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Child Soldiers in Genocidal Regimes: The Cases of the Khmer Rouge and the Hutu Power

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Genocide is one of the worst things one can imagine throughout the history of humanity. But in the cases of Cambodia and Rwanda this was even more serious as children were used as instruments of the massacres. Both the Khmer Rouge and the Hutu regime had their specific reasons for this act. The number of victims surpasses the millions, who either lost their lives, or suffered from various kinds of violence, because the young perpetrators were also victims, who carry the invisible scars in their souls. These historical examples are warnings for the international community to be active in situations like these, and stand up for the defenceless ones.

Keywords: *Khmer Rouge, Hutu, Tutsi, genocide, child soldiers*

Introduction

At the end of the 20th century one of history's most brutal genocides took place in Southeast Asia and Sub-Saharan Africa. Between 1975 and 1978, the Khmer Rouge in Cambodia, then in 1994, the Hutu regime in Rwanda, together murdered approximately 2.5 million people.[3] In both countries, the armies of the ruling regime took part actively in the atrocities, which largely have been exposed by now. However, it is less known that due to the regime's policies tens of thousands of children were indoctrinated and trained to serve as child soldiers and became perpetrators of the mass killings.[4] Unfortunately, in the current world, mainly in developing countries, the use of children as soldiers is still widespread and the problem needs more attention from the international community. Actually, the phenomenon of child soldiery became a new threat to our security in the 21st century. [4] This article examines two extreme cases of child soldiering in Cambodia and Rwanda, where the genocidal regimes, committing their crimes, did not spare the future generations as well. The presentation of these historical examples may help to understand better the problem of child soldiery not only in the past, but in the future too.

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3   In Cambodia, the death toll can be estimated at 1.7 million and in Rwanda at 800,000. [1] [2]

4   The internationally agreed definition of child soldier can be found in the Paris Principles and Guidelines on Children Associated with Armed Forces or Armed Groups of 2007: "A child associated with an armed force or armed group (child soldier) is any person below 18 years of age who is, or who has been, recruited or used by an armed force or armed group in any capacity, including but not limited to children, boys and girls, used as fighters, cooks, porters, messengers, spies or for sexual purposes. It does not only refer to a child who is taking or has taken a direct part in hostilities." [3]

The Kampuchean Revolutionary Army

The Khmer Rouge, under the leadership of Pol Pot, the General Secretary of the Cambodian Communist Party had started to revolt against the Sihanouk administration in the 1960s, then after the fall of the Prince in 1970, continued the fight against the US backed Lon Nol government. In the context of the Vietnam War, China and North Vietnam supported the Khmer revolution, thus in spite of the US bombing and the financial-military aid received by Lon Nol, by April 1975, the Khmer Rouge victory became reality. The Ultra Maoist regime set about to transform the country thoroughly at once, for which the loyalty of the army were needed. Between 1975 and 1978, the Communist Party, through the use of armed forces did everything to exterminate the enemies of the revolution, inside and outside of the country as well. Finally, from 1976 the clashes with Vietnam become continuous, and two years later the attacking Vietnamese army caused the overthrow of the regime.[5] [5] The unified Kampuchean Revolutionary Army came into being only in 1976, under the overall command of Son Sen, the Minister of Defence and the Chief of the General Staff. The army consisted of more than 72,000 soldiers in 9 divisions, as regular troops. Beyond that, there were the regional troops and militias in the zone, region and district level. [6]

The weapons and munitions flowed from China and Vietnam, therefore the Khmer commanders just had to concentrate on the drafting and training of the troops. In accordance with the official policy of the communist party, the poor and the lower middle class peasants made up 98% of the soldiers, as they were to be the bases of the rural revolution, imagined by Pol Pot.[6] [7] In the first half of the 1970s, people from the remote villages and mountains volunteered for military service in the ranks of the Khmer Rouge, conscription was only later introduced in consequence of the serious losses suffered on the battlefields. After the victory, everyone had to serve the revolution: the people from the cities ("new people"), like former soldiers, intellectuals, factory workers and other "enemies" were employed in agriculture, while the poor destitute were recruited for cadres in the army and the security forces.

Children in the Armed Forces

From the beginning, the Khmer Rouge considered the youth within the lowest social classes as the core force implementing the revolution. As Pol Pot declared: "It is the youth of today who will take up the revolutionary tasks of tomorrow." [8: 16] The Khmer leader, like Mao Zedong during the Great Leap Forward and the Cultural Revolution, turned to the youth whose role in the revolution was to be the "dictatorial instrument of the party." [9: 5]

In theory, the basic education of the youth was compulsory, but during the rule of the Khmer Rouge illiteracy rates remained high as indoctrination in communist ideology was given priority and the need to serve in the armed forces became imperative. The young children in most cases were taught the use of small arms and the laying of landmines.[7] Often

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5   Following the fall of the Khmer Rouge administration, Pol Pot and his army retreated to the Thai border and remained as a considerable military force until the middle of the 1990s.

6   The General Secretary promptly realized that the less educated poor are the perfect candidates to follow orders without questioning and fight loyally under the guidance of the party.

7   Children in general were used as forced labour as well and those who refused military service were sent for re-education at working sites for example digging canals, or simply tortured and executed with their family members too.

conscription concerned 10–12 year-olds, who after indoctrination were to be the most brutal cadres of the regime at the ages of 12–15. There are no records available for how many children were used as combatants in Cambodia, but their numbers can be estimated as tens of thousands during the 1970s and 1980s.[8] For the brutal Khmer Rouge regime the youth were the perfect soldiers as "it is […] easy for the commanders to give orders because the children did not have a conscience and are illiterate […] they don't know what is good what is bad. So, they simply follow the orders the commanders give them." [10: 28]

Child soldiers in possession of small arms could control and intimidate the civil unarmed masses, but the military knowledge they mastered and their physical abilities did not make them eligible to become an efficient army in the battlefield, though this did not cause anxiety for Pol Pot and his entourage. During the siege of Phnom Penh in 1973, the young Khmer Rouge army already suffered incredible losses which demonstrated the leadership's total disregard for the lives of their men. Later against the Vietnamese army this attitude did not alter, thus the masses of the children were to be nothing other than just cannon fodder in the eyes of their superiors. [11]

According to the extreme communist ideology, the Khmer Rouge did not draw distinction between young males and females and recruited girls in much greater numbers than the other combatting factions. Recent studies suggest that in the world presently, around 40% of all child soldiers are female, but in Cambodia during the 1970s this rate was probably higher. [12] Cambodian girls could have been valued similarly to the African ones: they were perceived "as highly obedient and easily manipulated […] and ensure a constant pool of forced and compliant labour."[9] [12] Due to the latest research, now it is evident, that young women played a significant role on every level of the Khmer Rouge administration, even if in the past, it was understated.

Child Soldiers: Perpetrators and Victims

Child soldiers in Cambodia can no doubt can be seen as victims of the brutal regime, who after indoctrination could be turn into perpetrators of the mass killing as well. There is no exact numerical data of the children who participated in the atrocities, let alone the young girls, but the survivors accounts correspond in this aspect, that the average ages of the security force and the army personnel were especially young. The personal stories, through the recollections of some former child soldiers may help to understand the human tragedy that was played out in full during the Khmer Rouge in Cambodia.

As a result of her memoirs, the story of Loung Ung became known all over the world.[10] The 7 year old girl was taken from her family (previously her parents were killed by the Khmer Rouge) to be trained as a child soldier, but she survived the regime and settled down in the USA with her eldest brother. Her own records demonstrated clearly the ordeal the children went through: "I was a very angry kid. I was so angry the supervisor at one of

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8 Still in the middle of the 1990s, the Khmer Rouge army consisted of approximately 2,000 child soldiers. [13]

9 Little girls can be used in messenger, reconnaissance and supplier functions much more easily than boys, because they do not arouse the enemy's suspicion.

10 UNG, L.: First They Killed My Father. New York, Harper Collins, 2006.; UNG, L.: Lucky Child: The Daughter of Cambodia Reunites with her Sister She Left Behind. New York, Harper Collins, 2010.;UNG L.: Lulu in the Sky: The Daughter of Cambodia Finds Love, Healing and Double Happiness. New York, Harper Collins, 2012.

the orphanage camps picked me out of many other children to go and be trained as a child soldier. […] I was given a stick to hit people. [...] Instead of learning about compassion and joy and kindness, I was taught to hate. I was taught to kill. […] Because the children of the Khmer Rouge were the saviours of the future, and you all wanted us dead. I grew up with that [...] I grew up thinking you all gonna kill me." [13: 3–4] The other famous narrative is that of Aki Ra, whose parents were also murdered by the Khmer Rouge, and at the age of 10 he was conscripted into the army where he became familiar with landmines. In 1985 he was captured by the Vietnamese, then 4 years later was drafted by the Cambodian Army. Finally, from 1992 with the help of the UN he dedicated his life to clearing mines in his country.[11] He remembers the times with the Khmer Rouge as "We believed what they told us, as we didn't have any choice […] [and] I didn't know anything of the outside world." [14] Hong A. Chork one of the co-author of the book *Children of Cambodia's Killing Fields: Memoirs by Survivors*, recalled that as a little child he had to carry munitions for the troops thus "[…] my childhood was lost during those years. […] I will never be able to feel the peace that I did before I turned six." [15: 128]

The recollections of the combatants of the elite Khmer Rouge Division 703 are also revealing. This was the army formation guarding the most infamous Tuol Sleng detention centre and is responsible for numberless killings and tortures.[12] In the early stage of the revolution, poverty and hatred against the Lon Nol government were adequate stimulus for many children to join the communist army. As Top Launh recalled: "I was poor and orphaned of my father from the age of nine. I lived with my mother and four sisters. My family life worsened from one day to the next. Combine that with my belief in the propaganda of the Khmer Rouge, and that is why in 1973 when I was fourteen years old, I volunteered to join the army." [7: 13–14] Later the conscription still could not been avoided. Ieuv Lay stated that "Since all members had been drafted into military service, in late 1973 the sub-district chief selected me for the region army like all the others. Then, whether I wanted to or not, I forced myself to join the military. If I had not done as assigned, the village chief would have persecuted me and my family." [7: 18]

Many of these Khmer Rouge child soldiers were involved in the atrocities as well. Tuy Kin, a former "red female combatant" of the Division 12, who was drafted at age 14, took part in the battles until the capture of Phnom Penh, then became the member of the guard securing the Tuol Sleng Prison. Although she has insisted that she never killed people, she was sentenced to 18 months of prison for the involvement in the killing of 300 prisoners. [14] However, there are many more former child soldiers in Cambodia, who escaped from justice and have never been held accountable for their acts.

The Killing Machine of Genocide in Rwanda

For the public interest, Rwanda was almost unknown until 1994, when the country drew the world's attention: in a few months, hundreds of thousands of people lost their lives in massacres. But the media often reported mistakenly about the events as the exacerbation of ancient tribal enmity. In reality, it was a consciously planned action by the official government. The

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11 Between 1992 and 2007 he personally defused about 50,000 mines.
12 In the Tuol Sleng or S–21 security prison approximately 20,000 people were executed during the rule of Pol Pot.

Habyarimana-led Hutu government, which had been in power since 1973, was becoming more and more extremist, as the economic and political situation was worsening. For them, the final solution was the total extermination of the Tutsi population in Rwanda.

Between 1990 and 1992, Rwanda doubled its spending on weapons – and as a result the IMF and the World Bank suspended granting part of their aid. [17] A vast amount of machetes was imported into the country,[13] which became the genocide's notorious weapon, as most of the murders were carried out with them. [18]

In 1993, a nationwide self-defence program was announced, where the (Hutu) population was armed, they were trained to use firearms and also involved in local patrol services. [18] The genocide was implemented by, in addition to the trained population, the State Army (Rwandan Armed Forces – Forces Armées Rwandaises [FAR]), the police, the political parties and their militias. Among the latter, perhaps the most notorious was an extremist paramilitary organization, the Interahamwe, established as the youth organization of the ruling party.

The militia held three week long trainings in Rwandese military camps, for nearly 2,000 people, who allegedly were so well-prepared that 40 of them could kill 1,000 Tutsis in twenty minutes. [19] Roméo Dallaire, the Force Commander of United Nations Assistance Mission for Rwanda (UNAMIR), said in his reminiscence that according to one of his informants, lots of children took part in the Interahamwe's training. The core group of the organization was supplied with weapons, and the children were given machetes during the preparation, the use of which did not cause them trouble because they used them during agricultural work. [20]

Children as Participants of Genocide

The Hutu leadership used thousands of children as instruments of genocide, who attended the slaughter as members of the army, or the Interahamwe, or were activated due to the general mobilization of the civilian population. But child soldiers – called "kadogo" in Swahili – did not fight only on the side of Hutus. A few days after April 6, the Rwandan Patriotic Front (Front Patriotique Rwandasi – FPR), led by Paul Kagame, attacked the genocidal regime and started to recapture the country. A lot of children were recruited into these guerrilla struggles as well. [21]

The use of children as soldiers basically resulted for two reasons. The first reason was that a significant and rapid increase took place in the number of military troops. Between 1990 and 1993 the number of the FAR soldiers increased from 5,000 to 28,000. Within the same period, the FPR swelled from 3,000 to 22,000 fighters. [20] With such a rate of expansion the presence of child soldiers is not surprising, since both sides' – especially the FPR – human resource requirements could only meet scarce resources. [20]

The other reason was – similarly to the Cambodian case – the children's emotional and mental immaturity, which made them more vulnerable to the government's hateful propaganda than adults. In addition, as in Rwanda children are taught to obey adults, they carried out orders more readily from the authorities than adults. [21]

The number of children participating in the genocide is estimated from 4,500–5,000. According to the Human Rights Watch, at least 5,000 children and juveniles have been arrested on genocide charges, [21] UN sources claim that from the 120,000 persons in custody, nearly

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13   Between January 1993 and March 1994, a total of 581,000 kg, approximately enough quantity to arm the third of the Hutu adult male population. [18]

4,500 had been younger than 18 years at the time of the genocide. [22] According to a study conducted by the Rwandese government in 1996, the number of kadogos were the same in the Tutsi army, fighting against the genocidial: 5,000 children were identified in the FPR, of whom 2,600 were younger than 15 years. [23]

The child soldiers functioned in many different areas in the Armed Forces. A Rwandese survey of 1995 interviewed eyewitnesses who said that among the children there were a number of persons who had to supervise the condemned ones to prevent their escape. Others worked as informers pretending to be orphans, and asked people to hide them. Then, a few days later they returned to the militia and revealed the names and whereabouts of those people. [24]

Witnesses also reported that the children participated in almost all crimes related to the genocide: they murdered, raped women and young girls, burnt and destroyed houses, robbed, and detected people hiding from military troops. [24] Dallaire also confirmed these statements: "By the time the genocide was in full swing by mid-April 1994, the Interahamwe were very visibly using the children to commit acts of killing and man roadblocks. The use of children was a deliberate tactical and strategic plan by the extremists." [20]

The number of the badly effected people surpasses child soldiers and those who lost their lives or suffered any kind of abuse. Since the usage of child soldiers has long-term effects on society, as those children were socialised in violent circumstances, their reintegration into the society after the war has a slim chance. [25] Shadrack, who was a child soldier in the Interahamwe, reported the following from this period: "It was terrible! I was a member of the so-called 'Interahamwe' militia. We were backing the army to flush out anything that resembled a Tutsi. It seemed to me that almost everyone was taking part in the fighting. […] In Gikondo suburb (Kigali), I remember going through hundreds of dead bodies with a FAL rifle. People were crying all the time, amid heavy gunfire and mortar shells." [26: 56]

Gilbert B. was a kadogo in the FPR. He left primary school in 1993, and joined Kagame's army before the age of 14. As a child soldier, he killed at least 3 people. Eventually he was demobilized in 1994. After he returned home to Gitarama, he came to know that his parents had been killed, and their house had been destroyed. In a rage, he killed a Hutu boy, who also was recruited by FPR, Gilbert's fourth victim. Gilbert said that he deeply regrets the murders, and he has been suffering from depression since his demobilization. He tried to live with his older sister, who has a family now, but he felt he did not belong to them, so he decided to live on the streets instead. "I had no place to live and I was alone in total isolation,"– he said. "I was going to commit suicide. I had so many problems. I was out of control. I had no one to help me. I could not see any solutions." [21: 15]

Conclusions

The genocidal regimes in Cambodia and Rwanda alike brutally exploited the youth for their own purposes and committing the atrocities with the use of child soldiers were an acceptable solution for them. In Rwanda, the rival factions similarly drafted children in their armies, deliberately pressing them to become the tool of genocides. However only the reigning regimes used minors as the tools of violence, as the intimidated and tortured citizens were unable to put up resistance. In both cases the regimes clearly realized that the children were cheap and obedient servants and the losses they suffered were not under consideration. However, there

is one distinction between Cambodia and Rwanda, for Pol Pot recruiting children (including little girls as well) was a core interest of the movement according to their extreme ideology. There was no such a policy for the Hutu Power only the scarce human resources led the regimes to this act. But it can be concluded without doubt, the children can be seen as perpetrators of the atrocities and victims of the regimes alike.

Unfortunately, at present there are still a lot of developing countries where the use of child soldiers is a common thing, so the international community has a lot to do to prevent the repetition of the Cambodian and Rwandan scenario.

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Analysis of Resupply of Energy for Workforce Accomplishing Long Term Damage Cleanup Duties

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There are a growing number of disasters in Hungary, and throughout the world, that have had devastating effects, and the activities related to prevention, protection and damage cleanup last for a long time. The defence activities are accomplished by professional organizations responsible for remedial actions, namely the National Directorate General for Disaster Management, Ministry of the Interior (NDGDM) and the Hungarian Defence Forces (HDF). Working for a long period of time at the site of damage cleanup works is a heavy burden and effort. Therefore, maintenance of the appropriate physical condition of the official staff intervening in disasters and carrying out demanding physical duties is essential for effective work activities. Catering, providing food and drink supply for organizations carrying out intervention is one of the basic responsibilities of the professional organizations. With the aid and application of the methods of modern food science the energy need of the human body accomplishing demanding activities can be determined by taking body weight and parameters of weather into account. In this work, we aim to analyse the impacts physical workers' bodies are exposed to. We also define and through examples present the amount, quality and form of the required nutrient and fluid intakes. Through our research, we would like to assist medical and logistic professionals responsible for catering the intervening organization.
Keywords: *disaster, damage cleanup, hard physical activity, nutrient supplies*

Introduction

In recent times, Hungary has faced increased number of catastrophic events, floods, the red sludge disaster when the success of the liquidation process largely depended on the physical capabilities of human resources. Although, in his previous work R. Kuti [1] studied the technical and personal conditions and planning difficulties of prolonged and complex technical rescues, he did not examine the importance of upholding resupply of energy of workforce in order to maintain the physical fitness and working ability in professional staff. Professional bodies dealing with damage cleanup tasks can face catastrophes at any time of the day, and the prevention of harmful effects can last for days, during which they are exposed to hard physical labour. We do believe that the human being is the central element of damage cleanup tasks. Thus, the question of upholding resupply of energy of workforce in order to maintain

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physical fitness and working ability is a high importance. In this paper, we intend to reveal the effects of prolonged hard physical activity on the human body as well as the body's energy needs. Since in many cases women are also involved in hard physical work, we defined the required nutrient and fluid intake for both men and women. Through this work, we aim to contribute to the more effective health protection of the intervening staff.

The Effects of Physical Strain on the Human Body

Professionals carrying out complex technical rescues and damage cleanup tasks often perform their duties amid extreme working conditions in special protective clothing. [2] Tasks that are to be carried out under extreme temperature conditions or in special protecting clothing and respirator with hazardous materials present are particularly energy intensive to the human body. [3] [4] Carrying the specialised equipment is a burden itself and the physical activity further increases the energy needs. Extended physical exercise coupled with insufficient inadequate nutrient intake can lead to the exhaustion of the human body. The first sign of this condition is the decrease of physical performance, to which the body can adjust itself by slightly altering its operation. Without energy intake or rest this condition can lead to health damage. Under extended physical exercise the main stress is on the muscular system through the adaptation of the circulatory system. During hard work the muscular system's demand for oxygen significantly increases, thus the blood flow speeds up 12 times more than when the body is at rest; at the same time, it requires 20 times more oxygen (it can be 50 times higher than normal under very intensive labour). This leads to more intensive work of the circulatory and the respiratory system. The efficiency of muscle work is relatively low, approximately 30%, therefore 70% of the energy put into work is released as heat. [5] The body gets rid of this excess heat through heat dissipation. Through heat dissipation the body loses fluid that is important to be retained.

Working in summer at a relatively high average temperature the fluid loss increases, thus to support the members of the acting organization with adequate drinking water supply must be given high importance as early as the planning period. Besides the form of activity, the calorie requirements of the human body are also influenced by the weight, gender, age, outside temperature, the intellectual or the physical work as well. With the increase of the body weight the body requires more calories as maintaining a bigger body calls for more energy, and the human body burns off more calories when moving if the body was bigger. The table below shows the amount of energy needed to carry out two burdensome duties.

Table 1. Energy demand to carry out hard physical work.
(Authors' compilation on the basis of [6].)

Form of work	Energy consumption of the work form kcal/min
manual handling work	7.23
logging	6.87

The table clearly shows that hard physical work requires substantial amount of energy. Consequently, adequate energy intake must be provided in order to protect the working body from irreversible health damage.

Specifying the Necessary Energy Supply for Hard Physical Work

Human energy requirement can be ensured through adequate intake of calories and nutrients. The burning of different nutrients releases energy that is utilized by the human body. The three fundamental nutrients are carbohydrate *(CHO)*, lipid (fat) and protein. Burning these substances releases energy that is displayed in the table below.

Table 2. Released energy in the human body through burning nutrients.
(Authors' compilation on the basis of [7].)

Nutrient/gram	Energy released/kcal
Carbohydrate (CHO)	4.1
Fat (F)	9.3
Protein (P)	4.1

The daily calorie target for an average man is 2,000 kilocalories. To maintain this pattern the following nutrient distribution is recommended:

Table 3. The required amount of energy to maintain the normal function of the human body.
(Authors' compilation on the basis of [7].)

Source of energy	Energy/%	Required amount/gram
Carbohydrate (CHO)	55–58	268.29–282.92
Fat (F)	30	64.51
Protein (P)	12–15	58.53–73.17

These figures are based on estimated energy requirements for the average man; in the case of increased physical activity, higher energy intake is needed. The daily calorie need of a grown-up man to deliver hard physical work is between 3,000–6,000 kilocalories. The recommended daily amount of carbohydrate, protein and fat can be calculated from their required amount of energy (3,000–6,000 kcal). Please note 1gram of carbohydrate equals to 4.1 kcal, 1 gram of fat equals to 9.3 kcal, whereas 1gram of protein equals to 4.1 kcal, as Table 2 indicates. [7] A grown-up woman's energy need to do hard physical work is 2,000–4,000 kcal. Since women participate in hard physical work only exceptionally, these figures were gained through examining sportswomen's increased performance and the energy intake required to maintain their performance. The needed quantities are expressed as a percentage, for frequent usage it is suggested they be calculated in gram.

*Table 4. Calorie intake recommendation for a grown-up man requiring 3,000–6,000 kilocalories
of intake to deliver hard physical work.*
(Authors' compilation on the basis of [6].)

Source of energy	Energy/%	Amount needed/gram
Carbohydrate (CHO)	56	409.8–819.5
Fat (F)	27	87.9–174.19
Protein (P)	17	124.39–248.78

*Table 5. Calorie intake recommendation for a grown-up woman requiring 2,000–4,000 kilocalories
of intake to deliver hard physical work.*
(Authors' compilation on the basis of [6].)

Source of energy	Energy/%	Amount needed/gram
Carbohydrate (CHO)	56	273.2–546.6
Fat (F)	27	58.6–116.12
Protein (P)	17	82.92–165.84

The above-mentioned energy amount is better divided into five small portions so as to provide continuous nutrient intake. This way the equal loading of the digestive system – without any extreme swing – can also be achieved. The following table contains the breakdown of the energy intake through the recommended five meals a day.

*Table 6. Recommendation of carbohydrate, fat and protein intake divided into five meals
for a grown-up man delivering hard physical work.*
(Data used on the basis of Table 4. Authors' compilation on the basis of [8].)

Percentage breakdown	Carbohydrate (CHO)/gram	Fat (F)/gram	Protein (P)/gram
20	81.96–163.9	17.41–34.84	24.80–49.70
10	40.98–81.95	8.71–17.42	12.44–24.87
35	143.43–286.82	30.48–60.97	43.54–87.08
10	40.98–81.95	8.71–17.42	12.40–24.80
25	102.45–204.87	21.77–43.55	31.10–62.20

*Table 7. Recommendation of carbohydrate, fat and protein intake divided into five meals
for a grown-up woman delivering hard physical work.*
(Data used on the basis of Table 5. Authors' compilation on the basis of [8].)

Percentage breakdown	Carbohydrate (CHO)/gram	Fat (F)/gram	Protein (P)/gram
20	54.64–109.26	11.6–23.22	16.52–33.12
10	27.32–54.62	5.8–11.6	8.28–16.58
35	95.62–191.2	20.32–40.64	29.02–58.04
10	27.32–54.62	5.8–11.6	8.28–16.58
25	68.3–136.58	14.5–29.02	20.72–41.46

Providing the professional staff carrying out remedial actions with the amount of energy presented in the tables above is a demanding task for the body responsible for catering. During tasks when continuous work and high performance is required at tight time frame (such as filling sacks during flood control), the providing of the above-mentioned energy amount is crucial, since the decrease of the supply or inadequate distribution times will greatly affect the workers' achievement and efficiency.

