (OTD) in conjunction with TT-OED; (9) interdependence of research into elements of operational-tactical demands (OTD) in conjunction with TT-DTT conditions faced in such circumstances; (10) interdependence of research into elements of operational-tactical demands (OTD) in conjunction with DTT-OED conditions faced in such circumstances; (11) criteria of speed, exactness, safety and reliability; (12) criteria of economy, rationality, effectiveness and efficiency; (13) and, criteria of material-technical elements of the development of traffic systems.

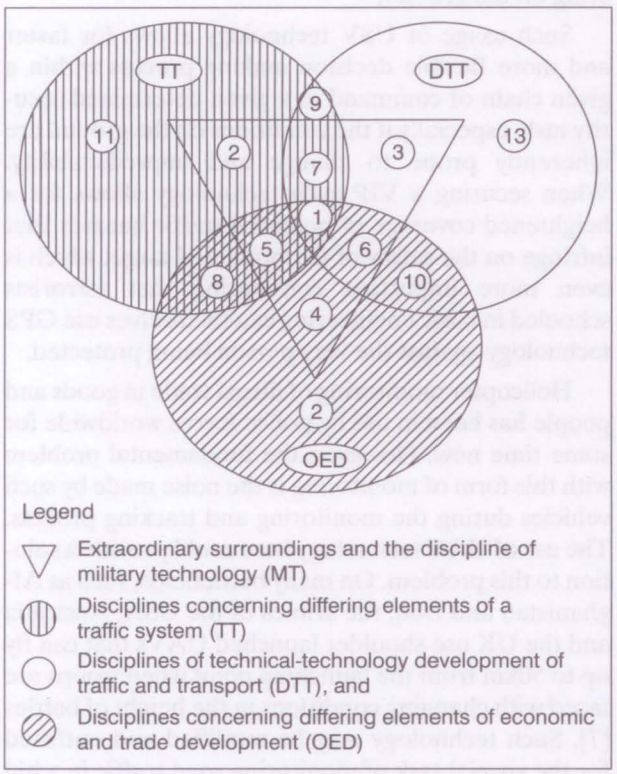

Figure 5 - A systematic approach to research into traffic under extraordinary conditions

3. THE POSSIBLE USE OF UAVS IN THE RESOLVING OF TRAFFIC PROBLEMS UNDER EXTRAORDINARY CONDITIONS

The complexity of researching traffic in times of extraordinary circumstances, especially in the context of finding a solution that is substantiated by the attainment of exact operative information under concrete extraordinary conditions, can be alleviated by the willingness to accept new technical-technological discoveries within the field of UAV development.

The process of globalisation and the subsequent rise of in the threat of terrorism and the military responses to the threat terrorism poses at a regional and global level is more and more becoming a major security issue within pre-existing traffic systems as governments seek to create more efficient ways in dealing with extraordinary security circumstances and conditions created by the threat. These demands on ensuring the efficient functioning of transport and trade routes are becoming more important to states, inter-state security alliances and armed forces alike in the wake of the events that occurred in the USA on September 11, 2001.

The functionality of UAV technology in supplying part of the answer to such external threats to traffic will be analysed here from the point of view of its potential use in the monitoring and securing of road, rail and maritime traffic. Whether or not UAV technology could be used for air traffic monitoring will not be discussed here as the authors feel that the high standards of contemporary radar and satellite technology already provide an efficient security system for air transport under all conditions; including extraordinary ones.

UAV technology has developed rapidly since the first tentative steps were taken toward the military research into the area in the 1950s by the US Department of Defense. However, it has been in the past 15 years that UAV technology has been developed to the highest levels for the specific use in military interventions and actions, to the extent that it is now being openly courted for use in the private sector. The non-military use of UAVs in the region of South Eastern and Central Europé has already been used at a strategic, operative and logistical level in fighting fires throughout Dalmatia in Croatia which followed the models developed by Californian fire fighting units. In such cases UAVs have been used with success, especially in identifying the threat to main roads and highways that can act as evacuation traffic corridors for the local population during major fires.

A comparative analysis of potential solutions to traffic security issues can show the potential capabilities of UAVs possess in resolving traffic crises in times

of extraordinary security circumstances with a specific accent on the threat of terrorist activities upon pre-existing traffic systems. Experiences up till now tell us that UAVs may be amongst the more efficient forms of monitoring technology available to state security apparatii interested in dealing with external political threats to vital traffic and transport arteries of state. The rest of this work will comparably analyse the security problems that may be resolved by the usage of such technology in securing road, rail and maritime traffic.

3.1 A comparative analysis of the usage of UAVs in road traffic monitoring

The analysis of the potential need and usage of UAV technology in monitoring road traffic shows that there does not seem a need for its monitoring facilities when functionally planning and mapping the development of road infrastructures. Though, when looking at its potential benefits in monitoring and securing inter-city, tollway and motorway traffic there do seem some advantages in further researching how it may benefit traffic flow and security, especially in terms of determining risks (in terms of exposure, menace, threat and risk) at vital traffic points due to speed, difficulties and capacity to deal with attacks to vital trade and traffic lines or even major criminal problems of the illegal trafficking of people and goods.

