



Mérnöki Szimpózium a Bánkin előadásai

*(Proceedings of the Engineering
Symposium at Bánki)*

2020



ÓBUDAI EGYETEM
ÓBUDA UNIVERSITY



Mérnöki Szimpózium a Bánkin Előadásai

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BÁNKI DONÁT GÉPÉSZ ÉS
BIZTONSÁGTECHNIKAI MÉRNÖKI KAR

BÁNKI DONÁT FACULTY OF MECHANICAL
AND SAFETY ENGINEERING

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Köszöntő

Az elmúlt évtizedben megrendezett ESB – Engineering Symposium at the Bánki - konferenciák hagyományát méltó módon követve az idén is - a Covid-19 járvány jelentette kihívások és nehézségek ellenére - sikerült a különböző kutatói területek képviselőit megszólítani és egy konferencia kötetet, - immár megújult külsővel – összeállítani, amely a kar oktatóin és doktorandusz hallgatóin túl a társegyetemeinken tanuló és oktató kollégáinknak is kínált publikálási lehetőséget.

Tanulmánykötetünk a legszínvonalasabb publikációkat mutatja be, magyar és angol nyelven. A cikkek témagazdagsága és sokszínűsége nagyon hűen tükrözi napjaink hallatlanul izgalmas, kihívásokban gazdag időszakát, kutatási trendjeit és irányát. Az eddigi hagyományos tematikán túl az idén az ergonómia, mint új kutatási terület is helyet kapott a kiadványunkban.

Ezúton szeretnék köszönetet mondani elsősorban a kötet szerzőinek, de mindazoknak is, akik támogatták, valamint ösztönzésükkel és segítségükkel nagyban hozzájárultak ahhoz, hogy e tanulmánykötet megjelenhetett.

A tanulmánykötet sokszínűségére és tartalmi gazdagságára hivatkozva bízom benne, hogy elnyeri minden olvasó tetszését és mind az akadémiai, mind pedig a vállalati szférában tevékenykedő szakemberek számára érdekes és hasznos kiadvány.

Olvasásához, tanulmányozásához sok sikert kívánok!

Budapest, 2020. december 18.



Prof. Dr. Rajnai Zoltán

Dékán

ESB Fővédnöke

Greetings

Following the tradition of the ESB - Engineering Symposium at the Bank - conferences held in the last decade, despite the challenges and difficulties posed by the Covid-19 epidemic, this year we also managed to reach out to representatives of various research fields and compile a conference volume with a renewed look. In this volume in addition to our doctoral students, we also offered the opportunity to publish to our colleagues studying and teaching at our partner universities.

Our conference proceeding presents the highest quality publications in Hungarian and in English. The richness and diversity of the articles very faithfully reflects today's very exciting, challenging period, research trends and direction. In addition to the traditional topics so far, ergonomics as a new field of research has also been included in our publication this year.

I would like to take this opportunity to thank the authors of the articles, but also all those who supported it and, with their encouragement and help, contributed greatly to the publication of this study volume.

Referring to the diversity and richness of the content of this publication, I am confident that it will win the favor of all readers and will be an interesting and useful reading material for professionals in both the academic and corporate sector.

I wish you good luck reading and studying!

Budapest, December 18, 2020



Prof. Dr. Zoltán Rajnai

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WC-Co szerszám indentációs törési szívósságának meghatározása

Determination of indentation fracture toughness of WC-Co tool

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Összefoglalás

A Vickers keménységméréssel meghatározott indentációs törési szívósság értéke erősen függ a vizsgált minta belső feszültségi állapotától. Ennek következtében az indentációs törési szívósság a legtöbb gyakorlati esetben a terhelőerőnek is függvénye, a terhelés növekedésével az indentációs törési szívósság értéke csökken. Az összes terhelési szint együttes értékelésével (Palmquist módszer) az indentációs törési szívósság megbízhatóan meghatározható.

Kulcs szavak: indentációs törési szívósság, WC-Co ötvözet, Palmquist szívósság

Abstract

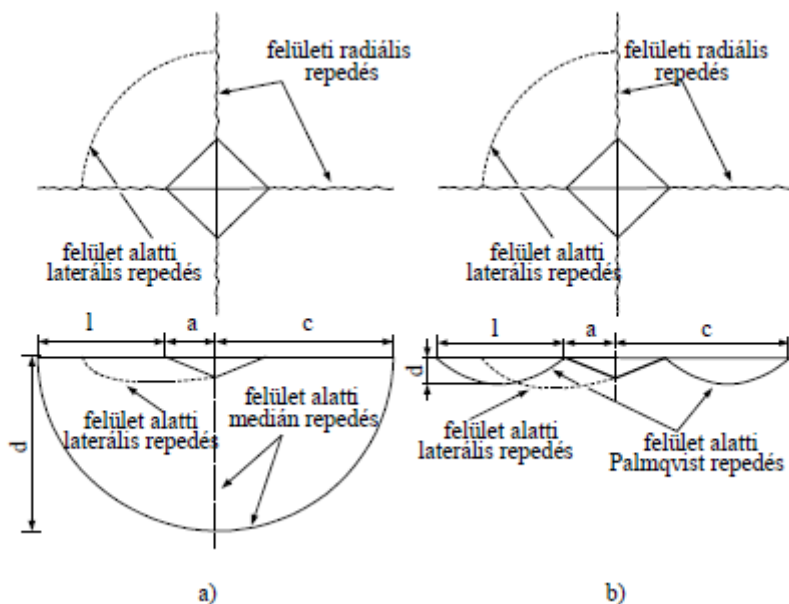
The value of the indentation fracture toughness determined by Vickers hardness measurement strongly depends on the remaining stress state of the tested specimen. As a result, the indentation fracture toughness depends on the load force in most practical cases, and the value of the indentation fracture toughness decreases with increasing load. By evaluating all load levels together (Palmquist method), the indentation fracture toughness can be reliably determined.

Keywords: indentation fracture toughness, cermets, Palmquist toughness

1 Az indentációs törési szívósság meghatározásának alapjai

A nagy szilárdságú és keménységű anyagok repedésállóságának egyik legfontosabb és mérőszáma a törési szívósság. Rideg anyagok esetében a törési szívósság meghatározásának egy lehetséges módja a Vickers lenyomat környékén kialakuló repedések értékelésén alapszik. A témakörrel foglalkozó első kutató Sven Robert Palmqvist volt, aki 1957-ben keményfémek viselkedését tanulmányozta a Vickers keménységmérés közben [1, 2]. Azt tapasztalta, hogy az éles indenter az alakváltozásra lényegében képtelen anyagban repedéseket hoz létre, melyek mérete összefüggésbe hozható a törési szívóssággal. Ezt a megközelítést a tudós társadalom csak mintegy húsz évvel később, Lawn és szerzőtársai munkásságának [3] eredményeként kezdte elfogadni és alkalmazni. Az ezt követő mintegy 25 évben igen sok tapasztalati és elméleti eredmény született, melyeket Ponton átfogó tanulmányai [4, 5] részletesen ismertetnek és elemeznek.

A nagy keménységű, éles indentációs szerszámmal végzett keménységmérés során (ilyen a Vickers eljárás is) az indentáció folyamán a rideg vizsgálati anyagban repedések keletkezhetnek. A repedések alapvetően két csoportba sorolhatók, amelyek értelmezéséhez tekintünk az 1. ábrát.



1. ábra Az indentációs repedés környezetében kialakuló repedési típusok

Az 1.a) ábra az ún. félkörlap jellegű, vagy radiális-medián helyzetű repedés megjelenési formáját mutatja, melyre az angolszász szakirodalomban gyakran „félpeny” alakú repedésként hivatkoznak. Jellemzője, hogy a repedés körlaphoz hasonló alakú, a Vickers lenyomat átlói vonalában a felületre merőlegesek, és a lenyomat alatti anyagrészben egy összefüggő repedési felületet hoz létre. Az 1.b) ábrán bemutatott repedéstípus az ún. radiális-Palmqvist elnevezésű helyzetben van. Ebben az esetben a repedések a lenyomatok csúcsából indulnak ki, körülbelül az átló meghosszabbított irányába, és az egyedi repedések nem kapcsolódnak egymáshoz.

Az indentációs törési szívósság vizsgálata során meg kell határozni, hogy melyik repedési rendszer működik, mivel a törési szívósság meghatározásának módja is függ a repedéstípus jellegétől. A szívósabb anyagokban általában a Palmqvist helyzetű repedések fejlődnek, a rideg kerámia anyagokra pedig a félkörlap (medián) alakú repedéskép jellemző. A kialakult repedés jellege a terhelőerő és az állapotváltozók függvényében is változhat. Két módszer alkalmazása terjedt el annak eldöntésére, hogy melyik repedéstípus működik, illetve működött az indentáció során. Az egyik módszer azon alapszik, hogy a tapasztalatok szerint a Palmqvist és a medián helyzetű repedések esetében szignifikánsan különbözik a lenyomat és a repedés méretét jellemző c/a arány (lásd. 1. ábra jelölései, c - a repedés hossza a lenyomat középpontjától a repedés végéig, a - a lenyomat átlójának fele). A kutatók zömében egyetértenek abban, hogy ha a c/a viszonyszám kisebb, mint 2.5, akkor Palmqvist, ha nagyobb, akkor medián helyzetű repedés jött létre. A másik eljárás a minta felületének ismételt polírozását igényli az indentációs vizsgálatot követően. Ennek eredményeként egy vékony anyagréteg eltávolításra kerül a felületről, és ha Palmqvist típusú a repedés, akkor repedés elválik a lenyomat végétől, mivel a lenyomat alatt nem folytatódik a repedés. Keményfém szerszámanyagok esetében a Palmqvist jellegű repedésképződés dominál.

2 Az indentációs törési szívósság becslésének módszerei

2.1 A törési szívósság meghatározása egy adott terhelési szinten

Az indentáció eredményeként kialakuló repedéskép, illetve repedésméret alapján az indentációs törési szívósság meghatározása elméleti és tapasztalati modellek alkalmazásával lehetséges. A szakirodalomban számos ilyen eljárás fellelhető, Ponton a már említett tanulmányában 15 radiális-medián és 4 radiális-Palmquist repedéskép esetén alkalmazható számítási eljárást elemez. A témakörrel foglalkozó szakirodalmak értékelése alapján a WC-Co keményfémek Palmquist repedésképehez tartozó indentációs törési szívósságának meghatározása az 1. táblázatban bemutatott eljárásokkal történhet.

1. táblázat Az indentációs törési szívósság meghatározásának módszerei

Számítási módszer	Kód	Hivatkozás
Niihara, Morena, and Hasselman egyenlet $K_C = 0.0089(E / H_v)^{2/5} P / (al^{1/2})$	NMH2	[6]
Shetty, Wright, Mincer, Clauer egyenlet $K_C = 0.0319P / (al^{1/2})$	SWMC	[7]
Niihara egyenlet $K_C = 0.0264HV \cdot a \cdot (E / HV)^{2/5} \cdot l^{-1/2}$	NI	[8]
Palmquist (Roebuck) egyenlet $K_C \approx W_K = A \cdot \sqrt{H} \cdot \sqrt{W_G}$	P_egyedi	[9]

Jelölések: K_C – indentációs törési szívósság ($\text{MNm}^{-3/2}$), E – rugalmassági modulus (GPa), H_v – Vickers keménység (GPa), HV – Vickers keménység (-), P – terhelőerő (N), a – Vickers lenyomat félátlója (m), l – a lenyomat átló végétől a repedés végéig átlagos távolsága (m)

A P_egyedi kódjelű számítási modellel bővebb magyarázatot igényel. Az Exner által bevezetett repedési ellenállás fogalma [10] a terhelőerő és az adott lenyomathoz tartozó repedések összegének hányadosaként definiált:

$$W_G = \frac{P}{T}, \quad (1)$$

ahol W_G a repedési ellenállás, N/mm (azaz J/mm^2 , az alakváltozási energia felszabadulás sebessége), P az indentációs terhelés N-ban kifejezve, T pedig a lenyomat sarkaiból kiinduló repedések összegzett hossza mm-ben.

A repedési ellenállásból az ún. Palmqvist szívósság az alábbi összefüggéssel számítható [7]:

$$W_K = A \cdot \sqrt{H} \cdot \sqrt{W_G}, \quad (2)$$

ahol W_K az ún. Palmqvist szívósság ($\text{MN m}^{-3/2}$), H a keménység N/mm^2 -ben kifejezve, A pedig konstans, melynek értéke 0,0028. Az A konstans értéke adott anyag esetén és az indenter geometriája alapján számítható az

$$A = A' \frac{1}{3 \cdot (1 - \nu^2) \cdot (2^{1/2} \pi \tan \psi)}, \quad (3)$$

összefüggéssel, melyben ν a vizsgált anyag Poisson tényezője, ψ az indenter lapszöge (Vickers gyémánt esetébe 136°), A' értéke pedig az mértékegység váltásból adódik (1/36.1). Hagyományos keményfémek esetében a K_{Ic} és a W_K értéke között szoros a korreláció, vagyis $K_{Ic} \sim W_K$ teljesülése feltételezhető [7, 11].

2.2 A törési szívósság meghatározása többszintű terheléssel

Az indentációs törési szívósság egy adott terhelési szinten történő meghatározása (2.1 fejezet) akkor ad megbízható eredményt, ha az indentációs törési szívósság értéke független a terhelőerőtől. A gyakorlati esetek döntő többségében ez nem tételvezhető fel, az indentációs törési szívósság függ a terhelés nagyságától, elsősorban a mintában lévő, általában nyomó jellegű maradó feszültségek miatt [9]. A maradó nyomófeszültség – mely a gyártástechnológiából, illetve a mintaelőkészítés folyamatából származhat – azt eredményezi, hogy a repedések kialakulása csak egy bizonyos terhelési küszöbérték elérése felett történik meg.

A W_G repedési ellenállás meghatározására kétféle lehetőség van. Ha a repedési ellenállás és a Palmqvist szívósság független a terhelőerőtől (nincs számottevő maradó feszültség a mintában), akkor az aktuális terhelés és az összes repedési hossz hányadosaként definiálható az (1) egyenlettel összhangban (P_egyedi számítási kód). Ha a terhelés függvényében változik a repedési ellenállás és a Palmqvist szívósság (számottevő maradó feszültség van a mintában), akkor célszerű többszintű terheléssel elvégezni a vizsgálatot, mely esetben a W_G értéke a repedéshossz és a terhelőerő függvény iránytangensével vehető azonosnak (P_multi számítási kód). A nulla repedéshossz értéknél adódó indentációs terhelés jelenti azt a küszöbértéket, melyet a repedések létrehozásához minimálisan alkalmazni szükséges. Ez a küszöbérték közvetve jellemzi a minta belső feszültségi állapotát is.

3 Vizsgálati tevékenység

Az indentációs törési szívósság meghatározását egy WC-Co alapanyagú, bevonat nélküli 3,6 mm átmérőjű fúrószerszám keresztirányú metszetén végeztük. A vizsgálati anyagból gyémántbevonatú koronggal, állandó hűtés mellett, alacsony tárcsa-fordulatszám alkalmazásával vágtuk ki a vizsgálati anyagrészt, így a minták felületének szerkezetváltozását okozó hatások elkerülhetők voltak.

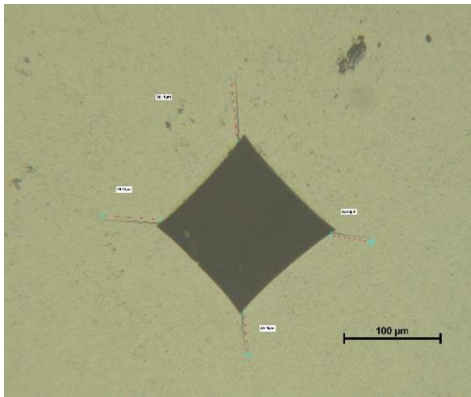
A szerszámról a fentiekben leírt módon leválasztott anyagrészt metallográfiai beöntő gyantába ágyasztuk, majd a csiszolás, polírozás történt. A műveletek során lehetőség szerint igyekeztük figyelembe venni az indentációs törési szívóssági vizsgálat mintaelőkészítésre vonatkozó ajánlásait [11]. A csiszolás SiC tartalmú csiszolópapírok sorozatával történt, a polírozást pedig gyémánt szuszpenzióval, használt polírozóvászon alkalmazásával végeztük.

Az indentációs nyomokat keménységmérő géppel 30, 40, 50 és 60 kg terheléssel hoztuk létre, mely választás összhangban van a kerámiamátrixú kompozitokra megadott irányértékkel [11].

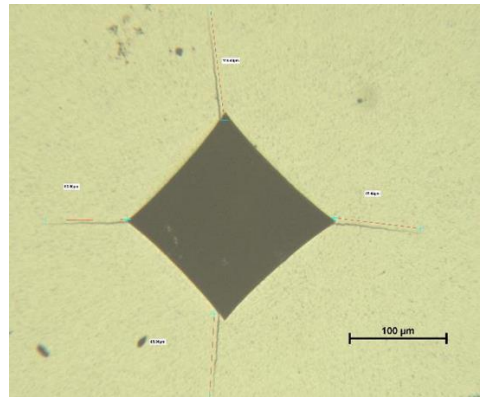
A lenyomatokat egymástól olyan távolságban helyeztük el, hogy az azok környékén kialakuló rugalmas-képlékeny feszültségmezők egymást ne befolyásolják. További szempont volt a keménységi nyomok készítésénél, hogy a lenyomatok a mikroszkópos vizsgálatok során könnyen megtalálhatók és azonosíthatók legyenek.

A keménységi érték és a kialakult repedések hosszának meghatározása optikai mikroszkópon készült felvételek alapján történt. Az 2. ábra képsorozata a mintán létrehozott lenyomatok optikai mikroszkópos felvételeit mutatják. A felvételek úgy készültek, hogy a lenyomat és a repedéskép teljes kiterjedésében látható legyen. A vizsgálati sorozatban a keménység 1548 HV és 1617 HV

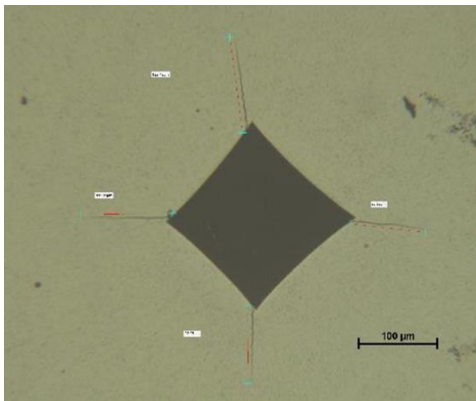
között változott, az átlagos repedésméret pedig a növekvő terhelés szintek sorrendjében 0.054 mm, 0.093 mm, 0.108 mm és 0.181 mm volt.



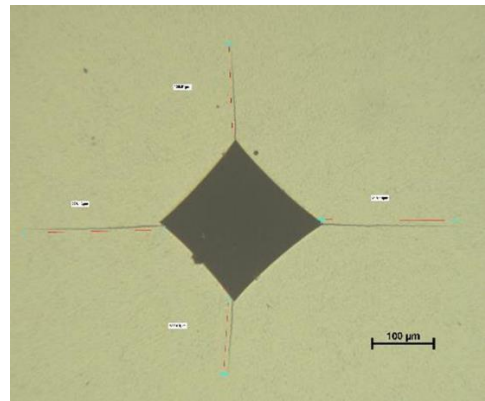
a.) 30 kg



b.) 40 kg



c.) 50 kg

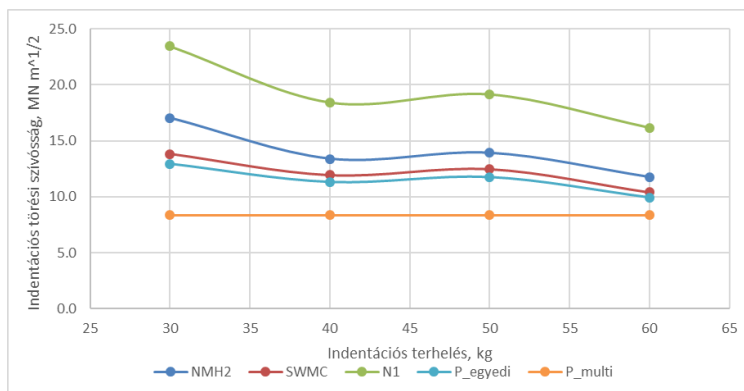


d.) 60 kg

2. ábra A lenyomat és repedésképek a különböző terhelések esetén

4 Eredmények, értékelés

Az 1. sz táblázatban összefoglalt eljárásokkal meghatározott indentációs törési szívósság értékeket az alkalmazott terhelőerő függvényében ábrázolva mutatja be a 3. ábra. A terhelési szintekre adódó eredmények mind a négyféle megközelítés esetén a terhelőerőtől függőnek mutatkoznak, mivel minél nagyobb a terhelés, annál kisebb az indentációs törési szívósság. A P_multi kóddal jelzett módszer az összes terhelési szinten mért repedési jellemzők együttes figyelembe vételével becsüli az indentációs törési (Palmquist) szívósságot, így az eredményt egy vízszintes vonal reprezentálja. Ebben az esetben terhelési szintenként az összegzett repedéshossz és terhelőerő függvény összetartozó értékeire illesztett egyenes iránytangensének értéke került meghatározásra. Az illesztett függvény és a y tengely metszéspontja jelöli ki a 0 repedésmérethez tartozó terhelőerő nagyságát, mely jelen esetben 192 N-nak adódik. E határérték alatti terhelőerővel végzett indentáció esetén repedések kialakulása nem várható. Az egyenes iránytangense 573 N/mm, azaz az indentációs nyomból kiinduló repedési összhossz megduplázásához 573 N terhelésnövekedés szükséges.



3. ábra Az indentációs törési szívósság becsült értékei a különböző terhelések és számítási módszerek esetében

Köszönetnyilvánítás

A jelen dolgozatban bemutatott kutatási munka a 2018-1.3.1-VKE-2018-00041 számú „Intelligens, prediktív szerszámfelügyeleti eljárások kidolgozására és rendszer kialakítására, valamint a fejlesztés fenntartására alkalmas kutatási együttműködés létrehozása” című pályázat támogatásával valósult meg.

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Inverz posztprocesszor fejlesztése a CAD/CAM/CNC munkafolyamat rugalmasságának növelésére

Development of an inverse postprocessor to increase the flexibility of the CAD / CAM / CNC workflow

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Összefoglalás

Ipari környezetben gyakran előforduló nehézséget jelent egy már nem elérhető programozó(rendszer) által írt NC program illesztése valamely, az eredeti programtól jelentősen eltérő logikájú és szintaktikájú vezérlésre. A kutatásunk fő célja egy inverz posztprocesszor kifejlesztése volt, mely algoritmus egy meglévő NC programot szabványos CLDATA nyelvre fordít vissza. A ZW3D szoftver és az ISO 3592:2000 szabvány alapján fejlesztettünk egy rendszerfüggetlen algoritmust NC program inverz posztprocesszállására. Ezen algoritmus alapján C# környezetben felhasználóbarát programot hoztunk létre, melyet 2D-s esztergálási és 2,5D-s marási környezetekben teszteltünk. A kifejlesztett algoritmus időhatékonyan, rugalmasan és biztonságosan használható —a specifikációkban rögzített feltételek mellett— NC program CLDATA programmá való visszaalakítására.