Factors Influencing Energy Intake

The energy and nutrient requirements of the human body can be varied according to different patterns. Primarily, the changes are influenced by age, and there are further factors in the case of women. Consequently, the energy need of the young, the middle-aged and the elderly can be varied. It is essential for the professional staff to maintain strong physical fitness. At the same time, particular attention needs to be given to healthy diet. It is highly recommended to pay more attention to the quality supply of micro- and macro nutrients (trace elements, minerals, vitamins) over time. Energy intake is also influenced by gender, since women need less energy than men. Actual types of physical activity and environmental factors can also be influencing factors, which are subjects of research. Hard physical work that significantly alters the physical fitness and stamina increases the need for energy. Environmental factors are also needed to be taken into account regarding the dietary patterns, seeing that the body needs increased amounts of energy during the winter months. In comparison with the civil society, the defence sector is a "dangerous territory", since injuries and serious accidents are more frequent. In these instances, the average energy intake is to be increased compared to the average energy and macro nutrient demands. It is because proteins, carbohydrates and fats can be regarded as building blocks of the human body and they play a key role in the healing process like vitamins and minerals.

Recommended Nutritional Intake

Energy demand of soldiers involved in hard physical work is also between 3,000–6,000 kcal. This amount should be compiled for them during work in a varied, tasty and healthy pattern. In the past, food science aimed to maintain soldiers' fitness by providing them with a high number of calories (wrongly), and failed to pay attention to the vitamin and mineral demand of the human body. Therefore, varied dietary patterns got far too little emphasis, and a monotonous yet calorie-rich diet become common with corn beef and rusk as the main staples for soldiers.

When examining the intake possibilities of various forms of foods, not only the quantity distribution needs to be considered but it must be insured that the quality of the consumed food is the best. The insufficient intake of some macro nutrients can lead to decrease of performance, weight loss, or in the case of hard physical and mental burden, it can lead to exhaustion or illnesses. [9] That is the reason why products that are enriched with proteins, amino acids, unsaturated fatty acids, vitamins, minerals, as well as dried products are becoming more and more popular besides traditional foods. Yeast based single cell proteins with a high amount of protein content and favourably composed fatty acids are becoming the centre of food science. With their help, this addition can be used efficiently even with micro

elements that are basic for the human body, since yeasts pile up micro elements efficiently. Packaging of various foods is not a minor issue. Resistant packaging, sufficient microbiological stability, instant packaging forms greatly contribute to the use of quality foods in the area of operation. The intake of vitamins and minerals plays an important role in maintaining health. Being excellent sources, the consumption of fresh vegetables and fruits is the easiest way to provide these nutrients. If they are not available, the consumption of dried fruits is a possible alternative. The calorie content of dried fruits is higher than the fresh ones, since during the drying process water is subtracted and the fructose content is more concentrated.

Dried meat can be another alternative. It is very popular among bodybuilders and can be available in gyms in small packings. Known as Beefy Jerky abroad it comes in 25 g and 50 g containers.

Alternative Options

Dried fruits and vegetables have been used in the army for a long time. A publication in the American Journal of Physiology appeared as early as 1919, on this topic. Dried vegetables are considered to be essential. Their nutrient value is characterised by their high digestible material content, especially carbohydrates. This group contains the vitamins and minerals that are essential for the human body, as well as proteins, organic acids and volatile oils. One of the benefits of dried vegetables and fruits is that their mass is decreased by 80–90% during the drying period and the space requirement can also be reduced by 50%. In the respect of storability, these dried products can be stored for years. The above-mentioned article claims that the base of soups in the army were dried vegetables that were stored in paraffin-covered barrels for more than 50 years. This also proves that these dried products can keep their qualities. Since the availability of fresh fruits and vegetables is limited in the winter months, dried products can be good alternatives. [10]

Besides dried products, other alternatives are the Single Cell Proteins we have mentioned earlier. Supplying the human body with protein is one of the key factors regarding the quality of life and physical performance. [11] In order to insure that the amino acid kit remains intact under hard physical activity (in soldiers) protein of animal origin is needed, since the essential amino kit is defective in plants. [12] When manufacturing single sell proteins, the main focus is on the production of large cell mass that has biological advantages. As to nutrient requirements, it has a satisfying content for the human body with high protein and low saturated fat content. For the first time, single cell proteins were used in Germany and Russia during WWII. They have a wide use as therapy products. The most popular form of single cell protein is baker's yeast which is mass produced worldwide. Though single cell proteins are not used for human consumption or as food supplements yet, we can find specialised literature that discusses their possible consumption.

Summary

Members of official bodies performing complex technical rescues often have to work under extreme conditions for a prolonged period and deliver hard physical work. The efficiency of this work is determined by steady physical fitness and stamina that can only be achieved through an adequate energy supply. In our work, we have studied the factors that endanger

the workers' health. We calculated and with the help of examples presented the quantity and pattern of the needed fluid and nutrient intake. With our research, we would like to raise interest in the topic, so we place a great emphasis on presenting the alternative solutions in the supplying soldiers who carry out hard physical work. Among these alternatives, we presented dried products and their forms of use. We also presented the single cell protein (SCP) the importance of baker's yeast protein that was used in human consumption during WWII. The reason for discussing and emphasizing these dietary alternatives is their high protein beneficial macronutrient content, as well as their concentrated vitamin and mineral content. As we considered during our research, the calculated numbers are highly varied and demand effectively utilized foods and food alternatives. With our research, we would like to contribute to the work of professionals responsible for the energy supply to human resources involved in hard physical work during technical rescues.

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The Environmental Impact of Plastic Waste Incineration

Ágnes NAGY,[1] Rajmund KUTI[2]

According to environmental and safety-conscious behaviour in the 21th century, it is necessary to strive to reduce all those activities that cause environmental damage in every aspect of life. More emphasis should be placed on recycling, waste-handling and environmental-friendly solutions, due to the increased amount of waste caused by the penetration of plastics. Plastic manufacture is a constantly growing industry – especially the production of packaging – so the amount of plastic waste generated is also growing steadily. Only a part of the accumulated waste is recycled, another part is destroyed and the remaining amount will continue to pollute the environment. One form of destruction may be energy recovery or incineration. Destruction is a form of energy recovery or incineration which is subject to strict legal requirements in addition to other possible activities. It could pose a serious burden on the human and natural environment if the process is not properly controlled and monitored. This article writes of the situation that seemingly a growing amount of plastic waste is used in residential combustion appliances, of which adverse environmental and health effects the majority of citizens are not aware, so these will be shown in particular. In this article, we examine the environmental and health effects and harm caused by the burning of plastics in detail. We write this study with the purpose of drawing people's attention to the importance of reducing the quantities of plastic waste and thus the environmental impact they cause as well as the human and environmental risks of incineration.

Keywords: *environmental safety, environmental damage, plastics, plastic waste, recycling, incineration*

Introduction

Since 1950 we have witnessed the rise of plastics. Plastic products produced from crude oil derivatives – due to continuous technological progress – can be prepared with relatively low manufacturing costs and possess excellent usability characteristics. It is no surprise that global production has increased exponentially. [1] Hungary is also experiencing the expansion of plastics, which involves the formation of steadily growing plastic waste. [2] Nowadays, the management, recycling and disposal of plastic waste is a major issue. These developments pose a serious burden on environmental elements, accordingly, it is essential to examine the

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effects of plastic products and waste on human health and the environment at a deeper level. The scope of this article does not examine the entire process of waste management, therefore, after a general presentation, the energy recovery, the risks of incineration and their adverse effects are analysed.

Features of Plastics, Waste Management

Plastics are organic compounds consisting of giant molecules which are mostly produced from synthetic oil derivatives. According to user needs, their quality (such as flexibility, impact, fire resistance and special colours, etc.) depends on the various additives allocated into the raw material. In terms of its type, plastic can be thermoplastics or thermosetting polymers. According to Central Statistics Office (CSO) data, in Hungary the population produces approximately 300 thousand tons of plastic waste annually. Most of the plastic waste is thermoplastic packaging, therefore this type of waste is examined in detail. As the majority of plastic does not biodegrade in nature, the most important task is to reduce waste emissions, create responsible management of resulting waste and recycling. [3] [4] The following figure shows the hierarchy of waste management:
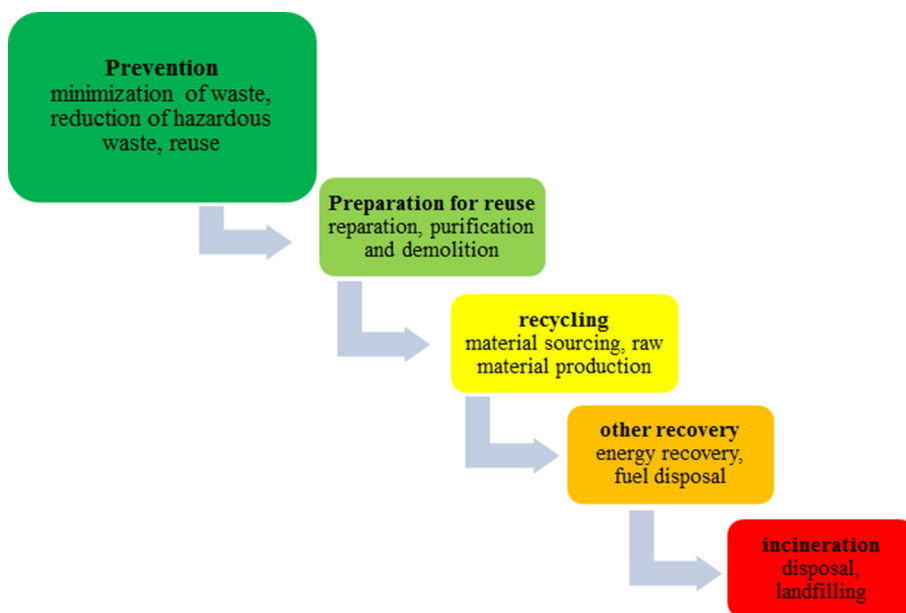
Figure 1. The hierarchy of waste management.
(Compilation of data by the authors based on source [5].)

The colours in the figure are consistent with the environmental influences, which means that energy recovery and incineration can be found at the bottom of the hierarchy, therefore they are not considered to be the most advantageous solutions.

Risks of Plastic Waste Incineration and Its Adverse Effects

The incineration of waste as a fuel generates heat energy in cement factories and power plants which is utilized in technological equipment. The resulting heat is used for operating systems, heating and generating power. The disadvantage of combustion of plastics is the air pollution caused by the noxious fumes released into the atmospheres. In Hungary, this activity is regulated by the 29/2014. (XI. 28.) Regulation of the Ministry of Agriculture on waste incineration, technical requirements and operating conditions for the incineration technology and emission limit values. The incineration of waste as a fuel is possible, therefore, subject to licensing only in accordance with legal requirements and technology incineration plants with flue gas filtration equipment along with the continuous monitoring of the combustion gases emitted. The following diagram shows the built-in filtration systems technology.
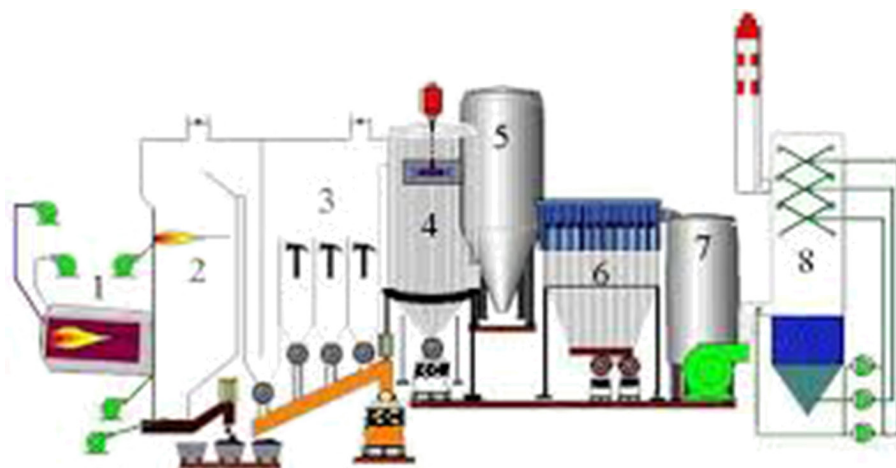
Figure 2. The flow chart of the Incinerator in Sarpi Dorog Environmental Ltd. [6]

Explanation:
1. Rotary Kiln
2. Post-combustion chamber
3. Heat recovery boiler
4. Absorber
5. Calcium hydroxide dust and active carbon reactor
6. Dust bag isolator
7. Catalytic dioxin decontaminator
8. Washing Tower

According to the above-mentioned regulation, plastic waste can only be incinerated in licensed plastic waste incineration plants, all other forms of burning plastic waste are banned. Mostly plastic waste is generated by common households. The introduction of advanced selective waste collection systems has allowed the separation of different materials and types of waste. An important task is to emphasize the benefits of the separation of plastics, so they

become re-usable and less polluting to our environment. Unfortunately, in Hungary, due to the economic crisis, more and more families are having trouble purchasing fuel for the winter, so the household waste is incinerated, and the harmful effects are not taken into account. During incineration, plastics cause permanent damage to the combustion heater in the flue systems and the resulting combustion products pose a serious threat to both humans and the environment.

The burning of plastics is a complex chemical process. Depending on their structure, plastics can be micro-molecular or macro-molecular compounds. During plastic combustion, different phases take place, such as warming, degradation, flashover, combustion – all which are present at the same time. Low-molecular compounds can be vaporized directly in the air, and depending on their variety, are able to form a combustible mixture, or oxidize in solid form. Macro-molecular plastics have to decompose into small molecule compounds to initiate the combustion process. Burning is accompanied by the formation of chark, coking extent depends on the conditions of combustion. Two zones are formed during the combustion of most plastic. The first zone is the gas evolution (pyrolysis zone), the second zone is the chark zone (between the surface and the pyrolysis zone). [7] The chark zone consists of porous solid residues. Gases generated during the decomposition of the plastic composite products are extremely dangerous.

The most common household plastics are:
- Polyethylene (PE),
- Polyethylene terephthalate (PET),
- Polypropylene (PP),
- Polyamide (PA),
- Poly (vinyl chloride) (PVC),
- Polyurethane (PU).

The combustion characteristics of these plastics are shown below:

Table 1. Combustion characteristics of plastics used in households.
(Details of the authors' compilation based on source [7].)

Name of substance	Ignition temperature (°C)	Heat of combustion (MJ/kg)
Polyethylene (PE)	350	46.3
Polyethylene terephthalate (PET)	500	22.7
Polystyrene (PS)	470	41.6
Polypropylene (PP)	410	46.6
Polyamide (PA)	500	31.4
Poly (vinyl chloride) (PVC)	760	19.26

The combustion of plastics presented in Table 1 causes several chemical compounds which mean a serious risk to health and the environmental elements, among which, especially, the incineration of PVC poses the greatest threats, therefore that type of plastic is analysed in detail in this process. The use of poly (vinyl chloride) is highly restricted or banned in many countries of the European Union. However, in Hungary PVC is widely used in the form of

plumbing and sewage pipes, as the insulation material for electricity cables, floor coverings, furniture coverings and other household items as well.

The compounds generated by the incineration of PVC and its harmful health effects are presented in the following table:

Table 2. Generated compounds and their harmful effects during incineration of PVC.
(Compilation of data by the authors based on source [8].)

Name of compound	Health effects
Acetaldehyde	It damages the nervous system, causing lesions.
Acetone	Irritates the eyes, the respiratory tract.
Benzaldehyde	Irritates the eyes, skin, respiratory system, limits brain function.
Benzole	Carcinogenic, adversely effects the bone marrow, the liver, the immune system.
Formaldehyde	Serious eye damage, carcinogenic, may cause pulmonary oedema.
Phosgene	Gas used in the WWI. Corrosive to the eyes, skin and respiratory organs.
Polychlorinated dibenzo-dioxin	Carcinogenic, irritates the skin, eyes and respiratory system. It damages the circulatory, digestive and nervous system, liver, bone marrow.
Polychlorinated dibenzofuran	Irritates the eyes and the respiratory system, causes asthma.
Hydrochloric acid	Corrosive to the eyes, the skin and the respiratory tract.
Salicyl-aldehyde	Irritates the eyes, the skin and the respiratory tract. It can also affect the central nervous system.
Toluene	Irritates the eyes and the respiratory tract, can cause depression.
Xylene	Irritates the eyes. It can also affect the central nervous system, reduces the level of consciousness and impairs learning ability.
Propylene	Damages the central nervous system by lowering of consciousness.
Vinyl chloride	Carcinogenic, irritating to eyes, skin and respiratory system. Effect on the central nervous system, liver, spleen, blood-forming organs.

During the incineration of PVC, up to 2 milligrams per gram of phosgene is generated, which is one of the most dangerous gases, and a serious risk to health. Phosgene $(COCl_2)$ is an organic compound, colourless, its odour is reminiscent of musty hay, an asphyxiant gas it is a strong poison. It was used as a chemical weapon during World War I. [9] It hydrolyses easily and is freely soluble in non-polar solvents. [10] This also reacts with the condensing vapour during combustion, whereby hydrogen chloride is formed, which is also a toxic compound. The following equation presents this chemical reaction:

$COCl_2 + H_2O \rightarrow CO_2 + 2\ HCl$
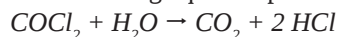
The adverse health effects of carbon monoxide gas *(CO)* and carbon dioxide *(CO$_2$)* generated during the combustion process are well known. In terms of quantities, we can say that every five grams of burned PVC derivatives pollute a cubic meter of air to such an extent that it will surely damage our health. The burning process of mixed waste also produces other toxic compounds, which are fastened to one another and exert their harmful environmental impact. A further problem is that fuel used in household appliances are not designed for burning plastics and other waste, therefore the burning of waste in plants and in flue gas can cause damage. One of the main conditions of the combustion process is the presence of oxygen. The oxygen required for combustion is included. To burn one kg of firewood depending on the variety, 12–16 m^3 of air is needed and to burn waste a much larger quantity is necessary. [11] Since the right amount of air cannot be provided, the lack of air results in an inadequate combustion and the flue may result in large amounts of flue gas deposits. The right amount of air cannot be provided, the resulting lack of air causes inadequate combustion which redounds the flue gas to sediment in flue gas deposits. Evacuation of the fumes during combustion is the task of the flue outlets, commonly called chimneys. In order to achieve sufficient heating efficiency, chimneys should be scaled for the heating system. It is also important to assure air supply for combustion. The combustion equipment and chimney system are designed to burn defined fuels. The deviation from the prescribed is always a risk because they may not develop the flue gas exhaust, and drafts of fresh air needed. The burning of domestic waste involves large amounts of flue gas formation, part of which is deposited in the chimney wall and because of the absence of built-in filtering equipment, the other parts enter the environment. The soot formation in the chimney occurs during strenuous plastic waste, burning rubber derivatives. The incineration of mixed waste causes a significant amount of smoke. The smoke flowing through the chimney cools down continuously. Due to the decrease in temperature, water vapour condenses on the chimney wall from the smoke. The plastic compound for smoke derivatives found in the precipitating liquid is acidic. This acidic fluid, on one hand, damages the chimneys internal plaster – this primarily can be said in the case of masonry chimneys – secondly, it is also a good adhesive surface for the solid particles in the exhaust smoke, including black carbon and also a tar inner layer is formed. Due to the constantly sticking flue combustion products the inside of the chimney narrows, therefore the temperature of the exhaust fumes increases. Due to this temperature increase, the internal temperature of the chimney also rises. After reaching the ignition temperature of the flue combustion products deposited in the chimney they ignite and a chimney fire occurs. The internal temperature can reach 1,000 ºC while burning. [12] We have already mentioned the adverse effects of toxic gases arising from the combustion of plastics above, it should also be mentioned that the soil and the aquatic environment suffer from the effects of combustion products. While the combustion of solid combustion products of plastics, ashes, soot and various powders are formed, which settle on the ground objects such as plants or soil, they may appear in the aquatic environment. Rainfall causes blurred toxic substances entering the soil, exerting further polluting effects which allows these substances to become incorporated into the food chain. Some of the contaminants chemically react with water and resulting compounds alter the pH and thereby change the functioning of aquatic ecosystems. Non-soluble compounds added to the food chain exert their harmful effects.

Summary

Hungary is also experiencing an increase in the amount of generated plastic waste. In accordance with the tightening of environmental standards, the priority these days is to manage plastic waste recycling or disposing where possible. In our country, a significant part of plastic waste is used as energy recovery or incinerated, which processes are not the most advantageous solutions environmentally. Unfortunately, despite the legal prohibition of residential combustion where plastic is also burnt, the majority of citizens are not aware of the dangers of environmental and health impacts. In this article, we have examined the environmental and health effects, harmful and toxic materials in detail generated during incineration, highlighted the example of burning PVC. With this script, we wish to draw attention to the reduction in the volume of plastic waste and the importance of protecting our environment.

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Military Science Research Across the Carpathian Basin

Zoltán OROSZ[1]

Military science has always been an important factor of scientific life, considering its relevance for current strategic stability and the possibly prosperous future of a country or a nation. The century long shaping of military technology and warfare was a process through which ancient military commanders' strategic and tactical concepts were correspondingly reformed to adapt and exceed the rapidly changing characteristics and the continuously shaping environment. Strategic research is the basis for turning "unpredictable" and "world-shaking" into "understandable" and "prognostic". This analysis aims to highlight the current institutional capacities of military science in the Carpathian-basin and present the guidelines and operational level of the ongoing strategic studies in the region, while demonstrating the importance of maintaining and supporting the relevant Hungarian military research purposes.

Keywords: *military science, scientific research, military technology, strategic planning, research institutes, Carpathian-basin, Slovakia, Slovenia, Austria, Croatia, Serbia, Ukraine*

Introduction

At all times, the depositary of a state's sovereignty is its military force. A country that has a weak military capability is vulnerable to the will of other states. There are theories that preach the peaceful coexistence of people, but this kind of idealistic environment may only be maintained until the state's resources meet the basic human needs. As we know, the increased demand for resources and a parallel process, climate change, has induced a number of armed conflicts currently, and is expected to do so in the near future as well. Quoting József Padányi: "More and more conflicts occur in the world for potable water, more and more people die violent death during the struggle for water resources. Until the millennium, the number of annually reported water conflicts has not reached the half-dozen or so, but in the last ten years, this number was repeatedly exceeded on annual basis". [1: 283] The population growth of the third-world countries, [2] migration generated by the water and food shortages are factors that strongly influence the security situation of the states. [3][4]

Without specialized scientific research the army is unable to perform its function. This knowledge is essential in the field of either military theory, leadership theory or technical military knowledge. [5] Considering what changes the appearance of firearms or the proliferation of weapons of mass destruction has made in military history, much like the appearance of sociology and psychology in the application of psychological operations (PSYOPS). In pre-

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vious times military research conclusions were frequently used by civilian researcher, these days it seems that this process has reversed. Various fields of military science use civilian research and integrate the results of the civil world to their specific arena.

Military science is typically the area, among different disciplines, which is a priority national interest. In peacetime, it is typically somewhat overshadowed, but when there is a need for national self-defence – or expansion – it moves to the forefront. The cyclical nature of this process is indisputable. However, one should definitely pay attention to maintain an appropriate level of scientific analysis capability also in times of peace, otherwise restoring the potential in a more insecure period may be too late, and thus may even contribute to the collapse of the nation as well.

The specificity of military science research compared to other non-governmental scientific research are rooted in its partial publicity. [6] Insofar one's own military research results are fully shared with other nations the country could lose comparative advantage. It is therefore a difficult situation for scientists in the field of research, to publish the results of their area of competence without putting the opposing side in a position by making pieces of information public.

In order to locate our country's current military science research position and direction in the international environment, it is our duty to contemplate other countries' military science research conditions. Considering Hungary's population, the capabilities cannot be compared to superpowers, since we do not have such economic potency as their assets invested in these areas. The research results should rather be analysed in the surrounding geopolitical context. That is why in this essay I aim to highlight the main military research centres across the Carpathian Basin.