We must recognise that many police forces worldwide are already using aircraft such as helicopters and gliders; foremost in monitoring traffic points and blockages during traffic waves on intercity motorways, distribution channels and busy intersections.

The most commonly used flying technology amongst police forces worldwide is the helicopter, though it must be recognized that other technologies are also used. In Australia the NSW Police Force, for example, have in the past used single pilot fixed wing light airplanes along the Sydney to Newcastle leg of the Pacific Highway to monitor the 190 km due to their cheaper fuel expenditure compared to helicopters. In fact due to the high fuel expenditure the NSW Police Force's Traffic Control Department has been seriously considering the use of UAV technology as a possible solution to the high expense of monitoring from the air [3]. The fact that after the initial outlay of purchase costs will be saved due to the fact that no flight crews are needed is also an advantage. This in itself falls into the category explained in Figure no. 1 whereby SE is better protected from CC where levels of exposure are contained to maximum gain. Add to this the fact that such technology can readily be adapted to monitoring extraordinary security situations without risk to reconnaissance teams also interlocks the area of cross over shown in Figure no. 4 where though risk cannot be negated nevertheless shows that S and CC can be controlled via alleviating R.

From the perspective of police reconnaissance and the securing of VIP transit the securing of such personage is incredibly difficult without high technology. The potential danger from terrorist or other forms of military attack upon VIPs are specifically acute at strategic juncture points such as roundabouts, entrance and exit pints of tunnels, bridges, viaducts, underpasses and overpasses of thoroughfares [4]. At this point exposure, menace, threat and risk conjoin to make targets most prone. This creates the triangular effect shown in Figure no. 5 where the most efficient state response comes from those states willing and capable of achieving flexible technological response via combing the 13 points of inter-juncture shown in the model of Figure no. 5. In monitoring such juncture points, i. e., potential points of contact between target and attacker, the usage of UAV technology could be of great scouting use for counter-terrorist units and tactical response groups. UAVs already deployed can be of real-time benefit to security teams on the ground as opposed to satellite technology which due to the relative security clearance levels need to gain unfettered access to cannot always guarantee direct access to all security personnel on the ground at lower levels [5]. UAVs armed with cameras cannot co-ordinate all teams but allow for all levels to be included in immediate decision making processes and information gathering on the ground.

Such usage of USV technology allows for faster and more flexible decision making process within a given chain of command in a given determined security task, especially if the conditions on the ground are inherently prone to change and unpredictability. When securing a VIP such technology allows for a heightened coverage of potential traffic hazards that infringe on the safety of the protected target which is even more important considering that terrorists schooled in basic engineering can themselves use GPS technology against the very person being protected.

Helicopter monitoring of illegal trade in goods and people has been in use by police forces worldwide for some time now. However, the fundamental problem with this form of monitoring is the noise made by such vehicles during the monitoring and tracking process. The use of UAV technology here could provide a solution to this problem. On many battlefields, such as Afghanistan and Iraq, the armies of the USA, Australia and the UK use shoulder launched UAVs that can fly up to 50km from the launching point when troops are faced with changing conditions in the height of battles [7]. Such technology may be modified and outfitted for the special task of monitoring road traffic in a bid to halt terrorist attacks on VIPs by counter-terrorist units.

3.2 A comparative analysis of the use of UAVs in rail traffic

In rail transport there already exists a system of security checks and balances that successfully deal with problems in the general area of safety. However, UAV technology can be of use in differing weather and topographic conditions that can prove ideal covering for terrorist actions such as ambushes on trains carrying VIPs. Especially in alpline areas where landslides, avalanches and other natural phenomena can provide ideal ambush cover as shown in Figures no. 1 and 2 that deal with the problems of exposure and menace; especially when as shown in Figure no. 2 the development of the direct menace arises from the natural occurence of PEC, especially in recurring FT and IT, is exploited by the PA and TA found in the meeting juncture of PEC and SO hence creating ultimate conditions of both menace through exposure.

Low visibility because of fog, sudden emergence of ravines and cliffs above rail lines can provide grave problems for manned air flights, be they in classic fix winged aircraft or helicopters. In such cases the advantages of UAV technology are many. Piloted flights in these conditions place crews in the danger of potential fatal aircrash. On the other hand UAVs allow for a greater mobility in monitoring potential ambushes above ruggered terrain. Such technology was used by the US Armed Forces and other NATO led special forces in the mountainous terrain of Afghanistan in the successful monitoring of opposing troop movements in terrain renown for rapid topographic change.

There exists a potential capability for the successful use of this technology in the monitoring of rail traffic and transport in alpine regions.