Kulcsszavak: CAD/CAM/CNC, posztprocesszor, CLDATA, inverz posztprocesszor

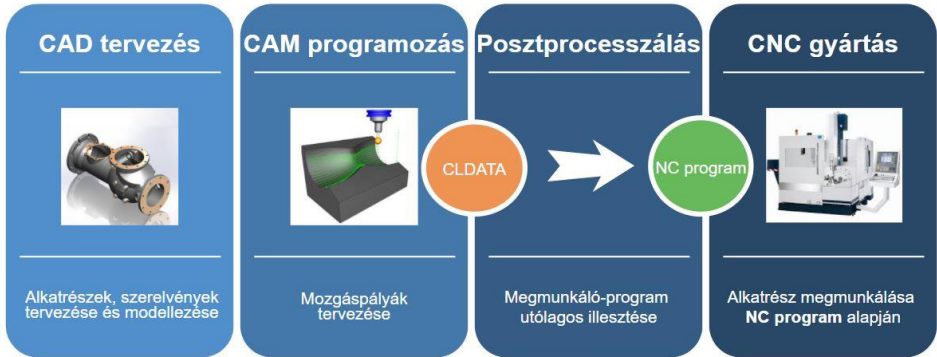
Abstract

In an industrial environment, it is often difficult to fit an extant NC program to that other controller with logic and syntax differ significantly from the original one. The main goal of our research was to develop an inverse postprocessor, which algorithm translates an existing NC program back to CLDATA. Based on the ZW3D software and the ISO 3592:2000 standard, we developed a system-independent algorithm for the inverse postprocessing of an NC program. Based on this algorithm, we developed a user-friendly program in C#, which was tested in 2D turning and 2.5D milling environments. The developed algorithm can be applied time-efficiently, flexibly, and safely under the conditions specified in the specifications, to convert an NC program back to CLDATA.

Keywords: CAD/CAM/CNC, postprocessor, CLDATA, inverse postprocessor

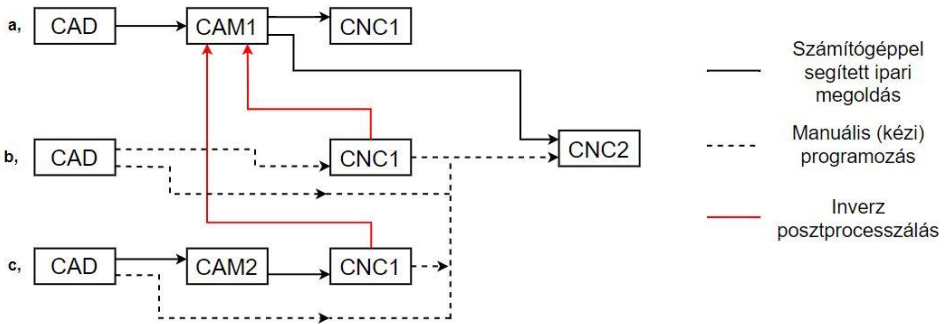
1 Bevezetés

A bonyolult geometriájú forgácsolt alkatrészeket jellemzően CNC szerszámgépeken gyártják, amennyiben a gyártás ütemezése és/vagy tömegszerúsége ezt indokoltá teszi. Ezen alkatrészek gyártóprogramját leggyakrabban különböző számítógéppel segített CAD/CAM tervezőrendszerekkel állítják elő [1]. Ezen széleskörűen elterjedt és alkalmazott ipari munkafolyamatot szemlélteti az 1. ábra.



1. ábra: CAD/CAM/CNC munkafolyamat

Az alkatrészek 3D-s testmodelljeinek elkészítése után (amit jellemzően egy konstruktőr végez) lehetőségünk nyílik egy CAM szoftver segítségével megmunkálást programozni. A programozott geometriai és technológiai információk ISO 3592:2000 szabványos CLDATA nyelven tárolódnak a CAM rendszerekben, sokszor a felhasználó számára nem elérhető formában. A CLDATA olvasható szövegszerkezetű (ASCII kódos) programnyelv, alapvető egysége a rekord (mondat) [2]. A CLDATA adatokat a megmunkálásra kiválasztott szerszám gép vezérlőjének nyelvére a posztprocesszor segítségével tudjuk utólag illeszteni (fordítani) [3]. Az utólagos illesztéssel a megmunkálásra felhasznált vezérlő környezetében megkapjuk azt az NC programot, amely alapján az alkatrészgyártás megtörténik [1, 4]. Ezt az iparban gyakran előforduló folyamatot szemlélteti a 2.a ábra. Szintén gyakran előforduló eset egy forgácsolt alkatrészeket gyártó vállalatnál, hogy egy már elkészült 3D-s CAD modell vagy alkatrészrajz alapján kézi programírással hozzák létre az NC programot az adott vezérlő környezetében, mely folyamatot a 2.b ábra szemléltet. Előfordul azonban olyan eset is, hogy az NC programot egy olyan szoftver segítségével generálták, amelyhez már nincsen hozzáférésük (pl. érvényes licenz vagy működőképes hardver) (2.c ábra), vagy helyette egy más/újabb szoftvert használunk. A gyártás során gyakran előforduló feladat, hogy egy másik típusú vezérlésre kell áthelyezni egyes gyártási tevékenységeket (pl.: újraütemezés, tervezett karbantartás, meghibásodás miatt), ahogy azt az ábrán „CNC2” szerszám gép szemlélteti.



2. ábra: Az inverz posztprocesszor szükségessége

A 2.a ábrán szemléltetett esetben (rendelkezésünkre áll a gyártóprogram CLDATA formátumban) a gyártás átütemezése egy másik vezérlőjű szerszámgépre egyszerűen és gyorsan véghezvihető. A 2.b és 2.c ábrán szemléltetett esetekben azonban kevésbé rugalmas az átállás. A kutatómunkánk fő célja egy inverz posztprocesszor fejlesztése volt, mellyel a 2. ábrán piros nyilakkal szemléltetett módon egy meglévő NC program visszaalakítható szabványos CLDATA programnyelvre, ezáltal kiküszöbölve az időigényesebb és nehezebb manuális megoldásokat (szaggatott vonal), és új kapcsolatokat hozva létre, amelyek elősegítik a már meglévő számítógéppel támogatott, gyors és rugalmas ipari folyamatokat (folytonos fekete vonal).

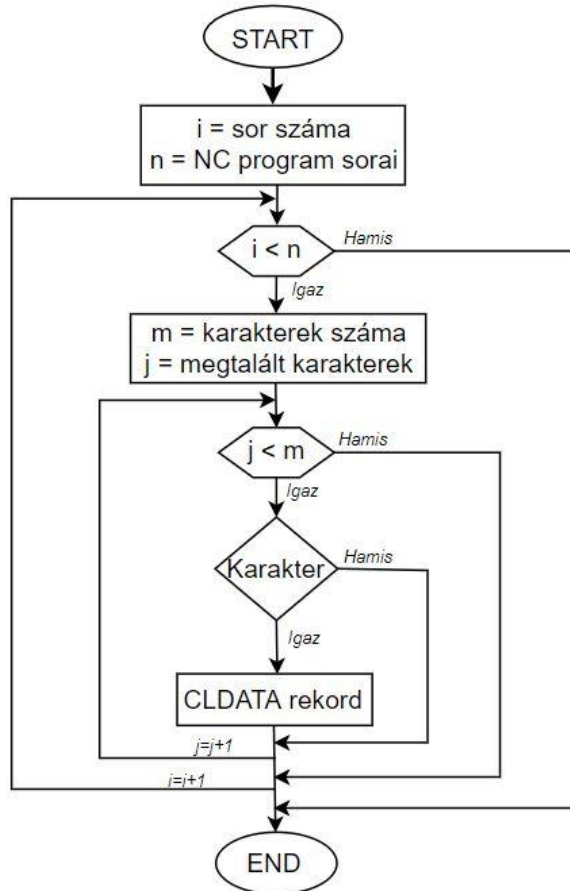
2 Követelményjegyzék

Egy követelményjegyzékben foglaltuk össze azokat a főbb szempontokat, amelyeket figyelembe vettünk a fejlesztői munkában: (i) az általunk fejlesztett inverz posztprocesszor alkalmas Fanuc és Milltronics 2,5D-s marógépekre, és 2D-s esztergagépekre készített NC programok kezelésére; (ii) az inverz posztprocesszor alkalmazása lehetővé teszi alapvető megmunkálások, kontúrsimítás, síkmarás, valamint az ezekhez szükséges műveletelemek NC programjainak visszaalakítását szabványos CLDATA nyelvre; (iii) az inverz posztprocesszor képes visszaalakítani az NC mondatban szereplő szerszámszámra, fordulatszámra, forgásirányra, és előtolásra vonatkozó parancsokat, valamint a szerszámsugárkorrekcióra, abszolút koordinátamegadásra, és különböző M-parancsokra (M05, M08, M09, M30) vonatkozó utasításokat; (iv) képes továbbá az inverz posztprocesszor a gyorsmeneti pozicionálást és lineáris interpolációs mozgásokat, az adott koordináta értékekkel szabványos CLDATA formátumba visszaalakítani.

3 Az inverz posztprocesszor algoritmus

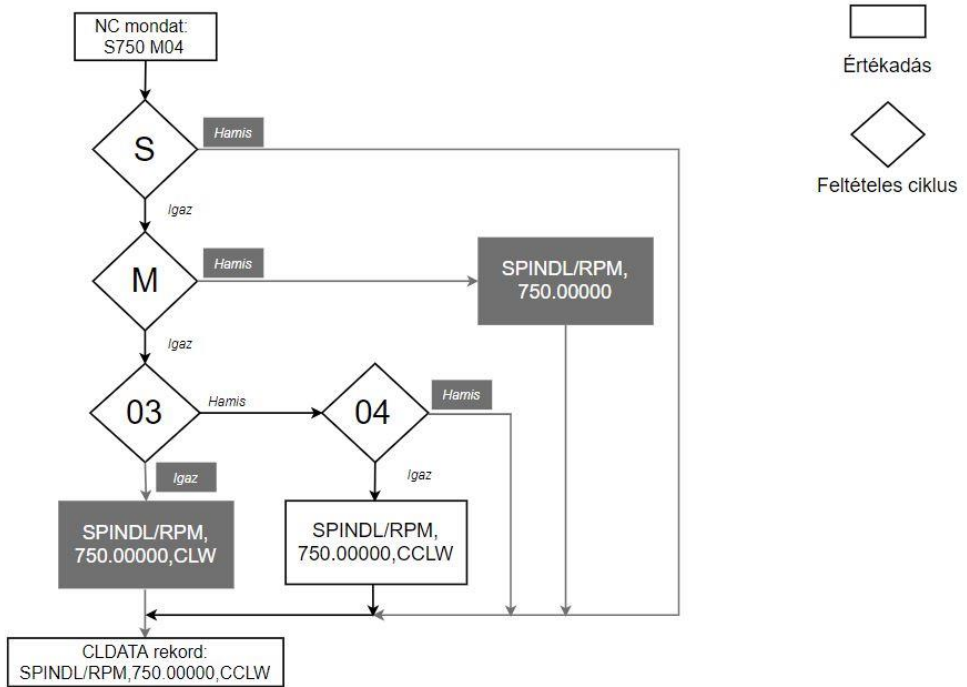
Az általunk kifejlesztett algoritmus feltételes és iterációs utasításokból épül fel, bemenetként az NC program szavait vizsgálja, kimenetei pedig a CLDATA rekordok. Az algoritmus első lépésben az NC programot úgy alakítja át, hogy azon tartalmi változást nem alkalmaz, azonban formailag a CLDATA szerkezetéhez szabja (pl.: G1 X_x helyett: G1 X_x Y_y Z_z, ahol x, y, z az interpolált mozgásciklus végkoordinátái). Az így kapott, kiegészített NC programon a C# környezetben leprogramozott algoritmust lefuttatva visszakapható az eredeti CLDATA program. Az általunk fejlesztett algoritmus átfogó bemutatása a 3. ábrán látható. Az algoritmus minden egyes keresett parancs esetén addig fut, míg az az NC programban fellelhető.

Az elkészült algoritmussal az NC programban az adott parancsra jellemző karakter megkeresésével visszakaphatók szabványos CLDATA formátumban a követelményjegyzékben meghatározott utasítások, így pl.: a fordulatszám, előtolás, szerszámcseré, előkészítő funkciók és koordinátaértékek. Az algoritmus elkészítése során különös figyelmet fordítottunk arra, hogy az adott programban szereplő, ismétlődő utasítások mindegyike visszanyerhető legyen, valamint arra is nagy hangsúlyt fektettünk, hogy a kapott CLDATA adatok a megfelelő formátumban álljanak rendelkezésre az inverz posztprocesszáshoz.



3. ábra: Az inverz posztprocesszor átfogó algoritmusá

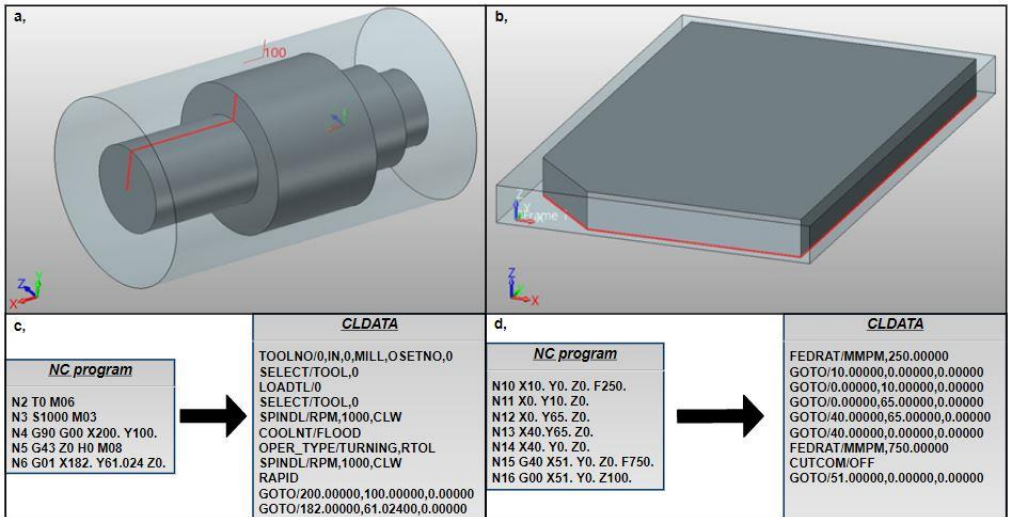
Az NC programon belül szereplő, különböző parancsok visszaalakításához, eltérő feltételek megadása szükséges, ezért az algoritmuson belül szükség van különböző sub rutinokat (alprogramokat) létrehozni. Ilyen rész-algoritmusra látható példa a 4. ábrán, ahol jól megfigyelhető, hogy az egyes feltételek teljesülése esetén a keresett NC mondatra válaszul az azonos információt tartalmazó CLDATA adatot kapjuk vissza. A rész-algoritmusok esetében a legnagyobb kihívást az jelentette, hogy míg az NC mondatok adott soron belül több utasítást is tartalmaznak, addig a CLDATA nyelvben csak egynemű adatok fordulnak elő. Minden esetben fontos volt tehát, hogy az ilyen esetekben az utasítást, a CLDATA nyelvnek megfelelően, logikusan, egymás után adja vissza az inverz posztprocesszor.



4. ábra: Példa a fordulatszám algoritmusának működésére adott NC mondat (fehér út) esetében

4 Validálás

Az inverz posztprocesszor validálása során azt tartottuk szem előtt, hogy a folyamat segítségével kapott CLDATA a későbbiekben szabadon illeszthető legyen bármely szerszámgép vezérléséhez. Ennek érdekében a kapott CLDATA adatokat az eredetivel összevetve más NC gépek vezérlőjéhez posztprocesszáltuk, ezáltal bemutatva, hogy az inverz posztprocesszor alkalmazásával sikeresen lehet egy adott vezérlő környezetéhez illesztett adatokat egy másik vezérlő környezetéhez illeszteni. Az 5. ábrán látható alkatrészekben a ZW3D CAD/CAM szoftver segítségével egyszerű szerszámmozgásokat programoztunk, majd ezeket a kiválasztott Fanuc és Milltronics vezérlőkhöz posztprocesszáltuk, így megkapva az NC programot (5.c és 5.d ábrák). Ezt követően az általunk fejlesztett algoritmus segítségével, Visual Studio fejlesztőkörnyezetben C# nyelven létrehoztunk egy felhasználóbarát inverz posztprocesszort, amellyel a korábban megkapott NC programot sikeresen visszaalakítottuk CLDATA adatokká, ahogy ez az 5.c és 5.d ábrán is látható. A kapott CLDATA tehát ilyen módon később ismételt posztprocesszálnak a kívánt vezérlőhöz a CAM szoftverek létező algoritmusával.



5. ábra: Inverz posztprocesszor validálása

5 Összefoglalás

Kutatómunkánkban olyan inverz posztprocesszor fejlesztését kezdtük meg, mely algoritmussal egy NC program átalakítható szabványos CLDATA programmá. Az általunk fejlesztett inverz posztprocesszor segítségével –alapvető műveletelemek esetében– sikeresen tudunk különböző NC programokat CLDATA nyelvre visszaalakítani, majd másik vezérlő környezetéhez illeszteni meglévő CAM posztprocesszorokkal. Az általunk fejlesztett inverz posztprocesszor lehetőséget ad arra, hogy megvalósítsa a CLDATA és CNC program közötti kétirányú kommunikációt, ezáltal növelve a CAD/CAM/CNC munkafolyamatok gyorsaságát, hatékonyságát és rugalmasságát.

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Challenges of the application of machine learning in the serial production.

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Abstract

The industrial applications of the machine learning methods have promising results in the field of smart manufacturing and quality assurance; however, the development of these models have challenges. In this paper we present the classical steps of model creation and the challenges and questions of industrial applications in each step, especially for series production. Finally, we present a possible workflow for model development in the manufacturing.

Keywords: machine learning, industry 4.0, intelligent manufacturing, smart manufacturing, quality assurance

1 Introduction

The industrial applications of the machine learning methods have promising results in the field of smart manufacturing and quality assurance; however, the development of these models have challenges. The typical industrial use-cases of artificial intelligence are pattern recognition, classification, anomaly- or fault detection and fault prediction for predictive maintenance. The serial production plants are highly automated, and with the spread of industry 4.0 and the IoT equipment, enormous amount of data available to train models for the above-mentioned tasks. However, in these plants the processes are strict standardized and highly specialized, this can no longer said of the data acquisition, data analytics and data interpretation. Besides the heterogeneity of the data acquisition, the diversity of industrial and enterprise systems, the interconnectability of these systems and the lack of structured and standardized storage of data makes the creation of models even harder. At last, but not least, the data and the key feature selection are the key steps of successful model creation, this is where the process- or domain knowledge and the functional approach of data analytics plays very important role. In the following sections we present the classical workflow of model creation and their challenges in accordance with industrial application.

2 Methodology of data analytics and model creation

In this section we present a brief overview of the main steps in the methodology of data analytics and model creation with the short description and role of each steps in the procedure. In the followings we discuss the topics data preparation, data pre-processing, model selection, training, performance evaluation.

2.1 Data preparation

Data preparation is the very first step of data analytics and model development. The aim of data

preparation is to get an overview of the process data and then select the most corresponding samples and features for modeling. The main tasks are data extraction from databases or systems, data structure analysis and data selection to build and train models. The sample and variable selection is based on the model to be built.

2.2 Data pre-processing

Data pre-processing is essential to be carried out to improve the quality of the data, and some appropriate data transformations may be needed to make the data modeling more efficient. This process boosts the model's performance and accuracy. In this step, the inconsistency in time needs to be eliminated, outliers and gross errors should be removed, the missing values need to be addressed, e.g. deletion of the sample, missing value estimation and the scale difference among process variables needs to be considered (the step of scaling or normalizing) to increase accuracy and decrease training time. In this step takes place the splitting of the dataset for training, testing and validation datasets, which are used for training and model validation and performance evaluation.

2.3 Model selection and training

After the data selection and pre-processing comes the selection of an appropriate machine learning algorithm for data model construction. Based on the detailed analyses of data characteristics, the architecture of the model and the complexity of the data model can be evaluated. After the architecture of the model has been selected, the model parameters can be determined by implementing and testing the machine learning algorithm on the training dataset. In this step, different data models (algorithms) can be formulated as different optimization problems. During the training we optimize the loss function of the model.

2.4 Performance evaluation

After the training, the performance of the model needs to be evaluated. The most used model validation and performance evaluation methods are cross-validation, model stability analysis, model robust analysis, parameter sensitivity analysis, etc. For model validation and performance evaluation, separate testing or validation dataset required.

3 Challenges of machine learning applications in serial production.

In this section we present the most common challenges of application of machine learning methods in industrial environment, with special attention to serial production. We inspect the challenges in accordance with the steps of the methodology of data analysis and model creation.

3.1 Challenges of data preparation

The data preparation and selection are essential steps of data analytics and model creation. In the manufacturing there are several systems for data acquisition, each with different purpose. A part tracking system tracks the manufactured parts and their statuses, an inline supervision system measures and stores process signals and values, the ERP system stores additional information like financial or supplier data; just to name a few possible systems. There are data, which are present only in one or all the systems. Which will be the lead system, which provide the 'ground truth'? The data representation can be different in every system. How do we know what data format to use? How do we convert the data between the systems? If a measurement system stores only the measured values and the timestamp of the measurement and the part ID is stored only in the part tracking

system to prevent redundant data storage, how do we connect the data in the two systems? Which timestamp is used in which system, the timestamp of the measurement or the timestamp of the data acquisition? How do we synchronize them? If the identification or the name of the data source is different in the systems which must be interconnected, how do we connect the corresponding data? What technology to use to collect the data? What are the key features in the collected data? These are only the few of the possible challenges of data preparation in real-world industrial applications, which must be addressed. These questions cannot be answered without the exact knowledge of the system architecture, the data acquisition, infrastructure, and the process.

3.2 Challenges of data pre-processing

Data pre-processing is essential to be carried out to improve the quality of the data. We need to deal with the inconsistency, the missing values, the outliers or delete corrupted samples. But are these samples really corrupted or they are only exotic values in the process? How do we replace the missing values? Is the usage of the average value of the samples are good enough? If there are labels, are the labeling valid? Are the data valid and describes the process well? To answer these questions, the knowledge of the physical process and the manufacturing technology is essential.

3.3 Challenges of model selection and training

To choose the best performing model first we need to determine the desired behavior of the model. The architecture, the algorithm, the loss, and optimization function can be very different for the different tasks. It is essential to frame the problem. Is it a regression or a classification problem? Is there any seasonality in the data or not? Is it a timeseries or discrete values or features? Do we need a standalone model, a stacked or a multi model architecture with different architectures which corresponds to the relevant features? The industrial processes are well standardized and controlled, thus the quality of the product is highly unbalanced and the data also: the percentage of waste and rejected products are relatively small. How to train a classification model if the input data highly unbalanced? Which training strategy to choose? Are there similar problems and solutions? What is the best batch size for the training? How many epochs do we have to train the model? These questions are the addressed to the data scientist or to the machine learning engineer.

3.4 Challenges of performance evaluation

Before deploying the model in production, to evaluate and tests are needed. But if the training and the input data also highly unbalanced, the evaluation can take long time. In the production the appearance of a rare event can vary between days and years. If the model misclassifies or cannot detect these rare events, was the result of the poor training data or was the results of the behavior of the model, which thought to be the good? Do we have to detect events which are occurs in every few years or not? That depends on if we manufacture candy bars or operate a nuclear power plant. Often there is no time to make expensive and well-prepared manufacturing or process tests. We need to decide which features and events are worth the time and cost. These are both the questions addressed to the model's creator and for the process engineers and the process hosts.

4 Conclusion

As it seems form section 3, the industrial application of machine learning not just machine learning problem, rather a complex, multidisciplinary engineering task. Not only the domain knowledge, but the knowledge of the industrial processes, the products and their characteristics, the quality characteristics, the data acquisitions methods, the automation technologies, and the IT architecture are essential for the successful industrial application of ML methods. In addition, the

application of these methods and the tasks of these models are based on rational technological and financial decisions.