Slovakia

Military scientific research is continuous at several institutions across Slovakia. Among them, one of the most important, the Slovak military academy, functions in the north of Slovakia, at Liptovský Mikuláš. [7] The district boasts more than sixty years of military training. After the establishment of the Slovak Republic, in 1993, the government created the Armed Forces Academy of General Milan Rastislav Štefánik. [8] The institute was an open and available university for a large audience, but the National Academy of Defence of Marshal Andrej Hadik, founded at the same time [9] became the venue for special training and further education. The two institutes merged simultaneously with the transformation of the ministry of defence in 2004. Four years later, in 2008, the Slovak government decided to terminate the Andrej Hadik National Defence Academy, and transferred its tasks to the Armed Forces Academy of General Milan Rastislav Štefánik. The head of the institution is the rector, who is appointed – in consonance with the proposal of the Minister of Defence – by the Slovakian President. [8]

The ongoing research takes place at the Security and Defence Policy Department of the Military Academy, founded on September 1, 2009. [10] In addition to the education of admitted students, the department's objective is to articulate and shape security policy and maintain the professional connections with other Slovakian and foreign academies. In addition, improvement of military training, as well as developing and implementing NATO and Slovak military doctrines also play an important role. [11]

The current leader of the department is Vojtech Jurcák, apart from him, the department's education and research unit consists of 11 people. [10] The International Security Policy Conference takes place every October in the academy, whose organizers include – inter alia – the Slovak Ministry of Defence and other Czech and Polish military academies, as well as the Slovak Police. [12]

In Slovakia, for the testing and development of military equipment and techniques, a specific institution, namely the Military Technical and Testing Institute, in western Slovakian Záhorie (Vojenský technický a skúšobný ústav [VTSU] Záhorie) have been set up within the defence ministry. [13] The institution was founded in 1923, until the dissolution of Czechoslovakia in 1993, it served as the testing area of the most modern equipment of the military and arms industry exclusively. [13] Since the establishment of the Slovak Republic in 1993, the main profile of the institute is still in the testing of military developments, while the research also plays an increasingly important role within the VTSU. As a body of the Ministry of Defence, this institution carries out the official accreditation for the technical conditions of hazardous substances in accordance with the rules of NATO and operates the military training base as well. [14] The current director František Petráš, beyond seven people work within the VTSU. [15]

Slovenia

The Defence Research Centre within the University of Ljubljana – Faculty of Social Sciences – is an important player of Slovenian military science research work. [16] The research workshop centre was officially founded in 1985, which aimed to analyse security and defence policy, military science, war, and social dimensions of peace in the modern world. As a main objective, the centre defined the empirical and theoretical contributions to the security policy studies. In the last decades, it was involved in a number of international and domestic projects, in addition its researchers are active members of several international organizations (International Studies Association – ISA, International Political Science Association – IPSA, European Research Group on Military and Society – ERGOMAS, European Association for Standardising Information and Communication Systems – ECMA). As well as research, the defence research centre takes an active part in the training and education of future scientists. [16] The head of the centre is Marjan Malešic, and including him, the institute has 14 members. [17] In 2015, they published several Slovenian and English-language materials, and they are actively involved in several international projects as well. [18] The analysed topics cover the issues of terrorism, the conflicts of the Balkans and many other relevant questions. The training of Slovenian soldiers takes place – among others – in the military education and training centre of Maribor. [19]

Austria

In Austria, the gist of military science research work is carried out by the Austrian National Defence Academy (Landesverteidigungsakademie). [20] The prestigious Academy, established in 1963, employs a large number of researchers, and is labeled as the Austrian forces' "think tank". Currently it has 240 employees, including more than 35 man-at-arms, around 2,000 students, out of which the number of foreign students has reached one hundred.

Professional personnel at all levels are trained at the academy, moreover, significant work in scientific research is also present. The longest-operating part of the academy is the Institute of Higher Military Leadership (Institut für Höhere Führung Militärische), whose main task is operational, tactical, logistical and organizational education. In addition, foreign exercises and conferences are also organized by the students and staff, as well as lots of publications available on the topics of education. [21] The main profile of the Institute of Strategic and Security Policy of the Academy is professionalized in the research field of military strategy, international security policy and recent history. Their results are regularly communicated in their publication series (Schriftenreihe der Landesverteidigungsakademie). [22] The institute also organizes conferences and symposia, as well as cooperates with universities and research institutions both at home and on an international level. [23] The Peace and Conflict Management Institute (Institut für Friedenssicherung und Konfliktmanagement) [24] also operates within the academy, which was founded in 1999. In addition to the research, they are responsible for PR-activities, as well as engaging in policy advice.

The Social Sciences Institute (Institut für Human- und Sozialwissenschaften) of the academy, in addition to teaching and training, carries out sociological research within the field of military sciences and provides consultancy as well. [25] One of the main pillars of their activities are the analysis of sociological, social and human factors that affect the relationship between military and the civilian population. The second pillar's ambition is to increase the social acceptance of the armed forces within the Austrian political system. The research also contributes to consolidating the Austrian Security Strategy. Considering domestic relations, similar specialists of military sociology are working currently at the National University of Public Service, in the Hungarian Defence Force (HDF) General Staff Scientific Research Centre, and the HDF Civil-Military Cooperation and Psychological Operations Centre.

The Language Institute of the Austrian National Defence Academy (Sprachinstitut des Bundesheeres an der Landesverteidigungsakademie) in cooperation with the Austrian Ministry of Defence is responsible for the language training, testing, translation, interpretation and administrative work. [26] The Central Documentation Department of the Academy (Zentraldokumentation) is the information source for Austrian Armed Forces. [27] The institute issues the Austrian military magazine (Österreichische Militärische Zeitschrift), which is a bi-monthly magazine of the armed forces (published every odd month), consisting of about 120 pages with photos and illustrations, as well as military-themed scientific articles. [28]

Austrian officer training is located in Wiener Neustadt's Maria Theresian Military Academy (Theresianischen Militärakademie). The Institute is one of the world's oldest military academies, founded on 14 December, 1751. [29] The academy offers three years of intensive training for the soldiers, who are given the rank of lieutenant when acquiring diploma.

Romania

Romanian military scientific research is based in the Defence and Military History Political Studies Institute within the Ministry of Defence in Bucharest (Institutul Pentru Studii Politice de Aparare Si Istorie Militara – ISPAIM). [30] The Institute's three main research areas are international security, defence policy and military history. The Institute's website has articulated a number of objectives, one of which is to present and analyse NATO, the EU, and the Romanian Army transformation steps and challenges. [30] Military leadership training is

also involved, and it mainly focuses on security policy and cultural knowledge. Members of the Institute carry out Romanian and universal historical research, in addition, inform the active members about the latest military research. The military history research is an important element of their activities, the lessons learned in the historical analyses are regularly carried over to modern warfare. The members of the Institute publish regularly and they are similarly active at international conferences as well. Their scientific results are published in periodicals.

Scholarly work is carried out at the Bucharest, Charles I National Defence University as well. [31] Since the school was founded in 1889, more than 21 thousand officers have been trained. In addition to the training, the Institute of Strategic and Defence Security (Centrul de Studii Strategice de Apărare şi Securitate) received areas which cover the national defence and security in scientific research. [32] The institute was founded in 2000, it was given its current name in 2003.

The Institute's scientific research is not only used by the military but also by the political science institutes and ministries. A special emphasis is placed on social sciences, the centre studies those Romanian social phenomena that could affect the military. Their scientific research covers five programs: security and defence theories, European and Atlantic security, military strategy, military and society, as well as areas of strategic importance. [33] An International Symposium has been organized every May since 2003, international scientific conference launches every November. [34] The institute issues quarterly publications titled "Impact Strategic", the first issue appeared in 2001, since 2005, in addition to Romanian it is also displayed in English, in which there is often a place for the researchers of the HDF General Staff Scientific Research Centre to publish. [35]

Croatia

In Croatia, studies in higher military are carried out in Franjo Tudman National Defence University, and similarly to other countries, the institution plays an important role in military science research. [36] The importance of scientific research is within the organization of the University of Zagreb, a separate institution (Centre for Defence and Strategic Studies "Janko Bobetko") was set up for that purpose. [37] The members carry out special applied research, with the aim of contributing to the long-term development and modernization of defence technology. The centre operates, in addition to facilitating the provision of technical conditions, to set long-term strategic planning tasks. Its objectives are to provide the scientific research needed to develop the training of military leaders.

The centre has several departments. The technical development and research division carries out scientific research in order to develop military technology. The strategic planning and analytical department focuses on strategic research. The military geographic information system division conducts research in the field of cartography and geography. The work of the centre will also be assisted by a separate laboratory.

Serbia

A separate Strategic Research Institute was established within the Ministry of Defence in October 2006 in Serbia. [38] In the centre of Belgrade, 14 full-time researchers working in four

department, they are: strategic assessment and safety integration, security studies, military history and general administration. The Institute carries out extensive research, not only in terms of military science, but also analysing its sociological aspects. For example – among others – they analyse the threats Serbian society faces and international challenges in security affecting the international status and safety of Serbia, and the possibilities of civil-military cooperation.

The military history department pays special attention to pre and post WWII Serbian history, but there are researchers who specialize in morale of the military and the psychological effects of warfare. The Director of the Institute is Jovanka Saranovic, [39] her major research area is gender equality, and possesses a series of publications on the subject.

The research institute has several long-term projects. Previously it has already researched the situation of women in the Serbian army, but they also studied what effect the information about the army has on high schoolers. The military history department is currently investigating the 19th and 20th Century history of the Serbian army. [40] Recently released analysis elaborates on how to improve the morale of the Serbian army. [41] The Strategic Research Institute has a separate library, which is not available to the general public. [42] They regularly publish publications [43] and issue the printed Military History Magazine (Journal of Military History) twice a year. [44]

In Serbia, the military science training is done by the, 161 year old, Military Academy, where in addition to formal training, military science conferences are often held. [45] The Serbian military technological developments have private institutions within the Department of Defence, namely the Military Technology Institute. [46] After WWII, in 1948, it was created specifically for the development of military equipment, its budget is fully covered by the state. Since its development, it was involved in more than 1,300 modernisation programs, contributing significantly to the fact that Serbian military assets are currently 75% domestic products. [47]

Additionally, to the central organizations, the Belgrade Centre for Security Policy is in operation, and it defines itself as an independent security policy organization on its website. [48] The centre, founded in 1997, aims at contributing to the research of the country's security, as well as the propagation of democratic rights. [49] The institution analyses the relations of Serbia as well as the European Union and Balkan security policy.

Ukraine

Due to the particular situation of Ukraine and its history, military training is significantly differentiated. The centralization efforts only began in the nineties after the collapse of the Soviet Union, which still have not completely met their objective, although in 1997, the then government, declared a unified concept of higher military training. [50]

Uniformed military researchers thus cannot be mentioned, but the Taras Shevchenko University in Kiev, which is the military academy, performs important functions. [51] The academic department began its training program in 1933, but the only multidisciplinary education began to develop in the nineties. The science life of the academy nowadays is booming, military scientific research in sociology and engineering studies are included. In addition to publications, many books, encyclopaedias, dictionaries, manuals and scientific articles were presented in the last years. They often organize international conferences and further pro-

fessional specialized training. [52] In parallel with security and defence policy, the academy has additional studies on the topic of military law, but there are other social science courses as well.

As a result of the 1997 government regulation, in 1998, Kiev National Defence University was established, which in 2013, was named after Ivan Csernakovszkij. [53] In the university, in addition to military training, technical developments and scientific research is also carried out.

Conclusion

Military research in the light of the 21st century challenges deserved significant appreciation. The security structures have to adapt to the dynamically evolving social, economic, administrative or technological changes that have arisen and may radically change the reigning security arrangements. During this adaptation process, forward-looking and multi-year strategic planning is no longer sufficient, keeping in mind that several years ago, defined defence development may be too weak for the environment. Research and the introduction of a modernization process is highly important. The current circumstances require widely based – supported by scientific research – continuous monitoring of short and medium-term planning and strategic goals supported by appropriate background information. [54]

The Carpathian Basin not only ensures the safety of strategic interests and long-term priorities for our country and neighbouring countries, but – as it is increasingly manifested in recent years – is the key to stability of Europe. The scientific research on the adaptation of defence structures, as well as institutions engaged in examining other aspects affecting the force thus play a central role in the international defence system. Although their primary task is the examination of the national security environment – considering past, present and future trends –, it is vital to consider present scientific outcomes of their work as international results.

Similarly, to neighbouring states, in line with the growing demands we have also realized the need for the development of this area to the highest level. Considering Hungarian relations, the HDF General Staff Scientific Research Centre has a niche role, which operates now with 11 employees and a 40,000-volume strong professional library. In the last three years, it has functioned as a key element in domestic military science, and has proven to be substantial on an academic and international level as well.

Among the research units described above, the region must enhance cooperation so that as a result of an active dialogue we may contribute to the more successfully guaranteed medium- and long-term protection of the region. As to the importance of scientific analysis, according to my view, we might not only count the increasing amount of funds for this area, but the exponential increase in the number of professional achievements (publications, conferences, international scientific co-operation), which are designed to serve a more practical role, that is to help the region's military forces. In light of the current technological development of more modern technologies and combat procedures and the complex security challenges, it is essential to sustain an active scientific life at both international and national levels, in order to continue supporting the adaptation process of research and the armed forces, without which it is impossible to establish effective security systems and maintain current protection levels.

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Emotional and Cognitive Influence in Extraordinary Situations – Psychological Study of Responses with Content Analysis Methods

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The experience of extraordinary situation influences the whole personality. Nowadays the dominant crises – events such as war, natural disasters, economic crises and terrorism – affect an individual's emotional, cognitive and behavioural responses. The emerging security challenges require adequate prevention strategies and crisis intervention, which involves the analysis of the psychological processes with modern methods. This paper shows the effectiveness of the psychological methods in the management of such situations. The article is divided into several parts; the first part is a general definition of special situations, the second is the presentation of the emotional and physiological consequences, while the third deals with the description of the cognitive aspects. The final part of the study attends to the psychological content analysis in emergencies as a possible research area.

Keywords: *extraordinary situations, crisis, psychological methods, emotional, physiological and cognitive aspects, psychological content analysis*

Introduction

The new types of security challenges of the 21st century require the modern definition of extraordinary situations and their consequences. The termination of the Cold War reduced the possibility of interstate conflicts; new conflicts such as the regional and intra-state tensions emerged, these have negative impact on international stability. Furthermore, the transnational threats – such as terrorism, cybercrime, proliferation of mass destruction weapons, the depletion of natural resources and the natural disasters – have created new challenges for the defence sector.

The adequate recognition and management of the above-mentioned extraordinary situations can prevent unfavourable consequences of such conflicts. The present study focuses on the extraordinary situation as a psychological phenomenon and explores its psychological impact on individuals. Dangerous situations cause emotional, behavioural and cognitive reactions and the intensity of these responses depends on the individual's psychological condition as well as on the current situation. Analysing the extraordinary situation is an important step towards the understanding of the responses. In everyday language, extraordinary situations are phrased as extreme situation, urgency, crises. In this paper, we analyse the types and characteristics of these situations.

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The Possible Definitions of Extraordinary Situations

In the Conflict Theory of Michael S. Lund crisis is described as a space, where the beginning is represented by peace, i.e. conflict-free state, and the end of the continuum is war. When, for any reason, peace is disturbed, unstable peace, crisis or armed conflict emerge. In Lund's theory, these situations are extraordinary situations. Furthermore, the operations to resolve peace, as preventive diplomacy, crisis management, peace enforcement, peacekeeping and peace establishment missions are enclosed in this definition as well. [1] [2] Boutros Boutros Ghali's peace operations[3] (conflict prevention, peacekeeping, humanitarian operations, etc.) are also extraordinary situations. Attila Murinkó concludes in his thesis[4] [3] that the term "extraordinary situation" comprises any unusual events including military enforcement and aggression.

However, the term "extraordinary situation" can be interpreted not only in military terminology. Crisis can emerge from any unexpected situation of law enforcement, which effects the mental and physical condition of individuals. [4] Unexpected situations include the operations on the battlefront, the political disturbances, industrial and natural disasters and any unusual circumstances. Natural disasters and destructive human activity often result in extraordinary situations. Although the disasters caused by extreme weather conditions are not associated with human activity (earthquake, tsunami, flood), some experts classify disasters originated from global warming and the depletion of natural resources as destructive human behaviour. The disasters caused by destructive human behaviour are characterized as events initiating from human failure. [5]

The next sections present the above-defined extraordinary situations in details from the law enforcement and national security point of view.

Foreign Military Operations

The military personnel of the Hungarian Defence Force often perform operational missions in foreign countries due to their obligations towards NATO (North Atlantic Treaty Organization) and the Constitution of Hungary. The primarily peacekeeping operations and missions are demanding both physically and emotionally; therefore, they are extremely challenging for the personnel of the armed forces. Despite the precise selection procedure and the preparation measures, unexpected difficulties may occur leading to various physical and mental pathologies causing severe damages to both the individual and the organization.

The social interactions in the unfamiliar environment, the language and the cultural differences can be overwhelming, thus leading to increased stress in the long term. The fact that the individual cannot influence his/her environment can stimulate a sense of inability, consequently, a loss of self-esteem. This phenomenon is the so-called "culture shock", which is caused by information overload, language or generation gap, homesickness, work addiction or boredom. The foreign environment can create anxiety or disorientation in the individuals. The lack of familiar reference points in social interactions may lead to tension between the soldiers and the local community. After only a few months, the stress and deprivation of

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3   Boutros Boutros Ghali is an Egyptian politician, he was the Secretary-General of United Nations (UN) from January 1992 to December 1996.
4   Attila Murinkó wrote his thesis about the coaching of the special situations.

family and friends is followed by difficulties to implement the operational tasks in a foreign country. [6]

In addition to the above-mentioned culture shock, the stress caused by the battlefield is a significant potential for crises, causing major problems in foreign military operations. Stressful situations belong to the everyday experiences on the battlefield. To survive these situations, and to cope with the circumstances, soldiers need to have extraordinary adaptive skills. The personnel of the armed forces may respond to this stress by increasing fear or acute stress reaction. In long-term military service, there are many mental, physiological and environmental stimulations, so-called combat stressors. Physical stressors include extreme temperatures, asphyxia, chemical and radiation danger. Physiological stressors include insomnia, dehydration, hunger, poor health conditions, illness or injury. In addition, mental stressors cover for example too little/too much information, overload of sensory organs, organizational and decision-making problems; furthermore, fear or threat of e.g. death, injury, loss, exasperation, anger or irritation can act as stressors as well. [7]

Industrial and Natural Disasters

In addition to crises resulting from military action, the 21th century acknowledges further security risks in the form of industrial and natural disasters. Despite the high technology development, such events are not precisely predictable; nevertheless, having serious consequences. The disaster, by definition, is an event that endangers the life or health of many people, causes material, environmental and economic losses, damages the basic care and services in such an extent that the intervention of authorities, institutions and organizations is necessary to repair the previous state. [8]

The individual often behaves unexpectedly in emergencies because he/she instinctively performs actions to protect him/herself from physical harm. As long as the unusual behaviour serves the resolution of the situation, it is a valid adaptive response. However, if the irrationally narrowed-minded and egocentric behaviour dominates, then permanent behavioural disorder prevails. [9: 17–19] At disaster-events, extreme behaviours appear instantly, which require constant monitoring and treatment, otherwise the individual might become dangerous towards himself and others. The most important symptoms of such behaviour are extreme anxiety, stupor, physical reactions (e.g. hyperventilation, hypertension, vomiting), cognitive deficits (confusion, ambivalence, depression, suicidal thoughts) and affective responses such as fear or frustration. [10]

Terrorism as extraordinary situation

In the 21st century, terrorism represents the biggest crisis in addition to military operations and natural disasters. After terrorism became a worldwide threat, it turned into the main security challenge in the world. The terrorist act, by definition, is such a purposeful or accidental murder, which causes permanent injury, and which targets mainly civilians to achieve political, religious or ideological goals. The terrorists intend to influence the government or the state authority using assassination, kidnapping and bomb attacks. [11] Such actions are determined to provoke and to communicate symbolic messages generating extreme fear in the enemies on the way.

The motivation of these attacks is usually political or religious fanaticism, which is often associated with extreme aggression. The terrorist evaluates every consideration, action and event from the aspect of the main ideology (e.g. the terrorist organization called the Islamic State and its expansion in the Middle East) and he shows intolerance for contrary opinions; furthermore, he aims to destroy anything, which is not in line with his own fanatical beliefs. The fanatical extremist groups exploit those individuals whose personality can be transformed into the above-mentioned fanatic identity. In the psychological term these individuals have fitting character for sadism, masochism, and absolutism they have often narcissistic personality disorder, identity crisis, loss of self-integration and they are attributed to lack of autonomy and social norms and deficiency of aims and motivations. The terrorist-candidate experiences the role of his idol (often his mentor) by imitating the behaviour of the admired person. Often the candidate identifies him/herself with the idol thereby believing he can become an identical member of the group. [11: 24]

In addition to the above detailed situations, other political, economic and regional conflicts can lead to extraordinary situations, which can cause similar behavioural disorders. The above sections clearly state that extraordinary situations result in crisis conditions, which lead to mental, emotional, cognitive and behavioural consequences. Moreover, the direct effect of the crisis can be anxiety, insecurity, fear, narrowing of the capability of decision-making, irrational thinking and incorrect adaptation of resolving strategies. [12] For the better understanding of the psychological responses, it is necessary to present the psychological approach of crisis theory.

The Term "Crisis"

Crisis is a Greek word, meaning decision or turning point, in everyday usage it is used in all kinds of crises, critical status or emergency. [12] A crisis can originate from psychological, biological and economic causes. The crisis is unexpected, it has an emotional tone, and it causes a feeling of fear, helplessness and decreased consciousness. Crisis leads to an imbalance resulting in partial or complete personality dysfunction. [13]

Two types of crisis are distinguished: the developmental or normative (internal) crisis, which covers the individual development crises such as puberty or menopause, the other is the accidental (external) crisis, which is initiated by an incidental situation that affects the individual. Such situations can be natural disasters (earthquake, flood, storm, hurricane, tsunami, etc.), human-caused disasters (war, fire, bombings, mass catastrophes, terrorist attacks) and other accidents. The above-described extraordinary situations are all such incidental situations, additionally more ordinary situations are robbery, violence crime, financial bankruptcy, loss of job or a threat of serious illness. [14]

Behavioural and Physiological Responses to a Crisis

In crisis, individuals produce specific physiological reactions, which induce changes in the behaviour. In an emergency, the individual often experiences fear, which develops stress-responses. Stress originally meant only physical overload, however, its modern terminology covers generally a situation whereby someone feels overwhelmed physically or psychologically. [15: 467] The person evaluates events as stressful whenever he or she feels that the cir-

cumstances endanger his/her physical or mental well-being. In a stress situation, the human body is preparing to eliminate the stressors. The sympathetic nervous system generates stress responses such as increased heart rate, faster breathing, the mouth dries out, the Adreno-corticotropic hormone (ACTH) is produced, which increases the production and release of cortisol into the blood, causing increased blood pressure, blood sugar level and suppression of the immune system. The liver produces more glucose, providing more energy to the body. This so-called fight-or-flight response is an acute stress response, which activates the body to have more energy for fighting or running. This state can be dangerous to the individual or to others. [16: 541]

The Stress-Related Emotional Responses

In the stressful situations, besides the emotional and behavioural responses, the physiological reactions are important. Most dominant are anxiety and fear: anxiety and fear are not interchangeable processes, as anxiety is an emotional response to the thread, while fear is a cognitive process when the stimulus (i.e. thread) is evaluated intellectually. Anxiety causes faster heartbeat, tremors, nausea, and dizziness. Fear activates when an individual is exposed to a physically or psychologically threatening situation. [17: 6–8]

Other psychological reactions are anger and aggression, emotions which are usually related to frustrations such as unachieved goals, realization of material damages or a loss of an important person. The response to a given frustration is different from person to person, nevertheless, if the anger prevails for a long time, it becomes a stressor itself, leading to physical symptoms. [15: 231] Conceptual definition of the aggression originating from frustration is such an "offensive behaviour, which is triggered by hostile, often irritating experiences. The offensive behaviour can be self-directed or intended to harm others, can be conscious or unconscious, can be direct or indirect, moreover, it can convert into other forms (e.g. anxiety and physical symptoms of repressed aggression)." [18: 24] In contrast to the generally negative meaning associated with aggression, a positive or actually constructive aggression exists, because a certain level of aggression is necessary for the self-sustainment, for the self-defence and for the protection of the family as well.

In addition, depression can occur in stressful situations, which causes a feeling of sadness, anxiety, emptiness or helplessness. Depression, also known as melancholy is characterized by excessive reactivity or inactivity, and if it is a reaction to a life event such as grief, it can have higher intensity and longer duration than normal. Depression is a mental disorder, which negatively affects the person's whole life, his/her everyday performance, the general well-being, the physical and mental functions, and his/her human relationships. [19: 27] Symptoms can be on cognitive, affective, conative and a physical level. Characteristics of depression are the extreme unhappiness, the loss of the interest, inability to experience pleasure; these are associated with typical cognitive and physical symptoms (e.g. slower movements). [19: 27] Anxiety, low self-esteem, negative expectations, emotional paralysis, lethargy, self-hatred are all possible symptoms of depression.

The Cognitive Aspects of Extraordinary Situations

According to Bolgár and Szekeres, the characteristics of the behaviour in an emergency appears in four levels: physiological, cognitive, emotional and behavioural dimensions. [12: 10] In the previous chapters, the physiological and emotional aspects of the extraordinary situations have been presented; however, the cognitive processes cannot be ignored in the extraordinary crisis and in the related decision-making processes. Cognitive processes include the difficulty of decision-making, confusion, disorientation, poor concentration, memory deficits, inability of solving complex problems and occasionally flashbacks. [12: 10] The individual cognitive structure can change in a stressful situation, which entails impaired consciousness and hallucinations.

The revolution of cognitive psychology[5] reflects on the particular situation, its individual interpretations and its decisive cognitive processes. Everly et al. [20] studied the psychological effects of Hurricane Katrina, when they concluded that the cognitive elaboration of an event is the best predictor of the evolved stress. The study highlights the effectiveness of cognitive behavioural therapy in coping with the specific situation, the method of which is based on the conception that the primary determinant of human behaviour is the learning/cognitive process. The theory states that in the background of the dysfunctional behaviour there is always problematic thinking. Accordingly, the changing of maladaptive cognitive schemas can help the individual to cope with crises.