3.3 A comparative analysis for the use of UAVs in maritime traffic and transport

There is a common belief in the field that it is in the field of maritime transport that UAV technology has its greatest potential for wider use, especially in the following fields:

a) Today there exists the problem of modern day piracy. In the region of South East Asia and the Bay of Bengal piracy is becoming and ever more present threat to shipping lanes. In the majority of cases pirates are seasonal professional fishermen who earn extra profits through piracy in the off season. Often they are protected by local political interests so the will of the local policing authorities to intervene is minimal [8]. Hence, ship crews often themselves have to find a solution to the problem. Satellite pictures and radar technology may warn ships of varying boats and ships in the region but they cannot identify the intent of the crews nor their home ports. In such situations UAVs can be of great use to crews in securing themselves, their ships and cargoes. When the intentions of a boat in the vicinity are unknown then the launching of a shoulder launched UAV can be of great use in determining many kilometres out whether they are armed or in fact fishing. The US Navy itself played a major role in the development of this technology, which means by all contemporary technological parameters the technology exists for the maritime use of such technology. In fact, lightweight UAVs can fly up to 250 km, a sufficient distance to determine the nature of an unknown fleet. A fact that could lead the maritime industry playing a greater part in the widening of the scope of UAV technology for such purposes as demonstrated in Figure no. 4 dealing with technology alleviating risk.

b) The second advantage of this technology is its minimal ability to be perceived visibly or by noise. This means that UAVs can be used for secret reconnaissance missions in areas of high human traffic such as harbours. This can provide a solution that can be of use to water police when monitoring the movement of highly suspicious cargoes that could contain drugs, weaponry or people.

c) One of the more important areas for its usage is in the protection of national fishing boundaries, and hence national fishing industries. The existence of seemingly continuous "fishing wars" between, e. g., the Royal Canadian Navy (RCN) and the Spanish salmon fishing fleets. The costs of monitoring fleet movements in protected fisheries for the RCN were great [9]. In the case of the Royal Australian Navy (RAN) the illegal fishing of the protected Patagonian toothfish has led to conflicts between the Australian and New Zealand Governments on the one hand and the Chilean, Japanese and Uruguayan Governments on the other hand [10]. The costs of protecting fishing zones to the Australian Government must include the costs of sending RAN frigates as far as South African territorial waters and Antarctic waters, in one case, in hunting down illegal fishing fleets [11] [12]. Hence we can consider it opportunistic in such circumstances to find new technologies such as AUV technology in ensuring that the chase is in fact worth undertaking as no satellite photo can truly determine what type of fish is being harvested on deck as a well launched UAV may.

4. CONCLUSION

The selected methodological approach used here into researching traffic difficulties in extraordinary circumstances and conditions, along with the estab-

lishing of methodological problems to this approach, has proven according to us, the authors, that such new technology could be of great use in ensuring traffic security in times of extraordinary attacks and threats to these systems. In fact such UAV technology can be of great use not just in "extraordinary" but also in "ordinary" traffic situations since exposure, menace, threat and risk are common to all traffic environments.

Hence the methodological specificity in forming this research and shaping it to resolve problems that threaten the functioning of traffic within preexisting traffic systems in extraordinary security circumstances (especially from terrorism and times of military mobilisation) through analysing the levels of threat to a given traffic system from the four positions of exposure, menace, threat and risk.

In searching for an applicative solution to the exact solidifying parameters of such threat the concrete information data attained from UAVs could supply in real time and in all weather conditions, especially in times of extraordinary security circumstances can be great. The analysis here has shown that the use of UAV technology in road, rail and maritime traffic should be developed to a higher level especially in dealing not only with the threat of terrorism or unfriendly military mobilisation but also in times of natural disaster.

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SAŽETAK

METODOLOŠKI PRISTUP ISTRAŽIVANJU PROMETA U IZVANREDNIM UVJETIMA

Kompliciranost istraživanja prometa u izvanrednim uvjetima, za zagotavljanje njegovog učinkovitog funkcioniranja kako u normalnim, tako i u uvjetima prelaska iz normalnih u izvanredne kao i u izvanrednim uvjetima, postavlja pred istraživače brojne metodološke probleme.

Polazeći od potrebe i mogućnosti istraživanja prometa u izvanrednim uvjetima, u ovom radu je opisan odabrani metodološki pristup preko istraživanja izloženosti, prijetnje, ugroženosti i opasnosti prometnog sustava od izvanrednih uvjeta koristeći pri tome metode ratne vještine, što omogućuje rješenja koja su sukladna simuliranim ili stvarnim izvanrednim uvjetima.

U traženju mogućih aplikativnih rješenja za egzaktno utvrđivanje zahtjevanih parametara s konkretnim podacima u realnom prostoru i vremenu, za učinkovito funkcioniranje prometa u izvanrednim uvjetima je analizirana mogućnost uporabe sustava bespilotnih letjelica s uporednom analizom uporabe u cestovnom, željezničkom i pomorskom prometu

KLJUČNE RIJEČI

metodološki pristup, istraživanje prometa, izvanredni uvjeti, bespilotne letjelice

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