The aim of ML in the manufacturing is to support decision making and the efficient productions of high-quality products, therefore the applications of the methods should be placed on the shopfloor, near the production, where the real value is produced and where knowledge for application are present.

4.1 Workflow for industrial applications of ML

Based on the above-mentioned experiences, we propose one possible workflow for successful industrial application of machine learning consist the following steps:

1. Framing the problem with technological approach, domain knowledge: we determine what event or cases has the model detect or classify, then we choose the relevant technological parameters and features based on the product and the manufacturing process. (In contrast with classical BigData methods, where we collect every data, and we try to find pattern in the data.) Consultation with product-, process-, automation- and quality assurance engineers.

2. Identifying source systems and data format, data map: we identify which data in which system(s) are present, identification of data and creation of data dictionary. Defining data acquisition technology to collect data from systems. If possible, we use uniform naming convention for naming the data in the different systems. Consultation with automation-, IT-engineers and applications hosts.

3. Model creation, training, and evaluation: based on the needs of the production, we create the model for the predefined task, then we test and evaluate the model on the real process data. Consultation with data scientist-, product-, process- and automation engineers.

4. Deploying the model in production: after successful evaluation of the model deployment of the model to the production. Full life-cycle management needed for further development and fine-tuning if needed. Consultation with product-, process-, automation- and quality assurance engineers and process host.

4.2 Further research

Based on experience, further research on the topic and the proposal of a framework for the industrial application of machine learning with standardized, homogenized data collection technology, uniform naming conventions and a modular toolbox are required.

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Intelligent Driving System effectiveness testing in Highly Automated Vehicles

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Abstract

The autonomous vehicles will appear on the road as soon as possible in the future. But first, the developers need to think about the highly automated vehicles and conventional vehicles. Because they may conflict with each other during transport, that is why required to use various safety, and security features in environment sensing become increasingly important. These automated functions support the drivers and replace them in specific movements. For the safe ride, the vehicles need to recognize the environment very accurately. The automotive industry can make an environment sensing system safely with a design test scenario in many types of critical tests. There are some advantages and disadvantages of autonomous test types, but it is always useful. This paper demonstrates our test scenario (which is on the ZalaZONE proving ground in Hungary) with three kinds of highly automated vehicles, focus on driver assistance applications such as traffic sign recognition. We provide in this article some examples of the extreme factors, considerations, and roadside anomalies that require testing and validation of sensor systems.

Keywords: traffic signs anomalies, highly automated conflicts, environment recognition

1 Introduction

Currently, developments are made to autonomous vehicles all over the world. With the advent of new comfort and safety features, the vehicle industry is continually evolving. The primary goals of autonomous vehicles are to reduce environmental pollution, emissions, and the number of accidents. Automated vehicle functions execute a significant role in reducing these factors and are more effective than human drivers. Further benefits can be achieved by improving infrastructure and connecting vehicles, such as reducing traffic and travel time. But maybe in the future, the infrastructure, traffic signals, traffic rules need to develop in parallel with the autonomous vehicles.[1]

Advanced systems provide more efficient and safer transport than human drivers. Vehicles can be graded from 0 to 5 according to SAE (Society of Automotive Engineers) levels. [3] The first of which means that the vehicle has no degree of automation. The fifth level is characterized by the fact that the vehicles are capable of driving on their own. And as the tools in the levels evolve, for example, the autonomous levels increase, and functions expand, there is a need for layer control as a redundant system. The autonomous vehicles need to know about their environment and control the vehicle in safety, such as trajectory planning and following. [4]

In technologies, there may be a problem between the necessary laws. In the case of autonomous vehicles, there are legal issues besides design tests. Therefore, essential to building a single decision-

making system between countries that applies to autonomous vehicles. Some aspects are summarized in the current statement in the Vienna Convention on Road Traffic, which must clearly state that a vehicle should always drive by a human driver. The other difficulty is to decide responsibility. For example, if an accident occurs in an autonomous mode, then who is responsible. There are, of course, suggestions on how they can be grouped and likely to continue to develop. [5]

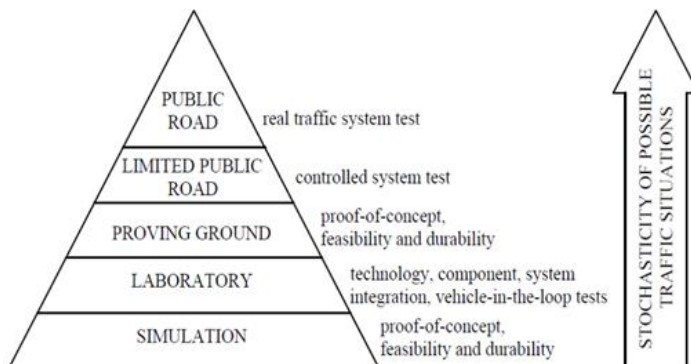
Because of new technologies and functions, it is essential to create further testing and validation methods. [6] The sensors and other systems in the vehicles should all know what people recognize and do with their senses in many situations.

With the advantages of existing testing methods, it is possible to test autonomous vehicles in critical circumstances or failure modes. But the real environmental testing is hard in actual traffic conditions. All these tests are hard reproducible, always need a method with a ruleset. This paper examines the existing techniques of autonomous driving functional testing, verification, and validation. This knowledge is useful for our processes and helpful to set up some reliable, quick, safe, low cost and reproducible testing methods and accelerate the development.

2 The methodology of test and validation

Today, modern vehicles are made up of several subsystems, most of which contain age-appropriate electronic components, such as embedded systems that perform the function of regulation, actuators that physically operate various components, or sophisticated, high-sensitivity, long-range sensors. Due to a large number of subsystems and the number of products produced annually by vehicle manufacturers and their suppliers, it is no longer possible in engineering practice to test early-stage versions of subsystems and their components in the final product. Samples can also be examined under conditions that best approximate reality. As a result, various simulation procedures have become an indispensable element of product development, which can be applied with excellent efficiency with the advent of increasingly powerful computers and the creation of increasingly realistic simulation algorithms. The purpose of using simulations is to observe the behaviour of different systems and, in most cases, to test them in vehicle development, which has the additional positive effect of accelerating development processes and reducing costs by eliminating errors at an early stage of development.[7]

Several types of tests can be distinguished. Some initial tests, such as those in a simulation environment, are cheaper, safer, and faster, and are easier to adapt in the real world. On **Hiba! A hivatkozási forrás nem található.** test and validation pyramid can help validate a system; the pyramid shown below illustrates the different forms of tests. [8]



1. Figure Test and validation pyramid [8]

2.1 Simulation testing

The role of simulation procedures used in vehicle development can be grouped in several ways, depending on whether we consider simulation as a tool for product development or testing, or as a tool that makes the whole development process faster and more economical. In the following, I examine the simulations from these two perspectives.

Economic benefits of using simulations during product development, it is essential to filter out possible errors at the earliest possible stage and to identify not only the mistakes of the given product but also the cooperation and communication errors with other tools during its later integration. That is why it is necessary because the repair costs due to each defect increase significantly in the various product development phases from concept to series production. [9]

One possible way to eliminate defects is to use simulations, which can be used to test and even validate products in different stages of development until they need to be installed in a specific vehicle.

First, simulation is well-defined mathematical modelling that can give very close results to the real world. [10] It is the most typical advantage understanding of the functioning of systems by modelling reality. “Key Elements of Computer Simulation:

- Integrated vehicle dynamic simulation,
- Combined traffic and traffic simulation,
- Interaction simulation with other transporters
- Simulation of visibility and weather
- Simulation of region-specific road conditions and traffic signals. ”

The simulation test environment is the basis for the rest of the tests. There are two ways to apply it. It is primarily listed as a Level 1 test in the test and approved list. Secondly, it can be a test track and road test scenario. Some of the errors that occur during tests can be eliminated using the simulation environment, making them much more economical.

Critical elements of computer simulation include integrated vehicle dynamics simulation, traffic and traffic simulation, interaction simulation with other transport actors, visibility and weather simulation, and simulation of region-specific road conditions and traffic signals.

More and more software is developed to test the various autonomous functions in advance. Examples include Vires, IPG Carmaker, and PreScan. In this case, we present the advantages and disadvantages through PreScan.[13]

PreScan is a software developed by TASS International that provides a development environment for management support systems. The program consists of several main modules. The simulation engine of PreScan is SimCore, which controls the sensor simulation, visualization environment, and combined dynamic and control functions. [11]

There are many benefits to using a simulation environment for testing and developing autonomous vehicles and their features. In any case, it is worth taking advantage of the help of the software to make or repair a sensor. It is advantageous if you want to design a test scenario or quickly modify an existing one. By running a preliminary simulation of the tests, they can quickly identify potential errors and can be easily and economically repaired at this stage. The use of “vehicle in the loop” for future real tests is a significant economic and security advantage for testers and developers. Despite the disadvantages of using simulation software, which can be easily eliminated by improvements, it is entirely usable and supported in the development of autonomous vehicles. That is why we create first the test scenario in simulation software. [22][23]

In the future, the further development of the Neural Network with detection capability can help

to prepare the scenarios. Then, after completing the simulation environment, the next step, the real tests on the ZalaZONE proving ground.

2.2 Laboratory testing

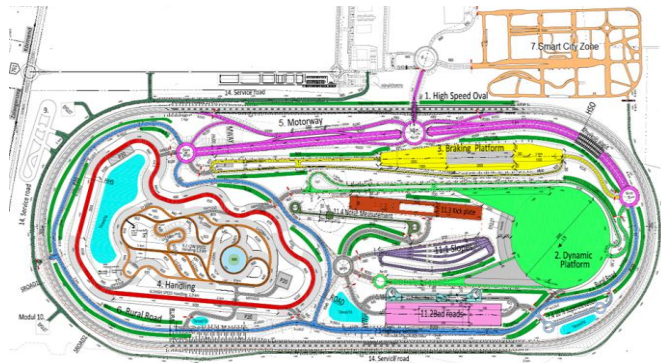
The next phase is the implementation of the laboratory tests, which will enable the vehicle-in-the-loop (6), the existing systems separately or even the entire system. It is possible to perform tests in a closed environment several times on test tracks, which provides a safe test for testing improvements. [14] The autonomous vehicles need automation functional test on source code level security of enduringly safety-critical systems. The testing practices could be used, which requires automatically created test cases, hardware-in-the-loop (HIL) testing use ISO26262 functional safety specifications. [12][26]

The other options between the laboratory and real test environment are the Software-in-the-loop (SIL) simulations, where the remaining hardware components, vehicle dynamics, and environment are simulated in real-time. [7]

2.3 Proving ground testing

There are several test tracks available worldwide for developers to test traditional systems. In recent years, they have begun to build the types of trails that can be used by highly automated and autonomous vehicles to test all functions.[8]

The primary purpose of the sensors is to detect movements in the environment and collect information about it. Following the appropriate inputs, use the command layer to instruct the vehicle to plan the route. Environmental sensors are sensitive to environmental influences, so more attention should be paid to their testing. The following examples, experiments, highlight the need to address their weaknesses and then tailor the tests to the end so that the developer can get a complete, secure system.



2. Figure Proving Ground in Zalaegerszeg [24]



3. Figure Comparison of simulation and real test

Cameras can already be tested in the simulation process with several factors. The software has been developed to test various driver assistance systems. The Traffic Signal Recognition System is an excellent example of how sensitive a camera-based recognition technique is. Figure 3 shows a measurement prepared in a simulation program that is completed on the ZalaZONE Smart city test track in March 2019. The software offers a lot of possibilities for distorting the boards (mud, scratches, snow), [11] making the position of the recognition systems more difficult. There is a significant difference in the appearance of the environments (simulation, real), which may distort the measurement results. Based on the examples mentioned above, preparation and design is an essential step in the development of a new function in the simulation process. It proves that the need for tests in real-world environments too. Finding the perfect test method need to test in a lot of various situations with many types of vehicles. [15][16]



4. Figure Location of the measurements at Zcity

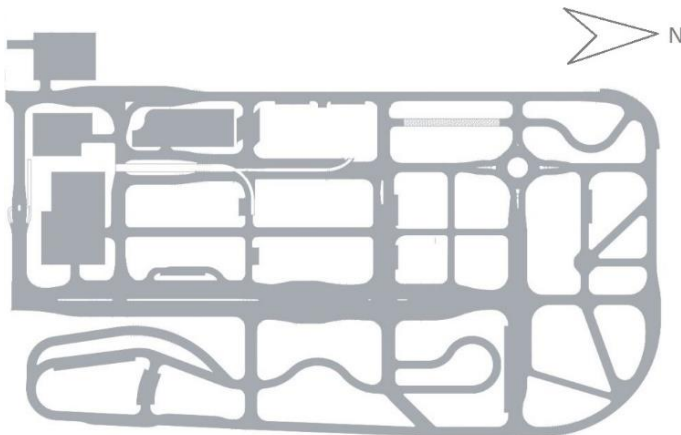
2.4 The location of the test

The measurement started in autumn at 10:00 and lasted until 16:00. From the results, we had to pay attention to the light conditions and the sun. It was deliberately selected to measure the day, so the most critical condition could be examined for recognition. For the scenario planning we used the test and validation pyramid steps. [25] That's why, first we chose our test location (implemented Smart City) in simulation software; after that, we used photos about ZalaZONE and planned the real environment scenarios. (Figure 4, 5, 6.)



5. Figure Recording the measurement

The speed limit on the vehicles were 20-25 km/h. We recorded the measurement with two GoPro cameras and mobile phones with different angles of view. The traffic signs were used in the measurement was selected according to the standard (2.2 m). We used some traffic signs which were the ZCity included and also we had some speed limit 30 km/h signs. [17]



6. Figure Our chosen test area on ZCity at ZalaZONE

2.5 Traffic signs anomalies of the test

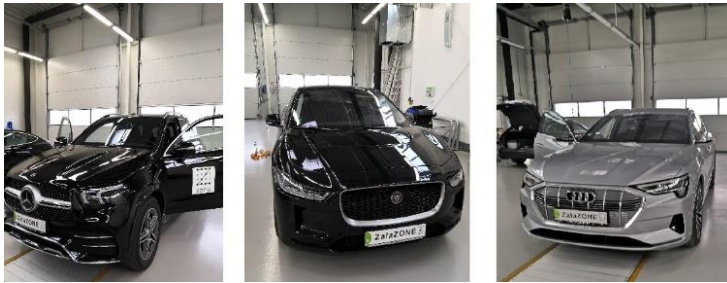
We use some parameters that are included in the measurement table. The traffic sign anomalies were chosen by previous measurement experience. The visibility means when a traffic sign cover by a tree or column: the clarity when you can see a clear traffic sign, or a foul one. Recognizability is when you watch a traffic sign size, deformity, colours, and stickers. [18] The position means that the sign is not at the right height. Simplicity means when too much or conflicting information should be observed. [19] This table which include an example with traffic signs anomalies help us previously measurements and tests.

Table 1. Classification of traffic sign anomalies

	Visibility 1= not visible 5= visible	Clarity 1= dirty 5= clear	Recognizability 1= not recognizable 5= recognizable	Position 1= Improper 5= standard	Simplicity 1= complex 5= simply
1. Example	1	4	2	2	4

2.6 Vehicles of the test

We got an opportunity in last year from the JRC (Joint Research Center), we could choose three types of highly automated vehicles. We thought about which vehicle for the best for our measurement and chose an Audi e-Tron, Jaguar I-Pace, Mercedes EQC 400. All of these vehicles are electronic but include the modernist traffic sign recognition system. (Figure 6.) [10]



7. Figure Test vehicles on ZalaZONE

2.7 Some remark of the test

We needed to plan the test trajectory for the safe and short test time; that’s why we chose a circle on the test track. But we needed to think about how we cancelled the recognized traffic sign about the test vehicle. It was interesting for us that we need another type of traffic sign for the cancelling.

For the experience of previous tests, we needed to think about the reproduction. We chose the traffic sign with Speed Limit 30 km/h (because it’ was easy to get them), we took them in one line, and we rotated just one traffic sign with one anomaly. (Figure 7.) This was a good opportunity for these kind of systems test.



8. Figure New test scenario for our measurement

Recognition difficulties also apply to traffic signs that are fully or partially covered by labels, dirt, or bushes. High speed and bad weather conditions, especially at night, make it difficult for the system to recognize road signs reliably. For the current top speed limitations to appear as accurately as possible, the map of the navigation must be up to date.



9. Figure Visibility traffic sign anomalies in the test environment

We measured the critical point of the traffic sign recognition system is highly automated vehicles. Every single measure, we searched the limit with a predetermined percentage when the system could not recognize the traffic sign with anomalies. [20]

3 Results

The goal of the measurements was to examine the test methodology itself, and which is the critical point of a highly automated vehicle when it cannot to recognize traffic signs with anomalies. From this, one can infer the area to be developed. The darker notation shown what values were critical for each system. [21] In the next tables the “✓” mark said the system could to recognized the traffic sign. The “x” mark said the system could not to recognized the traffic sign.

Mercedes performed best traffic signs recognition covered by a column. The vehicle system isn't sensitive for the position changing, unlike the mud and bush covering. The vehicle performed well with the traffic signs rotation.

Table 2. Results of Mercedes's recognition system

1) Column	0%	100%	50%		25%	44%	37,5%	44%		
Recognized?	✓	✗	✗		✓	✓	✓	✓		
2) Poition	0%	100%	-		-	-	-	-		
Recognized?	✓	✓	-		-	-	-	-		
3) Mud	0%	100%	87,5%	75%	62,5%	50%	37,5%	25%	12,5%	1%
Recognized?	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓
4) Bush	0%	100%	50%		25%	12,5%	5%	-		
Recognized?	✓	✗	✗		✗	✗	✓	-		

The **Jaguar** was the most sensitive to changing position and mud covering. The vehicle in this test performed moderately at the traffic sign covered by the column. With the position anomaly, the temporary traffic situation was simulated, positioned at a standard height. Here, further extreme values can be tested later with height changing.

Table 3. Results of Jaguar's recognition system

1) Column	0%	100%	25%	37,5%	44%
Recognized?	✓	✓	✓	✓	✗
2) Poition	0%	100%	0,5%	75,0%	87,5%
Recognized?	✓	✗	✓	✓	✓
3) Mud	0,5%	0,3%	0,1%	0,05%	-
Recognized?	✗	✗	✗	✓	-
4) Bush	0,0%	100,0%	0,5%	0,25%	0,00125
Recognized?	✓	✗	✗	✗	✓

The **Audi** performed moderately at the traffic sign covered by the column. The traffic sign covered by a column is easily recognizable for the vehicle. The bush and mud hiding is hard than the other anomalies.

Table 4. Results of Audi's recognition system

1) Column	0%	100%	0,50%	0,25%	0,375%	44%
Recognized?	✓	✗	✗	✓	✓	✗
2) Poition	0%	100%	-	-	-	-
Recognized?	✓	✓	-	-	-	-
3) Mud	100,0%	0,8%	0,5%	0,25%	0,375%	-
Recognized?	✗	✗	✗	✓	✗	-
4) Bush	0,0%	100,0%	0,5%	0,25%	0,125%	-
Recognized?	✓	✗	✗	✗	✓	-

All in all, the test scenario can be used to determine the critical values of each vehicle's detection system in the beacon. For later measurements, the grading system could work. The recognized signal receives not only a “✓” but also a value associated with it, in this case, for example, 1 point if the detection system hits the signal at certain anomaly levels. If “x” recognized the traffic sign, it gets a value of 0, then the visibility. The various weaknesses of the sensors can be avoided by using the other sensors at the same time. Therefore, based on the tests, it can be concluded that sensor fusion is the solution for accurate and safe detection.

4 Conclusion

In many cases, the results obtained are impressive, but they are easy to validate and develop the results, and test later. The test scenarios still need improvement despite preliminary measurements and experience. Measurements can be done easily and quickly, possibly with more vehicles. Multiple vehicles are more comfortable to perform with the tests we invent. The results can be well analyzed, and the recognition characteristics, weaknesses and strengths of each vehicle are visible. With the help of the test, the boundary point, the critical point of the system of each vehicle type is evident. Of course, more measurements are needed for full accuracy. **Our goal is to find a suitable, reproducible and effective test procedure for the time being.** In the future, special attention should be given to the increasingly widespread neural networks. The basics of the test are likely to remain unchanged but will require weighting and other anomalies. With this test, both systems and neural networks can be validated. Our future plan that we will use this test procedure and the scenario for attacking neural networks with our optimized traffic signs attack. [27]

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Evolution of loading surface in the ultrasonic field

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Abstract

This study discusses the evolution of loading surface associated with the phenomena of ultrasonic temporary softening and ultrasonic residual hardening and residual softening registered in the experiments for plastic deformation of aluminum and titanium in the ultrasonic field. The aim is to model these phenomena in terms of the synthetic theory of irrecoverable deformation. We extend the flow rule relationships by two terms based on microstructural processes occurring in ultrasound-assisted deformation.

Keywords: loading surface, ultrasound, plastic deformation, residual hardening, residual softening.

1 Introduction

The present paper aims to study the evolution of the loading surface in terms of the synthetic theory (ST) for plastic deformation in the ultrasonic field.

Many studies relating the effect of ultrasound upon metals' deformation properties can be resumed by Zhou et al. [1], whose results are shown in Figs. 1.

Two portions can be identified:

- (i) Ultrasound-assisted deformation (acoustoplasticity). The plastic flow of both aluminum and titanium takes place at stresses less than during ordinary loading (Fig. 1, US-on). This phenomenon is referred to as ultrasonic temporary softening.
- (ii) Deformation in post-sonicated period (Fig. 1, US-off). High-frequency vibration can permanently change metals' mechanical properties, which results in so-called ultrasonic residual effects.

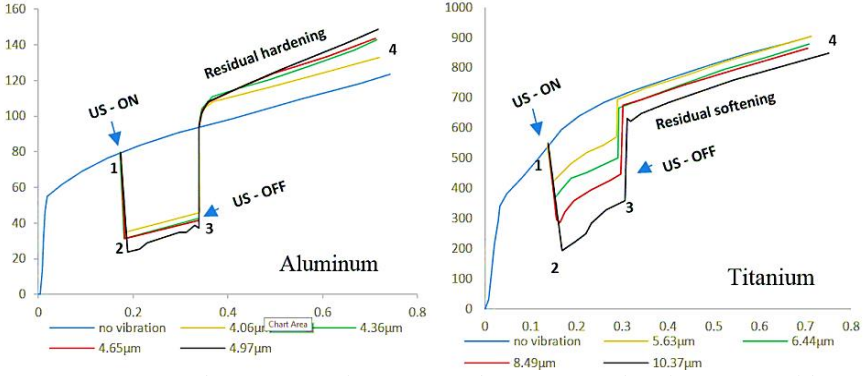
Yao et al. [2] interpret the residual hardening effect for aluminum by the ultrasound-assisted multiplication of the crystalline lattice's defects. Zhou et al. [1] derived the softening mechanism for titanium [1] from the study of the fraction of twinning boundaries, abundant in many metals with low stacking fault energy (SFE) such as titanium, copper, gold, etc.

From the short review of experimental results above, the conclusion cannot be escaped that, at least in terms of experiments considered, the metals with high SFE, such as, e.g., aluminum, are inclined to ultrasonic residual hardening. In contrast, metals with low SFE (titanium, copper, gold) manifest the phenomenon of ultrasonic residual softening.