Decision-Making in an Extraordinary Situation

The subjective interpretation of reality is particularly important because it determines the decisional coercion of the extraordinary situation. According to Stern [21] we talk about decisional crisis when the situation threats essential interests, requires urgent action and it is associated with a high degree of uncertainty. Based on Mezey's decision-making model [22] the individual perception is the first step of a decision that involves the situational awareness. The normative interpretation of the given situation results in rational decision, although due to the special conditions the rationality may be limited as well.[6] The situation awareness in extraordinary circumstances and the following decision-making process can trigger distinct behavioural schemas as cooperative or provocative.

The military conflict as an extraordinary situation, similarly to the need of decision-making requires specific cognitive abilities. According to a study about US military crises done in 2010, [23] the decision-making of the military leaders requires creative thinking, a high level of problem-solving skills and adequate comprehension in a military action. In the article, the approach of the military personnel is summarized, which describes the cognitive heuristics and bias used in a stressful decision-making situation. Due to the uncontrollable amount of information and a large number of sensory inputs, an individual is unable to interpret them,

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5   In the seventies of the last century the cognitive perspective see the individual as a recognizer agent against the long dominant behaviourist approach, the new perspective's central concept was the subjectivity and the representation. According to the cognitive approach the individual constructs the reality with strategies based on his environment, previous experience and cognitive processes, with this he exclude the objectivity.

6   The alternatives of the acts are defined by the decision criteria, the weighting of the aims and the multiphasic analysing in the normative decision-making model.

because the soldier uses simplifications and pre-programmed schema of thinking. Williams argues that facing new circumstances, the individual will compare them to similar situations residing in the memory, prior to adopting the behavioural plan. This is connected to retrievability bias, which means that the subjective probability of future events is related to the personal experience. People after experiencing a traumatic event expect that it will happen again.

Summarizing, we can see that decision-making involves both the general cognitive abilities and the subjective heuristics. Bolgár and Szekeres [12: 26–27] used the theory of Tversky and Kahneman's 1974,[7] to classify the thinking processes into three categories. The availability heuristic is a decision-making method, when the subjective probability of the particular events is based on the ease of imagining or recalling a similar event from memory. The adjustment and anchoring is heuristic, when people make decisions by using a reference point, to which the result will be correlated, regardless how relevant this reference point in the current question is. The representativeness heuristic arises if a situation is categorized to a certain type, i.e. when the situation is compared to a prototype of a certain category.

Cognitive Deficits in the Crises

Our study suggests that the individual applies cognitive bias in an emergency based on previous experiences and this bias can significantly affect the decision-making. In the last decades, the psychological research emphasises the post-traumatic stress (referred to as post-traumatic stress syndrome (PTSD)[8] following an extraordinary situation. PTSD influences negatively on the mental health of the individual, especially on the operation of cognitive functions. To better understand the information processing errors; it is necessary to clarify the concept of PTSD. This disorder has the following main symptoms: [20]
  • intrusive memories,
  • recurrent recollections of the traumatic event,
  • nightmares,
  • intrusive images,
  • depressive symptoms,
  • avoidance of trauma-related people,
  • places and thoughts,
  • symptoms of increased arousal, such as irritability, sleep disturbance, outbursts of anger.
The cognitive behavioural therapy of post-traumatic stress approaches the information processing deficits related to the traumatic event.

The false interpretive procedures, which follow the stress, involve maladaptive coping strategies and dysfunctional problem-solving skills. One example is the terror attack in Oklahoma City in 1995,[9] and its first erroneous interpretation: after the incident, the police investigators suspected terrorists from the Middle East, because previous experiences, the threat from al-Qaeda and the interpretation of the assassination suggested that Islam terrorists were responsible for the attack. [21]

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7   Amos Tversky and Daniel Kahneman (1970) developed the theory of the operation of human errors and cognitive biases. Their research significantly contributed to the development of cognitive psychology.
8   Post-traumatic stress syndrome (PTSD) first appeared in 1980 in Diagnostic and Statistical Manual of Mental Disorders (DSM, published by the American Psychiatric Association).
9   Timothy McVeigh, a former US soldier detonated two bombs in April 1995 in Oklahoma City. 168 people were killed in the attack, the bomber was executed in 2001.

The heuristics and the preconceptions, used in information processing, play a significant role in developing false interpretations of the situation. The monitoring of the complex physical and social environment is inherently limited because of the infinite number of inputs; additionally, the stress and the motivation of the problem solving can also negatively affect the actions taken for interpretation. A person suffering from PTSD is likely unable to process the crisis in real-time, he/she may attach higher global importance to the negative effects. The individual overestimates the threats associated with the traumatic event, his/her fears about the future are irrational. Because of the intrusive memories, the person feels he/she is losing control, and because of the dominance of negative emotions, he/she starts to use maladaptive coping strategies. Hence, the mental illness of the individual causes a damaged autobiographical memory, which is not able to process and integrate the trauma related memories. [24]

According to Artman and Garbis [25] the failure or dysfunction of the mental capacity reduces the use of an adaptive coping strategy in extraordinary situations, because it negatively affects the processing of information. The study points out that cognition is not a static construct, but it dynamically changes depending on external factors. The awareness of situation can be understood at the individual level; therefore, the cognitive process and situation awareness of a group, organization or country is based on the capability of the individuals, and the common action is determined by the interaction between these individuals.

Content analysis methods of extraordinary situations

In addition to the psychological aspects, the cognitive process also play an important role in managing extraordinary situations, in decision-making and in behavioural responses. One way of testing the reactions to crises is the psychological content analysis. The analysis of the communication and the narratives in traumatic events contributes to the understanding of the emotional, behavioural and cogitative responses following the extraordinary situations.

The definition of content analysis

Content analysis is increasingly used in social sciences, and it is an analysis method of publications and documents for specific purposes; primarily of the oral and written materials. [26] The method consists of two parts. In the encoding phase, the words, phrases and symbols are detected and categorized. In the next, interpretation phase, these variables are analysed and the hidden associations are identified. Smith suggests [27] that the content analysis can identify the underlying meaning of the text, till Berg suggests [28] that the method allows an objective examination of a particular text. The narrative psychological content analysis is the most used tool in Hungary, it is a method developed by János László and his colleagues.[10] The method searches for grammatical categories and functions, and derives a psychological meaning from them. According to László, [29] a relationship exists between the narrative compositions and psychological processes, as the narrative construction of the word is egocentric, and it is derived from the personal experiences of the narrator.

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10 The experts from the University of Pécs and from the Institute of Psychology of the Hungarian Academy of Sciences (MTA) created a Hungarian basis for narrative psychology where the nature of narratives and the human behaviour can be examined.

Literature review on content analysis of extraordinary situations

The interpretations, related to the extraordinary situations, often explain the prevailing causalities of an event, although, the alternative narratives, which help to process the crises, can assist the better understanding of the event. After a traumatic event, the public opinion also affects the judgment of those who are in decision-making power. Furthermore, content analysis is not only applicable in the field of interpretations and opinions, but also can be used in investigating the consequences of the crises. The method is mainly applied in the business sector, because the companies affected by the economic crisis strongly support crisis communication and crisis management. Crisis communication and management are used in a crisis situation by companies, communities and social organizations.

Much international research has examined crisis communication and management of economic companies: a study from 2013 [30] compares the industrial disaster of British Petroleum to the Japanese earthquake and the accident of the Fukushima nuclear power plant along the strategy of crisis communication.[11] The author examined these communication strategies with content analysis, the examined texts were press releases and posts from Twitter and Facebook. The research addressed the strategy of the companies to inform the public, and the level of information sharing. In the strategies of crisis, communication it has the most important aim to minimize the damage. This study points out the importance of the Internet, hence it greatly affects communication approaches. Nowadays individuals get information about traumatic events through social networks; therefore, the companies and organizations are unable to control the range of available information and data related to the accidents. Information related to crisis or disasters receive more attention on the Internet, thereby the leaked information to the public is not controlled.

The content analysis research, examining extraordinary situations investigates mainly economic events and their communication strategies used by multinational companies. However, studies about riots, violent political protests or military conflicts are published as well. An article from 2012 [31] examines the crisis communication strategies of leaders after the demonstrations in Tunisia and Egypt in 2010–2011. The author states[12] that the political speeches are special, because they contain less information and are often manipulative and persuasive. The author concludes that the main aims of the speeches were to preserve the reputation and to rebuild the authority of the leaders, to which different tools were used:
- The nonexistence strategies aim at ending the crisis using communication tools as denial, clarification, attack and intimidation. The leader attempts to diminish the relation between his actions and the crisis, and to trivialize the events.

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11 The one of the world's biggest industrial disasters happened in April 2010, when the one of the oil rigs of the British Petroleum (BP) exploded and sank in the Gulf of Mexico. The enormous oil pollution has led to massive desolation of fishes and birds. A year later, the Japanese earthquake and tsunami materially damaged the Fukushima nuclear power plant operated by the Tokyo Electric Power Company (TEPCO). The damage produced equipment failures followed with three nuclear meltdowns, causing a large amount of radioactive pollutants into the air. Later it turned out, that neither BP nor the TEPCO did not have an adequate operation plan for a disaster.

12 The Tunisian protests began in December 2010, marked the beginning of the Arab Spring, and the riots spread across the North Africa and the Middle East region. The demonstrators were protesting against high unemployment, corruption and dictatorial measures. The events in Tunisia also spread to Egypt in early 2011, where the anti-Mubarak protests aimed at defeating the government. The events of the Arab Spring finally led to the demission of two North African presidents (Zine El Abidine Ben Ali, Hosni Mubarak).

- The distance strategy differentiates from the nonexistence strategy in the leader's approach to the crisis. The speaker although admits the existence of the crisis, but he denies his responsibility in the events.
- The ingratiation strategy uses different communication tools. The leader admits the existence of the crisis, and highlights his strategy to resolve the situation. He specifies his positive steps towards the solution. The leader assures the public of his support and he praises the government's actions.
- The fourth strategy – mortification – is when the chief/leader emphasizes his responsibility in the events, shows remorse and promises to rectify the damages.
- The fifth – suffering – strategy is slightly different from the previous methods, aims at awakening the sympathy of the public and demonstrating/the leader as a victim, who was exploited by some external, malicious entity.

Alharbi examined the political speeches of Zine El Abidine Ben Ali, Tunisian head of state and Hosni Mubarak, Egyptian head of state, and concluded that the presidents used the above-mentioned forms of communication strategies, often combining them. The crisis communication strategies may help to protect or restore the leader's reputation; however, it does not guarantee the success of the political speech. According to the author, the content analysis of these speeches can contribute to our understanding of the political crisis in the Middle East.

Hart and his colleagues [32] studied in 2002, how the American people respond to the national events of great importance.[13] The research made by content analysis methods showed that the crisis is followed by an increasing need for the national-wide introspection and the understanding of difficult events.

Summarizing, the extraordinary, unusual situations change the political and everyday communication; the normative forms of communication cannot be applied for such events.

Conclusions

The employment in the defence sector is different from civilian occupations. It is accompanied by increased risks on both physical and mental level. The military personnel have to be in good physical condition; furthermore, have to have exceptional psychological endurance. The members of the defence sector often have to take responsibility for other people's lives and material goods; they regularly experience time pressure and face decisions in difficult situations. Moreover, their duty is based on complex rules and instructions, and the work requires creativity and flexible thinking simultaneously.

Any emergency (military missions, disasters, terrorism, riots, etc.) will create a critical situation, and people will start to search for possible solutions. The victims, the civilians and professionals involved in the rescue are exposed to physical effects and psychological damages, long-term disorders. These may include post-traumatic stress disorder, somatization disorders, distress, anxiety or difficulties in social life. As it was discussed above, the respond to a crisis involves a complex psychological response; therefore, in extraordinary

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13 The article studied the terrorist attacks in 2001 and Bill Clinton's constitutional impeachment. In the attack against the World Trade Center and the Pentagon were killed nearly 3,000 people, when Islamic terrorists hijacked four airplanes, while the cause of the Clinton's impeachment was his earlier sexual affair with a woman named Monica Lewinsky.

situations, the fast and professional psychological intervention is important. Crisis management includes not only the intervention in the events and the work towards the resolution, but also the prevention of post-traumatic effects and the follow-up care of the psychological conditions of both the executive staff and the victims.

The empirical research of extraordinary situations in the defence sector is essential for adequate preventive actions. The experts cannot determine the adaptive preventive and intervention tasks without the up-to-date scientific results. The new types of security risks are associated with new challenges. The recent crisis, the international terrorism since the terrorist attacks of 2001, the political riots in the Middle East, the increasing frequency of natural disasters, the regional conflicts in Europe – see Ukrainian crisis – and their psychological impacts are important research areas of psychology.

The dysfunctional behaviour in the crisis is always based on emotional deficits and maladaptive cognitive schemas, while in a usual situation the individual can use the appropriate coping strategies. The main question is how these processes help the individual to adapt the particular emergency. According to the proposal of the present study, the psychological content analysis methods can identify the psychological aspects of adaptive coping strategies.

The individuals, who are involved in extraordinary situations, re-experience the trauma during the narrative of the events; thereby, they re-conceptualize the reality. The content analysis methods are appropriate to examine the participants' subjective perceptions and to determine the occurring psychological responses. Knowing the emotional and cognitive reactions allows the adequate treatment of a crisis. Taking the cognitive aspects as an example, well-functioning and efficient cognitive behavioural therapy does not exist without the recognition of the distortions and heuristics.

In the here discussed crises, the aspects of the responsible persons have to be considered next to the victims' psychological disorders. The crisis communication of the leaders involved in – mainly economic and political – crises significantly affects the outcome of an extraordinary situation and the possible consequences. In the communication of the responsibility and the information, it is important to repair the caused damages and to recover the political power in the new circumstances. The crisis management of the leaders is often investigated by content analysis techniques. These studies show that the analysed speeches and messages significantly affect the resolution of the crisis and the reactions of the responsible persons.

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Examination About the Law Enforcement Strategies which are Influence the Criminal Behaviour

Csaba SZABÓ[1]

This study intends to react to challenges threatening Europe's internal security. The perception of security of Europe's citizens has deteriorated due to recent terrorist attacks. The internal security strategies of Europe's countries should be revised because it is impossible to predict which European country will suffer another terrorist attack. Prevention can be classified as the most important strategy in this situation. The deplorable terrorist attacks that occurred in France and Belgium have shown that in addition to the civilian population, members of the police are also exposed to attacks of terrorists. The study analyses the comprehensive theoretical approach, which is a research starter to help the law enforcement agencies in creating a more coherent and effective concept for preventing and uncovering crimes in order to protect, firstly, the civilian population and, secondly, policemen. Hypotheses are formulated, which examine basic elements of the strategies for preventing and uncovering crimes from the viewpoint of the organizational culture of the police.

Keywords: *terrorism, crime prevention, uncovering crimes, police, public safety*

Introduction

Experts engaged in research work in the field of police sciences have a uniform and unbroken opinion that the more police we have in a given country, the more effective indicators can be achieved in the field of crime prevention and detection.[2] The reduction in crime is one of the primary goals of any government. This is understandable, since the efficient management of activities of public authorities responsible for public security and the appropriate use of available tools can significantly improve citizens' perception of security.

The possibility of practical realization of criminal intent can primarily be suppressed by the crime prevention strategy of the police. The strategy shall define the effective use of police *forces* and *tools*, and the timeline for implementation of the formulated specific goals and objectives.[3] Both personal and material conditions of the police exceed the expectations of the age. Programmes of law enforcement training incorporate case studies and relevant

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2 Social scientists often argue that increasing the number of the police can make only minimal contributions to a positive move in indicators of crime detection and crime prevention. In their view, the extension of the social institution network and the strengthening of the stability of family relationships, as well as the successful solution of labour market challenges are increasingly able to contribute to the management of criminal inclinations of the society.
3 The spatial and temporal analysis of frequency and intensity of crimes is the cornerstone in the development of crime prevention strategies.

aspects of changes in legislation. Policemen are trained for management of unforeseen situations by psychological, educational and communication methods. Nevertheless, the efforts of the police were not providing adequate answers to the challenges of policing, and in some European countries the deterioration of public security can be observed.

Investigation of crime prevention and crime uncovering concept of law enforcement agencies.

The permeability of free borders in Europe is one of the most vulnerable points from the viewpoint of public security. Effective strategies for internal security, crime prevention and uncovering are a tool to combat unexpected crimes causing fear to all societies. However, to effect the desired results, the implementation of the strategy for public security shall not be restricted exclusively to the territory of one particular country and, primarily a system-level public security strategy shall be devised.

The types of crime, to which European societies are most vulnerable, include *terrorist offenses, homicides, assaults, robberies* and *car thefts.* The police can effectively reduce the number of these particular crimes provided *certain* work methods work properly under *certain* circumstances.

Policing and criminological research, being so far completed or pending, primarily addresses *criminal intents of juveniles, criminological aspects of crime scenes, the risks of globalized crime, issues of power structure in the stat*e, as well as the causes and consequences of economic crime. These studies are increasingly complemented by analyses of terrorist offenses planned or carried out in the European continent and the exploration of their causal factors. The patterns of the research provide answers to the many arising issues[4] and aim to achieve a result-oriented crime prevention concept with success rates that may not be always measurable in concrete figures.[5] If we accept the *paradigm* that the work of the law enforcement has impact on the criminal behaviour, we need to continue further research on the effects of law enforcement on crime and the causal context thereof.[6]

Along with ongoing changes in criminal behaviour *(age peculiarities, upgrading of means, criminal networks)*, the law enforcement bodies have been also constrained to revise their methods of preventing and uncovering crimes.

In order to define the area for further research, the *hypotheses*, which point out the shortcomings of the internal security strategies and may induce changes in the development of the police strategy for crime prevention and uncovering crimes, are specified in *eight* items.

The more police we have, the less crime there will be.

Governments make proposals to increase the police force when this is justified by the social expectations and the increase in the offense number. [1] The increase in the number of police also increases the police presence, however the public perception of security does not always show positive correlation. Research has shown that the increase in police presence causes the

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4   For example, personal and social causes of the development of criminal behaviour, the consequences of existential despair's crime-driving force, or definitions of the system of crime commitment.
5   Such results are the specific and purposeful use and integration of police resources, the *dissociated* detection of certain offenses causing social discontent, and the exploration and localisation of illegal activity spots directly threatening public security.
6   Herman Goldstein [12] conducted research and formulated new paradigms for the components affecting law enforcement and the direct effects of policing strategies on criminal behaviour.

transfer of criminal operations to an area less "infected" from the police point of view. [2] In terms the research effectiveness, issues shall be formulated with regard to the variables of criminal infectedness in the examined area, the evolution of types of the crimes committed and the correlation tests. The answers shall be examined in different social environments and the results shall be analysed to determine whether there is a correlation between the police numbers and the trends in crime rates. [3]

The shorter the time between a crime and the police arrival at the crime scene, the less crime will be in the examined area.

In analysing the hypothesis, we can conclude that the reduction in the police response time leads to relatively more arrests since offenders have much less time to leave the crime scene.[7] The establishment of *uniform emergency call centres* deemed to be the jewel of police development helps to reduce the response time of the police. The police response time is significantly influenced by location of crime victims in relation to the nearest police patrols.[8] The issues whether the trends in police response time are in correlation with the number of police patrols and the police excessive workload require further investigation. [4]

Determining random police patrol routes can greatly contribute to keeping potential offenders away from the public space.

Increasing the safety of public areas is considered an extremely important task. The number of crimes committed in public areas is affected by a combination of factors.[9] Randomly selected police patrol routes cover those public areas (parks, squares, bus and train stations, airports) where larger numbers of people occur. In the initial phase of research those factors influencing the development of crimes shall be examined, which point to the displacement of activity areas of offenders driven out from more populous public areas. This is understandable given that the randomness of police patrol routes should be decided taking into account the location of criminally infected areas. [5]

Research has shown that after the provision of *directed patrol* some police organizations analyse and assess data originated in relation to criminally infected areas and define the next patrol route based on those. [14] [15]

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7 The area of forensic science also deals with the social phenomenon, which focuses on the adoption of effective crime prevention strategy and not on statistical indicators of crime uncovering. [12] [13] In the context of social support of the police, an important aspect is how society accepts the view that intelligence is able to contribute to prevention. Crimes destroy the society's perception of security, thereby the value of operability of crime prevention strategies increases.

8 The time of arrival of the police patrol to the scene is significantly affected by the distance to the crime scene, weather conditions, traffic density, accessibility of the crime scene, the accuracy of description of the situation and/or location given by a person reporting the crime.

9 Such contributing factors are: the efficiency of public lighting, the density of surveillance camera locations and the number of police hours spent in public areas.

The more patrol presence is concentrated at the criminally infected areas, the less crime there will be.

Researchers have different opinions on the significance of the increase in police presence and its usefulness in uncovering crimes and crime prevention. Many knowledgeable researchers have a unanimous opinion that, as the first step, the solution shall be found for negative processes taking place in the society and only after this examine whether there is still a need for increasing the police presence in criminally infected areas. [6] Those arguing against the increase in police presence explain that, as the first step, homelessness, social justice, economic inequality and social phenomenon of racism should be addressed.

The more arrests of offenders representing high risks the police make, the less serious and violent crime there will be.

The increase in the number of arrests made by the police cannot be clearly linked to the reduction in the number of crimes. The processes should be studied, the results of which may contribute to the decrease in the number of very serious crimes. Fundamental issues should be formulated to develop *preventive* solutions to curb the criminal intent. The extent shall be determined, to which arrests initiated by the police can contribute to the suppression of *armed and committed in group crimes that involve taking of human life.* There are two possible ways I wish to show, with which, through their integration in the police methodology statistically measurable results can be achieved in the reduction of serious crimes.

Retention: it should be formulated as a question, whether the detention of persons, who have *committed* criminal offenses can serve as a deterrent for those *intended* to commit crimes. Research has shown that the higher the detection ratio is in relation to the particular crime, the less crimes of this type there are. [16] [17] The answer can be found in *effectiveness, decisiveness, strategy, responsiveness and social support* of the police.

Special prevention: it can be assumed that people who have already committed offenses and were arrested by the police – because of heavier sentences foreseen by the law – will not become re-offenders, as opposed to individuals who after committing an offense were not yet arrested and put in detention by the police.[10] *The special prevention focuses on the value of freedom deprivation.*

Community Policing strengthens trust between the police and the citizens, reducing the number of crimes committed.

Resulting from the research carried out so far, [18] [19] *community policing* aims to create an effective dialogue between the police and the citizens. The concept essentially consists of the coordinated cooperation between citizens, non-governmental organisations, business groups and the law enforcement agencies, which may facilitate the development and implementation of an effective strategy for crime prevention and uncovering. [7] This strategy leads to a complex problem-solving approach that can facilitate communication between the police and civilians (individuals and organisations). The efficient operation of the *community policing model* studied from the viewpoint of crime prevention and uncovering must meet a number of conditions.

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10 When studying the special prevention, we found a relationship between the number of arrests initiated by the police and the size of sentences decided by the court. Repeated offenses are actions based on individual decisions, however the authorities must demonstrate that these actions are not profitable because of the severity of punishment.

These conditions include:
- *Social stability and community cohesion.*[11]
- *Proper motivation and moral behaviour – modes of behaviour – within the police force.*[12]
- *Public confidence in the police.*[13]
- *Commitment to changes at political, economic and professional levels.*[14]
- *Providing sufficient resources required for the change.*[15]
- *Strong community and non-governmental organisations.*[16]

Community policing as a *new reform effort* is clearly in the interests of citizens and: consequently, strengthens police communications strategy.

The more policemen have the ability to detect and identify characteristic and direct root cause components of crimes, the more effectively can public security be strengthened.

The gist of *Problem-Oriented Policing* [11] is to ensure that police patrols and investigators, for the effective investigation, focus on the original proximate causes of crimes. The police will consider innovative solutions and involve neighbouring scientific areas to successfully complete the stuck investigations. The police are trying to build a much closer relationship with the public, thereby the citizens can ascertain that the police are serious about dealing with their problems. [8]

The problem-oriented strategy consists of four parts: *mapping, analysis, response and assessment.*

The police structure currently used is based on the *case-based* policing method.[17] The determination of the necessary tasks shall be started with the systematic mapping of information available on crimes. With the new results thus obtained, direct connection points will be laid down regarding the causes of crime. The strengthened abilities of the police in identifying causal relationships will lead to more successful crime uncovering.

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11 The condition of social stability and community cohesion is the development of an approach to be, to a certain degree, politically constant. It is difficult to fill the communication of the police with positive content if a given State uses the police for achieving its own objectives in politics.

12 Corrupt behaviour can more likely develop in police forces with low-paid staff with a low morality level.

13 Helpfulness, straightforward and honest dialogue, and corruption-free behaviour on the part of the police staff are prerequisites for confidence expected from the public. One of the basic conditions for the effective functioning of community policing is the cooperation between the police and civilians be based on unconditional trust.

14 A clear commitment is required on the part of the governmental decision makers to promote reform processes necessary for the development of community policing. These processes can increase the effectiveness of the measures and the police accountability, while making decisive steps forward in the area of such issues as corruption, excessive use of police force, or the violation of human rights.

15 The reform efforts require significant financial investment to establish new police agencies, purchase new equipment, as well as provide support for the implementation of new projects.

16 The strategy related to the community law enforcement can only be achieved if the community organisations cooperate with the police.

17 Case-based policing methods are: response to events, information collection, analysis and evaluation of available data.

Detection of illegal corruption offenses within the police can promote – at the individual and community levels – the formation of law-abiding behaviour.

Unlawful action of people is judged by the judicial authorities on the basis of sanctions regulated by the law and defined in the norms. Based on compliance with norms and reciprocity, people have a right to expect that members of the police provide corruption-free service. [9] The *normative compliance* is required by the law from all public officials, including the police. Enforcement of law-abiding conduct is a legitimate tool of accountability in the hands of the police and, as a result, the fight going on to uncover corruption offences within the police is positively perceived by the members of society.

Conclusions

By means of analysing and studying the scientific hypotheses, the basics of a comprehensive crime prevention model can be created that can assist in devising a unified security strategy. *This security strategy shall be based on the alliance of the police and people committed to law-abiding behaviour.* After serious terrorist offences of the last period causing a number of deaths, the people of Europe have expressed fear. Opinion polls confirm that people feel the need for stronger, more efficient and more decisive police. [10] The development of the analysed hypotheses within a research team will enable us to strengthen the public security in Europe.

The effectiveness of police can primarily be strengthened by the flow of intelligence from citizens to police, strengthening of the confidence index of the police and the citizens, and increasing the presence in public areas. [11] We have to keep the security of the EU's external border sections on the agenda, but we should not forget about such *internal challenges as illegal migration, terrorism, organised crime, economic problems, unstable states, and infectious diseases.*

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Managerial Responsibility and Efficiency in Public Service (Competency-based Solutions)

Szilvia SZABÓ[1]

This study aims to deal with a current and undoubtedly unique theme by examining the scope of leader responsibilities and effectiveness in a unique labour market environment following a concept which is still new in our country. The basic thesis of this study is that the responsibility of leaders is highly significant in achieving organizational efficiency even in public administration institutions, and additionally the terms of natural and developer leaders will be explained from this aspect as well. Furthermore, this study wants to define the importance of emotional intelligence and emotional competence in managerial work, particularly with regard to the practice of public administration. In relation to this topic the study also aims to formulate proposals for the behaviour of leaders with "creative vision", and it summarizes those competency-based methods and good practices that can support leader activities efficiently, effectively and with resource saving.

Keywords: *leadership management, civil service – public administration, emotional intelligence and competence, leader with vision, best practices, flow, work-life balance, coaching*

> "The key of being an effective leader is to be able
> to influence people without exercising power."
> (Thomas Gordon)

Leader Responsibility and Effectiveness

Leadership is first of all an effect. An effect on the environment and an effect on those employees and managers, who the appointed leader works directly or indirectly with. Therefore, his or her behaviour affects all, who share his or her goals and mission both at organizational and individual levels as well. Therefore, it is the responsibility of the leader to create a vision and be able to find the best ways to motivate others for effective actions. [1: 37] In case someone becomes a leader, it is of primary importance to be accepted and trusted by others, since he/she will be able to speak about goals, daily tasks and common vision as a leader based on this aforementioned acceptance. Sufficient experience, preparedness and skills are necessary for executive leadership, because the task is not only filling a particular position, but also leading a team's life with full responsibility. [2]

"The Myth No. 1 of leadership is that it exists." [3: 782] Accordingly, the presence of responsible and effective leadership has a very positive and progressive impact on any organizational culture. It can be particularly important in a time when there is a crisis, or a change in the life of the organization. It is felt exponentially in the life of public administration, since

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due to the nature of the organizational culture it means a different motivational media for its employees. [4] The mission consciousness of leaders extends beyond, whether they carry out all tasks effectively and well, since they have special responsibility in the organization's human resource management during the process of achieving the objectives. [5]

In organizations of public administration, the base of success and effectiveness lies, in addition to professional knowledge, in the leader behaviour and competencies as follows:

- One of the pillars of leadership is a process by which a leader influences the behaviour of the members of the organization with his/her own behaviour in order to achieve a goal taking into account more aspects. Therefore, psychological and professional maturity are key elements of the success, while leader motivations [6: 183] [6: 222] [7: 11] [7: 29] that stimulate leaders to fill certain roles [5: 178] are also very important.
- The other pillar of effective and efficient leadership is the existence of those leader competencies, which support such leadership practices that are able to create visions and managing human resources effectively. [5: 179]

The Competency Model of the "Natural" Leader in Public Administration

Leaders have a special position in the social structure. Nobody was born for any positions, but certain genetic and biological conditions are needed to develop leader behaviour with fairly complex qualities and skills. Becoming a leader is a result of a long learning-developmental process. Leadership has some so called general laws (leadership and organization science, management methodology), which should prevail at all management positions. It has long been proven that there are no "born leaders", but "being a leader" has some genetic and biological basis, on which the characteristics of "the leader's personality" will be simply based during personal development. Therefore, the leader characteristics of the individual function as a specific and complex system that are called leadership competencies. [8: 17] [8: 20]

The term of natural leader is still quite unknown in the practice of public administration, although its efficiency is proven by market practices. The internationally acknowledged book "Natural Leader" by Goleman, Boyatzis, McKee was published and translated into Hungarian more than ten years ago. [9] According to the authors "the previous leader ideal was functional minded and did not care much about personal and emotional aspects and looked at people only as replaceable elements." [10: 44] The main principle of natural leadership is therefore formulated saying that the emotional effect exerted by leaders should appear in the relationship of the leader and "the follower". [10: 44]

Being aware of the above-mentioned it has also become commonplace in practice that professional life explained the terms of success and efficiency with a new joint competency. It is called emotional competency (EC), while joint competency is a learned skill based on emotional intelligence (EQ) resulting in especially outstanding work performance. [11: 41] Of course, the high EQ itself does not guarantee that the individual actually learns the important emotional competencies being necessary for practicing leadership, but he/she has excellent chances to do so. Therefore, the new joint competency has a significant role during the managerial work already in the process of becoming a leader, since the competency model of the natural leader can be described by the joint leadership competency being characteristic of the emotionally intelligent leader.

Goleman coined the "framework", in which he identified a total of 25 "emotional competencies" along five dimensions. He determined two basic categories, such as, "personal competency" and "social competency". [12: 58–61] This is of great importance in leadership, because the leader as a human (human capital), as a separate subject takes part in the interpersonal (social) relationships.

Table 1. Goleman-Emotional Competency Model. [12: 58–61]

Personal Competencies	Social Competencies
Self-awareness • emotional awareness • accurate self-assessment • self-confidence Self-regulation • self-control • reliability • conscientiousness • adaptation • innovation Motivation • achievement motivation • commitment	Empathy • understanding others • development of others • client-centred • evaluation of diversity • political awareness Social Skills • influence • communication • conflict resolution • management • catalyst for change • networking • cooperation • team spirit

Based on these facts the EC is closer to practical life than the EQ, because it is primarily such personality traits that leads to outstanding work. The EQ is the general characteristics of individuals, while the EC is more than that, because it is the ensemble of the job-specific skills. Both develop with age, knowledge and experience, so they are less dependent on genetic conditions, or childhood experiences, than the traditionally used intelligence quotient. According to all these information, medium and high labour force, including the leader, differs from each other in their emotional competence levels.

In case of responsible and efficient leadership roles beyond professional and methodological competencies the existence of personal and social competencies is of great importance as well. Using these competencies would have particular significance in the closed, hierarchical, bureaucratic and often inflexible organizational culture and practice of public administration. Those leaders can best adapt to the constantly changing world of work, who are emotionally competent and able to convey this toward their subordinates. This means that they can easily develop themselves, and quickly adapt to organizational and cultural changes resulting from innovations, which is also a benchmark for subordinates. These leaders have open and people-centred attitude toward workers, and they do their tasks by providing support and caring leadership behaviour. All of these means for the organization measured results in the efficiency and performance.

Leader with Vision

We can see that the issue of leadership effectiveness and responsible behaviour is much more complex and goes beyond whether a person is professionally competent to fill the position. Considering not only the present behaviour and roles, but also the importance of the new leadership competencies of a leader, we can say that leaders being responsible for the organization have to be "leaders with vision". [3: 782] To meet this expectation such leadership attitude is needed that we can characterize with five basic joint competencies, based on the Goleman-model. [5] (Figure 1)

Figure 1. Joint competencies of the leader with vision. [5] [3: 782]

Empathy – those leaders are able to provide long-term motivation for people working in the organization, who understand emotions and feelings and take into account the point of view of others.

- *Motivation/Passion* – leaders, who are in possession of this competency, are able to convey important organizational goals as values to be followed for the subordinates by using this motivation.
- *Self-Awareness* – leaders will be only successful and efficient if they are able to define their own leader behaviour and goals, namely they are familiar with the leadership tools and techniques available and able to use them according to the needs of their subordinates.
- *Self-Regulation/Management* – exercising power does not mean self-serving and un-limited managerial work, but a well-controlled leadership process.
- *Social Skills – Openness* – leaders can be only creditable, if they also believe in orga-nizational ideas. In case their commitment and sense of purpose are not deep enough or only a pretence, others will quickly notice and this leads to distrust among subor-

dinates. The key to the effectiveness is the free and credible flow of knowledge and information, but this can be only realized in a trusting, honest and open atmosphere. In such an atmosphere employees feel needed and motivated, and that is why they are able to work the most efficiently. A lot of leaders still believe that keeping information and knowledge for themselves increases their power. Responsible leaders understand that sharing knowledge makes them truly successful.

Good Practices – Competency-based Solutions

The new leader attitude needs to find new solutions as well (besides the well-known and functioning HR tools) in order to increase efficiency and effectiveness. The realization lies in such innovative competency solutions that have to be added to the leadership methodology and thus to the human organizational strategy. Such solutions could be considered priorities as inter alia life-work balance, creating conscious experience flow, or coaching-oriented leadership and organization design. [13] It is indubitable that the listed solutions are obviously based on the "philosophy of a liveable workplace".

The life-work balance is of major importance in terms of the caring organizational culture as well. Its knowledge and conscious use are essential for today's leaders working in public administration, [5: 141] since employees spend most of their time at their workplaces. Creating balance is the individual's responsibility, but leaders in charge also have a key role in creating sustainable balance between workload and private life, because it provides increased capacity and efficiency if individuals as private persons and as employees experience flow within the organizational culture, since they are able to enjoy their jobs and workplaces as they are in accordance with their abilities and qualifications. Activities implemented under favourable circumstances provide protection for balanced and healthy employees. Mutual respect, and respect for each other's personality are keeping forces, which develop the organization and the work itself as well. Confrontations, intrigues, fighting for positions, unresolved conflicts only make life difficult and lead sooner or later to stress, loss of efficiency, and mental and physical health deterioration. [13: 195] [5: 144]
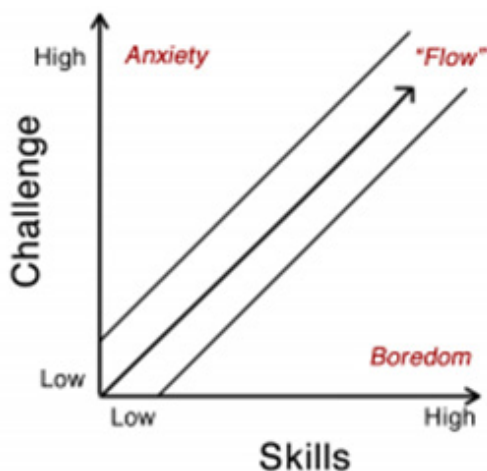

Figure 2. Flow. [14: 24]

The Flow experience is a feature of the advanced labour market situation of the 21st century, but unfortunately it is rarely known in our country. [14: 19–24] It refers to a conscious state, where the individual is able to focus maximally in order to achieve increased performance. The earmark of work flow is if employees can fulfil their duties in a motivating and trusting atmosphere without stress and excessive effort. Therefore, developing and maintaining such a working atmosphere should be the primary role of leaders.

The coaching-oriented organizational climate, and/or coaching-oriented leadership behaviour ensure a supportive atmosphere for work-life balance and the flow. It is characteristic for this approach that work performance takes place in an atmosphere of trust that is based on clear rules and processes with the support of a natural or developer leader. For this not only the existence of personal and social joint competency of leaders is necessary, but they also have to strengthen the empathetic, supportive, helping, and encouraging behaviour from among the roles of leaders with vision. In such organizational atmosphere both the employer's and the employee's roles change as well, since the employees become interested, therefore they are able to fulfil their tasks with long-term effectiveness in a highly motivating atmosphere.

Conclusions

It became commonplace to say that members, especially leaders, of public administration organizations face new challenges because of accelerated social changes and transformation processes of values. It is a fact that the issue of leadership efficiency and effectiveness requires a new approach in the practice of organizations. The way of thinking and practice being introduced in this study show new perspective for leaders working in public administration, but a new opened and recipient attitude is necessary for acquiring this approach. Based on studies of recent years [4] [5] there are some forward-looking initiatives in public administration, but there is still a long way to achieve a complete paradigm shift.

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Risk Management of New Technologies

Tamás SZÁDECZKY[1]

Nowadays businesses face multiple issues regarding new phenomena like cloud computing, which is a great business impetus: with the minimization of capital expenditure (CapEx) on IT infrastructure and personnel the efficiency can be improved. Technically this is not a new invention, but it is changing the approach to IT service, which has become outsourced, highly adaptive and scalable. Of course, the change in the technical landscape always implies security issues. Information security is not just a set of technical countermeasures: it is also a business requirement. It will help to avoid financial loss, avoid bad reputation or increase trust among clients.

The article analyses business alignment of information security in the case of cloud services. It shows the results of research, where the theoretical and practical issues of risk assessment-based business decision support were analysed and proved. Its finding was that there are cases when we can do examination, but general automatized tools are inadequate. However specialized tools and sometimes third party certifications should give more support.

Keywords: *risk management, cloud computing, IT security*

Introduction

In the early decades of IT history, the security profession fought for legitimacy of cyber security, and attention of high level management which did not really understand the importance of this field. The question now, at the beginning of the twenty-first century is not the why but the how and the how much information security. In the private sector, especially in times of economic crisis, cost constraints can be severe. Management's objective is to invest usually minimal resource on IT security elements, systems and networks. We find every day that the decrease in IT budget implies more decrease in security budgets at companies.

The aim of the research was to find out if risk assessment techniques are useful to support the above-mentioned security decisions or not. Security risks of implementing a cloud-based technology have been analysed from theoretical and practical views. A small company which is using cloud services actively lets the author do field research and do the risk assessments in a live environment thus analysing business drivers of information security. The full monography about the research is source [1].

Discussion

Cloud computing is a kind of outsourcing from the business side. "In the realm of information systems (IS), outsourcing involves making arrangements with an external party for the partial or total provision of the management and operation of an organization's information technology (IT) assets or activities." [2: 624]

According to NIST 800-145, by definition the cloud services have five essential characteristics: virtualized computing resource pool, broad network access, rapid elasticity, on-demand self-service and measured service. [24: 2] These features make the difference from classical server-based on-line service provision. Cloud computing is a well-developing IT service, it was already a $17 billion business in 2014. [3] Nowadays numerous conventional outsourcing or server-based service providers claim that they provide a cloud service, despite not meeting the above mentioned minimum requirements as Avram emphasizes. [4] This is actually a misrepresentation and a breach of contract. Cloud service providers build their computing centres geographically dispersed. Resources between systems are dynamically allocated, no matter where we are using the service to store our data at the moment. [5] As Mense points out, the security features of a private cloud are highly different: we can achieve a much higher security level with that than the public one. [6]

Virtual systems are scalable, flexible and redundant, when they are built according to general best practice. But the hypervisor is a new single point of failure, because it is generally not redundant. According to Metalidou, human factors are always an issue in information security, therefore awareness should be increased. [7] As Suicimezov and Georgescu point out, cloud systems typically involve Big Data issues during operation. [8] According to Brunette, the answers to those problems are to keep a high level of compliance according to Cloud Security Alliance's recommendations. [9] Because of the scale, with the concentration of capital a cloud service provider may invest more money on security than a bank. [10]

If we are about to implement security measures in a cloud system, one choice is to use general best practice, but it is not favourable, as it cannot be audited objectively. Information Systems Audit and Control Association's (ISACA's) Control Objectives for Information and Related Technology (COBIT) are a de facto information security standard, as the framework system of IT governance as detailed in source [11]. The International Organization for Standardization (ISO)/ International Electrotechnical Commission (IEC) 27000 family of standards was set off in the United Kingdom and now they are well-known and used all over the world and there are currently 45 members published or in preparation. The standard is process-centred, and applies the Plan-Do-Check-Act (PDCA) model and the implemented system integrated into existing quality control (ISO 9001) and environmental management (ISO 14001) systems. Payment Card Industry Data Security Standard (PCI DSS) is a standard for payment card security and it can be used in special cases when debit or credit cards are accepted by a merchant. As detailed in [12] data protection can be regarded as a legal area, which has a high impact on information security, especially in cloud systems.

Risk management theory

The risk-based thinking, which relies on mathematical rules, came into existence by the work of Blaise Pascal in the 17th century. Despite it roughly meaning uncertainty, according to Habegger, it is a key element in all political and economic activity. [13] There is still a debate if risk is equal to uncertainty according to Belyacz. [14] During the next century it became daily used: insurances, sampling, expectancy calculations were made. For a long time, risk management dealt with a sole issue, typically with decision making and financial analyses.

Decision making is a management and policymaker's issue with large literature based on mathematical statistics. Decision making in a well-known case can be described as a vector, but the more uncertainty is in the system, the larger table has to be made for the description. [15] The concept of decision making is that there is a goal or objective to achieve, but there are more alternative courses of action to achieve that, but our knowledge on the issue is imperfect, which creates doubt, but this doubt may be reduced. [16]

Financial markets are more complex than to be able to describe their mechanisms with Gaussian or Lévy distributions. They also depend on external factors, like news. This is how it became more and more complicated and therefore new methodologies have to be developed like 'Δ' hedging and Black-Scholes limit. [17]

In the 1980s the professional thinking on the coordination of previously unconnected risks started by the Fortune magazine's article "The Risk Management Revolution".

As analysed in regard to security controls in Section 3, there is a possibility to do things on our own, or using standards for a professional problem has advantages. In 1980, risk was generally $R = I \times P$ where I is the impact and P is the possibility, but this became more sophisticated nowadays. [18]

The first governance tool capable for general risk management was the Committee of Sponsoring Organizations of the Treadway Commission (COSO) Enterprise Risk Management (ERM) framework. [19]
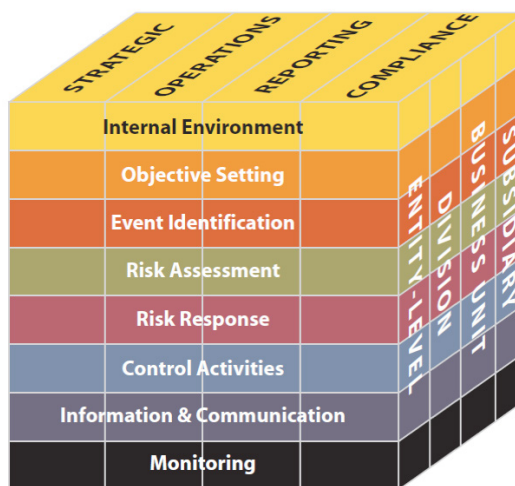

Figure 1. Components of Enterprise Risk Management. [20: 23]

The aim of COSO ERM is to provide value to the stakeholders with alignment of risk appetite and strategy, enhancement of risk response decisions (risk avoidance, reduction, sharing, and acceptance), reducing operational surprises and losses, identifying and managing multiple and cross-enterprise risks, seizing opportunities, and improving deployment of capital. In order to achieve them it provides a complete framework with multiple-level components as shown on Figure 1. Despite this being a general framework, it is frequently thought that it is only for banking, financial or back-office process-related use cases. This can happen because the founders are financial accounting-related companies. Also, its complexity may be frightening for the potential user. [19]

However, there are numerous widely used frameworks and de facto standards, the international standardisation lies in the hands of ISO. There numerous valid risk-related international standards. Below you find a non-exhaustive list of them.

General risk management ISO and IEC standards:
- ISO 31000:2009 Risk management – Principles and guidelines;
- IEC 31010:2009 Risk management – Risk assessment techniques;
- ISO/TR 31004:2013 Risk management – Guidance for the implementation of ISO 31000;
- ISO Guide 73:2009 Risk management – Vocabulary.

Specialised risk management ISO and IEC standards:
- ISO/IEC 27005:2011 Information technology – Security techniques – Information security risk management;
- ISO 14798:2009 Lifts (elevators), escalators and moving walks – Risk assessment and reduction methodology;
- ISO 14971:2007 Medical devices – Application of risk management to medical devices;
- ISO/TR 11633-1:2009 Health informatics – Information security management for remote maintenance of medical devices and medical information systems – Part 1: Requirements and risk analysis;
- ISO 17666:2003 Space systems – Risk management;
- ISO/IEC 16085:2006 Systems and software engineering – Life cycle processes – Risk management;
- IEC 80001-1:2010 Application of risk management for IT-networks incorporating medical devices – Part 1: Roles, responsibilities and activities;
- ISO 10993-1:2009 Biological evaluation of medical devices – Part 1: Evaluation and testing within a risk management process;
- ISO/TS 10303-1467:2011 Industrial automation systems and integration – Product data representation and exchange – Part 1467: Application module: Risk management;
- ISO 15743:2008 Ergonomics of the thermal environment – Cold workplaces – Risk assessment and management;
- ISO 22442-1:2007 Medical devices utilizing animal tissues and their derivatives – Part 1: Application of risk management;
- ISO/TS 22367:2008 Medical laboratories – Reduction of error through risk management and continual improvement;
- ISO 12100:2010 Safety of machinery – General principles for design – Risk assessment and risk reduction;

- ISO/TR 14121-2:2012 Safety of machinery – Risk assessment – Part 2: Practical guidance and examples of methods;
- ISO 13073-1:2012 Ships and marine technology – Risk assessment on anti-fouling systems on ships – Part 1: Marine environmental risk assessment method of biocidally active substances used for anti-fouling systems on ships.

The most important general risk management standard is ISO 31000:2009 Risk management – Principles and guidelines. This became the gold standard of the general risk management, in spite of its main components are also present in other standards.
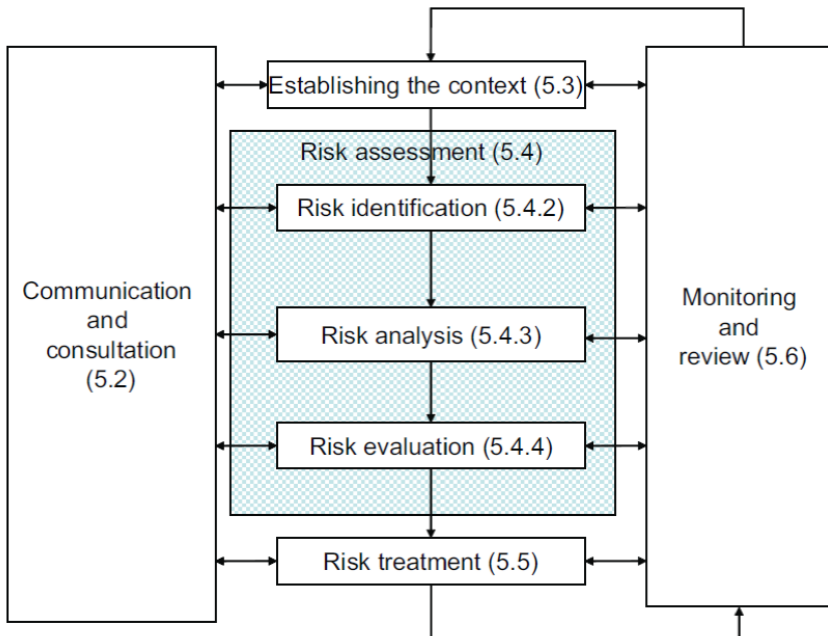
Figure 2. Risk management process. [25: 14]

One of its main elements is the risk management process, which is shown in Figure 2, is very similarly present in ISO/IEC 27005:2011 Figure 2. Risk management process is a "systematic application of management policies, procedures and practices to the activities of communicating, consulting, establishing the context, and identifying, analysing, evaluating, treating, monitoring (2.28) and reviewing risk (1.1)" according to ISO Guide 73:2009, definition 3.1. [26]

In spite of this not being a brand-new thing, it is very useful for standardising the process itself. The establishment of such a risk management project is presented in Figure 3.

There are numerous risk management and risk analysis methods. As an example, I introduce the Method for Harmonized Analysis of Risk (Méthode harmonisée d'analyse des risques – MEHARI) here, developed by French Information Security Club (Club de la Sécurité de l'Information Français – CLUSIF). MEHARI's actual version is 2010. It is a qualitative[2]

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2   Using scales in contrast to quantitative methods, where precise numbers are calculated like probability for a certain threat is p = 0.078

risk assessment and risk management method that also includes (in Excel files) the list of threats, generic risk situations, with some best practice probability presumptions based on French inputs. With those spreadsheets, it is possible (manually) to conduct the calculations. It is compatible with ISO/IEC 27005 and includes pre-built compliance checks for ISO/IEC 27001.

Phases of risk analysis:
- context establishment with scope definition and boundaries;
- valuation of assets;
- risk identification with confidentiality, integrity and availability factors and probability of threats;
- risk analysis: risk scenarios are set by default, however you can fine-tune it;
- risk evaluation on a 4-level scale.

Phases of risk management:
- risk assessment: display of critical risks;
- risk treatment: treatments options can be selected from reduce, accept, transfer and avoid;
- risk acceptance can be done on an individual basis;
- risk communication: stakeholder assignment can be done since the start of analysis.