2 Synthetic theory

In terms of this theory [3], plastic deformation at a point of the body is determined via deformations at the microlevel of material, i.e., as a sum of plastic shifts in active slips systems where the resolved shear stress exceeds the material yield strength (the Schmidt law):

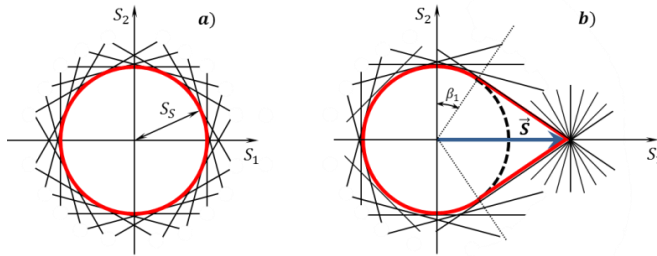
$$\vec{\epsilon} = \iiint_V \varphi_N \vec{N} dV, \quad (1)$$



1. Figure Stress-Strain diagrams of aluminum and titanium in the ultrasonic field of various oscillation amplitudes [1].

where φ_N – plastic strain intensity – is an average measure of plastic deformation within one slip system.

The main feature of the synthetic theory is the formulation of yield criterion and strain hardening rule in terms of three-dimensional stress deviator space \mathcal{S}^3 . We do not deal with a yield surface itself, but with its tangent planes, i.e., the yield surface is considered an inner envelope of the tangent planes. The location of planes is defined by their distances (H_N) and unit normal vectors (\vec{N}). For a virgin state, the synthetic theory works with the von-Mises yield criterion, which results in the set of equidistant planes in all directions (Fig. 2a).



2. Figure Yield and loading surface in terms of the synthetic theory in S_1 - S_2 coordinate plane.

In terms of ST, a stress vector (\vec{S}) represents loading, whose coordinates are composed of the stress deviator tensor components [3]. During the loading, the stress vector shifts at its endpoint a set of planes from their initial positions (Fig. 2b). The planes' movements at the endpoint of the stress vector are translational, i.e., the plane orientations keep changeless. Planes, which are not located at the endpoint of the vector \vec{S} , remain stationary. The plane's displacement at the stress vector's endpoint represents plastic flow within the corresponding slip system.

We define a plastic strain intensity – the plastic flow rule on the micro-level of material – as

$$r\varphi_N = H_N^2 - S_S^2 = \begin{cases} (\vec{S} \cdot \vec{N})^2 - S_S^2 & \text{for planes reached by } \vec{S}: H_N = \vec{S} \cdot \vec{N} \\ 0 & \text{for planes not reached by } \vec{S}: H_N > \vec{S} \cdot \vec{N} \end{cases} \quad (2)$$

The scalar product $\vec{S} \cdot \vec{N}$ determines the resolved shear stress acting in one slip system. It is evident that the plane distance H_N represents the hardening of material because the greater H_N is, the greater \vec{S} is needed to reach the plane. In Eq. (2), $S_S = \sqrt{2/3} \sigma_S$, where σ_S is the yield strength of the material; r is the model constant determining the slope of stress~strain curves; $[r] = \text{Mpa}^2$.

In a uniaxial stress state, the stress vector $\vec{S}(\sqrt{2/3} \sigma, 0, 0)$ extends along the S_1 axis, and $H_N = S_1 N_1 = \sqrt{2/3} \sigma \sin \beta \cos \lambda$. Eqs. (1) and (2) have the following form [13]

$$\varphi_N = \frac{2}{3r} [(\sigma \sin \beta \cos \lambda)^2 - \sigma_S^2], \quad (3)$$

$$e = \frac{4\pi}{3r} \int_{\beta_1}^{\pi/2} \int_0^{\lambda_1} [(\sigma \sin \beta \cos \lambda)^2 - \sigma_S^2] \sin \beta \cos \lambda \cos \beta \, d\lambda d\beta = a_0 \Phi(b), \quad (4)$$

where

$$a_0 = \frac{\pi \sigma_S^2}{9r_0}, \quad \Phi(b) = \frac{1}{b^2} \left[2\sqrt{1-b^2} - 5b^2\sqrt{1-b^2} + 3b^4 \ln \frac{1+\sqrt{1-b^2}}{b} \right]. \quad (5)$$

The integration boundaries in (4) are obtained from (3) by letting $\varphi_N = 0$ and $\lambda = 0$:

$$\sin \beta_1 = \frac{\sigma_S}{\sigma} \equiv b, \quad \cos \lambda_1 = \frac{\sigma_S}{\sigma \sin \beta}. \quad (6)$$

3 Extension of the Synthetic Theory to the case of plastic straining in the presence of ultrasound

To model the effects of ultrasound on the plastic strain of metals, we extend Eq. (2) by two terms, U_t and U_r :

$$r\varphi_{NU} = H_N^2 + U_t^2 + f(\gamma)U_r^2 - S_S^2. \quad (7)$$

U_t represents the temporary softening action of ultrasound:

$$U_t = A_1 \sigma_m^{A_2} (2 - e^{-pt}) (\vec{u} \cdot \vec{N}), \quad t \in [0, \tau] \quad (8)$$

where σ_m is vibrating stress amplitude (MPa), \vec{u} is a unit vector indicating the vibration mode. For longitudinal sonication, \vec{u} vector has (1,0,0) coordinates in S^3 . Further, τ is the sonication duration, and p and A_k ($k = 1, 2$) are model constants. If to denote through \vec{u} the vector $A_1 \sigma_m^{A_2} (2 - e^{-pt}) \vec{u}$, Eq. (8) becomes $U_t = \vec{u} \cdot \vec{N}$, i.e.

It is the power function $2A_1 \sigma_m^{A_2}$ that links the stress amplitude to the temporary softening effect. As a result, the term $A_1 \sigma_m^{A_2} e^{-pt}$ correlates with the temporary multiplication of ultrasound-induced defects (ψ_{NU}) proposed by Rusinko [4].

Therefore, Eq. (8) is dual. On the one hand, the ultrasound defects harden the material, but, on the other hand, they become centers of softening processes. As evident from (8), since the term $(2 - e^{-pt})$ is always positive; the net effect is a prevalence of softening mechanisms during

unidirectional and oscillating load simultaneous action.

The term $f(\gamma)U_r^2$ in Eq. (7) models the deformation properties of metals after the ultrasound is off, i.e., residual effects. Its effect depends on the sign of $f(\gamma)$ function, where γ is stacking fault energy. We define U_r as stress and time-dependent function:

$$U_r = h(\varepsilon - U) \times A_3 \int_0^\tau \sigma_m^{A_4} dt, \quad (9)$$

where h is the Heaviside step function, ε is any positive infinitesimally small number so that ultrasound of any intensity results in a negative value of $\varepsilon - \sigma_m$ difference. The presence of $h(\varepsilon - \sigma_m)$ function means that the U_r takes effect only after the ultrasound is off. Again, we propose a power function to express the dependence of ultrasonic residual hardening upon the ultrasound intensity with model constants A_3 and A_4 . Simultaneously, the intensity of sonication is not the only parameter governing the magnitude of the hardening effect. Namely, the duration of sonication plays a vital role as well. Summarizing, U_r reflects a post-sonicated-defect-pattern leading to the change in material characteristics/response after the acoustoplasticity.

4 Loading surface in the uniaxial stress state

4.1 Acoustoplasticity ($\sigma > 0 \wedge U > 0$). For vibrating-assisted deformation, $t \in [0, \tau]$, U_t increases in the way prescribed by (8). At the same time, due to $h = 0$ in (9), we have $U_r = 0$ during the action of ultrasound.

So, Eq. (7) takes the following form

$$\begin{aligned} r\varphi_{NU} &= H_N^2 + U_t^2 - S_S^2 = (\vec{S} \cdot \vec{N})^2 + [A_1 \sigma_m^{A_2} (2 - e^{-pt})(\vec{u} \cdot \vec{N})]^2 - S_S^2 = \\ &= \frac{2}{3} \left[(\sigma_U \sin \beta \cos \lambda)^2 + \frac{3}{2} [A_1 \sigma_m^{A_2} (2 - e^{-pt}) \sin \beta \cos \lambda]^2 - \sigma_S^2 \right]. \end{aligned} \quad (10)$$

Plastic deformation in acoustoplasticity (e_U) is calculated by Eq. (1) with the integrand from (10). As a result,

$$e_U = a_0 \Phi(b_U), \quad b_U = \frac{\sigma_S}{\sqrt{\sigma_U^2 + \frac{3}{2} (A_1 \sigma_m^{A_2} (2 - e^{-pt}))^2}}. \quad (11)$$

Eqs. (11) and (5)-(6) show that the deforming of material in the ultrasonic field develops at less stress σ_U comparing to that under ordinary loading. Consequently, Eqs. (11) and (12) describe the phenomenon of temporary ultrasonic softening analytically. To ensure the stress drop at the constant value of deformation, we demand that $\varphi_{NU} = \varphi_N$ at the same set of planes where the strain intensity is positive (compare Figs. 2A and 2B). As seen from Fig. 2B, the loading surface preserves its shape due to the compensation element \vec{u} , which means that less stress can keep the deformation as the ultrasonics vibration starts.

4.2 Post-sonicated deformation ($\sigma > 0 \wedge U = 0$). While $U_t = 0$ for $t > \tau$, the integral from (9) gives nonzero value ($h(\varepsilon) = 1 \Rightarrow U_r > 0$).

Compared to (10), the plastic strain intensity loses the term U_t , which facilitated the strain intensity, but includes U_r :

$$r\varphi_{Nr} = H_N^2 + f(\gamma)U_r^2 - S_S^2. \quad (12)$$

Since, so far, there is no enough experimental data on the effect of SFE upon the post-sonicated deformation for a wide range of metals, we propose a linear relationship for $f(\gamma)$ related to the value of SFE for aluminum:

$$f(\gamma) = k(\gamma_{Al} - \gamma) - 1, \quad (13)$$

where $k \geq 1$ is a model constant. Taking into account the range of SFE of metals considered, we obtain that $f(\gamma_{Al}) = -1$, and $f(\gamma_{Ti})$ takes a positive value because $\gamma_{Al} > \gamma_{Ti}$. Now, Eq. (12) takes the following shapes for aluminum and titanium, respectively:

$$r\varphi_{Nr} = \frac{2}{3} \left[(\sigma \sin \beta \cos \lambda)^2 - \frac{3}{2} [A_3 \sigma_m^{A_4} \tau]^2 - \sigma_S^2 \right], \quad (14)$$

$$r\varphi_{Nr} = \frac{2}{3} \left[(\sigma \sin \beta \cos \lambda)^2 + \frac{3}{2} f(\gamma_{Ti}) [A_3 \sigma_m^{A_4} \tau]^2 - \sigma_S^2 \right]. \quad (15)$$

The deformation for both aluminum and titanium specimen is calculated via formula (1), with the difference being that the strain intensities φ_N are governed by Eq. (14) and Eq. (15), respectively. Fig. 3B describes the phenomenon of a decrease in the stress required to induce plastic deformation (temporary softening), which is due to the ultrasound. The loading surface in Fig. 3C, which corresponds to the end of sonication, clearly demonstrates that the sum of static (\vec{S}) and acoustic (\vec{U}) vectors reach the loading point (corner point).

Comparing formula (3) to (14), it is evident that $\varphi_{Nr} < \varphi_N$, i.e., more significant stress is needed to keep the same strain development than for ordinary loading. Therefore, formula (14) models the phenomenon of ultrasonic residual hardening, which is observed for aluminum. Utilizing Eq. (7) for $t > \tau$, we get for aluminum that

$$H_N^2 = r\varphi_{NU} + U_r^2 + S_S^2, \quad (16)$$

where φ_{NU} is Eq. (10) at $t = \tau$. Eq. (16) says that the plane distances yield an increment of an equal amount U_r in all directions Fig. 3D, i.e., the loading surface preserves its shape. As a result, for example, point A moves to a new position, point B. By comparing Fig. 3D to Fig. 3A, one can see that a more extended stress vector can regain the plastic deformation after the sonication. This fact means the manifestation of the ultrasonic residual hardening.

With titanium, it is clear from (3) and (15) that $\varphi_{Nr} > \varphi_N$ i.e., plastic deformation develops at less stress compared to static loading. Eq. 7 gives

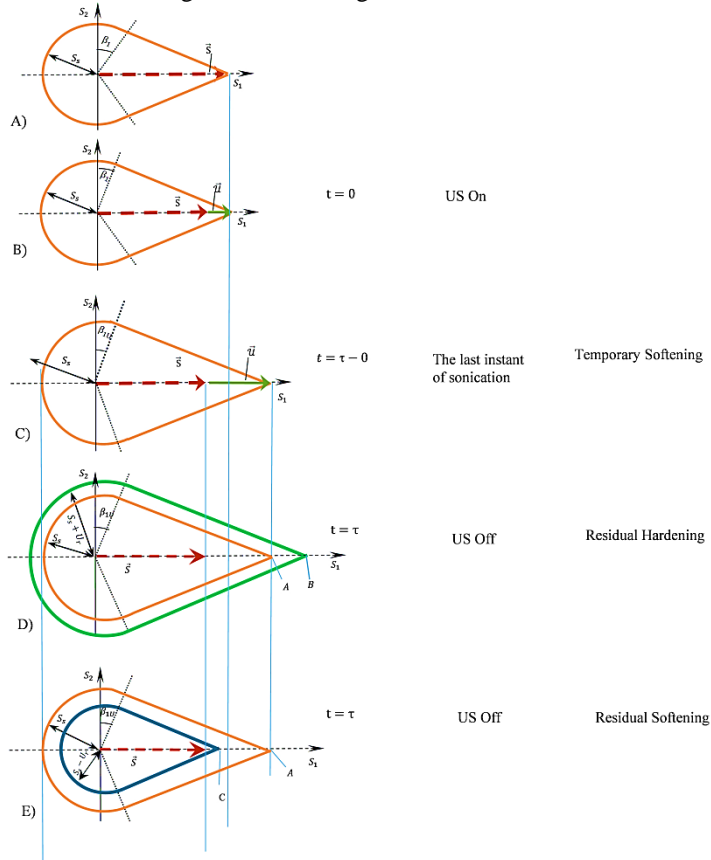
$$H_N^2 = r\varphi_{NU} - f(\gamma_{Ti})U_r^2 + S_S^2. \quad (17)$$

In contrast to (16), we obtain the case when the tangent planes move toward the origin of coordinates by the same amount in all directions (Fig. 3E). Now, it is clear from comparing the positions of the loading points in Figs. 3A and 3E (point C) that the plastic deformation of titanium for post-sonicated period starts and develops at less value of stress. Such a situation corresponds to the phenomenon of ultrasonic residual softening.

5 Conclusion

In this study, three phenomena observed during plastic deformation in the ultrasonic field are modeled – ultrasonic temporary softening, ultrasonic residual hardening, and residual softening. We utilize the synthetic theory of irrecoverable deformation to predict aluminum and titanium's deformation properties in the ultrasound-assisted compression. For this purpose, we extended the flow rule by two terms which govern the plastic deformation of the material in the ultrasonic field

and after the ultrasound is off, respectively. The first term symbolizes how ultrasound facilitates plastic deformation development by activating blocked dislocations, localized heating, and dynamic softening. The second one reflects the effect of the defect structure formed during the sonication on metals' plastic properties for the post-sonicated period. The analytical manipulations proposed are analyzed in the context of the changes in the loading surface.



3. Figure Evolution of loading surface during and after the sonication (tangent planes are not shown)

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Toughening of various PLA grades with natural rubber for 3D printing applications

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Abstract

The aim of this present work was to study the toughening efficiency of natural rubber (NR) on various poly(lactic acid) (PLA) grades for 3D printing applications. For this purpose three different types of PLA with varying d-isomer content and average molecular weight were applied. Firstly, PLA-based filaments suitable for fused deposition modeling (FDM) were prepared with 10 wt% NR content using a twin-screw extruder. Subsequently, specimens were fabricated with a desktop FDM printer using two different infill patterns: i) a grid-like infill with an alternating raster angle of $\pm 45^\circ$ and ii) a unidirectional infill, parallel to the length of the specimens. The quasi-static and dynamic mechanical properties were determined by tensile tests and Charpy impact tests. The results indicated an outstanding toughening efficiency of NR, regardless of the PLA type, however, only for the samples prepared with the unidirectional infill.

Keywords: poly(lactic acid) (PLA), natural rubber (NR), toughening, 3D printing, FDM

1 Introduction

The various additive manufacturing technologies – also known as three-dimensional (3D) printing techniques – have experienced an immense development throughout the last decade. 3D printing has been widely used in various fields, including the aerospace, biomedical, architectural and vehicle industry. Nowadays, the most diffused additive manufacturing methods are the extrusion based ones, such as the fused deposition modeling (FDM). The FDM type 3D printers are generally fed by various thermoplastic polymers, the most common of which is the poly(lactic acid) (PLA) [1, 2].

PLA is a thermoplastic polyester derived from natural feedstocks. It is not simply a bio-based polymer, but it is also compostable, which means that it can be completely biodegraded. Recently, due to increasing environmental awareness, the use of biopolymers, such as PLA has significantly increased. Its mechanical properties are similar to common plastics like poly(ethylene terephthalate) (PET) or polystyrene (PS). Due to its decent properties it is popularly used for various applications [3]. On the other hand, PLA has some serious drawbacks including its brittleness, as evidenced by the short elongation at break and low impact strength. Therefore, researchers have shown an increased interest in the development of PLA-based materials with enhanced toughness in order to expand its fields of applications [4]. One of the most common routes when it comes to increasing the toughness of PLA is to pair it with an elastomeric, rubber-like material [5].

The major objective of this present study was to investigate the toughening efficiency of natural rubber (NR) on various PLA grades for additive manufacturing applications. Therefore, NR-toughened filaments were prepared using three different PLA types. Then, 3D printed specimens

were fabricated using those filaments with different infill patterns. The specimens were characterized through tensile tests and Charpy impact tests to analyze the toughening effect of NR under various circumstances.

2 Materials and methods

2.1 Materials

Three grades of PLA with different d-isomer content were purchased from NatureWorks LLC (Minnetonka, MN, USA), namely the Ingeo™ 2003D, the Ingeo™ 8052D and the Ingeo™ 3D850 types. These PLA grades have a d-isomer content of 4.5%, 4.3% and 0.5%, respectively, and a melting temperature (T_m) of 150 °C, 155 °C and 175 °C, respectively. The density of the three types is uniformly 1.24 g/cm³. The natural rubber used as toughening agent (type SVR-CV60) was obtained from the Vietnam Rubber Association (VRA).

2.2 Preparation of the filaments

A two-step manufacturing process was applied to prepare PLA/NR filaments suitable for 3D printing. Firstly, a melt compounding under higher shear rates was performed in order to achieve a homogenous dispersion of the components. The melt mixing was followed by the extrusion of the filaments with a diameter of approximately 1.75 mm.

Both the NR and the different PLA grades were dried at 80 °C for 4 hours in a DEGA-2500 dehumidifying chamber (DE.GA S.p.A., Corte Franca, Italy) prior to processing. Melt compounding of the desired combinations were performed using a Labtech LTE 20-44 type co-rotating twin-screw extruder (Labtech Engineering Co., Ltd., Samutprakan, Thailand) with a screw diameter of 20 mm and an L/D ratio of 44. The barrel temperature profile from feed zone to die end was set to 155-160-160-165-165-170-170-175-180-185-185 °C and the rotational speed of the screw was 40 1/min. The achieved blends were cooled down in a water tank and then pelletized.

The prepared pellets were dried for another 4 hour at 80 °C. Subsequently, the 3D printing filaments were manufactured with the same twin-screw extruder that was applied for the melt blending. In this case, however, the barrel temperature profile was 170-175-175-175-175-170-170-165-165-160-160 °C and the rotational speed of the screw was set to 15 1/min. The intention was to maintain the same processing temperatures for all materials. However, since the melting temperature of the Ingeo™ 3D850 considerably exceeded the T_m of the two other grades, the temperature of all barrel zones was increased by 20 °C for this specific type. The diameter of the produced filaments was 1.75 ± 0.11 mm.

2.3 3D printing

The prepared PLA and PLA/NR filaments were used to print dumbbell-shaped specimens for tensile tests and prismatic specimens for impact tests. The printing was performed on a Craftbot Plus type desktop FDM printer (CraftUnique Ltd., Budapest, Hungary). The nozzle temperature was set to 215 °C, the nozzle diameter was 0.4 mm and the bed temperature was 60 °C. The layer height was 0.2 mm, the printing speed was 60 mm/min and the filling rate was 100%. Two shell layers of 0.4 mm were applied for all samples. The samples were fabricated using two different infill patterns: i) a grid-like linear infill with an alternating raster angle of $\pm 45^\circ$ between the layers and ii) an unidirectional linear infill, parallel to the length of the specimens. Schematic graphics of the applied infill patterns is shown in Figure 1.

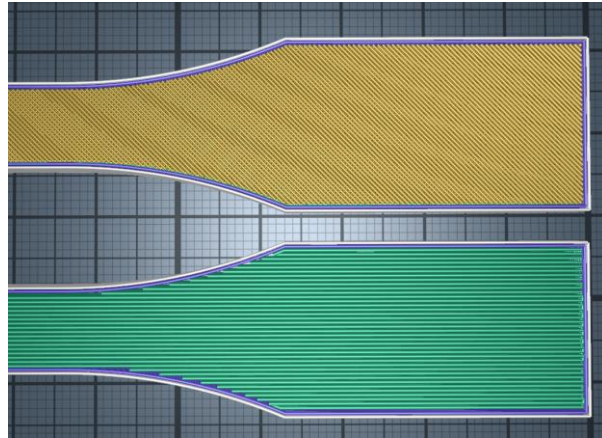


Figure 1. Schematic graphic of the printing orientation with respect to the specimen

The sample code, the formulation and the infill pattern of the prepared samples are summarized in Table 1.

Table 1. The designation, composition and the infill pattern of the fabricated samples

Sample code	PLA grade	PLA amount [wt.%]	NR amount [wt.%]	Printing infill pattern
2003D_PAR	Ingeo™ 2003D	100	-	parallel to length
2003D_GRID	Ingeo™ 2003D	100	-	±45° raster angle
2003D_10NR_PAR	Ingeo™ 2003D	90	10	parallel to length
2003D_10NR_GRID	Ingeo™ 2003D	90	10	±45° raster angle
8052D_PAR	Ingeo™ 8052D	100	-	parallel to length
8052D_GRID	Ingeo™ 8052D	100	-	±45° raster angle
8052D_10NR_PAR	Ingeo™ 8052D	90	10	parallel to length
8052D_10NR_GRID	Ingeo™ 8052D	90	10	±45° raster angle
3D850_PAR	Ingeo™ 3D850	100	-	parallel to length
3D850_GRID	Ingeo™ 3D850	100	-	±45° raster angle
3D850_10NR_PAR	Ingeo™ 3D850	90	10	parallel to length
3D850_10NR_GRID	Ingeo™ 3D850	90	10	±45° raster angle

2.4 Characterization

The tensile mechanical properties of the prepared samples were determined using an Instron® 5582 (Instron Ltd., Norwood, USA) universal tensile testing machine equipped with a 10 kN force sensor. The tests were carried out at a crosshead speed of 5 mm/min. The presented results are the averages of five parallel measurements.

The Charpy impact strength was measured with a Ceast 6545 (Ceast S.p.A., Pianezza, Italy) pendulum-type testing machine equipped with an impact hammer of 2 J. The specimens were unnotched, rectangular bars. The presented results are the averages of five parallel measurements.