The questionnaire can be assigned and tailored to stakeholders. In the case of MEHARI, there is a so called basic tool, with which we can do the calculations in excel sheets. However, this is a quite straightforward way, a more complex tool can make the risk management mechanism easier.
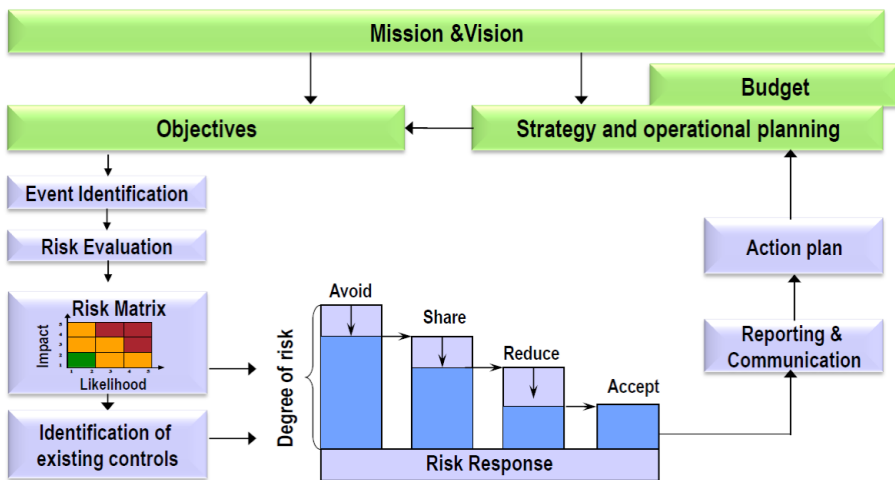

Figure 3. Establishing a risk management process. [19: 15]

Results

In order to research the business alignment of cloud computing, I decided to do a field study. The selected company is a small Hungarian software development Ltd., which is using public cloud services intensively. Actually, their whole business process is based on cloud services: for company e-mail they are using Gmail at Work, for data storage Google Docs and development related servers are in Microsoft Azure.

I have conducted a risk assessment with the above-mentioned ISO/IEC 27005-based MEHARI method, with the usage of the MEHARI-Risk tool. The scope of the assessment has been set to as narrowly as possible. The full research documentation is available in source [1].

After setting up of the scope and primary classification, a questionnaire is generated, which is 58 pages long, so approximately 930 individual questions were answered two times, because the on-premises and the cloud-based were two different assessments. It the answers, all known problems were included, such as interoperability problems of different used technologies. [21] As well as harm to cyberterrorist attacks because of sole online presence. [22]

The formal interviews were conducted in March 2014, and July 2014, in an ISO/IEC 27001 audit and the remaining questions were answered in an interview in February 2015. As soon as all the questions were answered, MEHARI-Risk generated a 25 page long report. At the end of the report we find radar diagrams, which show the findings.

At the end of the report we find two radar diagrams, which show the findings. In Figures 4 and 5 I show the "Risk seriousness for selected causes" radar diagrams for the on-premises and the cloud-based services next to each other. The description below the diagrams is the same for both. In the table the bold rows shows the differences.
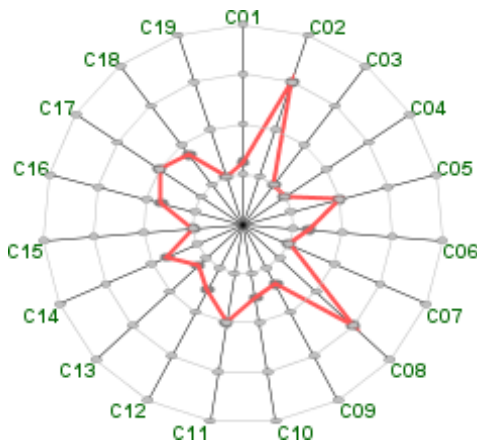

Figure 4. Risk seriousness for selected causes, on-premises.
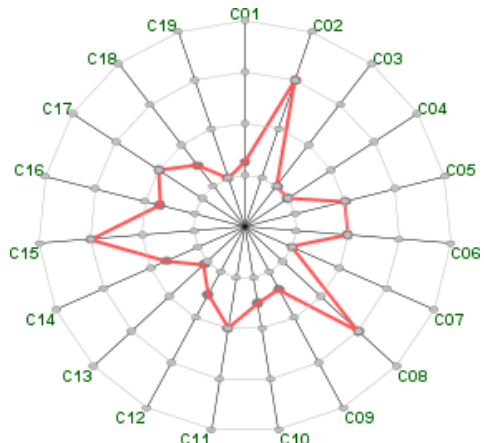[Generated with MEHARI-Risk, edited by the author.]

Figure 5. Risk seriousness for selected causes, cloud service.
[Generated with MEHARI-Risk, edited by the author.]

Cause	Cause description
C01	Theft of written or printed documents
C02	Accidental crash of a disk drive
C03	Absence of personnel
C04	Loss of documents by accident
C05	Data erased by a logical bomb
C06	**Access and consultation of system data**
C07	Theft of data media
C08	Accidental erasure of software
C09	Transient information pick up
C10	Accidental loss of files
C11	Theft or erasure of removable media
C12	Media erased by virus
C13	Accident or failure of one or several hardware resources
C14	Complete unavailability of premises
C15	**Diversion of temporary information created by the systems**
C16	Access to file servers and copy of office related files
C17	Deliberate erasure of media
C18	**Maintenance unavailable**
C19	Diversion of information during transmission

We see that there are three changes:

- C15 Diversion of temporary information created by the systems: this is much higher in the case of a cloud-based system. This should be because of the lack of audit possibilities; however, the magnitude of the change seems to be not proportional.
- C06 Access and consultation of system data: this is slightly higher in the case of a cloud-based system. This is because we do not have enough control over the system and especially the hypervisor.
- C18 Maintenance unavailable: this is slightly lower in the case of a cloud-based system. This is because the pool of IT engineers present at the provider and the very high level of maintenance contracts and spare parts.

On the next diagrams (Figures 6 and 7), called "Risk seriousness for selected scenarios", we see five major scenarios. The on-premises and cloud-based diagrams are again next to each other, with the common table.
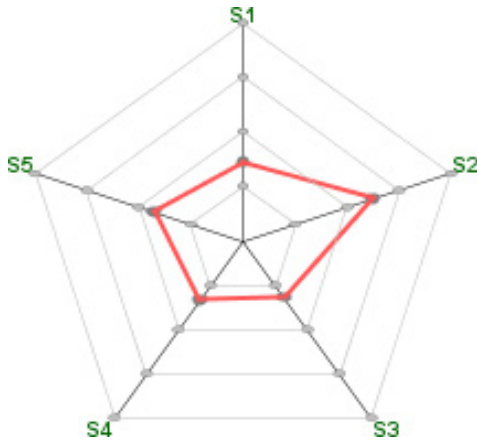
Figure 6. Risk seriousness for selected scenarios, on-premises.
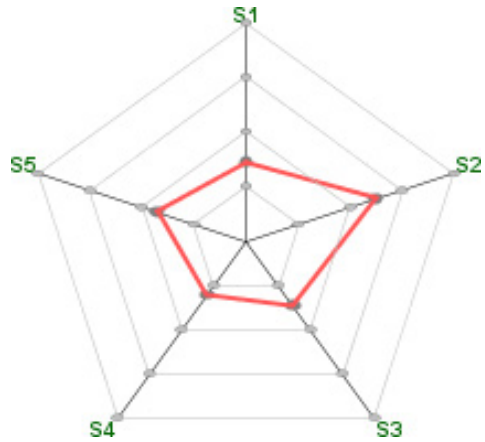[Generated with MEHARI-Risk, edited by the author.]

Figure 7. Risk seriousness for selected scenarios, cloud service.
[Generated with MEHARI-Risk, edited by the author.]

Scenario	Scenario description
S1	Loss of data files or documents
S2	Software destruction
S3	**Disclosure of data or information**
S4	**Temporary unavailability of resources**
S5	Diversion of data files

The changed scenarios are with bold. These are the following:
- S3 Disclosure of data or information: this is slightly higher in the case of a cloud-based system. This is because of the lack of auditing possibilities.
- S4 Temporary unavailability of resources: this is slightly lower in the case of a cloud-based system. This is because higher redundancy and resilience of systems.

If the risk analysis software is not prepared for new elements and new threats, the risk manager has to deal with them. For example, the MEHARI-Risk software did not fully contained the hypervisor and other cloud-related elements (just in one question) and failure of separation as a threat, therefore the professional judgement of the expert is required to adapt the answers and interpret the results correctly.

In contrast to the general scope-based case above, let us deal with the company's e-Business solution. In the case of card payments, the e-Business or web shop provider must obey PCI DSS, the data security standard for major payment cards. The standard has well-defined requirements for these cases. During the research, they were also analysed and risk of non-compliance was assessed. The level of full compliance is achieved if all numbers are 3. When there is any number, which is smaller than 3, the full compliance cannot be stated, thus the PCI DSS audit will fail. In the field study, we got different numbers varying from 1 to 3. In

this case, generally we are not allowed to accept the main payment cards. As a result of our risk/compliance level assessment we can state that the security risks of using a cloud service cannot be precisely evaluated from the user's perspective, thus the compliance level cannot be assessed on our own. However, Google Cloud Platform achieved PCI DSS certification in the end of 2014. If we accept a PCI DSS Qualified Security Assessor (QSA) audit, this problem is solved. To be precise, this is an issue of trust. Trust in the depth and thoroughness of the audit and "luck" in sampling. This means that system audits like PCI DSS and ISO 27001 are always based on sampling: not all the procedures, sites, systems, etc. are evaluated. Sampling must be statistical sampling, so it is representative to the whole. According to the European Union Agency for Network and Information Security (ENISA) we shall use third party certifications in this case, which could be used for decreasing the top-level risk "loss of governance". [23]

Consequences

We can conclude that in a business case alignment we can use risk management tools in order to provide input for the business decision, but we should not overestimate its importance or make a decision automatically based on some radar diagrams. As the field study showed us, even on a smaller scope, we had to answer almost two thousand questions and results can only be visualized in a simple way, however the problems are more complex and multi-dimensional. For example, we do not have only two choices like on-premises or a cloud-based system, but we can also differentiate on prices, security options, hybrid solutions and so on. As a matter of fact, the knowledge and experience of a professional cannot be excluded from the security-related decision making (with the usage of this tool and other above mentioned constraints), but it can be effectively supported with risk assessment techniques and tools. Visualization functions help the businessmen to make some problems understandable.

There is another mode of decision support: we can check the probability of compliance. This is not a brand-new thing: Common Criteria (ISO/IEC 15408) does the same with the Evaluation Assurance Level (EAL) logic. Conformance is a yes or no question, but the question is how sure are we about the answer. According to this logic a noncompliance risk assessment based on the requirements of PCI DSS was applied in field study. The requirements were focused on Shared Hosting Providers, which also includes cloud service providers. With those requirements, a rapid assessment was made on this scenario. Because of the deep evaluation required by PCI DSS the conformity cannot be evaluated without privileged access to the system. But as an interim solution we can accept the PCI DSS certification, which was achieved by the cloud service provider a half year before. Of course, this also has a level of uncertainty, but there is no perfect solution in this case.

There are cases when we have no chance to do a thorough examination, which could be precise input to our risk management procedure. We shall use third party certifications in this case, which could be used for decreasing risk.

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The Dangers of NATO–Russian Confrontation: Why the Official Western Threat Analysis is Irrational

Endre SZÉNÁSI[1]

We are witnessing a new era where NATO and Russia are engaged in deep a confrontation, including its military dimension. The West – especially the US and some countries on the Eastern borders of NATO – equal the Russian threat against Europe to that of the Islamic State of Iraq and al-Sham (ISIS), and Ebola. Plenty of studies examine Russian use of hybrid warfare in "aggressions" against independent states, including Ukraine, Georgia, and last but not least Estonia, a member of the Alliance.

The portrayal of Russia, as the leading military threat against NATO is a hopelessly flawed threat perception that makes no sense at strategic level, unless it serves unstated and concealed geopolitical goals of some great powers. Both a conventional and a nuclear war between NATO and Russia are completely irrational and in nobody's interest, since it will inflict enormous damage and there could be no real winner.

If a conventional military incident might occur between NATO and Russia, the parties will most likely restrain themselves to avoid a major war, as they did in several confrontations briefly analysed in the article. If a nuclear confrontation occurs, the capabilities of both parties are far more than enough to change living conditions on Earth beyond recognition, when the remnants of humanity will struggle to survive.

It is in Europe's interest to reverse the confrontational course with Russia, while the perception of an "aggressive" Russia as a key military threat mainly serves US interests. The ultimate paradox is that Russia would truly become a leading threat to peace and security if the West succeeds destabilising her.

Keywords: *NATO, US, Russia, ISIS, conventional war, nuclear war*

Introduction

US–Russian tensions have reached an unprecedented level since the end of the Cold War, when cooperation between the two countries broke off in Syria and the Obama administration started considering options to resolve the crisis, including direct US military strikes against the Assad regime without a UN Security Council resolution. [1] Lack of military cooperation and the possibility of parallel US–Russian bombing of each-others protégées in Syria could lead to a proxy war far more dangerous than simply providing various forms of aid (finances,

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weapons, training, intelligence info, etc.) to the respective parties (the Assad regime, the rebels, and/or terrorist groups, etc.), since it could lead to a direct military confrontation between the two great nuclear powers, that could possibly escalate into a major war.

The deterioration of diplomatic relations between the US and Russia lead to a reality, when the discussion of mortar fire by terrorist groups on the Russian Embassy in Syria was blocked by the US (plus Great Britain, and Ukraine) at the UN Security Council. [2] Such lack of trust and cooperation between great powers goes beyond rationality, contradicts international law and under no circumstances serves the interests of peace and prosperity of mankind.

Such conditions provide special actuality to reconsidering the threat assessment of Russia and the possibilities of new policies averting a major, direct military confrontation between the US and Russia – ultimately NATO and Russia.

Carefully Measured and Limited Russian Military Interventions In the Post-Cold War Era

The dissolution of the Soviet Union in 1991, combined with the demise of the Warsaw Pact signalled a new era when the legacy of the classic "Cold War" appeared to be mostly overcome for many politicians and experts around the world. NATO survived the unavoidable identity crisis resulting from the absence of a major communist threat against the West and waves of Eastern expansions become a success story, bringing NATO's boundaries ever closer to Moscow. It has become a mantra that the Eastern expansion of the Alliance equals more security, stability and prosperity. NATO could even enter the post-Soviet space when the three Baltic States[2] became members of the Alliance and Russia could do nothing about it.

With the emergence of China [3] several Western politicians and analysts argued that Russia must align with the West to counter the growing influence of her Asian neighbour. An unnamed, high ranking Hungarian Ministry of Defence (MoD) official phrased it as follows: *"We must not invite Russia to NATO. Instead we should wait until Russia would beg for NATO membership on her knees."* I have heard countless times that "*intensive Russian-Chinese political, economic, and military cooperation can only be temporary and unequal, where Russia could only play the role of a subordinated, junior partner."* [4] *"Enhanced cooperation between Russia and China would prove to be a 'death grip' for Russia."* – several defence policy experts of the Hungarian MoD argued.

It is by no means a coincidence that the re-emergence of Russia under Putin lead to increasing tensions with the West. Russian policies to halt Eastern expansion of NATO on the territory of the former Soviet Union successfully derailed ambitions of both Georgia and Ukraine, even though a geopolitical struggle concerning their NATO membership might not yet be over. Russia carefully managed both conflicts clearly avoiding a total war resulting in a "regime change" and prolonged Russian military occupation of entire states. Russia made it clear that she does not tolerate new NATO members in the post-Soviet space, advancing military occupation only as long as the boundaries of public support for Russia last. In Georgia, these boundaries are the so called "borders" of Abkhazia and South Ossetia that Russia officially regards as independent states. Current boundaries of majority public support for Russia

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2   Estonia, Latvia, Lithuania

in Ukraine are Crimea, Donetsk and Lugansk. Crimea is now part of Russia according to the Russian constitution, even though it is not recognised by international law. Parts of Donetsk and Lugansk are ruled by pro-Russian separatists, and still part of Ukraine on paper, but de facto act as client regimes of Moscow.

Russia also avoided a total war with the NATO member Estonia, limiting confrontation to cyber warfare and economic measures in 2007, that were more like a limited punishment for the replacement of the bronze soldier – a WWII monument surrounded by Russian pride and sensitivities – rather than an attempt to achieve a "regime change" in Estonia.

The Russian response to the Turkish downing of a Russian SU–24 bomber on 24 October, 2015, was also carefully measured avoiding direct military confrontation while assuring proper Russian deterrence capabilities are in place[3] if Turkey attempts to change the course of the Russian military intervention in Syria by military action. [5] [6] [7] [8]

Why a Major War Between NATO and Russia is Irrational and Unlikely

We can debate whether the described Russian policies serve genuine Russian interests or not, but that is not the point in our analysis. Carefully measured Russian military actions within the post-Soviet space and against NATO member states suggest that the Russian leadership is well aware of the costs and risks of unnecessary escalation. If we accept that Russian military actions were and are carefully measured regarding the quoted conflicts, it highlights the irrationality and absurdity of any suggested Russian intentions to go to a major war against NATO.

Russia can physically not achieve a military balance against NATO, since she lacks the necessary GDP and population, as key foundations for an arms race against the West. To be more precise: Russia has a fragment of the GDP and population needed to support such an arms race. It is irrational to assume that the weaker party – in our case Putin's Russia – would seriously consider entering a major war against an obviously stronger adversary. The fact that Russia has the second most powerful military in the world after the US, disregarding nuclear military capabilities, does not make any hypothetical Russian policies to conquer the West by military terms rational.

Even if Russia might be foolish enough to overstretch expanding her military capabilities in an attempt to match NATO, that – combined with low oil prices and Western sanctions – would definitely ruin the Russian economy, similarly to what happened to the former Soviet Union. If the Russian economy is ruined, it is needless to say, that the basis of sustaining an arms race is also ruined.

A major NATO–Russia war is irrational and unrealistic for simple reasons. As long as conventional weaponry is used, the parties could inflict enormous damage without winning the war. Once a conventional military victory is in sight – no matter who the winner might be – it is unlikely, that weaker nuclear power(s) would allow defeat, resorting to nuclear strikes. If a nuclear confrontation occurs, the capabilities of both parties are far more than enough to change living conditions on Earth beyond recognition, when the remnants of humanity will struggle to survive. [9] For such reasons a major war between NATO and Russia is in nobody's interest and highly unlikely, no matter whether it is conventional or nuclear.

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3   Powerful Air Defence capabilities, such as S–400; fighter escort of Russian bombers that did not appear necessary before, etc.

Even if Russia could do a "miracle", entirely matching all capabilities of NATO, a major war between Russia and the Alliance would still not make sense. Or given the scale of the foreseeable destruction, it would rather be even more irrational.

Such considerations are not driven by pacifist idealism, but a desperate search of balance between probable destruction, risks and potential benefits of a major NATO–Russia war. Neither such considerations suggest that war in general is something irrational and unwinnable. There are several historic examples when great powers went to war against weaker states, when the great powers possessed overwhelming military superiority allowing them to control the outcome of the war. Such wars could make sense in geopolitical terms. There are also countless wars between weak states, tribes, etc. that might prove to make sense or not, but no matter how much damage is inflicted, the limited nature of such wars pose no significant threat to world peace and security.

In spite of all arguments suggesting that a major NATO–Russia military confrontation is completely absurd and irrational, we are witnessing a new era where the Alliance and Russia are engaged in a deep confrontation, including its military dimension. The portrayal of Russia, as a leading military threat against NATO is a hopelessly flawed threat perception that makes no sense at strategic level, unless it serves unstated and concealed policy goals of some great powers. Arguments that re-emerging Russia is "aggressive", "revanchist" or "expansionist" [10] [11] cannot be taken seriously since Russia defends her geopolitical interests in countries traditionally belonging to her sphere of influence. It applies to not only the post-Soviet space but also to Syria, [12] where Russia has had good ties with the Assad family for some forty years.

An example of the mainly defensive nature of Russian actions at strategic level is Ukraine, where the denial of a long, common history with Russia cannot be a subject of a serious debate, even if Ukrainian nationalist might come to similar conclusions. Once the West attempts to take away Ukraine from Russia, the Russian insistence not to allow Ukraine to become a NATO and EU member state could only be a pretended surprise. We can argue whether Kiev has an independent foreign policy since the violent takeover of power in 2014, or not. We can safely assume that Ukraine is caught in a conflict between the West and Russia, where the war, the economic and social results of such a confrontation clearly do not serve genuine Ukrainian interests.

Given the geopolitical location of Ukraine, which is not a great power, surrounded by two "tectonic plates", namely the West (NATO and EU) and the East (in this case Russia, a great power), genuine Ukrainian interest would be served if the country had balanced, good relationship with both "tectonic plates". She might prefer one "tectonic plate" to the other to a certain degree, however a good, balanced relationship is definitely a genuine Ukrainian national interest. It is obviously *not* a genuine Ukrainian national interest to break relations with either "tectonic plates", or form an alliance with one of them against the other and try to win a war against a "tectonic plate" mainly on her own. This is precisely what happened, when Ukraine asked for NATO and EU membership, and was caught in a war with Russia in Eastern Ukraine, when neither NATO, nor EU membership was achieved. Ukraine mainly fights Russia on her own – despite Western political support, economic sanctions against Russia and loans from the IMF. The country can clearly not rely on substantial, direct military involvement of Western powers in the war in Eastern Ukraine that could match Russian capabilities as superior or at least equal.

Even if Ukraine had a flourishing economy rather than living standards matching severely underdeveloped African countries, with economic outlooks even worse than in Africa, breaking most political, cultural and economic ties with Russia in a historically short time is rather suicidal than rational, when economic interests are sacrificed for presumed political gains.

From a Russian point of view, the country *defends* the "buffer state" Ukraine that is clearly considered to be her sphere of influence *at strategic level*, even though some military action – such as the annexation of Crimea, or support to separatists in Donetsk and Lugansk – could be labelled as *"offensive"* operations.

Russia clearly has both the political will and the power not to allow Ukraine to become a member of NATO and the EU in the foreseeable future. This is why Western sanctions against Russia are counterproductive and fail so far to bring the desired results, hurting both genuine European and Russian interests.

It is in Europe's interest to reverse the confrontational course with Russia, while the perception of an "aggressive" and "expansionist" Russia as a key military threat mainly serves officially unstated and unadmitted US interests. Namely: justification of greater military spending, reinstallation of a lost European reliance on the US in all terms against an exaggerated threat stemming from Russia. Unstated US policy goals also include weakening of any rivals, such as Russia or even Europe that is an integral part of the Western world.

It is unfortunate, that junior partners of the US in Europe have not yet found the way to resist US lead geopolitical conflicts that hurt genuine European interests. Such US driven geopolitical conflicts are not limited to counter Russia, but also apply to several countries in North Africa, the Middle East, and Central Asia.

The Iraq war to topple the Saddam regime is a failed attempt to "export democracy", since it lead to civil war, chaos, death, destruction, and ultimately the rise of ISIS, the most powerful and dangerous terrorist organisation in modern history that executes all opponents, including Christians. [13] The Syria war to topple Assad with US backed opposition resulted in a long lasting civil war, enormous destruction, Russian military intervention, and a migration wave to Europe, which is also a major security threat, hurting genuine European interests. The failed Western military intervention in Afghanistan also provided a great contribution to the amount of migrants/refugees travelling to Europe. Elimination of the Muammar Gaddafi regime in Libya created favourable conditions for instability and insecurity, [14] civil war, and cheaply refineable, and thus good quality Libyan oil exports to Europe are disrupted, ISIS has gained ground, [15] and uncontrolled, illegal migration flourishes through Libya. It is safe to conclude, that all these developments contradict genuine European interests, not to mention the countries that are subject to destruction.

The Ultimate Paradox: When Russia Truly Becomes a Leading Threat

Paradoxically Russia would indeed become truly dangerous for the peace, stability and prosperity of Western world if the West succeeds breaking Russia in political and economic terms, successfully installing a new "coloured revolution" in Moscow in order to topple Putin's power. Successful destabilisation of Russia could lead to many unintended or even unwanted consequences, such as major accidents in Russian nuclear power plants for whatever reasons, or Russian nuclear weapons falling into terrorist hands, major disruptions of

Russian energy exports to Europe, previously unseen Russian migration waves to the West, the rise of religious extremism and terrorism in Russia that is also international in nature, etc. Such possible consequences suggest that a stable, re-emerged Russia under the leadership of Putin is the lesser "evil" against peace and security of not only the West, but the whole world.

It highlights the irresponsible nature of Western policies when attempting to break or subordinate Russia. Such attempts prove that the Western world fails to understand what Putin means when referring to the continuity of independent Russian foreign policy throughout the whole of Russian history. Similarly to US policies to save major private banks with taxpayers' money in 2008, that are "too big to fail": [16] [17] [18] Russia is also "too big to fail" when it comes to genuine security interests of mankind.

Why and How Should the West and Russia Cooperate?

Russian and Western cultures have a lot in common, even though the Russian culture also has significant Eastern attributes. Geographically a great part of Russia is also part of Europe, since it is on the Western side of the Ural Mountains. Historically Russia did not only confront Western powers, but also formed powerful alliances with the West. For these reasons Russia could be viewed as a natural ally of the West, supporting the arguments of US president-elect Donald Trump who intends to improve relations with Russia, breaking with the policies of the Obama administration according to which Russia became the No. 1 security threat to the Western world.

There are plenty of common challenges, where Western and Russian cooperation could serve mutual interests. I view the fight against international terrorism [19] and countering illegal, mass migration to Europe as good examples of possible cooperation. In case of fighting international terrorism, intelligence data could be shared and actions against terrorists could be coordinated. When countering illegal, mass migration to Europe the root causes (wars, political repression, poverty, religious conflicts, ecological degradation, etc.) in the countries of origin should be tackled, those that "beg" for Western-Russian cooperation.

Policy Recommendations to Western Decision-Makers

There are a few key issues in Western policy terms that need to be reconsidered. As long we want good relations and meaningful cooperation with Russia, we need to respect Russian interests in the post-Soviet region, that more or less match the territory of the former Soviet Union. NATO expansion into Russian zones of interest should be voluntarily terminated by the Alliance and the aspirants as well, since Russia does not tolerate that and it generates unnecessary conflicts resulting in less security. Examples of Georgia and Ukraine support this argument when – assuming current policies – no mutually acceptable solutions for NATO and Russia are in sight.

It is clear, that officially assuring Russia that no Eastern expansion of NATO would occur in the foreseeable future would be a major defence policy change. However, it appears to be the price of good relations between the Alliance and Russia. Such a policy change would acknowledge an already visible fact. According to current, official NATO policies, enlargement is limited to the decision of the Alliance and the aspirant country, when no third party has a

say. In reality, Russia – as a third party – does indeed have a say, since she has the political will and the power to halt Eastern NATO expansion, as we could see it in the case of Georgia and Ukraine, no matter whether we like it, or not.

The Western world should also terminate any policies that are – not admittedly – aimed to break or subordinate Russia. Putin's Russia proved to be resistant to such attempts when damage in economic and other terms hit both Europe and Russia, resulting in a lose-lose game. The later the Western world acknowledges this, the more damage would occur with no policy change in sight on Moscow's side.

The Western world should at least tacitly accept that Crimea is no longer part of Ukraine, but Russian. Self-determination is an integral part of international law and Russia had no need to force the Crimean population to vote to become part of Russia "at gunpoint". This was and is the genuine interest of the overwhelmingly Russian population of Crimea, and also Russia of course. Those who know the Russian mentality well enough might agree that it was clear from the very beginning that once Russia takes Crimea, she would not give this land back to Ukraine unless there is a dramatic liberal political earthquake in Russia, a new "coloured revolution" that is clearly not in sight. We might not like the current Russian political system or her role in the post-Soviet region but such realities need to be taken seriously.

Policy Recommendations to Russian Decision-Makers

Russia should terminate policies according to which NATO is viewed as a key threat to security. Since a major war between NATO and Russia is highly unlikely and Russia successfully withstands Eastern expansion attempts of Alliance, such issues should be solved exclusively peacefully, with mutual respect.

Russia should come up with powerful offers to countries that become victims of failed NATO accession attempts. Such offers might include security guarantees, improved economic cooperation in exchange of guarantees that former NATO aspirants will no longer want to join the Alliance and the interests of the Russian minorities would be respected.

To be realistic: the NATO membership of Georgia and Ukraine is not in sight. Even if it could be accomplished in the future, the territorial conflicts with Russia generate a risk of a NATO–Russian war that is in nobody's interest. In other words: it would serve the genuine interests of both Russia, NATO and the former aspirant countries, if the relations with Russia are normalised and geopolitical realities are officially acknowledged.

Russia should cease all provocative acts, such as airspace violations, flying close to ships or aircrafts belonging to NATO, cyber-attacks, increased military presence at the borders of the Alliance, etc.

Russia should provide security guarantees to NATO that she would not resort to hybrid warfare against the Baltic states in order to promote the real or the presumed interests of local Russian ethnic minorities in exchange to the respect of genuine, legitimate interests of such ethnic minorities. Such Russian guarantees could only work on a mutually beneficial basis.

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Variable Robot Geometry Optimization Method to Avoid Tip Over Situations During Slow Motion on Unknown Terrains

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This paper presents a parametrized stability control method for special slow motion field mobile robots, based on use cases from border surveillance. The concept uses the centre of gravity (COG) as the virtual centre of motion (VCM). The simplified robot geometry is an input parameter of the model, so it can work with different types of mobile robots, like holonomic-wheeled, differential-wheeled, steered, tracked, wheeled-tracked, segmented, etc. structures. This method resulted in the implementation of a flexible and universal control algorithm for transformable and hybrid drive mobile robots, where every parameter can be changed and recalculated for different applications or even in discrete time steps during the motion at a 3D path. The velocity reference, the angular velocity reference and the optimization parameter (for example gravity compensation) of the robot can be prescribed. The model was implemented in MATLAB and can be compiled to C for measurements and validation with test robots.

Keywords: *mobile robot, hybrid drive, transformer, variable geometry, police robots*

Introduction

In most of the cases concerning mobile robot control theory the only implemented algorithm is robot kinematics. These algorithms do not take into consideration the inertias and the masses of the robot (robot dynamics). This method is parallel with industrial robot control methods. At linearly independent joints (for example an XYZ Cartesian TTT organized 3 DOF milling machine) the usual control method is the implementation of inverse kinematics (decentralized control method). [1] [2] With decentralized control method the masses and inertias of the segments do not have significant effects on each other (they have effects just on the position and the orientation of TCP). (They are linearly independent.) In the case of decentralized control theory, the system can be controlled without dynamical equations perfectly. With the centralized control method, we take into consideration the dynamical equations of motion, the interaction between the links, masses, and inertias. [3] [4]

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Mobile robots have usually only one link, and the robot cannot be divided into different parts for centralized motion control method, so the whole mobile robot can be considered as a point (the centre of gravity, virtual centre of motion). The velocity and the angular velocity of the centre of gravity define the motion of the robot (at constant speed). Along the path of the motion we prescribe the velocity and the angular velocity of the robot. With the equations of the robot kinematics we can calculate the angular velocities of the wheels from the equations of motion of the centre of gravity. Parts of transformable mobile robots can be considered different links. These links usually have negligible dynamic effects on each other (because of the mass, inertia and velocity ratios between the whole system and one link). The geometrical transformation has many more important effects on the robot, like turning radius, length, width, height of the structure, stability, and etc. These parameters modify the whole robot kinematics. We can categorize the mobile robots for groups in the view of control theory. (For example: holonomic type mobile robots, non-holonomic type, differential type, non-differential type, etc.) In each group the control methods are very similar. Transformable mobile robots, the basic control method can be more difficult than having extra equations, additional parameters, or special equations of motion.

Use Case

Use cases can serve as a good platform to assume the challenges and needs as well as to present the necessity of discussed solutions. In this article the use case is border surveillance. Border surveillance is defined by the Schengen Border Code. Besides protecting the external borders of the Schengen Area, an area almost overlapping with the territory of the European Union, it also has a traditional key role in protection of the national security interests of the country, including fight against terrorism. [5] Border surveillance means "the surveillance of borders between border crossing points and the surveillance of border crossing points outside the fixed opening hours, in order to prevent persons from circumventing border checks." [6: 16]

This means border surveillance has three key aspects:
- solutions to supervise border sections between border crossing points (at land [including rivers and lakes] as well as at sea);
- solutions to supervise border crossing points (border gates) outside opening hours (when they are usually unmanned);
- movement control capabilities in order to prevent persons from circumventing border checks.

In the last year, a vast number of persons attempted to cross the Schengen external border into Hungary illegally. There were 10,046 persons arrested on the peak day in 2015, 430,607 persons were caught crossing the border illegally in total in 2015. For comparison, the total number in 2014, was 61,664 (according to statistical reports of the Hungarian National Police – published on [40].) Detection itself did not help authorities who faced a huge challenge only because of the sheer numbers. Moreover, if the police stopped them, they attacked the border gates (Röszke, September 16, 2015), but were driven off with tear gas and water cannons. First in realizing the nature of the current migration trend, meaning that the masses of migrants may start a riot at any time, Hungary erected a border fence along its southern border. Additional large waves are expected later in 2016 and some signs show that attempts

are becoming more and more aggressive (on February 19, 2016, an individual pointed a gun at the patrols, threatening them with shooting, on the same day a car broke through and tried to run down the officers trying to stop it). Every day, smaller or larger groups try to cut their way through the border fence. This means, that the border surveillance has to be able to cope with such mass breakthrough attempts. To prevent injury to officers and spare manpower for critical events, the Hungarian National Police launched a series of research and innovation actions, aimed at developing autonomous border surveillance capabilities. One of the possible solutions is the authorization of ground robot patrols in the form of slow moving ground robots equipped with sensor arrays, radio and extended power sources with hot-swap function. Some sensors shall be able to capture multi-modal biometric identifiers (e.g. motion picture with movement patterns in normal and infrared [IR] light), enabling later identification of trespassers. [7]

Infrastructure close to the border fence is slightly underdeveloped, as it had to be erected hastily in one month, especially manoeuvre roads are in bad condition on rainy days, tents and mobile toilets were hastily deployed to cover the patrol lines along the border fence. Currently, power lines are under construction at several border sections which can serve as a solid base infrastructure for ground surveillance robots covering areas which cannot be covered by power lines and static surveillance equipment. Therefore, control methods for ground robots applicable under such conditions had to be investigated.

Picture 1. Manoeuvre road after a rainy day.
[Courtesy of the Hungarian National Police. Made exclusively for the authors by Martin MEYER.]

Picture 2. Temporary infrastructure along patrol lines.
[Courtesy of the Hungarian National Police. Made exclusively for the authors by Martin MEYER.]

Background

Several types of mobile robots exist, such as tracked, wheeled, legged, wheeled-legged, leg-wheeled, segmented, climbing or hopping. Transformable mobile robots proved that they can be much more effective on terrain, than the single link ones, and can overcome obstacles 2–3 times their wheel diameter. [8] [9] [10] The control methods of these robots are implemented individually for every construction. In most of the cases the control algorithms uses the virtual centre of motion method and the path of the motion describes the path of this point. [8] [11] Usually the centre of gravity is not exactly the same with the virtual centre of motion. Mostly the virtual centre of motion is the geometrical centre of the structure. [8] At the design of the robot mechanics the geometry of the robot can be optimized for the expected terrain. [8] [9] [11] In some cases the control method is also optimized for the surface of the ground. [8] [9] The design and control of a robot for an unexplored terrain requires a different approach. [13] [14] Transformable mobile robots are designed for motion in special environments. With the variable geometry, the structure can optimize its shape to overcome the current obstacle. For example, after the attack of the World Trade Center these types of mobile robots were used in searching for victims. These machines can work in hazardous environments without any risk to human life. [11] [15] The robots can be smaller than dogs and go deeper in small tunnels. The most significant barriers are stairs, stones, and pits. [14] The key factor of this movement is the stability of the robot. In case of an impossible path a new route can be designed, but in case of a tip over situation the mission is unsuccessful. The main parameter of the stability is the effect of gravity. (In case of a relatively slow motion robot the dynamics can be neglected.) Variable transformation shapes give opportunity for the compensation of the gravity effect. [16] The low-level control algorithms are implemented in each structure individually. [17–26] For the high-level robot action control we can find general structures, and path controller algorithms. [22] [25] [27] The path of the robot motion is also different for example at a differential drive and a holonomic drive. [25] The low-level control algorithm (kinematics) of a transformable and a non-transformable differential drive is also different. At the transformable version of the differential drive the shape of the structure is continuously under optimization during motion. [27] [28] [29] [30] [31] The aim of the paper is to describe a parameterized low level mobile robot control algorithm for slow motion on unknown terrain. [32] [33]

Model Description

Simplifying the robot geometry, we can find a way to define the required parameters for the calculation of inverse kinematics generally. Consider the mass of the robot as a point (centre of gravity). This point is the centre of the robot coordinate system. Draw vectors from the centre of the coordinate system to the contact points between the floor and the wheels. The model can calculate with constant and variable coordinates also. For example, from a holonomic type robot model (Figure 1) we can sketch a simplified structure (Figure 2). Of course, the geometrical transformation can change the centre of gravity relatively to the wheels. In this case, all of the structure can be recalculated but this effect is usually negligible. (With future development a segmented robot with more concentrated masses will be defined. [34] [35]) A contact point can be geometrical and constrains perpendicular to the

plane of the floor (contact plane), and at a direction in parallel with the contact plane. These parameters also can be variables or constants. (For example, in radio control [RC] cars the steering angle, modifies the direction of the geometrical constrains at the contact points of the steered wheels.) Additional input parameters are the mass of the robot, the gravitational vector and the coefficient of adhesion friction. With this parameter description, we can calculate the normal forces at the contact points and the components of the acceleration (mainly the mass acceleration). This will result in a simple statically model that can be optimized in real-time during motion.

The path planning algorithm defines the velocity and the angular velocity of the COG(s) or centre of a multi robot system. [36] With these data and the parameters mentioned above we can calculate the angular velocities of the wheels (inverse kinematics). With the definition of the acceleration and the angular acceleration of the robot we can calculate the angular velocities of the wheels at discrete time steps. During the control of transformable mobile robots, we can prescribe optimums, maximal, or minimal values of robot parameters, like maximal acceleration utilization, maximal velocity utilization, stability optimum, energy consumption minimum, etc. (Figure 3) This way we can also make sure the robot is going to move slowly in case of a critical tip-over situation to avoid robot damage caused by high motional energy (and we can also neglect dynamic effects of robot motion).
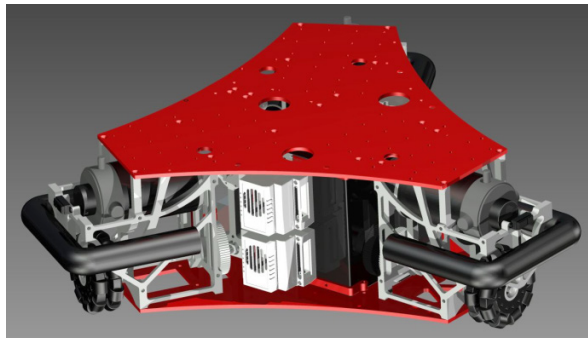
Figure 1. The rendered image of the holonomic robot base.
[Edited by the authors.]
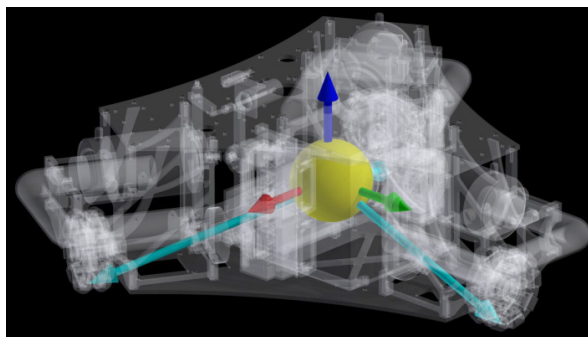
*Figure 2. The rendered image of the holonomic robot base with
the robot coordinate system, the centre of gravity, and the vectors of the contact points.*
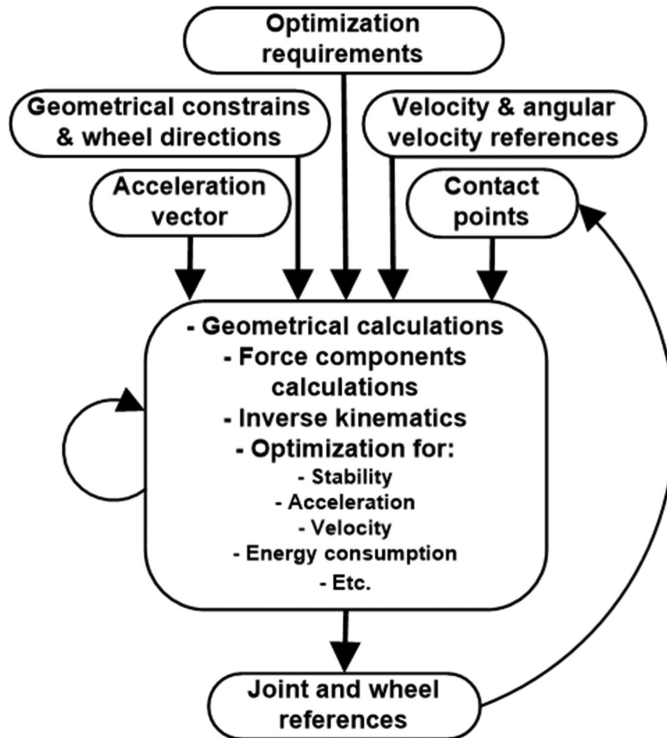[Edited by the authors.]

Figure 3. The block diagram of the system.
[Edited by the authors.]

Calculation Method

The implemented model can be divided into two main parts: basic calculations and optimizations. These can be also divided into different loops and iterations. At the end of the development the code must run on an embedded system or on an embedded computer. [37] The calculation throughput these hardware elements is limited, so the code most be speed optimized. [39] The program details have different priorities. The inverse kinematics has to run on the highest frequency in discrete time. The tangent plane (orientation of ground relatively to the robot) calculations, the normal forces and gravitational force calculations, the geometry transformation, or the stability optimization can run on different priorities and frequencies. (For example, in case of a constant acceleration vector the recalculation of the tangent plane function is unnecessary. It means the robot is moving on the same oriented flat terrain for a long time.) The time constants of the application define these priorities, frequencies, and the minimal calculation throughput.

Basic calculations

This part of the code requires the input parameters. These parameters can be given in the same frame for different robots. The values of the frames are constants, but the constants can

be calculated from any type of MATLAB compatible functions. (For example, the inverse kinematics of multi DOF legs or arms. [38] [39]) The required data of the robot are the followings in robot coordinate system:

- vector of the acceleration (provided by a 3-axis accelerometer);
- coordinates of the contact points (for example the output of the robot leg's direct geometry functions);
- direction of the geometrical constrains and the drives (direction of the steered wheels);
- mass of the robot;
- value of the adhesion friction;
- transformation matrix between the robot coordinate system and the world coordinate system (provided by navigation module);
- velocity and angular velocity references of the robot (provided by path planner);
- values of the acceleration and the angular acceleration of the robot (provided by path planner).

Every parameter is in robot coordinate system (except the references). (The references are usually given in world coordinate system and transferred to robot coordinates.) The program generates the simplified 3D model of the robot from the input parameters. It contains the acceleration vector, the components of the acceleration vector, the concentrated mass, the vector of the contact points, the tangent plane and the normal forces. (Figure 4) The method is implemented in 3D for contact points (e.g. wheels), location and positive integer.
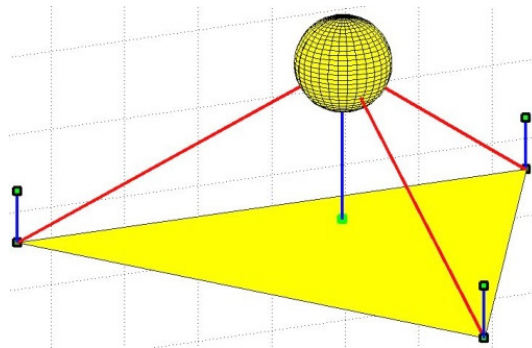
Figure 4. The 3D MATLAB model of the simplified robot (same as Figure 1) geometry.
(In this case the acceleration has only perpendicular component [only gravity effect].)
[Edited by the authors.]

As it was mentioned above in most of the cases the acceleration of the robot from the drives is negligible in the ratio of the gravity effect. The input parameters are dimensionless ratios. (Of course, these parameters can be easily changed to real dimensions.) The first part of the code generates the 3D model, the tangent plane, and the force components. The output of this process is a 3-dimensional free body diagram. The program calculates the distances between the gravitational vector and the contact points. Every distance is projected to the XY plane. With these distances, we can define a first iteration ratio for the normal forces at the contact points. (Normal forces are between the wheels and the ground.) The program selects three points to find the ground plane in robot coordinate system. Three points define a 3D plane.

Equation (1), where x,y,z are the coordinates of a general point on the plane, x_0,y_0,z_0 are the coordinates of a wheel contact point, and a,b,c are the coordinates of the normal vector of the plane (can be expressed from three points of the plane).

$$a(x - x_0) + b(y - y_0) + c(z - z_0) = 0 \tag{1}$$

These three points can be selected from any of the points with different combinations. The program calculates the maximal number of these combinations, where k_{max} in Equation (2) is the maximal number of the combination (and the number of the iterations), and n is the number of the contact points.

$$k_{max} = \frac{n(n - 1)(n - 2)}{6} \tag{2}$$

For the test of the first iteration, (the validation of the plane) we have to calculate, that the other points are lies on the plane, over the plane, or under the plane from the Equation (1). (I.e. point error.) This step also helps us in case of multiple wheel robots to figure out which 3 wheels are defining a plane. In case the gravitational vector goes through the plane the robot is standing on those three wheels and we can get estimation about the rest of the wheels. (We want to see if those are touching the ground, a stone, being on the first step of a stair, etc.)

The next part of the plane validation is the investigation of the relationship between the plane and the continuance of the gravitational vector. The continuance of the vector (3D line) should intersect the plane inside the triangle defined by the three main contact points. A rigid body rolls over when the impact line of the gravity is outside of the contact surface. (I.e. intersection error.) The coordinates of this point will satisfy the equation of the 3D plane [Equation (1)] and the equation of the 3D line [Equation (3)] at the same time, where r is the vector of an arbitrary point of the line (in this case the intersection point), r_0 is the vector of a known point of the line (in this case the gravitational vector), t is a real parameter $(t \in R)$ and v is the direction vector of the line.

$$r - r_0 = tv \tag{3}$$

Equation (3) can be expressed in coordinate form like Equations (4)–(6), where d_{gx},d_{gy},d_{gz} are the coordinates of the intersection point, (D_g), g_x,g_y,g_z are the coordinates of the gravitational vector, t_1 [Equation (7)] is a real parameter $(t_1 \in R)$ and x_1,y_1,z_1 are the coordinates of the main points from the plane (so as x_2,y_2,z_2 and x_3,y_3,z_3).

$$d_{gx} = g_x(1 - t_1) \tag{4}$$

$$d_{gy} = g_y(1 - t_1) \tag{5}$$

$$d_{gz} = g_z(1 - t_1) \tag{6}$$

$$t_1 = -\frac{a(x_1 - g_x) + b(y_1 - g_y) + c(z_1 - g_z)}{ag_x + bg_y + c\,g_z} \tag{7}$$

In case of a calculation error related to the coordinates of the wheel (x_1, y_1, z_1) the program creates a new combination with a different wheel. In case of a calculation problem with the intersection point (D_g) the program also creates a new combination of wheels to find the three wheels where the robot lies on the ground. The iteration runs maximally once with every combination (n times). These attempts are running in probability sequences. At the first successful case the next step will be the calculation of the gravitational components (force perpendicular to the ground plane and force parallel to the ground plane) and the normal forces (forces between the wheels and the ground plane). The normal component of the gravitational (and the normal) forces will be parallel with the normal vector of the plane. The point where the normal component intersects the plane can be calculated with the same method, where d_{cx}, d_{cy}, d_{cz} are the coordinates of the intersection point, (D_c), t_2 is a real parameter ($t_2 \in R$), defined by the normal component of the gravitational force. [See Equations (8)–(11).]

$$d_{cx} = a(1 - t_2) \tag{8}$$

$$d_{cy} = b(1 - t_2) \tag{9}$$

$$d_{cz} = c(1 - t_2) \tag{10}$$

$$t_2 = -\frac{a(x_1 - a) + b(y_1 - b) + c(z_1 - c)}{a^2 + b^2 + c^2} \tag{11}$$

The parallel component of the gravitational vector will be parallel with a direction vector calculated from the $D_c D_g$ vector. The sum of the normal vectors at the contact points results the normal component of the gravity. From the distances between intersection point of the gravitational vector and the contact points we can define the ratios for the calculation of the normal vectors in Equation (12), where L is the ratio number, n_a is the number of the points on the plane (some of the wheels can be over the plane), N_g is the normal component of the gravitational vector and $|F_{ni}|$ is the absolute value of normal vector of the ith contact point.

$$|F_{ni}| = -\frac{|N_g|}{\sum_{j=1}^{n_a} L_j} \times \left(\frac{\sum_{j=1}^{n_a} L_j}{\frac{n_a}{2}} - L_i \right) \tag{12}$$

As further development, the inverse kinematics module is under implementation. The program categorizes the structure:
- 3 DoF mobile robots:
  - steered,
  - non-steered.
- 2 DoF mobile robots:
  - steered,
  - non-steered.

A mobile robot usually has two or three DOF on the ground plane. The wheels of the robot can be steered or non-steered.

Optimizations

The firstly implemented optimization of the model is the 3D gravity compensation method. At transformable mobile robots, the geometry can be optimized for the stability of the robot.