3 Results and discussion

3.1 Tensile mechanical properties

The mechanical properties determined through the tensile tests are summarized in Figure 2-4. Figure 2. presents the yield strength of the prepared samples. Based on the results it can be assumed that the lower the d-isomer content of the applied PLA grade, the higher yield strength it exhibits. This statement is valid for both the raw PLA samples and the NR toughened ones. As a consequence of blending PLA with NR the strength values decreased markedly, which is in good agreement with the literature considering the soft rubbery character of NR. This was observed for all samples, regardless of the infill pattern. Interestingly, when using the grid-like infill (Figure 2/a) the drop measured in the yield strength was relatively ~30%, however, with the linear infill pattern parallel to the length of the specimen (Figure 2/b) the decrease was only ca. 15-20%. Whilst the interlayer adhesion has little to no significance in the specimens printed with an orientation parallel to the tensile load, in those samples prepared with $\pm 45^\circ$ raster angle it is essential. Evidently, the more prominent decrease in the yield strength measured on the toughened samples fabricated using the grid pattern refers to the fact that the presence of NR weakens the adhesion between the printed layers.

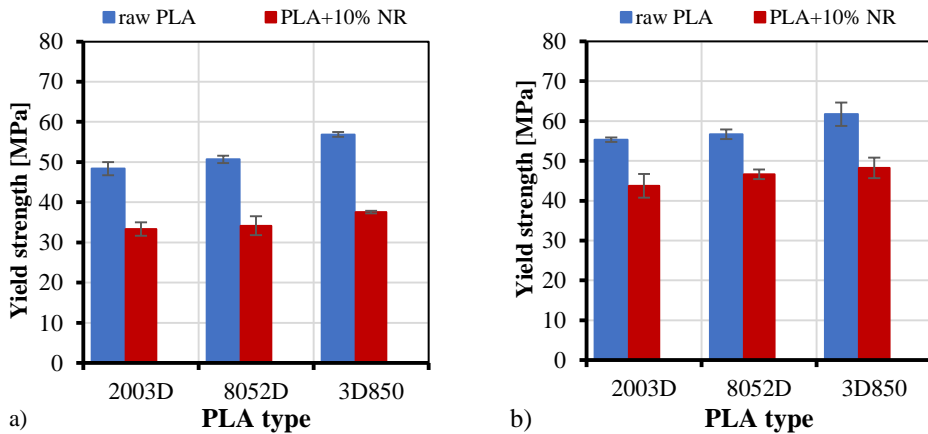


Figure 2. Yield strength of the fabricated samples with (a) grid-type infill pattern and (b) unidirectional infill pattern parallel to the length of the specimens

According to Figure 3. the Young's modulus values of the three PLA grades were in the range of 2.5-3 GPa with the Ingeo™ 3D850 (the type with the lowest d-isomer content) exhibiting the highest stiffness. Similarly to the yield strength, the modulus values of the NR containing samples dropped as well due to the soft nature of the elastomer component. Also, the reduction in stiffness was more notable for samples printed with the grid-like pattern as a result of the weaker interlayer adhesion compared to the ones with the unidirectional linear infill.

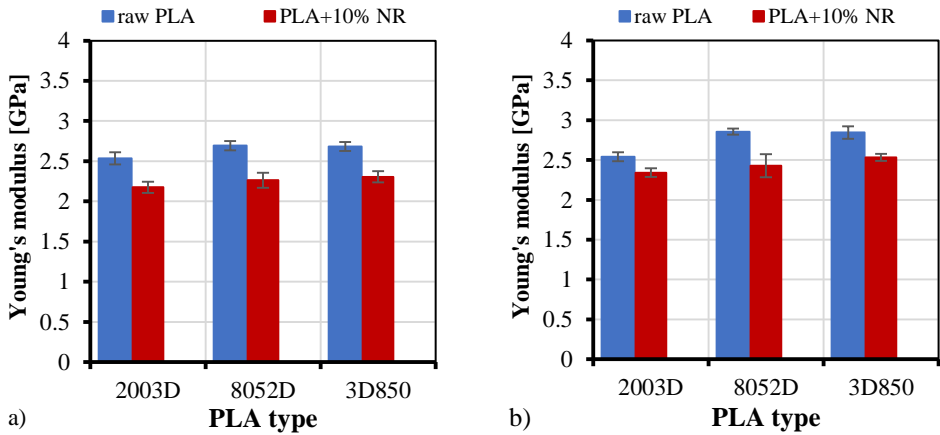


Figure 3. Young's modulus of the fabricated samples with (a) grid-type infill pattern and (b) unidirectional infill pattern parallel to the length of the specimens

Contrary to the strength and modulus, the elongation at break values of the different PLA grades enhanced greatly when blended with 10 wt% NR. There is, however, a marked difference in the achieved improvement depending on the infill type used. Even though the samples prepared by the $\pm 45^\circ$ raster angle infill (Figure 4/a) already showed an elongation 2-2.5 times as much (7-10%) as the raw PLAs (~4%), the ones with the linear infill parallel to the load (Figure 4/b) all exhibited an elongation higher than 80%, regardless of the PLA grade. In this aspect, the sample 2003D_10NR_PAR outperformed all the other ones by having an elongation at break of ~210%. By also showing the highest deformability (~10%) when using the grid-like infill pattern it can be concluded that most significant improvement was achieved when using the PLA grade with the highest d-isomer content, namely the Ingeo™ 2003D.

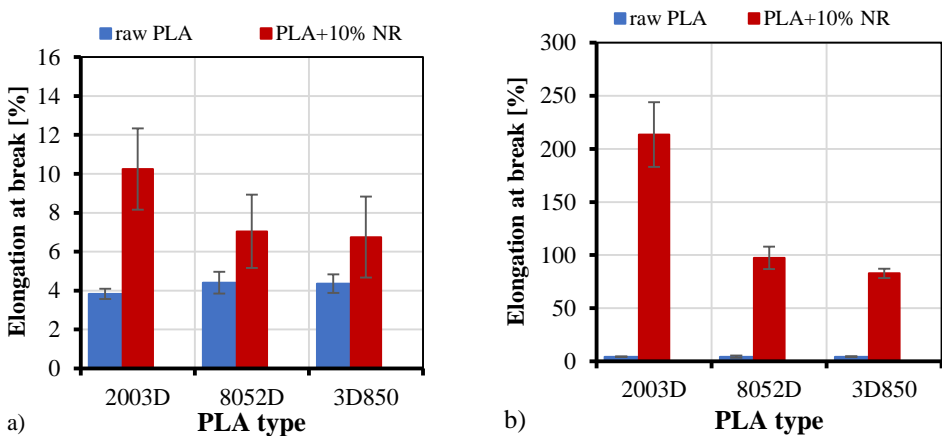


Figure 4. Elongation at break values of the fabricated samples with (a) grid-type infill pattern and (b) unidirectional infill pattern parallel to the length of the specimens

3.2 Impact toughness

The impact properties of the fabricated samples are presented in Figure 5. Apparently, the impact strength of the raw PLAs is independent of the infill patterns used. The Ingeo™ 3D850 is the one with the highest impact toughness (17 kJ/m^2), while the impact strength of the Ingeo™ 2003D, the Ingeo™ 8052D grades are 15.5 kJ/m^2 and 14 kJ/m^2 , respectively. The NR-toughened samples prepared with the grid-like infill (Figure 5/a) showed only a slightly higher impact strength compared to the raw PLAs, and the increment was within the deviation range in all cases. On the other hand, the samples with unidirectional infill (Figure 5/b) exhibited a markedly higher impact strength values in the range of $27\text{--}32 \text{ kJ/m}^2$, depending on the PLA grade. The rather poor toughening efficiency of NR, when using the grid-type infill can be attributed to the poor interfacial adhesion between the layers, which is in good agreement with the results of the tensile tests.

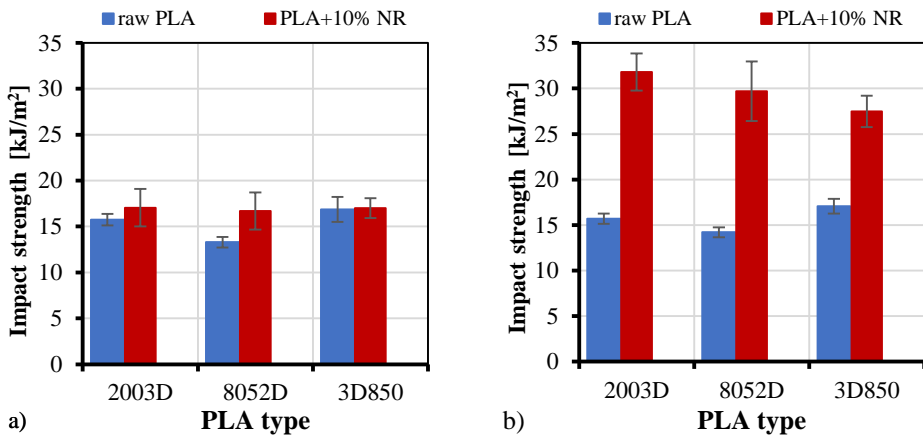


Figure 5. Charpy impact strength of the fabricated samples with (a) grid-type infill pattern and (b) unidirectional infill pattern parallel to the length of the specimens

4 Conclusion

In this present work the efficiency of natural rubber toughening was investigated on various PLA grades for 3D printing purposes. Therefore, 10 wt% NR was mixed into PLA grades with 4.5%, 4.3% and 0.5% d-isomer content *via* melt compounding. Subsequently, filaments were extruded using the prepared PLA/NR blends, which were then used to fabricate specimens by a desktop FDM printer with two different infill patterns. The presence of dispersed NR domains within the PLA matrix resulted in a greatly enhanced deformability and toughness, however, at cost of strength and stiffness. It was found that the improvement in ductility is most prominent when a unidirectional infill pattern is used, which is parallel to the length of the fabricated specimens. Out of the three examined PLA grades the Ingeo™ 2003D was found to be the most suitable to be used as matrix material for NR-toughened 3D printing filaments.

Acknowledgments

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Tribological behavior of graphene reinforced silicon nitride composites

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Abstract

The tribological properties of silicon nitride + 1 wt. % graphene composites, prepared using gas pressure sintering (GPS) and hot isostatic pressing (HIP) at 1700 °C, were investigated and compared to the wear properties of monolithic Si₃N₄. The tribological measurements were performed using reciprocating ball-on-plate technique under dry conditions in the air with Si₃N₄ ball as a tribological partner at an applied load of 5 N and 13.5 N and sliding speed of 10 cm/s. Scanning electron microscopy (SEM) was used for the characterization of wear mechanisms. The friction coefficient of the systems changed from 0.40 to 0.47 and 0.55 to 0.69 at applied loads of 5 N and 13.5 N, respectively, with the lowest values for monolithic Si₃N₄ in both cases. The wear rates of investigated systems are in the range of 10⁻⁶ ~ 10⁻⁷ mm³/N.m with the lowest wear rate for the monolithic silicon nitride prepared by GPS.

Keywords: Si₃N₄, graphene, hot isostatic pressing, tribology, wear

1 Introduction

Silicon nitride (Si₃N₄) based ceramics, because of their excellent properties as hardness, flexural strength, oxidation resistance, tribological and thermal properties, etc., are widely used in different engineering applications as cutting tools, bearings, parts of gas turbines, engines, etc., [1]. However, silicon nitrides also exhibit some negative properties, such as low fracture toughness, low reliability, limited functional properties as electrical conductivity, etc. [2]. Recent advances in carbon-based nanomaterials opened up new opportunities to tailor the microstructures of ceramic materials as Si₃N₄ at a micro/nanometric scale and to develop new classes of silicon nitride-based ceramics with improved mechanical, tribological and functional characteristics [3][4][5].

At the beginning, carbon nanotubes (CNTs) based Si₃N₄ have been developed, and the exceptional mechanical, electrical, thermal, and multifunctional properties of CNTs resulted in the significantly improved properties of the composites [6][7].

Recently graphene nanoplatelets (GPLs) have emerged as a particularly promising nanoscale filler phase for Si₃N₄ ceramics due to their exceptional mechanical and physical properties [8]. GPLs also hold the potential for improving the composites' tribological properties as graphite is known to be an excellent solid lubricant.

The tribological properties of Si₃N₄ + graphene composites were investigated intensively during the last decade, [9][10]. Hvizdos et al. [9] studied the mechanical and tribological properties of nanocomposites with silicon nitride matrix with the addition of 1 and 3 wt. % of various types of

graphene platelets. They observed that such amounts of graphene phases do not decrease the coefficient of friction at dry conditions but 3 wt. % of larger sized graphene addition results in higher wear resistance. Belmonte et al. [10] investigated the tribological properties of graphene nanoplatelets (GNPs)/Si₃N₄ composites using a reciprocating ball-on-plate configuration under isooctane lubrication. They observed that the exfoliated graphene nanoplatelets formed a protective tribofilm, which acted as lubrication and enhanced the wear resistance up to 56%.

The aim of the present work is to study the tribological properties of Si₃N₄ ceramics with 1 wt.% graphene additives, processed with GPS and HIP processing routes.

2 Experimental materials and methods

The starting powder 90 wt. % α -Si₃N₄ (Ube, SN-ESP), and sintering aids 4 wt. % Al₂O₃ (Alcoa, A16) and 6 wt. % Y₂O₃ (H.C. Starck, grade C), polyethyleneglycol (PEG) surfactants, and deionized water were added to the powder mixture, and milled in a highly efficient attritor mill (Union Process, type 01-HD/HDDM) equipped with zirconia agitator delta discs and zirconia grinding media (diameter of 1 mm) in a 750 ml tank. The milling process was performed with a high rotation speed of 3000 rpm for 4.5 h. Three commercial graphenes were used: two grades of exfoliated graphene nanoplatelets (xGnP-M-5 – particle size 5 μ m, and xGnP-M-25 – particle size 25 μ m)[11] by XG Sciences and nanographene platelets (Angstrom N006-010-P) by Angstrom Materials [12]. 1 wt. % of each type graphene was added to α -Si₃N₄ powders for a separate batch and milled with low rotational speed, 600 rpm until 30 min. The milling with low rotation speed and shorter time was performed to avoid damaging the graphene reinforcements particles. Starting compositions of sintered samples are given in Table 1. The substance was dried and sieved with a filter with a mesh size of 150 μ m. Green samples (green bodies) were obtained by dry pressing at 220 MPa. Before sintering processing, the green bodies were fired at 400 °C to eliminate PEG.

Two different sintering processes were performed to densify the powder compacts to observe the effect of the sintering process on the prepared composites' mechanical and tribological properties. Hot isostatic pressing (HIP) was performed at 1700 °C in high purity nitrogen by a two-step sinter-HIP method using BN embedding powder at 20 MPa, with 3 h holding time. The heating rate did not exceed 25 °C/min. The dimensions of the as-sintered specimens were 3.5mm x 5mm x 50mm. Gas pressure sintering (GPS) was performed at 1700 °C in high purity nitrogen using BN embedding powder at 2 MPa, with no holding time. The heating rate did not exceed 25 °C/min. The dimensions of the as-sintered specimens were 3.5 mm \times 5 mm \times 50 mm.

The sintered samples' apparent density was measured by a standard Archimedes method using distilled water as an immersion medium at room temperature. For graphene reinforced Si₃N₄, the tribology measurements were carried out on equipment UMT 3 (Bruker) using the reciprocating ball-on-plate technique. The wear behavior of the experimental materials was studied in dry sliding in the air. The tribological partner was a highly polished (roughness Ra < 0.10 μ m according to ISO 3290) Si₃N₄ ball with a 6.35 mm diameter. The applied load was 13.5 N, the sliding speed 10 cm/s, and the sliding distance was 720 m. The experiments were realized at room temperature at the relative humidity of 40 \pm 5%.

Table 1 - Details of materials and parameters of processing

No.	Starting Powders (wt. %)			Graphene (wt. %)	Type of additives	Sintering Conditions			Sintering Technique	App. density (g/cm ³)
	Si ₃ N ₄	Al ₂ O ₃	Y ₂ O ₃			T (°C)	Holding time	Pressure (MPa)		
SN-1	90	4	6	0	-	1700	-	2	GPS	3.329
SN-2	90	4	6	1	xGnP-M-25	1700	-	2	GPS	3.301
SN-3	90	4	6	1	Angstrom N006-010-P	1700	-	2	GPS	3.297
SN-4	90	4	6	1	xGnP-M-25	1700	3 h	20	HIP	3.375
SN-5	90	4	6	1	xGnP-M-5	1700	3 h	20	HIP	3.379

3 Results and Discussion

The density values of the sintered samples are illustrated in Table 1. As it is visible the samples prepared by HIP method show higher density in comparison to the samples processed by GPS and the different GPLs addition results in similar density values.

Coefficient of friction (COF): Figure 1 shows the friction coefficient under 5 N and 13.5 N loads in the *run-in stage* (0 – 40 m) and *steady-state stage* (40 – 720 m) for the investigated systems. After the run-in stage the coefficient of friction under the testing conditions was stable for all investigated systems. The friction coefficient was between 0.40 to 0.47 under 5 N load and between 0.55 to 0.69 under the load of 13.5 N. The lowest coefficient of friction under both loads 5 N and 13.5 N was recorded for monolithic Si₃N₄ material (SN-1) prepared by gas pressure sintering. From composites at 5 N load similar COF value as for monolithic material was measured for Si₃N₄ + 1% xGnP-M-25 prepared by HIP and at 13.5 N load for Si₃N₄ + 1% Angstrom N006-010-P, prepared by GPS.

Wear rate: Figure 2 shows the wear rates under loads of 5 N and 13.5 N for the investigated systems. The investigated systems' wear rates are in the range of 10⁻⁶ ~ 10⁻⁷ mm³/N.m. Overall the wear rates of systems under 5N loads are lower than that of systems under 13.5 N. The lowest wear rate was observed for the monolithic silicon nitride prepared by GPS. From composites similar wear rates as for the monolithic Si₃N₄ was measured at 5 N load for the composites Si₃N₄ + 1% Angstrom N006-010-P, prepared by GPS and Si₃N₄ + 1 wt. % xGnP-M-25, prepared by HIP and at 13.5 N load for the composite Si₃N₄ + 1 wt. % xGnP-M-25, prepared by GPS. The wear resistance of these composites is higher than the reported values by several researchers [13], [14].

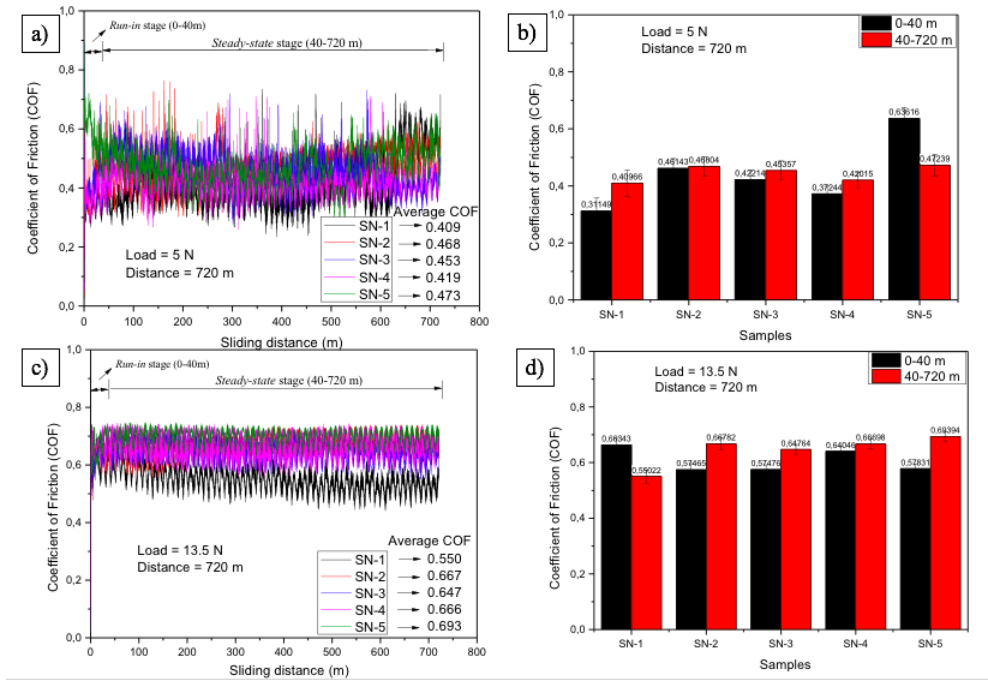


Figure 1 – Coefficient of friction of investigated composites: a) COF under 5 N loads; b) COF of composites during (0-40 m) and 40-720 m) under 5 N load; c) COF under 13.5 N loads; d) COF of composites during (0-40 m) and 40-720 m) under 13.5 N load.

Wear Mechanism: SEM observation of the wear track of investigated systems was used to identify the wear mechanisms. Similar wear mechanism was identified in all investigated systems. The worn surface of the monolithic Si₃N₄ was relatively smooth with only a small amount of abrasion groves and adhered debris can be identified. Under higher load of 13.5N, micro-crack formation and spalling layers were also observed. In wear track of composites only a very limited formation of tribolayer, thanks to the present graphene phase is visible.

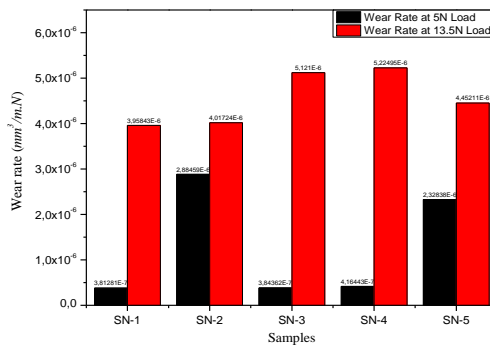


Figure 2 – Wear rates of silicon nitride composites with 1 wt. of different types of graphene under 5 N loads and 13.5 N loads.

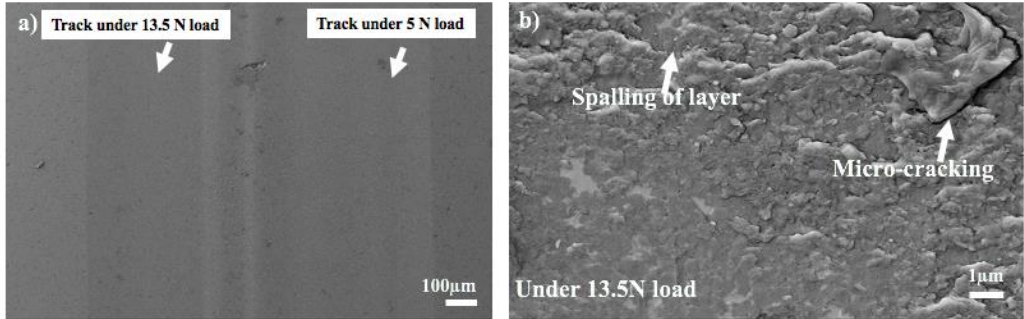


Figure 3 – Wear mechanism of monolithic Si_3N_4 prepared by GPS, studied by SEM: a) wear tracks under 5 and 13.5 N, looks smooth surface; and b) wear track under 13.5 N with higher magnification, microcracking and chipping off material in the wear track are visible.

4 Conclusions

The aim of the present contribution was to investigate the tribological properties of silicon nitride + 1 wt. % graphene composites prepared using gas pressure sintering (GPS) and hot isostatic pressing (HIP) and compare to the wear properties of monolithic Si_3N_4 .