A rigid body rolls over when the impact line of the gravitational acceleration is outside of the contact surface. The static torque of the body calculated to the centre of the coordinate system (S_{MO}) can be expressed as Equation (13), where m is the mass and r is the vector of the elementary points of the mass.

$$S_{MO} = \int_m r \, dm \tag{13}$$

The vector of the centre of the body (r_s) can be expressed from Equation (4.13) as Equation (14).

$$r_s = \frac{1}{m} S_{MO} \tag{14}$$

The vector between the centre of the mass and the elementary points (R) can be expressed as Equation (15).

$$R = r - r_s \tag{15}$$

The static torque of the body calculated to the centre of the rigid body (S_{MS}) can be expressed as Equation (16).

$$S_{MS} = \int_m R \, dm = S_{MO} - mr = 0 \tag{16}$$

The connection between the torque and the static torque can be expressed as Equation (17), where M_A is the torque, calculated to the point A and g is the gravitational vector.

$$M_A = S_{MO} \times g \tag{17}$$

From Equations (16), (17) Equation (18) can be expressed. (Torque calculated to the centre of the polygon is zero.)

$$M_S = S_{MS} \times g = 0 \tag{18}$$

The torque of the force in the point P (F_P) at point B (M_B) can be expressed as Equation (19), where r_{BP} is the vector between point P and B.

$$M_B = r_{BP} \times F_P \tag{19}$$

If the distance between the intersection point and centre of the polygon (r_{SDg}) is zero [Equation (20)], the continuance of the g intersects the plane at the center of the polygon. This case results normal distribution of the robot mass on each of the wheels.

$$r_{SD_g} = 0 \tag{20}$$

In this case the torque of the gravitational force is zero, so the stability of the robot is maximal. (See Equation 21.)

$$M_{D_g} = r_{SD_g} \times (mg) = 0 \tag{21}$$

The other key factor of the robot stability is the height of the structure.

The wheels of the robot define a polygon on the ground plane. (Figure 5) The centre of the polygon is the average of all points of the polygon. The polygon can be divided to triangles. The centre of the polygon can be calculated from the centres of the triangles. The centre of a triangle projected to the XY plane can be calculated from the coordinates with the Equations (22) and (23), where s_{1x}, s_{1y} are the coordinates of the center of the first triangle.

$$s_{1x} = \frac{x_1 + x_2 + x_3}{3} \tag{22}$$

$$s_{1y} = \frac{y_1 + y_2 + y_3}{3} \tag{23}$$

If we project all of the coordinates to the XY plane we can calculate the area of the triangles in 2D with Equation (24), where T_1 is the area of the first triangle.

$$T_1 = \frac{1}{2}|x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)| \tag{24}$$
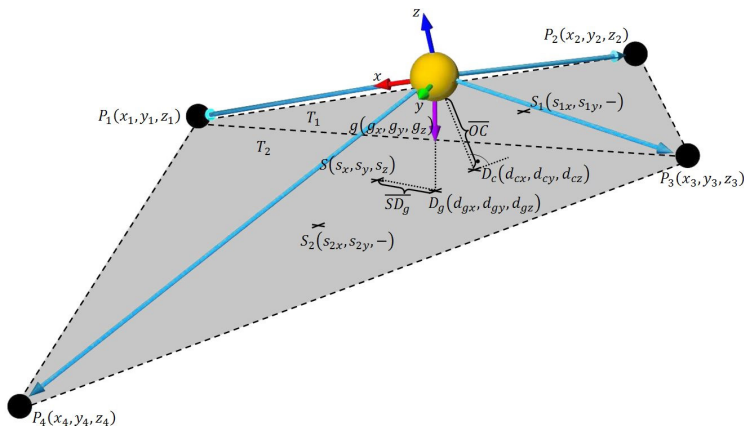
Figure 5. The 3D model of the stability optimization method.
[Edited by the authors.]

From the centres and the areas of the triangles the centre of the polygon can be calculated in 2D with area weighted average with Equations (25) and (26), where s_x, s_y are the x and y coordinates of the centre of the polygon.

$$s_x = \frac{\sum_{i=1}^{n} T_i s_{ix}}{\sum_{i=1}^{n} T_i} \tag{25}$$

$$s_y = \frac{\sum_{i=1}^{n} T_i s_{iy}}{\sum_{i=1}^{n} T_i} \tag{26}$$

The z coordinate of the point can be expressed from the plane Equation (1) as Equation (27) form, where s_z is the z coordinate of the center of the polygon.

$$s_z = ax_1 + by_1 + cz_1 - \frac{as_x + bs_y}{c} \tag{27}$$

The distance between the centre of the coordinate system and the ground plane (the height of the robot structure) can be expressed as Equation (28), where $|OC|$ is the height.

$$|OC| = \sqrt{d_{cx}^2 + d_{cy}^2 + d_{cz}^2} \tag{28}$$

The distance between the centre of the polygon and the point, where the continuance of the gravitational vector intersects the plane (i.e. stability factor) can be expressed as Equation (29), where $|SD_g|$ is the "stability factor".

$$|SD_g| = \sqrt{(d_{gx} - s_x)^2 + (d_{gy} - s_y)^2 + (d_{gz} - s_z)^2} \tag{29}$$

Implementation of the control method

The block diagram of the control method can be seen on Figure 6. The blue boxes of the diagram are coded and simulated. These are the basic calculations, the stability optimization and an additional transformation matrix for the simulation of the gravitational vector during the optimization. The grey boxes are the inverse kinematics, the kinematics optimization and final reference control box. The method can be extended with these further optimizations in the future.

The input variables of the block diagram are the followings:

- max $|SD_g|$, $|OC|$ are the optimization requirements for the stability;
- min $\dot{s}, \ddot{s}, \dot{\theta}, \ddot{\theta}$ are the optimization requirements for the velocity ($\dot{s}$), angular velocity ($\dot{\theta}$), acceleration ($\ddot{s}$) and the angular acceleration ($\ddot{\theta}$);
- $P_{i=1...n}$ are the functions of the contact points (depends on different parameters like $\alpha_i, \gamma_i, \vartheta_i, ...$);
- $f_{i=1...n}$ are the geometrical constrains of the contact points;

- S_0, θ_0 are the current position and orientation of the robot;
- m, μ are the mass and the adhesion friction (the centre of gravity $M(0,0,0)$ is in the center of the robot coordinate system);
- $g(x,y,z)$ is the gravitational vector;
- $s, \dot{s}, \theta, \dot{\theta}$ are the position (s), velocity ($\dot{s}$), angular (θ) and angular velocity references ($\dot{\theta}$).
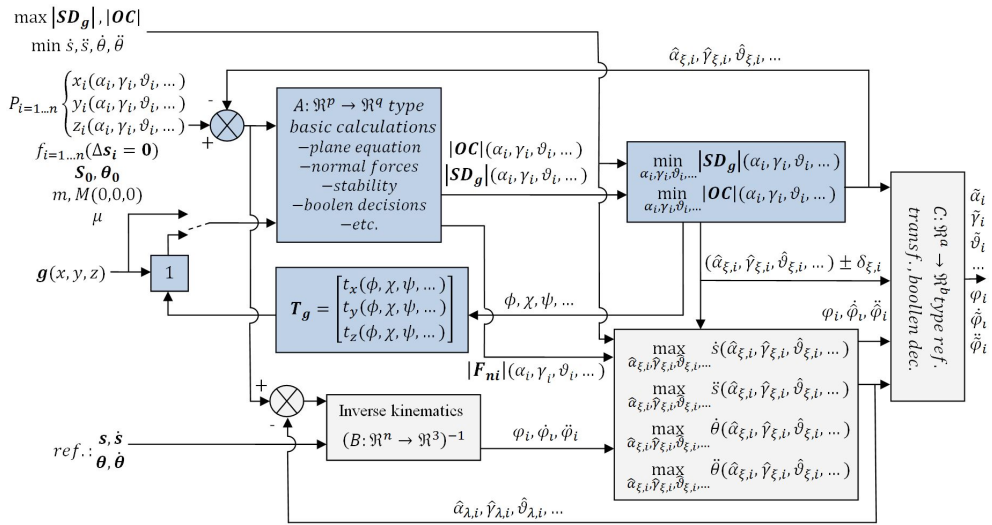

Figure 6. The block diagram of the control method.
[Edited by the authors.]

The variables in the block diagram are the followings:
- T_g is the transformation matrix of the gravitational vector (when the stability factor is under optimization the change of the gravitational vector must be also simulated);
- $\phi, \chi, \psi, \ldots$ are the variables of T_g;
- $\hat{\alpha}_{\xi,i}, \hat{\gamma}_{\xi,i}, \hat{\vartheta}_{\xi,i}, \ldots$ are the estimated parameters of the contact points (estimated by the stability optimization, indicated with ξ);
- $\pm \delta_{\xi,i}$ is the range of the estimated parameters, where the parameters are acceptable;
- $\hat{\alpha}_{\lambda,i}, \hat{\gamma}_{\lambda,i}, \hat{\vartheta}_{\lambda,i}, \ldots$ are the estimated parameters of the contact points (estimated by the kinematics optimization, indicated with λ);
- $\varphi_i, \dot{\varphi}_i, \ddot{\varphi}_i$ are the angular position, the angular velocity and the angular acceleration references of the wheels;
- $\varphi_i, \hat{\dot{\varphi}}_i, \hat{\ddot{\varphi}}_i$ are the angular position, the estimated angular velocity and the estimated angular acceleration references of the wheels (mostly these estimated values are the same with the original values).

The output variables of the block diagram are the followings:
- $\tilde{\alpha}_i, \tilde{\gamma}_i, \tilde{\vartheta}_i, \ldots$ are the final estimated values of the contact point parameters (contact point references);
- $\varphi_i, \tilde{\dot{\varphi}}_i, \tilde{\ddot{\varphi}}_i$ are the final angular position, the estimated angular velocity and the estimated angular acceleration references of the wheels (mostly these estimated values are the same with the original values).

Simulation results

The first simulation of the results is the MATLAB simulation of a basic three wheeled transformable robot geometry. (Figure 7) The position of the P_1 point is variable with the change of α parameter. (Can be tuned between α_A to α_B.) The distances between the wheels and the centre of gravity are equal at every wheel. Between the first two wheels and the XY plane there is 30.964°. In case of $\alpha = 30.964°$ ($\alpha_{opt.}$) and with a horizontal plane $|SD_g| = 0$.
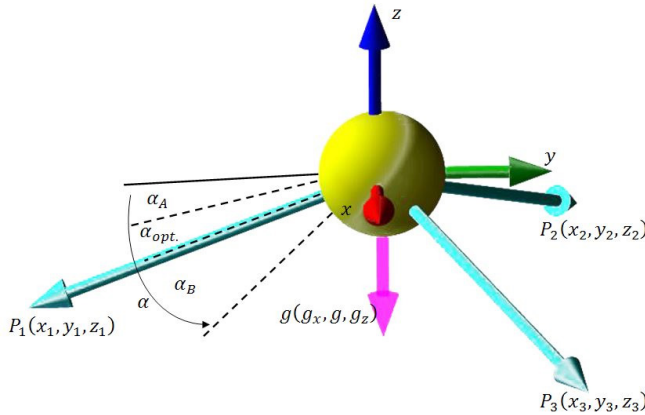
Figure 7. 3D model of the simulated robot structure.
[Edited by the authors.]

Assuming a horizontal plane the blue function on (Figure 8) is $|OC|(\alpha)$, and the red one is $|SD_g|(\alpha)$. As we can see on $|OC|(\alpha)$ the increase of α increases the height of the robot. The red $|SD_g|(\alpha)$ function is more important. It has a minimum value at $\alpha \simeq 31°$. It means that simulation could find the value of α to get back the original optimal structure of the robot.
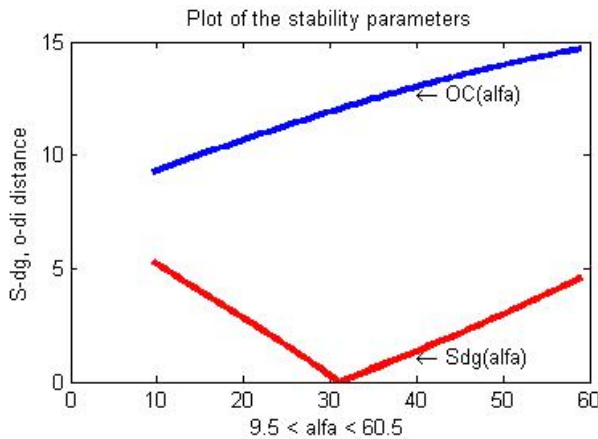
Figure 8. The result of the simulation.
[Edited by the authors.]

The implementation generates different $|SD_g|(\alpha_i,\gamma_i,\vartheta_i,...)$ functions. During the function generation, the program makes logical decisions so the $|SD_g|(\alpha_i,\gamma_i,\vartheta_i,...)$ function cannot contain symbolic variables.

The second simulation made with the same geometry, but in this case two of the parameters where variables (α,γ). (Figure 9) In case of $\alpha = \gamma = 30.964°$ ($\alpha_{opt.},\gamma_{opt.}$) and a horizontal plane $|SD_g| = 0$ (the maximum of the stability).
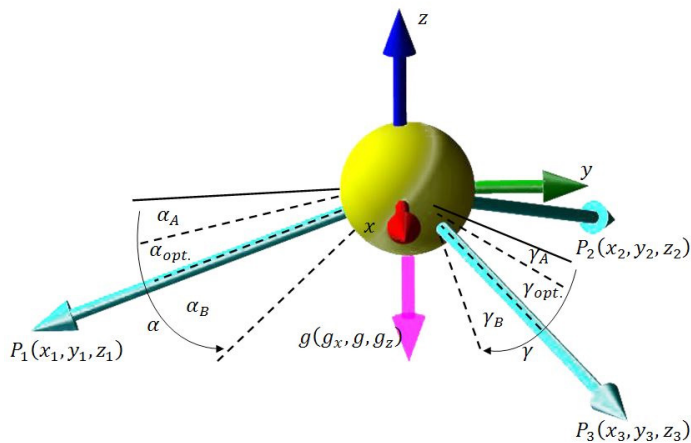
Figure 9. 3D model of the second simulation.
[Edited by the authors.]

In this case three methods were programmed and tested for the calculation of the optimal α and γ values. For comparison: at the worst case in case of $|SD_g|(\alpha,\gamma) > 10$ the robot tips over. Of course, on a ramp less stability can be reached, than in case of a flat and horizontal ground.

At the first method, the program calculates the $|SD_g|(\alpha,\gamma)$ values at 2,500 times. (50 times α and (multiplied by) 50 times γ) As we can see on (Figure 8) and (Figure 9) the $|SD_g|(\alpha,\gamma)$ function has a minimal value at $\alpha = \gamma = 31°$. In this case $|SD_g|(\alpha,\gamma) = 0.0022$. This value is only the 0.022% of the tip over situation. This method could provide the expected results around the original optimal α,γ values. The disadvantage of this method is that the calculation of these points at a normal PC is more than an hour, because of the 2,500 iteration steps. As an advantage of the method it did not use symbolic variables in the $|SD_g|(\alpha,\gamma)$ function and we can visualize the whole "stability map" for different gravitational vectors. At an embedded system, a look up table can contain the values of these maps, although it requires an additional flash memory to store the data points.
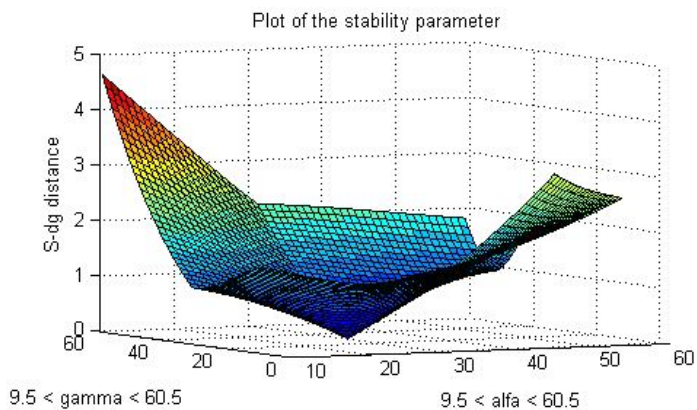
Figure 10. The result of the second simulation (stability map) in 3D.
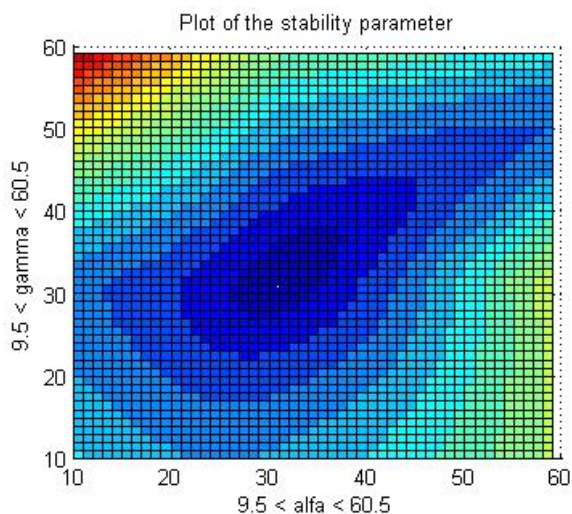[Edited by the authors.]

Figure 11. The result of second simulation (stability map) in 2D.
[Edited by the authors.]

The second method is the use of the "fminsearch" MATLAB function (so it solves the $\min_{\alpha,\gamma}|SD_g|(\alpha,\gamma)$ problem). The results have been the followings: $\alpha = 30.9628$; $\gamma = 30.9605$ and $|SD_g|(\alpha,\gamma) = 0.00009092$. This value is the 0.0009092% of the tip over situation. It is an advantage; that MATLAB could solve this problem in less than a second with 49 iteration steps. The problem with this method is that α and γ where symbolic variables at the program. At a more difficult case the symbolized equation cannot be generated by the MATLAB implementation, and it could not handle the logical decisions even in this simple case.

The third method is the use of a simple search algorithm in 3 steps. At the first search the program calculates $|SD_g|(\alpha,\gamma)$ values at 25 times. (5 times α and (multiplied by) 5 times γ) This iteration is resulted the followings: $\alpha = 30$; $\gamma = 30$ and $|SD_g|(\alpha,\gamma) = 0.0821$. This value is the 0.821% of the tip over situation. (Figure 12)
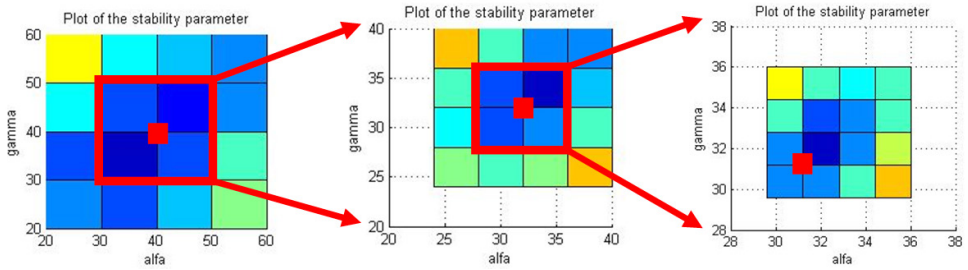
Figure 12. The results of the 1ˢᵗ, 2ⁿᵈ, and 3ʳᵈ steps at the searching algorithm.
[Edited by the authors.]

At the following search the program refines the mesh around the previous minimal point. (Figure 12, 1 and 11)

The second step required 50 iterations (25 for the first and 25 for the second step) The results are the followings: $\alpha = 32$; $\gamma = 32$ and $|SD_g|(\alpha,\gamma) = 0.0566$. This value is the 0.566% of the tip over situation. (Figure 13)

The third step required 75 iterations (25 for the first, 25 for the second and 25 for the third) The results are the followings: $\alpha = 31.2$; $\gamma = 31.2$ and $|SD_g|(\alpha,\gamma) = 0.0131$. This value is the 0.131% of the tip over situation. (Figure 14)

After 150 iteration (6×25) the algorithm could find a solution, where $|SD_g|(\alpha,\gamma) = 0.00037889$. This value is the 0.0037889% of the tip over situation.
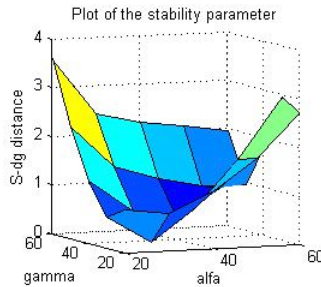

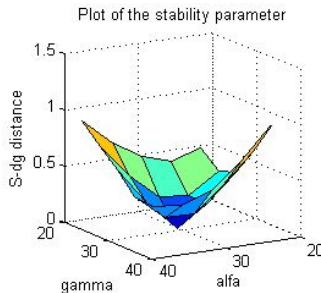*Figure 13. The result of the 1ˢᵗ step.*
[Edited by the authors.]

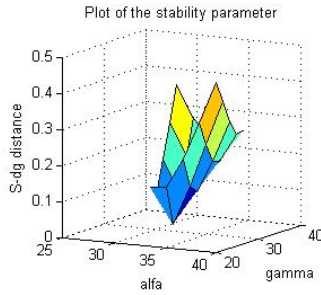*Figure 14. The result of the 2ⁿᵈ step.*
[Edited by the authors.]

Figure 15. The result of the 3rd step.
[Edited by the authors.]

Table 1. The results of the different iteration methods.
[Edited by the authors.]

Method	Stability map	fminsearch	Searching algorithm			
Num. of iter.	2500	49	25	50	75	150
	31	30.9628	30	32	31.2	30.9568
	31	30.9605	30	32	31.2	30.9568
	0.0022	0.00009092	0.0821	0.0566	0.0131	0.00037889
Error %	0.022	0.0009092	0.821	0.566	0.131	0.0037889

This method worked without symbolic variables and could run in less than a second. The main disadvantage of the algorithm is that it can find a local minimum value instead of the optimal solution. This problem can be solved with further developments.

At the next simulation, MATLAB simulated the robot on a rough terrain. The 3D path on the terrain can be described as Equations (30)–(33), where $r(s)$ is the distance function of the 3D path and the gravitational vector and can be described as Equation (34).

$$r(s) = x(s)i + y(s)j + z(s)k \tag{30}$$

$$x(s) = 1 \times s \tag{31}$$

$$y(s) = 0{,}8 \frac{\sin x(s)}{x(s)} \tag{32}$$

$$z(s) = 15 \frac{\sin^2 x(s)}{x(s)} \tag{33}$$

$$g = \begin{bmatrix} 0 \\ 0 \\ -9{,}81 \end{bmatrix} \tag{34}$$

During the 3D path simulation MATLAB worked with the implemented searching algorithm to estimate the optimal geometrical structure arrangement.

At the first test robot performed a slow motion on the path without any stability control methods. The simulation calculated the number of tip over situations at 100 points (with normal distribution of the path) and it resulted, that the robot would tip over on the 72% of the path. (Figure 16, where the red parts mark the tip over on the path.)

At the next step the robot performed a slow motion with the stability control method, where the phase shift of the discrete system was implemented, so the control algorithm used the $(i - 1)$th gravitational vector to control the robot at the ith point. This simulation resulted that the robot would tip over only on the 22% of the path. (Figure 17, where the red parts mark the rollover on the path.) The robot had the same orientation along the path so the robot could not turn its variable wheels towards an obstacle. Changing the robot orientation can also improve this number.
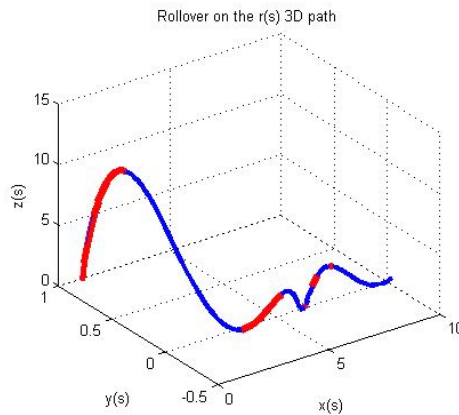

Figure 16. Tip over on the 3D path without stability control.
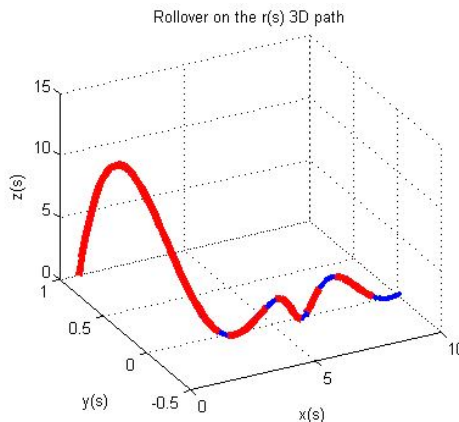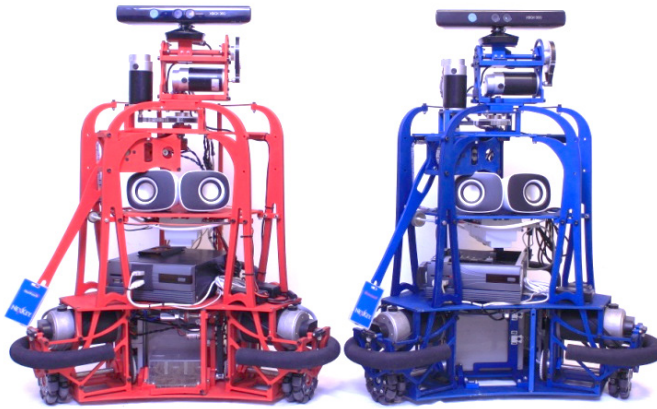[Edited by the authors.]

Figure 17. Tip over on the 3D path with stability control.
[Edited by the authors.]

Conclusion

This paper presented a universal mobile robot control method for transformable and hybrid drive mobile robots performing slow motion on unknown terrains, inspired by use case of border surveillance. The basic calculations and the stability optimization method could provide the expected results at the MATLAB simulations. We designed two ethologically inspired holonomic mobile robots called "Ethon" (Picture 3) and these were the bases of the validation. Unfortunately, these robots are having fix geometry parameters so we could validate the first simulation only with a 3-axis accelerometer and they were not tested in live environment (at the border) yet.

Picture 3. Ethons.
[Made by the authors.]

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