1. The friction coefficient of the systems changing from 0.40 to 0.47 and 0.55 to 0.69 at applied loads of 5 N and 13.5 N, respectively, with the lowest values for monolithic Si_3N_4 in both cases.
2. The wear rate of investigated systems at the applied load of 5 N changing from $3.8 \times 10^{-7} \text{ mm}^3/\text{N.m}$ to $2.8 \times 10^{-6} \text{ mm}^3/\text{N.m}$ with the lowest value for monolithic Si_3N_4 and Si_3N_4 + graphene/Angstrom composite.
3. The wear rates of investigated systems at the applied load of 13.5 N changing from $3.9 \times 10^{-6} \text{ mm}^3/\text{N.m}$ to $5.2 \times 10^{-6} \text{ mm}^3/\text{N.m}$ with the lowest value for monolithic Si_3N_4 and Si_3N_4 + graphene/xGnP composite.
4. The dominant wear mechanisms were abrasion, microcrack formation, and spalling with minimal tribo-layer formation.
5. The volume fraction of the graphene platelets in the Si_3N_4 matrix is probably not enough to improve the tribological characteristics of the investigated silicon nitride based composites.

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Metaanyagok mechanikai tulajdonságainak vizsgálata eltérő geometriák esetén

Investigation of mechanical properties of metamaterials in case of different geometries

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Absztrakt

A metaanyagok igen nagy kutatási potenciállal rendelkeznek az elmúlt években. Ezek az anyagok számos olyan tulajdonsággal rendelkeznek melyek a hagyományos anyagstruktúráktól eltérőek. A metaanyagkutatások többsége különleges elektromágneses tulajdonságokkal rendelkező anyagokat igyekszik létrehozni. Ezzel szemben a mechanikai metaanyagok kutatási területe viszonylag új témának számít. A mechanikai metaanyagok olyan anyagok, amelyek mechanikai tulajdonságait elsősorban felépítésüknek, geometriájuknak köszönhetik. A 3D nyomtatás fellendülése miatt olyan anyagstruktúrákat is létre tudunk hozni, melyeket hagyományos eljárással eddig szinte lehetetlen volt. Ennek fényében olyan metaanyag struktúra tervezetek és ezek végelem szimulációi kerülnek bemutatásra melyek különböző számú ismétlődő egységcellát tartalmaznak.

Kulcs szavak: új geometriák, egységcella, falvastagság, végelem szimuláció, fémnyomtatás

Abstract

Metamaterials have a very high research potential in recent years. These materials have many properties that are different from traditional material structures. Most metamaterial research attempts to create materials with special electromagnetic properties. In contrary, the field of research on mechanical metamaterials is a relatively new topic. Mechanical metamaterials are materials whose mechanical properties are primarily designed by their structure and geometry. Due to the boom for 3D printing, we can also create material structures that have been almost impossible with traditional methods so far. In light of this, metamaterial structure designs and their finite element simulations containing different numbers of repeating unit cells are presented.

Keywords: new geometries, unit cell, wall thickness, finite element simulation, metal printing

1 Bevezetés

A metaanyagok felhasználhatósága igen széles skálán mozog, ezért nagy a kutatásukban rejlő potenciál is. Bevezetésként a következőkben három metaanyagokkal kapcsolatos főbb kutatási terület kerül bemutatásra, amelyek mind különböző metaanyag felhasználhatóságát igazolják.

1.1 Átalakítható metaanyagok

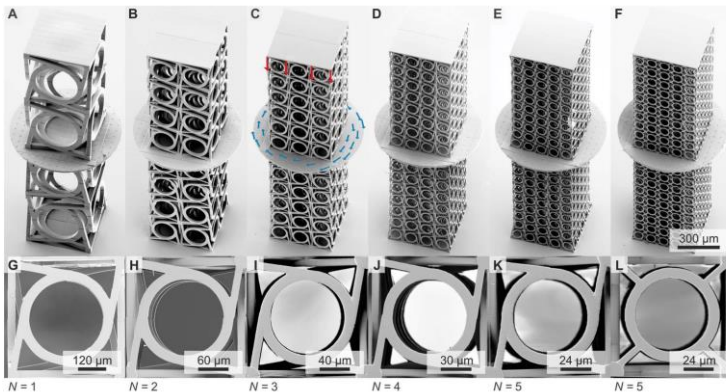
Az átalakítható mechanikai metaanyagok megalkotásához az origami művészetét használták, így összehajthatók és kibonthatók a hajtási vonalak mentén. A szóban forgó mechanikai metaanyagok általában rugalmasak, különösen az összehajtási irány mentén, ami sajnos sok esetben azt eredményezi, hogy nyitott állapotukban instabilak. Ilyenre mutat példát Zhai, Z és társai [1] munkája. Ennek a metaanyagnak az alapállapota különbözik az összecukott állapottól és két különböző módon csukható össze melyek közül az első esetben alacsony merevséget míg a második esetben lényegesen nagy merevséget tanúsít. A létrehozott metaanyag nagy teherbírással rendelkezik az átalakításának irányában, de emellett átalakítható és összecukható.

1.2 Feszültség hatására átpattanó mechanikus metaanyagok

Rafsanjani, A. és társai [2] kutatásában egy olyan monolit mechanikus metaanyag került bemutatásra, amely átpattanó egységekből épül fel és tervezhető a szakítópróbán való viselkedése. Húzó feszültség alatt ez a metaanyag nagy kiterjedést mutat, ami abból fakad, hogy egységenként átpattan deformálatlan hullám alakú állapotából egy „gyémánt” alakú nagyobb kiterjedésű állapotba. A numerikus számítások, és elméleti modellezés mellett 3D prototípusokon elvégzett kísérletek is bemutatják, hogyan valósulnak meg a fentebb leírtak.

1.3 Három dimenziós mechanikai metaanyagok csavarással

Egy közönséges, egytengelyű rúd nyomás alatt sokféleképpen viselkedhet azonban statikus esetet vizsgálva a csavarás értéke nulla. Ez sok esetben akadályozza a fejlett mechanikai tervek megvalósítását koordináta transzformáció segítségével. Ebben a projektben olyan háromdimenziós királis metaanyag struktúra készült, amely leküzdí ezen az akadályokat. A mintákon mért csavarás és az axiális deformáció aránya meghaladta a 2%-ot. Statikusan vizsgálva egy rugalmas anyag mechanikai viselkedését, egytengelyű húzó vagy zömítő vizsgálat esetén nem keletkezhet benne csavarás hiszen nyomaték nem keletkezik benne. A tervezett és legyártott metaanyag egységcellája úgy lett kialakítva, hogy a csavarás irányában legyen szabadságfoka, statikus esetet vizsgálva.

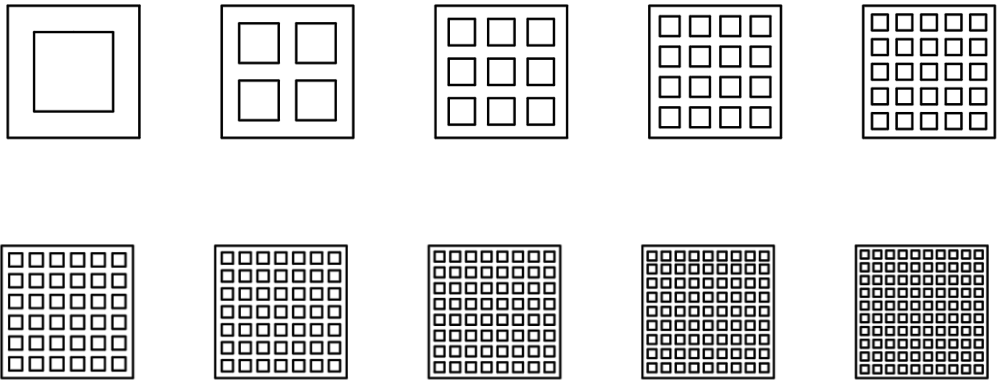


1. ábra: Csavarodó metaanyag struktúrái [3]

A legnagyobb elfordulás mértéke a négy egységcellából álló mintadarab esetén volt a legnagyobb, ahol az axiális deformáció aránya meghaladta a 2%-ot (1 ábra). A maximális cellaszám felé haladva ez az érték csökkent: a maximális cellaszám mellett ez az érték 50 %-kal csökkent.

2 Új metaanyag geometriák tervezése

A geometriák alapja egy négyzet alakú egységcella. Az egységcellák számának növelésével különböző mechanikai tulajdonságokkal rendelkező metaanyag jön létre. Az egységcellák száma négyzetesen növekszik (2. ábra), tehát a cellaszám növekvő sorrendben így alakul: 1; 4; 9; 16; 25; 36; 49; 64; 81; 100. Fontos, hogy minden egyes struktúra térfogata állandó legyen, hiszen a metaanyagok sajátossága, hogy tulajdonságaikat nem anyaguk szerkezetének, hanem felépítésüknek köszönhetik. A tervezett geometriák fémről, 3D nyomtatás technológiájával kerülnek majd legyártásra. A kinyomtatott próbadarabokon ezután zömítővizsgálatot végzünk. A mérés kiértékelésével megkapjuk, hogy az egyes geometriák mechanikai tulajdonsági, hogyan változnak a cellaszám függvényében.



2. ábra: metaanyag geometriák x - y síkú kontúrjai növekvő cellaszámmal

2.1 Egységcellák kialakítása konstans falvastagság mellett

A geometriák létrehozásakor minden geometria befoglaló mérete (X_0) megegyezik. A több egységcellás geometriák kialakítása során az is alapvető feltétel az, hogy minden kialakítás keresztmetszetének területe (T_n) egyenlő legyen (a térfogatállandóság miatt), illetve, hogy a falvastagság (Y_n) az egyes geometriáknál egyenlő legyen.

A következőkben paraméteres úton kerülnek meghatározásra a geometriák egyes méretei úgy, hogy a fentebb említett alapvető feltételek teljesüljenek. Általános alak az n -edik geometria méreteinek meghatározásához amely n^2 számú egységcellát tartalmaz:

$$T_n = X_0^2 - n^2 X_n^2 \quad (1)$$

$$Y_n = \frac{X_0 - n \cdot X_n}{n + 1} \quad (2)$$

$$X_n = \frac{X_1}{n} \quad (3)$$

Ahol:

T_n – n -edik keresztmetszet területe

X_0 – a geometria befoglaló mérete

X_n – n -edik egységcella mérete

Y_n – n -edik falvastagság mérete

2.2 Tervezett geometria méretei

A következőkben a tervezett geometria egységcellája kerül bemutatásra a gyártás és a zömítés szempontjából legfontosabb tulajdonságok feltüntetésével. Ezek a zömítés irányára merőleges legkisebb keresztmetszet, a zömítés szempontjából kritikus X_n/Y_n arány és a legkisebb falvastagság. A legkisebb keresztmetszet a választott zömítőgépek korlátai miatt maximum 200 mm^2 lehet és ezt a határt ki is kell használni, hiszen így a falvastagság is nagyobb lesz, ami gyártási szempontból kedvező. A keresztmetszet a különböző számú egységcellák esetén nem változik. A kritikus X_n/Y_n arány az egy egységcellás geometria esetén a legnagyobb, így ez lesz a kritikus eset. A kritikus X_n/Y_n arány számításakor az egységcella oldalhosszát osztjuk el a falvastagsággal, hiszen itt áll fenn a kihajlás veszélye. A falvastagságot a 81 és a 100 egységcellát tartalmazó geometriák esetén vizsgáljuk hiszen itt a legkisebb.

1. táblázat: Tervezett geometria egységcellájának vázlatja és méretei

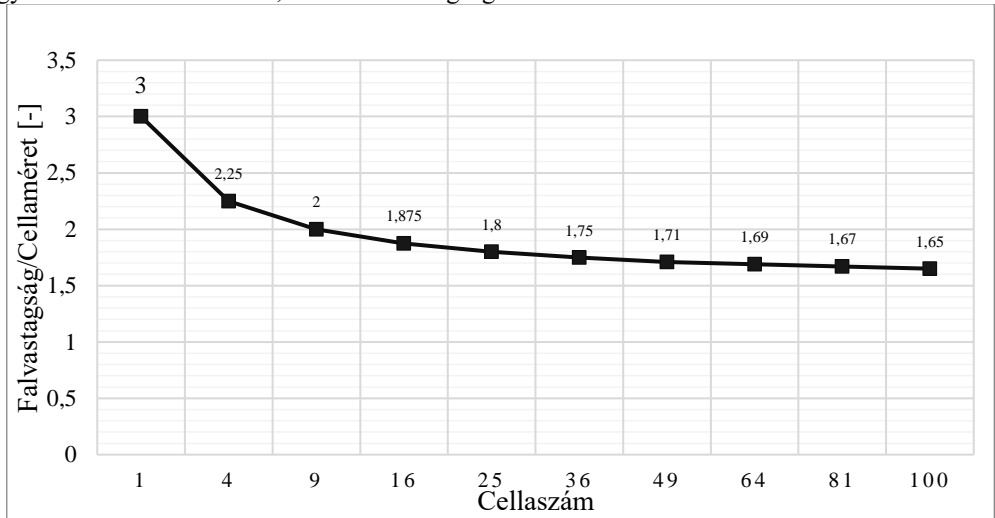
Geometria térbeli vázlatja:		
Legkisebb keresztmetszet:	$8 \cdot 12,5 \cdot 2 = 200 \text{ mm}^2$	
Kritikus X_n/Y_n arány:	$\frac{24}{8} = 3$	
Legkisebb falvastagság:	81 egységcella esetén:	1,6 mm
	100 egységcella esetén:	1,45 mm

2.3 Falvastagság/cellaméret hányados

A falvastagság a cellaszám növelése mellett értelemszerűen csökken. A falvastagság a gyárthatóság szempontjából érdekes, hiszen minél vékonyabb a fal annál nehezebben gyártható. ábra: Falvastagság változása a cellaszám függvényében

A falvastagság mellett fontos tényező még a falvastagság és a cellaméret hányadosa is (X_n/Y_n). A cellaszám növelésével a cellaméret is csökken. Ebből tehát nem derül ki, hogy hányadosuk milyen

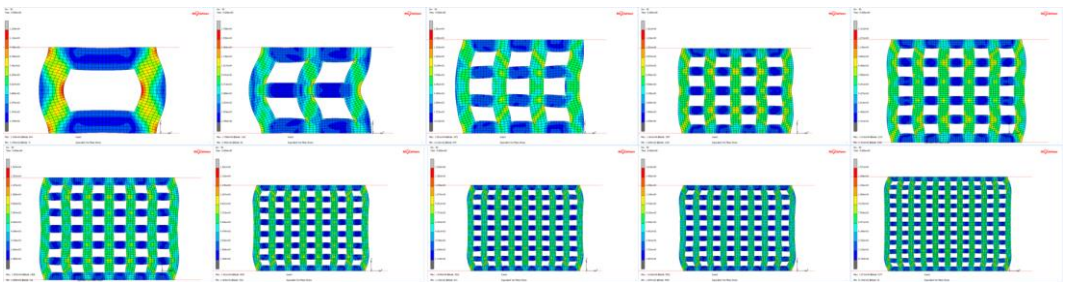
irányban változik a cellaszám növelésével. Ahogyan a 4. ábra szemlélteti ez az arányszám csökken a cellaméret növelésével. Ez annak köszönhető, hogy a cellaméret a cellaszám emelkedésével nagyobb mértékben csökken, mint a falvastagság.



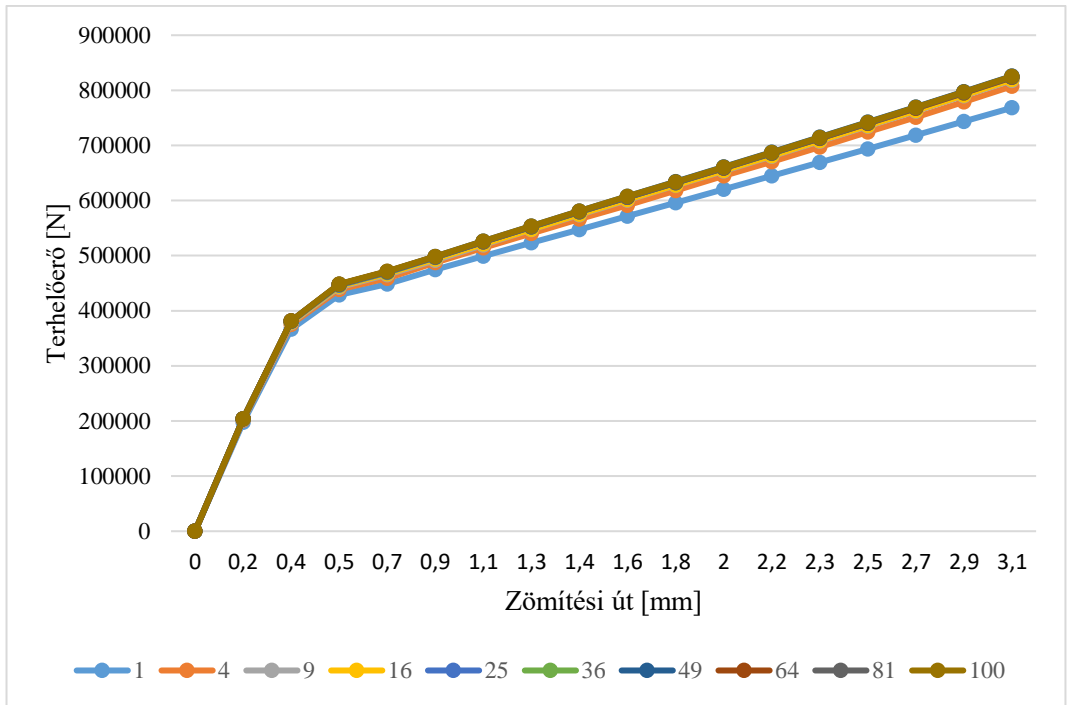
3. ábra: Falvastagság/cellaméret hányados változása a cellaszám függvényében

3 Végelem szimulációk

A végelem szimulációk a Marc programmal készültek. Az összes geometriával zömítés szimulációval esetén lett megvizsgálva. A szimulációk során a zömítési út 3 mm volt. A zömítés közben fellépő erő értékei és karakterisztikája is kirajzolódott a szimuláció során. A továbbiakban az σ_{eq} érték vizsgálatakor a teljes zömítéshez tartozó képek (4. ábra) szerepelnek, illetve a zömítés során fellépő erők karakterisztikája (5. ábra).



4. ábra: teljes zömítési úthoz tartozó egyenértékű, redukált feszültségeloszlás



5. ábra: Az erő-elmozdulás diagramok összehasonlítása a vizsgált cellaszámoknál

4 Konklúzió

Összehasonlítva a végeelem szimulációkat, látható, hogy a cellaszám növelésével a struktúra stabilabbá válik. Ennek következményeként, nem hajlanak ki a falak, mint a kevés cellaszámú struktúrák esetében. Az 1; 3; és 9 egységcellaszámú geometriák esetében a falak a terhelőerő hatására láthatóan kihajlanak így a zömítés maximális ereje is kisebb lesz, tehát kevésbé terhelhetőek. A 16; 25; 36; 49; 64; 81 és 100 cellaszámú struktúráknál nem jelentkezik a kihajlás. Ez azt is eredményezi, hogy a függőleges részekben ébred feszültség, ezek veszik fel a terhelés nagy részét. Mivel a nyomott keresztmetszet minden esetben megegyezik, az erőkarakterisztika ezeknél a struktúráknál nagy mértékben egyezik.

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Proposed home office design solutions to inspire productivity

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Abstract

The traditional workplace environment has suddenly changed due to the outbreak of the Covid-19 pandemic. Thus, many companies encourage their employees to work from home to continue their online and remote activities, avoiding congestion in offices, means of transport, etc. Prestigious European institutions and companies in the field of design, facilities management, labour research have conducted research on this major change in the work process and have tried to provide the best possible solutions to maintain high levels of productivity of people while working from home (WFH). The research presented in this article aims to identify the main challenges faced by teleworking operators and provide specific recommendations for overcoming them. At the same time, the study aims to emphasize the importance of ergonomics, active behaviour and well-being in the design of new work environments and to propose solutions that can inspire and support workers' productivity through conscious design choices.

Keywords: Telework, Wellbeing, Home Office, Design, Workplace, Covid-19

1 Introduction

Starting with the spring of 2020 several studies have been conducted as teleworking has become a general practice for millions of “white collar” workers worldwide, due to restrictions imposed by the health contingency of the Covid-19 pandemic. Studies aim to define this unprecedented situation, identify the main challenges, and provide insight information about the future of the workplace. Representative examples of exhaustive researches have been published recently such as the large global survey of Cushman and Wakefield from August 2020 [6], the Harvard Business Review article on “The Implication of Working Without An Office” [11] and the Gensler’s research “Insights From Gensler’s U.S. Work From Home Survey 2020” [10].

As the global Covid-19 pandemic unfolds, among the most common questions raising in the recent studies are [5; 6; 10;11]:

- *Will people wish to go back to their workplace?*
- *What is future for the physical workplace?*

According to the various opinions of researchers, practitioners and workplace strategists, the future workplace will offer *new experiences*, rather than just offering a newly decorated space. Liz Burow, a leader in Workplace Strategy and Design Research, has been analysing the current situation and thought about new potential strategies for developing the future workplaces [4]. She argues over the importance of social connections in the workplace: formal and informal, scheduled,

and spontaneous, interactions that are not possible while working from home (WFH). Thus, a “*hybrid model*” of teleworking and meaningful on-site interactions between colleagues, management, clients is potentially one path towards rethinking the future job place [4; 5].

The emergence to the massive home office transition phenomenon with seemingly positive productivity outcomes, determines researchers to question the future existence of the physical office. Burow argues that spontaneous interaction with peers, moments of informal collaboration and creativity need to be rethought to fit the new framework [4], supported by [1; 2, 3; 10; 11]. It is fairly said that “*one size does not fit all*”, flexibility is key, as Burow shows [4]. Furthermore, three categories of work settings, each to serve a specific purpose, must be considered: (1) home office for concentration, (2) small hubs for community connection and (3) exchange, headquarters meetings for collaboration. In any given situation, telework will unquestionably be part of the future.

The office buildings were closed temporarily for many businesses, as a rapid expansion of the pandemic caused the „*largest work-from-home experiment in history*” [6]. Professional desks have been replaced by dinner tables or improvised home desks, business attire by comfortable tracksuits, conference rooms by video conference software and office colleagues by family and pets [1; 2, 3; 10; 11]. At first, this picture appeared rather convenient, as a long-awaited pause from commutes, meetings, irritating bosses or colleagues and more family time. However, as the telework period shifted from weeks into months, signs of fatigue started to show. The new lifestyle, balancing work, school, and childcare at the same time and in the same space, turned out to be less enjoyable and more stressful than anticipated [12; 15]. The importance of ergonomics within people’s private space, their active behaviour and wellbeing gain more territory while companies’ analysed productivity during home office hours.

In this context, the research presented in this article aims to identify the main challenges faced by teleworking operators and provide specific recommendations for overcoming them. At the same time, the study aims to emphasize the importance of ergonomics, active behaviour, and well-being in the design of new work environments and to propose solutions that can inspire and support workers’ productivity through conscious design choices

2 From telecommuting to the teleworking challenges

2.1 What is telework?

The official definition formulated in the European agreement of telework [15] explains telework as “a form of organizing and/or performing work, using information technology, in the context of an employment contract/ relationship, where work, which could also be performed at the employer’s premises, is carried out away from those premises on a regular basis”. Working from home WFH is not a new practice, as one might categorize any residential activity as „work at home”. However, the newly assigned term of telework additionally involves using technology to accomplish given tasks while being at home. The term was initially introduced in 1975 by engineer and researcher Jack Nilles, also known as “the father of telecommuting and teleworking” (as cite by [14]). Further, the term of telecommuting evolved into telework along with the technological implications in the process, such as the information and communication technology (ICT) and the Internet. Gradually, people’s flexibility increased in terms of working hours and location [10; 11, 14].

Repeatedly, telework is being confused with remote work that refers to being able to work from a different location, anywhere outside the office premises. Remote work was previously embraced by younger generations, as Millennials (named also Generation Y, people born early 1980s to early 2000s) and Generation Z (people born late 1990s till early 2010s) who preferred flexibility regarding time schedules and location. Younger generations are the ones heavily impacted psychologically, by the Covid-19 pandemic restrictions [6; 1], while Baby Boomers (people born mid-1940s to mid-

1960s) seem to appreciate more the time at home. The reason for this unexpected difference resides in the multiple responsibilities that young workers need to balance, such as family, childcare, work, and personal commitments [1; 2; 6].

2.2 Outcomes of teleworking in Europe during the Covid-19 pandemic

According to the Eurofound Report on “Living, working and COVID-19” [1] based on a survey developed with a sample of 87,477 respondents which are workers in the EU, there have been recognized that the workforce has suddenly shifted to a new world of teleworking. As most jobs were developed on-site beforehand, the disruption in daily habits and social interaction had a big impact on employees physical and mental wellbeing, their financial situation and work-life balance. As job and financial insecurity increased drastically, the struggles of WFH involved childcare, household activities and the absence of work-life boundary, all in the same timeframe. The report highlights several important aspects regarding teleworking habits developed by people during the past months: 48% of employees worked from home fully or partially during the pandemic and by July, 78% of respondents who have been WFH declared that they would continue to work from home at least several days per week even after the pandemic, despite difficulties in managing work-life balance. Regarding job quality, 84% of respondents feel that they are doing meaningful work, while 33% of respondents feel exhausted at the end of the workday [1].

There are multiple pros and cons of teleworking, and rely on the quality of the setting, currently very hard to define, since many individual homes have become working environments. Whether it is a studio, an apartment or a house, the transformation of space and furnishing was key to overcome the challenges of WFH. Each person has become the designer of his own home office, a pleasant opportunity on the one hand and a challenge on the other hand. We are learning from the surveys that a cocktail of negative and positive feelings due to financial, occupational, or childcare issues is impacting people’s wellbeing. There are few studies though that are mentioning the importance of WFH environmental aspects, such as indoor air quality, ergonomics, spatial traits, and connection to the nature.

3 Working from home new challenges

Withing the next section, there will be analysed the ergonomic and wellbeing challenges and we will highlight several potential methods for home office optimization.

3.1 Ergonomic challenges

Management-wise, telework seems a highly effective model from productivity points of view on a short term, but the lack of interaction leads to decrease of creativity and innovation on the long run. Homes went through rapid preparative processes to accommodate inhabitants` workspaces, as the transition was fast and had to be accomplished with as little productivity loss as possible. Internet connection, a laptop, a chair, and a table were the minimum number of items for WFH. But as months passed, improvised work settings proved insufficient to support workers` ergonomic necessities, especially those related to back pain, headaches, and other physical conditions. The International Labour Organization recommended posture and seating solutions [12], but did not include details regarding spatial characteristics, except for mentioning the importance of finding a quiet area within the household.

3.2 Home office design challenges

Ergonomic aspects also include the planning of the interior design, furnishing and usage of space. When discussing about homes, we can only refer to residential building regulations to identify

minimal norms and certain common traits: minimal room surface (varies depending on country), minimal natural light intake (glazed surface represents 10-15% of the total floor area or 80% of the working plane should receive direct light from the sky – according to BREEAM regulations [3]) and functional scheme traits. It is a personal choice whether the home includes a designated office space.

Adaptability was mandatory to obtain functional work environments away from the office buildings, but also away from distractions and other family members. In this regard, an additional enclosed room was the ideal situation, although the tendency worldwide was to decrease the size of the homes due to high density levels in urban areas. In this case, reconfigurations of furnishing layouts were imposed to bring a certain level of practicability in terms of work to living rooms, dining rooms, bedrooms or even kitchens [14; 15].

Another aspect of identifying suitable work areas at home is the possibility to segregate functions, separate workspace from living-space, to create at least a perceptive differentiation between the two types of activities. Furthermore, natural light, acoustical insulation, layout adaptability, functional segregation are the main aspects to take into consideration when designing one's own office space at home.

3.3 People's seating challenges

Although the term was issued in direct correlation to workspace environments by the Veldhoen Company, "activity-based-work" is a contemporary design methodology that defines criteria for workplace configuration in a wide variety of spaces and experiences, that empower users to adapt the space to their own needs [7]. This definition is more accurate than ever, in choosing and adapting one's personal workspace at home.

Among the principles of activity-based-work, several practices tend to be applied in teleworking activities: alternating between multiple places and seating types depending on activity; seated/ergonomic chair for focused work; standing or bar chair for casual phone calls; soft seating or lounge chair for creative work. If space allows, it is important to switch to informal seating such as fitness ball, bean bags, etc. This practice of alternative seating involves motion, reducing completely sedentary intervals, although insufficiently to balance so many hours spent in seated position. It was being said that "seating is the new smoking" [2].

Furthermore, physical activity is an essential part of workplace design independently of its location. Sedentarism was well known as a modern life health issue and along with excluding commuting and all types of travel whether short or long, when closing sports facilities, people around the globe are increasingly living more and more sedentary lives. In this regard, active design [2] encourages movement through space, bringing a powerful argument to the seating-work correlation [1; 8; 9; 15].

3.4 Wellbeing challenges

Overall wellbeing is decreasing due to the constant struggle to maintain work-life balance and have some time away from work, causing a general fatigue among people. One factor impacting the lack of time away from work may be the absence of a daily commute. This absence means there is no natural limitation for the start and the end of the working day, to provide the time to switch off, therefore creating a negative impact on mental and physical wellbeing [14]. Another factor of impact is the loss of physical and psychological sense of separation from work, all activities being conducted within the same space. People's managers can support their teams in this regard by encouraging employees to take time out and not be permanently connected [2; 4; 8; 9; 14].

4 Proposed home office design solutions

During the last decades sustainability has been translated into architecture through building codes, regulations and most importantly, certification systems such as WELL, BREAAAM and LEEDS. These analyse the impact of designing the outdoor or indoor environment, through well-established criteria. Many newly built and refurbished office buildings have been configured to obtain one or more sustainability certifications, offering their inhabitants optimal air quality, low emission materials, the best filtration systems, and access to daylight, in controlled spaces. Once transferred to the residential environment, these principles become hardly controllable, as each individual home has a different design [2; 3; 10; 11].

Air pollution measurements for outdoor environments are accomplished with professional software, but nonetheless, indoor air quality should be a priority for everyone, as we spend most of our time indoors and specifically nowadays, in our homes. A newly developed consultancy program, “Fusion-spaces” [9], aims to provide support for home-based office workers in order to help them increase their environmental comfort regarding air quality and daylight, but also creating a work schedule that includes relaxation intervals.

Biophilic design [13] is a concept that increases human-nature connection through relatively simple design features, that are also applicable at home to potentially increase wellbeing. Among these is space appropriation, belonging and personalization, an aspect that should already be part of any home, whether owned or rented. The presence of family members and pets are factors that can decrease stress levels while features like window views, daylight and greenery are proven to participate in overall wellbeing. Consciously utilizing biophilic design includes rational choice of natural materials and colours, even representations of nature that could support the wellbeing [13].

Analysing the current challenges when WFH and considering the sustainability principles, we are proposing three adaptable solutions that inspire and facilitates people’s productivity in any space as illustrated in Figure 1 and 2. First, there are some minimum space requirements necessary for any working area within an apartment or a house. These spaces can be accommodated in the dining area, kitchen, living room and even bedroom. There are some optimal dimensions for the space that includes seating options and tables, as well as their position facing the light or window. Flexibility in the configuring the spaces is extremely important, as there are no standard solutions available. Second, it is recommended to use as much as possible the biophilic elements to personalize each working area and keep a high level of productivity. A Norwegian experiment using six different environmental conditions, released in 2013, showed that plants maintain attention rates and the focus on work, even if temporary these are disabled due to short relaxation periods [12]. Third, is having different seating options available. Switching between classical desk chair and more comfortable seating or even standing is recommended for facilitating the movement and changing the body position.

In any chosen layout for performing work related activities, people should make sure they have access to natural light as much as possible and a good air quality level within the space.

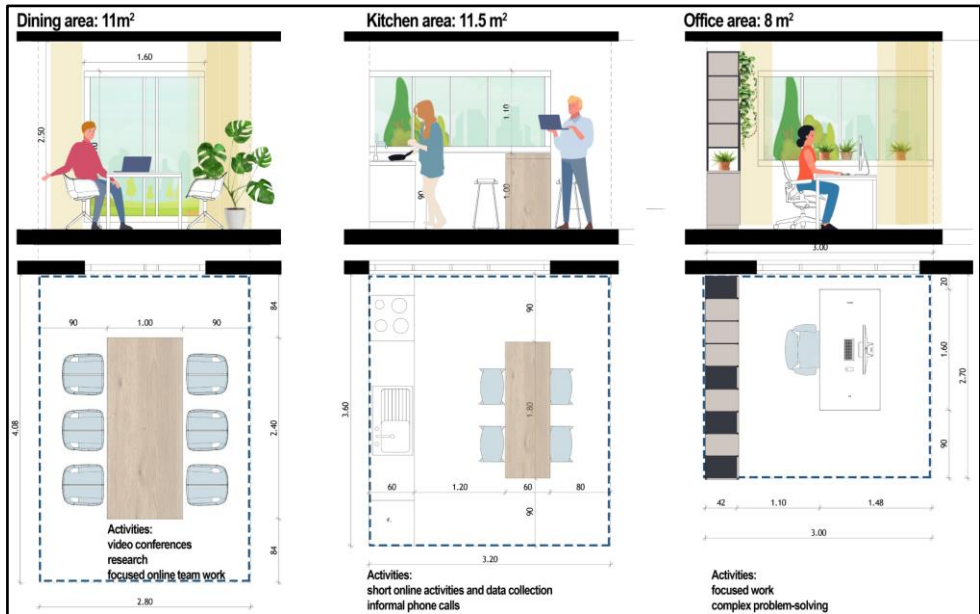


Figure 1. Adaptable solutions that inspire and facilitates people's productivity – example for dining, kitchen and an office area

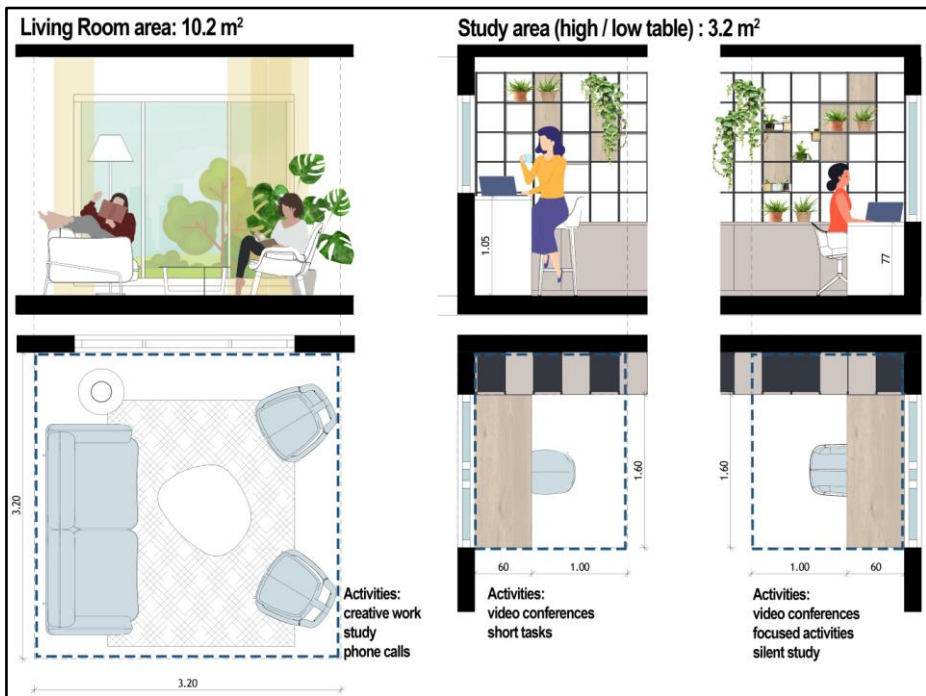


Figure 2. Adaptable solutions that inspire and facilitates people's productivity – examples for living room and study areas

5 Conclusion

Workplaces are certainly passing a challenging period due to the Covid-19 pandemic, a period that will change the ways people collaborate and interact. A hybrid workstyle that combines teleworking and on-site activities is foreseen in by experts for the near future. However, the WFH concept was prevailing in the year 2020 and forced the companies to redefine their way of collaborating and keeping employees on a high productivity level. Based on the identified challenges highlighted in this paper, the authors propose three main solutions for a home office design, with ergonomic and wellbeing boosting elements. These are addressing the minimum space requirements of a working zone, the use of biophilic elements and availability of different seating options.

Taking advantage of the already emerging design trends focused on sustainability and space efficiency, we intend to raise awareness of the importance to create a home working environment to inspire and sustain productivity.

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Work-life balance and workplace wellbeing in Covid-19 pandemic conditions: a pilot study in Romania

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Abstract

The end of 2019 was marked by the grim beginning of a new pandemic: Covid-19 hit China and spread across the world in a few months. 2020 saw the world experiencing new ways of working in a common effort to reduce incidence of Covid-19 infection. However, working remotely had its own impact on peoples' health and wellbeing. The purpose of the paper is to understand the impact of teleworking on workplace wellbeing through the launch of a pilot study based on a detailed survey that was applied in a private company in Timisoara. The study revealed that the quality of life worsened as respondents reported symptoms of musculoskeletal disorders, weight gains, increase of blood pressure and glycaemic index, and somatization of stress.

Keywords: Teleworking, Wellbeing, Covid-19

1 Introduction

Covid-19 pandemic turned upside down the majority of 'normal lifestyle' perspective across the world. Romania was not an exception from this, as the number of Covid-19 positive cases has been exponentially increasing since January 2020. Since March 2020, Romanian Government put in place a set of restrictions, including lockdown, teleworking and online school. November 2020 came with a new set of restrictions like those applied in the first round of lockdown, including the shift to teleworking wherever this was possible [6]. In this context, the question was: how will this affect both physical and mental health status of individuals?

For employees, a major challenge was adapting to the shift to remote work environments (i.e. teleworking), new workplace policies or procedures that limit human contact [2]. These changes have been exacerbated by a work-family conflict where professional and family roles become incompatible as these are expected to be performed at the same time in the same space throughout the day. This type of conflict can be remediated by offering employees flexible work arrangements, on-site childcare or childcare subsidies [2]. Unfortunately, such employee benefits became difficult – or even impossible in some countries – to offer in the new pandemic conditions. Work and family roles fused to an extent where adequate role boundaries were highly difficult to maintain. Another interesting aspect is that during lockdown childless families and single employees are at particularly high risks of loneliness, feelings of social exclusion and isolation [2].

In the context of these new challenges that must be addressed as soon as possible, studies on how to improve workplace wellbeing are essential. The present paper aims to highlight how teleworking impacted workplace wellbeing for employees in teleworking.

2 Literature review

Lockdown and sanitary restrictions imposed by Covid-19 pandemic marked a period of changes in habits and rules. However, studies in various parts of the world do not have consistent conclusions: in some cases, lifestyle habits and wellbeing were negatively impacted, while in other cases people started eating healthier or exercising more. Without doubt, the pandemic left traces on health and work, with major changes such as switch to teleworking and education based on online tools, increased stress, reduction of physical activity, deterioration of health status and concerns over safety and social interactions.

Exposure to emergent disease outbreaks occurred in recent years were associated with significant alteration of day-to-day life and health status [1], primarily on the basis of social distancing measures such as home isolation and quarantine. A cross-sectional study on 1,254 respondents in Spain tracked lifestyle behaviour, experience with Covid-19, self-reported health and previously diagnosed diseases. The study revealed that outdoor activities were significantly reduced during lockdown, with impact on physical activity. Further, sleep patterns and feeding habits suffered changes during lockdown; changes in diet were primarily caused by uncertainties over food supply and increasing use of comfort food [1].

As per a cross-sectional study on 995 respondents in India [3], healthier meal consumption was the major positive change, whereas reduction of physical activity, longer time spent in front of the screen (both for work-related activities and leisure) and rising stress and anxiety represented the negative sides of lockdown.

However, a very interesting conclusion was revealed by a cohort study on young adults in Switzerland: changes imposed by the pandemic context were regarded as facilitators for increased wellbeing, as lockdown represented a great opportunity for spending more time with family, partners and friends, exercising more, spending more time on hobbies and sleeping more [9]. Swiss young people engaged in activities that improve both physical and emotional life; also, the generally good health status reduced distress regarding the impact of Covid-19. This is further supported by a study on lockdown effects on UK people, where increasing participation in physical activities was associated with better mental health [5]. Nevertheless, perceived stress and anger increased after Covid-19 outbreak, backed by pre-existent emotional distress combined with stressors characterising the pandemic situation (lifestyle and economic changes) [9].

A study on 194 companies in Romania, performed during August-September 2020, showed that major advantages of remote working are lower health risks for employees, reduced costs for the company and more autonomous employees [10]. However, among the key challenges these companies face is weaker communication across the organisation, reduced time for coaching and training, and lower employee engagement [10].

Resilience was found to help people cope with effects of lockdown. A cross-sectional study with 711 respondents confirmed that subjects with higher levels of resilience are more likely to easily overcome difficulties faced in stressful situations, including Covid-19 lockdown [7]. One of the conclusions of a study on 587 individuals in Australia (both healthcare employees and community members) is that social connection with families and friends, limiting exposure to news regarding evolution of pandemic, sufficient and high-quality sleep, healthy diet, physical activity and meditation/mindfulness are the most adequate coping strategies in this challenging period [8]. This is further supported by a study that highlights fear and anxiety as main effects of Covid-19 pandemic. To minimise such negative outcomes, coping strategies mentioned above should be combined with a positive attitude and reading of stories about people who recovered from infection with Covid-19 [4].

3 Study Methodology

The authors developed a survey to understand how workplace wellbeing was modified by the shift from traditional working systems to teleworking. The survey comprises 24 questions referring to the following aspects: working scenario (teleworking, mixed, only in the office), training for teleworking, sources of information to properly organize remote working, investments (furniture, devices, re-decoration etc.), physical health (musculoskeletal disorders, weight gain, blood pressure and glycaemic index changes, infection with Covid-19, visits to the doctor and treatment), mental health, medical leaves, physical exercise and variables for subject classification/demographic information (gender, age, work experience, whether the respondent has management position, and the industry in which the company operates).

The survey was elaborated and distributed using SurveyMonkey, an online platform dedicated to development and use of data collection tools for businesses and researchers.

For validation purposes, the authors performed a pilot study in a private company operating in waste collection industry, where 44 employees have been working remotely since March 2020. The survey was distributed via email.

Research hypothesis was that lockdown and teleworking negatively impact wellbeing, with effects on physical and mental health.

The results of this pilot study are detailed in the following chapter.

4 Results and discussion

4.1 Study results

Out of the 44 employees invited to the study, 26 provided full responses, with a response rate of 59.1%. As per Table 1, 64% of respondents are female and 36% are male; 72% are aged between 35 and 55 years old and 84% have more than 5 years of experience.

Table 1. Respondents profile – statistical analysis

Variable		No of respondents	% of respondents	Median	Mean	Standard deviation
Gender	Male	9	36%	2.00	1.64	0.48
	Female	16	64%			
Age distribution (years)	<25	2	8%	3.00	2.84	0.83
	25-35	5	20%			
	35-45	13	52%			
	45-55	5	20%			
Management position	No management position	18	72%	4.00	3.40	1.06
	Supervisor	3	12%			
	Middle management	2	8%			

Variable		No of respondents	% of respondents	Median	Mean	Standard deviation
	Top management	2	8%			
Experience in work (years)	<1	1	4%	6.00	5.28	1.78
	1-3	2	8%			
	3-5	1	4%			
	5-10	3	12%			
	10-15	5	20%			
	15-20	4	16%			
	>20	9	36%			
Type of employment	Full-time	24	96%	1.00	1.12	0.59
	Student employed full-time	1	4%			

48% of respondents have been working remotely (teleworking) since March 2020 and 44% worked in a mixed scenario (alternated teleworking with physical presence in the office). For more than half of the respondents (56%), teleworking was the main scenario for over 6 months. Further, 52% of employees benefited from trainings/informative sessions/webinars dedicated to teleworking. When analysing the sources of information used to properly organize their activity at home, discussions with peers and acquaintances were the main source of information (68%), followed by multimedia materials and demonstration videos (such as YouTube) (20%), and e-books and online articles (12%); 24% of respondents did not search for information on this matter. In addition, 44% employees invested in improvements and redecoration of a room to organise a working space, 28% invested in furniture and 8% in electronic equipment such as PC, laptop or smartphone. However, 40% of respondents did not make investments for adapting their home for teleworking. The amount spent for the above investments ranges from 0 to 1,000 lei (~200 Euro), as follows: 0 (54.2%), 8.3% below 200 lei, 16.7% between 200 and 500 lei, 8.3% between 500 and 1,000 lei, and 12.5% above 1,000 lei.

The questionnaire also includes a set of questions regarding physical and mental health. Respondents were asked to rate from 1 (no pain) to 5 (unbearable pain) the discomfort felt in certain body regions. The results are presented in Figure 1. As expected, neck, shoulders and back were the main regions where respondents reported pain – these are the regions primarily affected by working in front of a computer/laptop. However, only one respondent reported unbearable pain in the lower back region. Long hours spent sitting, combined sometimes with inappropriate furniture and inadequate time organisation (long hours spent sitting without breaks) are the most common causes for these pains. Nevertheless, few respondents paid a visit to the doctor for musculoskeletal disorders (17.4%). Furthermore, 60% employees reported weight gains (32% gained 1-2 kg and 28% gained 3-4 kg); 3 respondents had high blood pressure (12%), 3 reported a slight increase in glycaemic index and 1 mentioned accentuated increase of glycaemic index. As mental health was not left apart, the most frequent psychosocial symptoms reported were exhaustion (32%), incapacity to relax (28%), headaches (20%), anxiety (16%) and insomnia (16%). Majority of employees were not affected by Covid-19 (88%). Since March 2020, 32% of respondents went to the doctor, 16% are under treatment prescribed by a specialist, 4% are under homeopath treatment and 4% are under naturist treatment. 12% of them had medical leave for 1 week (8%) or maximum a month (4%).

Considering that physical activity is highly important for overall wellbeing, 52% of respondents performed moderate physical activity and 12% vigorous physical activity. 36% did not perform any type of physical activity. 68% of respondents used to perform physical activity before Covid-19 pandemic.

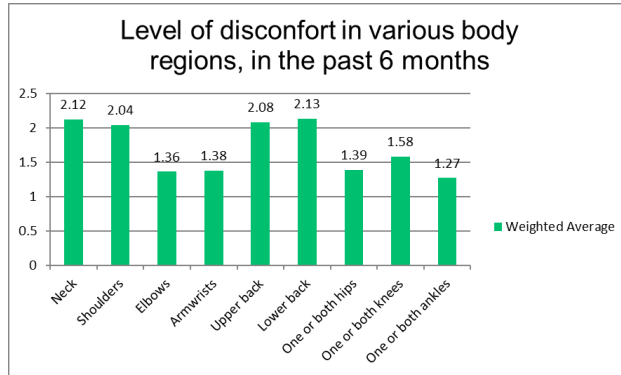


Figure 1. Level of discomfort by body region in the past 6 months – weighted average

4.2 Discussion

The hypothesis of the study was that sanitary restrictions and teleworking would impact workplace wellbeing, as it fuses with aspects from personal life to an extent where there is no clear limit between work and private life (as these all take place in the same space for the whole day).

After 6 months, respondents have already started to feel pain (moderate levels, but still a question mark on the long-term impact of such arrangements), gained weight, reported symptoms of stress and mental unwellness and followed treatments to ameliorate the symptoms. A positive aspect is that respondents performed physical activity, which is proved to reduce stress and improve the overall state of wellbeing.

Since majority of employees are aged between 35 and 55 years, the age is not necessarily a factor that would explain some of the symptoms. However, the large number of female respondents might explain high incidence of mental health symptoms, as social inequity forces women to take responsibility for aspects such as childcare and children education, online schooling (children need to be helped/supervised during online classes, especially in the first years of school), houseware etc., which all completely merged with job responsibilities in the moment when lockdown was officially put in place.

The authors consider that the results of the pilot study validate the survey as a proper tool for evaluating workplace wellbeing and will further perform a cross-sectional study to understand the impact of Covid-19 restrictions on workplace wellbeing of Romanian employees.

5 Conclusion

Negative outcome of Covid-19 pandemic consists in reduced outdoor activity, fear, anxiety, and reduced wellbeing. The pilot study highlights the negative effects of lockdown and teleworking on employees' physical and mental health (neck, shoulders and back pain, weight gains, rising glycaemic index, anxiety, headaches, impossibility to relax, reduced quality of sleep). Further, 32% of respondents required medical assistance for reported symptoms. To improve their working conditions, employees made investments in furniture and devices and they gathered information

primarily from acquittances and peers. Moreover, 64% employees performed physical activities since March 2020, a reduction from the 68% who used to perform physical activities before the pandemic.

Nevertheless, the negative impact of Covid-19 pandemic on work-life balance and workplace wellbeing should not be minimised: new strategies for improving quality of life for people working in remote scenario, finding new ways of social bonding in the context of social distancing and alternation of home and office working should be immediately addressed in order to reduce the long-term negative outcomes.

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International comparison of drone usage regulations

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Abstract

Nowadays nobody gets surprised to see a picture on a social media taken on an event or of a nice nature scene from an interesting perspective taken with a drone. However, the increase in popularity and quantity of drones requires regulations. Not only because of dangerous situations generated by a drone flying in a wrong place in a wrong time (like in the vicinity of airports) but also because it raises serious questions around data protection and privacy.

The subject of pilot-free flying vehicle is a very large one, thus in our paper we will study only the drones used for private, hobby and sport purposes, limited to remotely operated, weaponless flying vehicles equipped with a camera.

First, we will review the regulations used in the European Union, with a focus on the Hungarian regulations, followed by regions the regulations of which differ from the ones used in the European Union, such as the United States of America, Australia, Thailand and Russia. The main guidelines for regulation comparisons will be the weight of the drones, flying height and distance, as well as specifications of forbidden areas.

Finally, we will review countries in which the usage of drones in the airspace is completely forbidden.

Keywords: Drone, regulation, airspace protection, privacy, public safety

1 Preface

The development of electronic devices results in the need for new legislations and regulations on several domains. Due to their fast evolution, there will always be some areas of this industry the regulations of which will keep challenging the authorities.

The increasing number of pilot-free flying vehicles for civil or commercial use requires to set the limits and boundaries for their usage, thus, to protect privacy and private properties.

Nowadays most countries realize the importance of drone regulations and support the limitation of the usage of such flying objects as well as for their operators.

These regulations are even more important since these objects use the same airspace as other flying vehicles for transportation and other purposes.

It is important to emphasize the protection of individuals and their privacy, the need to avoid being able to fly too close to some buildings, people, events.

Thinking about public safety it is important that the drones should not be used as a weapon, should not be able to carry and drop down hazardous or hazardous-looking material.

2 Brief history of drones

One would think that drones are the result of the technical developments of modern times. As many developments, it has a history of several decades. Moreover, its development is far from being finished, it is still ongoing to propose always better and more modern drones on the market, easily accessible to private consumers.

As for most of the technical findings, the drones are originating from the military industry. Back to the end of the 19th century, the need to developing a flying vehicle without pilot sitting in it has been risen. The first written note about it dates from 1849, but of course at that time it was about a very rudimentary version and changes in wind and weather conditions mostly deviated them from their original destination. Such was the construction of the American version used in 1863 as well.

In the beginning from the 1900's this technology was in the focus of many engineers. The developments of this technology were sustained by the military and resulted in a solution where there still was need for pilot for takeoff, however later, during flight, the pilot could leave the aircraft.

Remote operation was introduced The Second World war. The explosives were mounted on an aircraft without pilot, which was operated from another aircraft, and they were all accompanied by a fighter plane. Yet the accuracy of this solution was still not satisfying.

The Cold War did not stop further developments, The American, Japanese, and Russian army kept working on remote operated flying weapons. A major change came during the Vietnam War where the American army used with high efficiency remote operated flying objects for night reconnaissance, signal disturbing and distribution of flyers.

Later, Israel - being in constant fear from attack - became the leader in research and development of remote operated solutions and became soon the supplier of pilot free flying vehicles for many countries including Russia, India, Great Britain, Germany, and Turkey¹.

In the 1990's drones used in the Yugoslav War were very useful for reconnaissance purposes, were equipped with high-end cameras and had an extended reach. In the 2000's such vehicles became one of the main weapons in counter terrorism.

Furthermore, the term 'drone' will be defined as per the generally accepted definition e.g. drone is an unmanned aerial vehicle² or vehicle system³ without a human pilot.

3 The ranking and regulation of drones in the European Union

About 8 to 10 years ago do use of drones for civil purposes had an extraordinary increase. The appearance of civil drones in such quantity resulted in serious new challenges for the lawmakers, since such remote operated objects are not only part of aerial traffic, but they are also generating many questions regarding data protection and privacy rights.

The first task was to define what is a drone, what are the subcategories and what regulations should apply to these subcategories.

In the European Union, the law of 2008 was replaced by a decree 2018/1139 of the European Parliament and European Council, entering in force in 20 days after its annunciation in all EU countries, including Hungary. This decree aimed the development and increased competitiveness of EU aerial circulation activity.

The fact that drones are using the same aerial space as other flying vehicles, and that the sale and usage of drones is a cross border phenomena, yet their purpose and use are differing makes this issue even more complex. Within the European Union every member state has the liberty to develop its own regulation system, since every country has his own risk level, and the adaptation of the regulations must be realized by local authorities.

Hungarian regulation is set by edict 4/1998. (I. 16.) section 1. § (3) about usage of aerial space. According to the regulation in force, drones do not need to have identification, thus their use for

¹ Dr. Palik Mátyás (szerk.): *Pilóta nélküli repülés profiknak és amatőröknek*. Budapest, Nemzeti Közszolgálati Egyetem, 2013. 44.p.

² Unmanned Aerial Vehicles (UAVs)

³ Unmanned Aircraft Systems (UASes), amely nemcsak a pilótánélküli repülőgépet, hanem a kezelőszemélyzetet, a földi irányítóállomást, a szükséges adatkapcsolatot, illetve tartalékeszközöket is magában foglalja

sport or private purposes does not require a registration by the Pilot-free Flying Vehicle department of the Deputy Secretary of State for Traffic Affairs of the Ministry for Innovation and Technology. Such vehicles belong to an open category, within which three subcategories are defined: A1, A2 and A3. These categories are defined by the weight of the drones, and the pilots of such drones need to pass a drone usage exam in which they must prove their knowledge about the most important data security, aerial space limitation and flying security regulation. In case of drones below 250 grams only the information of basic regulations needs to be acquired, and most of the drones do belong to this category. There are some basic rules that every pilot must respect. The pilot needs to guarantee that the drone will not put any person in danger, that it will keep the required distances, that it will not fly above more than 120 meters except if it must overcome an obstacle, that it will not carry dangerous goods and that it will not release any material. Moreover, the pilots must know the specifications of its own vehicle and must perform a technical check-up prior to take off.

There are still ongoing negotiations between member states of the European Union about a unified regulation system, based on decree 2019/947 which contains the practical regulations, and although it is in force since the 1st of July 2019 the local application thereof should start only from the 1st of July 2020. The European Union is thus offering the required time for preparation for adaptation to the member states.

4 Outside the European Union

In the following section of our paper, we will study some countries and states outside the European Union, such as states from the American continent, Asia, Middle East, and Far East region.

4.1 United States of America

One would think that in the United States of America the legal background has a hard time to catch up with the fast IT developments. Just like in the European Union the states still have the freedom and authority to regulate with their own decrees the usage of drones, however there are some centralized rules that apply to all states.

Before flying drone in the United States of America, one must register it on the government website FAA DroneZone⁴, specifying the purpose of the drone usage as well as its technical specifications. Drones for hobby and pleasure purposes must be below 250 grams, drones above these weights are subject to different regulations. Although it may seem obvious, but the regulations specify that the drone cannot fly close to other flying objects, they must respect the basic regulations, and cannot fly in vicinity of high voltage power lines. In America except for territories with G⁵ classification, drones need to have an air space usage permit. And the drones always must stay within visual distance⁶.

4.2 Russia

The Russian civil flying authority allows the flying of drones; however, the regulation does not differentiate between recreational, hobby and industrial usage⁷. Whereas in most countries the industrial use of drones requires a special permit, in Russia there is only weight restriction. Drones below 250 grams do not need to be registered and above this weight they do.

⁴ <https://faadronezone.faa.gov/#/>

⁵ *A légterek nemzetközi szabályozása A, B, C, D, valamint F és G betűkkel jelöli a különféle kategóriákat, az A és B osztályú légterekben a leghigorúbbak a szabályozások, a leghababban pedig a G osztályú légtérben mozoghatunk, azonban ez csak látás utáni repülést enged.* Forrás: <https://legikozelekedes.com/2017/06/17/a-legterek-i-avagy-hogyan-szarnyaljunk-szababan/>

⁶ UAV Coach: United States of America drone regulations. URL: <https://uavcoach.com/drone-laws-in-united-states-of-america/>

⁷ *A rekreációs célú drónok a kellemes, szórakoztató időtöltést szolgálják (pl. versenyek, fényképek készítése), a kereskedelmi célúknak pedig valamely vállalkozás profitjának a növelése a célja.* Forrás: <https://www.drone-made.com/post/the-5-differences-between-recreational-and-commercial-drone-flying>

Drones can be used during daytime in clear weather with good visual conditions, the flying vehicle must stay within visual distance, cannot fly above dense areas or above some specified habitats, military objects, or airports. Specific rules apply in Moscow to Kremlin and the Red Square above which hobby purpose drones are fully prohibited without a permit.

Russian authorities do not hesitate to react fast and to force to land almost without warning a flying vehicle operated from ground when they consider it is flying above some areas, events, or city centers being disturbing, by detecting them using their GPS signals.

4.3 Australia

Australian regulation slightly differs from the previous patterns in terms of weight of the drones as well as their use. According to Australia's Civil Aviation Safety Authority (CASA) it is legal to fly drones for recreational and commercial purpose in the Australian air, by using a very efficient regulation.

In Australia the focus was set on informing the civil society and offering them the required help, by creating an application which by determining the position of the pilot shows clear signs and comments on the regulations of drone flying in the given place and in vicinity of this position.

In areas marked with red color it is completely forbidden to use such devices, on orange areas one needs to pay special attention when flying drones, and around areas without marking one can freely fly drones. The application also contains the details of the regulations so the pilot can check them immediately before flying the drone. These being said, only drones for recreational purpose can be flown without a permit.

It is clearly set that one must keep a visual contact to the drone all the time during the flight, the drone cannot fly above 120 meters, the drone has to be kept at a distance of minimum 30 meters from people, must not approach temporarily rented airspace, privacy must be respected, at a given time one pilon cannot fly more than one drone, any crowd and gathering must be avoided. In case of drone of more than 100 grams control towers must be avoided by at least 5,5 km⁸.

4.4 Thailand

In Thailand there is a major differentiation between drones below and above 2 kilograms. Drones above 2 kilograms need to be registered at the Civil Aviation Authority of Thailand. Moreover, any drone equipped with a camera needs to be registered independently of its weight.

As a rule, drones cannot be flown closer than 30 meters to people, vehicle or construction areas, it cannot endanger others life, privacy and belongings. Its flying height must be between 30 and maximum 90 meters above ground. Airports and airport runways must be avoided by at least nine kilometers, and drone flights above cities any communities or gathering points is prohibited. In any case the drone needs to stay within visual contact distance, it cannot fly above clouds, and cannot carry dangerous goods. Flying above prohibited areas, danger zones, governmental buildings and hospitals require a special permit.

The violation of these laws results in serious repercussions, the punishment can be if one-year imprisonment, 40,000 TBH (cca. 1 000 EUR) or even the combination of both.

4.5 Japan

Japan was among the first countries in the world to introduce in 2015 regulations for use of pilot-free flying vehicles, however at the beginning these regulations were quite vague. After a small

⁸ UAV Coach: Australia Drone Regulations. URL: <https://uavcoach.com/drone-laws-in-australia/>

drone landed on top of Japan prime minister's office the lawmakers needed to rework these regulations. First, they determined areas above which the use of drones is prohibited.

Regulations are continuously reviewed and adjusted to the technical changes. As of today, without special permits drones can be flown up to maximum 150 meters above ground, it must be kept at a distance of minimum 30 meters from people, buildings and vehicles, drones must be kept within visual contact distance and can be flown only during daytime. Drones cannot carry dangerous or explosive material for example firework and no material can be spilled from drones, including liquids.

Flying of drones is prohibited above densely populated areas like cities, festivals, or events with many people. In Tokyo regulations are slightly different, 81 public parks and green areas are specified above which no drones can fly, independently of its size or weight⁹. An additional regulation of 2019 prohibits flying drones under influence of alcohol and drones are prohibited without permit in an area of 300 meters around Japanese and American military areas. Those who infringe the regulations are punished with serious penalties or even incarceration.

4.6 Mexico

In this country of the South American continent drones are differentiated by weights, drones below 250 grams do not require registration at the authorities.

In Mexico drones can be flown only during daytime, the drone cannot fly further than 450 meters from the pilots and must be kept at a maximum distance of 120 meters above ground. Drones cannot be flown in vicinity of people or animals, moreover it must stay away from historical sites except when the pilot has asked and received a permit from the related authorities beforehand to take video or photo shoots around these areas. Airports need to be avoided by at least 5 nautical miles which are about 9 kilometers. Drones must not let fall anything that can damage people or ruin one's possessions. It is important to be informed about the hotel's or accommodation's own drone usage rules before making a trip.

4.7 Iceland

The regulations in this northern island country are different from the ones we mentioned before. Drones for recreational purposes need to carry the name address and phone number of the pilot.

Above cities drones of maximum 300 grams can be flown and above rural areas vehicles of maximum 2500 grams can be sent into the air.

Maximum height of drone flights is 120 meters above ground or sea, safety distance from international airports is 2 kilometers, from buildings in cities 50 meters and from any other sites 150 meters, it must not disturb air traffic and must not get too close to any vehicle or boat.

Drones need to be kept within visual contact distance, and “the pilot needs to respect the basic directives for privacy and safeguarding”¹⁰.

5 Where prohibited or no regulations

Finally, we would like to mention some countries where pilot free flying objects are prohibited or where there are no regulations for these.

In Cuba the use of drones was never permitted and there are no plans for the near future to make any regulations for them, and that is why it is especially important for tourists to do their homework

⁹ Live Japan: Complete Guide to Flying Drones in Japan: Etiquette, Laws and Undersatinding No-Fly Zones. 2019.09.22. URL: <https://livejapan.com/en/article-a0003529/>

¹⁰ UAV Coach: Iceland Drone Regulations URL: <https://uavcoach.com/drone-laws-in-iceland/>

about conditions of traveling into the country and staying in the country before making the trip.

In Madagascar drones are completely prohibited, so if a tourist would like to enter such device into the country it will be most likely confiscated by the customs.

As of today, in Qatar the law says that only people of local nationality can fly drones but even they require a permit from the state.

In North Korea although there are some regulations regarding drones it is a general recommendation that such vehicles are better not used. The lack of regulations does not mean that drones can be used by anybody anytime and anywhere, as a matter of fact one should better be prepared to the contrary¹¹.

6 Summary

As we can see from the examples above questions about drones are rising in the whole world, there is a clear tendency to restrict the use of pilot free vehicle objects equipped with a camera.

There is clearly a pattern regarding the size of the drones, the safety distances from airports, the maximum of flying distance and sites where drones can be used freely, the respect of privacy is a basic requirement everywhere and we also need them to mention the protection of historical values.

The Australian solution could be an example, since thanks to the application within a couple of clicks all important information can be gathered by the pilots. We would consider important the introduction of sanctions, since regulations are of no use if their respect is left to the decision of the individuals, especially when we can observe an increasing number of delicate situations and misuse. Moreover, since the use of drones is not without risks, we would propose to consider the introduction of identification of drones by license plates which in case of recreational drones has not been introduced in any country yet. Finally, it could be useful to implement a general prohibition to flying drones under influence of alcohol.

In any case it is strongly recommended to gather enough information about drone usage laws and regulations in specific countries before making a trip there since changes in this area are to be expected soon.

In our next paper we will review legal case studies related to drone usage from Hungary and from the above-mentioned countries, showing the actual implementation of the theoretical sanctioning options.

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Lágyszámítási módszerek közlekedésbiztonsági aspektusai

Traffic safety aspects of soft computing methods

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Összefoglalás

Napjaink közlekedési szokásai jelentősen megváltoztak. Közlekedésbiztonsági szempontból fontos a közlekedési környezet vizsgálata is, így a külső eredetű zajok hallgatóságának objektív megítéskése. Jelen tanulmányban az utastérben kialakuló zajszint számszerűsítésére alkalmas fuzzy alapú modellek kerülnek bemutatásra és összehasonlításra. Az eredmények alapján a Sugeno típusú eljárás tekinthető pontosabbnak: a reziduumok terjedelme alacsonyabb -0,40...0,20 dB (-0,57...0,33%), továbbá normál eloszlást követnek 0 közeli várható értékkel és kicsi szórással.

Kulcs szavak: fuzzy következtető rendszer, közlekedésbiztonság, Mamdani típusú következtetés, Sugeno típusú következtetés

Abstract

Our traffic habits have enormously changed in the past decades. In analytical aspects, the investigation of the whole traffic environment is important even when analyzing the audibility of outer sourcing noise effects. In this paper, fuzzy-based phenomenological models are introduced and compared that can predict cabin noise level. The Sugeno type inference system was found better: the magnitude of the residuals was lower: -0,40...0,20 dB (-0,57...0,33%), and the residuals follow a normal distribution with a mean of approximately 0 and a low value of standard deviation.

Keywords: fuzzy systems, traffic safety, Mamdani type inference, Sugeno type inference

1 Bevezetés

Napjaink közötti közlekedési szokásai jelentősen megváltoztak a korábbi évtizedekhez képest. A járművek száma jelentősen megnövekedett [1]. Emellett megjelentek a részlegesen automatizált járművek is [2]. Mindezek következtében, közlekedésbiztonsági szempontból előtérbe került a közlekedési környezet átfogó vizsgálata. Azonban ezen elemzések legérzékenyebb „eleme” az ember, a személyből adódó szubjektivitás.

Kosztolányi-Iván és társai kimutatták, hogy bizonyos úttípusok felismerése nehézségeket okoz, míg mások besorolása egyértelmű a járművezetők számára [3]. További tanulmányok arra is rávilágítottak, hogy ez a folyamat azonban szoros összefüggésben van a haladási sebességgel. A környezet detektálása jelentősen javítható biológiai ihletésű rendszerek alkalmazásával [4].

A vizuális detektáláson túl, nagy jelentőséggel bír a közlekedési környezet zajossága, mely a

járművezető koncentrációs képességét is jelentősen befolyásolja.

A közúti zaj óránkénti mértékének közelítő számítására Singh és társai [5] négy különböző eljárást vizsgáltak. Ezek között egy hagyományos (lineáris modell) és három légyszámítási módszer (döntési fák, véletlen erdők, mesterséges neurális hálóok) szerepelt. A modellalkotáshoz a Patiala városában regisztrált mérések eredményeit használták. Arra a következtetésre jutottak, hogy a leginkább pontos és stabil eredményt a véletlen erdők esetén kapták.

Szintén fontos szempont az utastérben kialakuló zaj meghatározása és jellemzése [6], mely nem csupán a közúti járművek esetén bír döntő fontossággal [7].

Így összességében megállapítható, hogy egyre nagyobb szerepet kapnak a különböző légyszámítási eljárások, melyek lehetővé teszik a hangérzékelés szubjektívitásának figyelembe vételét.

Jelen tanulmány keretein belül két akusztikai méréssorozat eredményein alapuló fuzzy alapú prediktív modell kerül bemutatásra. Az utastérben kialakuló egyenértékű hangnyomásszint becslésére alkalmas modellek összehasonlítását a pontosság és a megfelelőség szempontjából végzem el.

2 Alkalmazott módszerek

2.1 Vizsgálati módszerek

Az akusztikai vizsgálatok egy 2004-es évjáratú Skoda Fabia személygépjárművön kerültek végrehajtásra. A mérések során egy kéthangfalas Hohner Stereo 50+ rendszert és egy Svantek 959 zajszintanalizátort használtam. A hangfalak a jármű két oldalán, attól 1 méter távolságra, míg a mikrofon az utastérben, a járművezető jobb fülének magasságában kerültek elhelyezésre. A vizsgálati elrendezést szemlélteti az 1. ábra



1. ábra Mérési elrendezés

A vizsgálatok végrehajtása során szakirodalmi ajánlásokat vettem figyelembe [6][9]. A mérés során az egyenértékű hangnyomásszint értékének rögzítése zárt ajtók és ablakok mellett történt. Vizsgálózájként rózsazajt alkalmaztam.

A mérési terv megalkotásakor két bemeneti változóként a gépkocsi üzemállapotához tartozó egyenértékű hangnyomásszintet (x_1 , dB), valamint a külső forrásból eredő gerjesztő hanghatás

szintjét (x_2 , dB) választottam. Mindkét változót három szinten változtattam. A méréseket ezek összes lehetséges kombinációja esetén végrehajtottam.

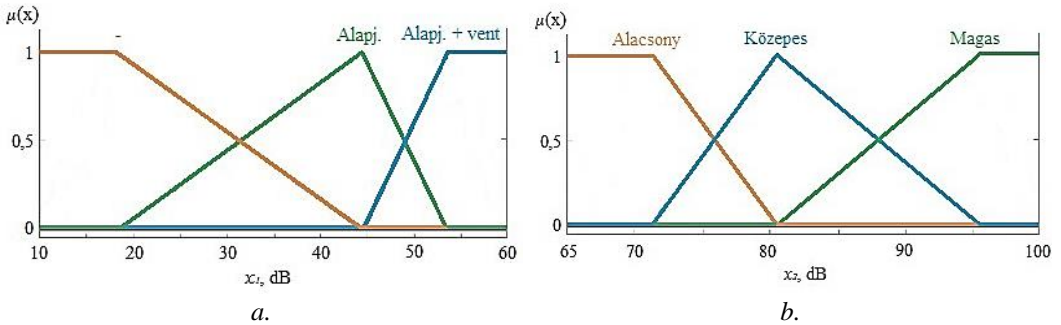
Az egyenértékű hangnyomásszint értékét rögzítettem, mely a környezeti zaj megváltozásának jellemzésére alkalmas paraméter[10].

2.2 Modellalkotási módszerek

L. A. Zadeh [11] nevéhez kötődik a fuzzy halmazok és a fuzzy logika, mely lehetővé teszi a részigazság matematikai kezelését. Így számos olyan probléma modellezhető, mely nehezen vagy nem algoritmizálható. A leggyakrabban alkalmazott fuzzy következtető rendszerek a Mamdani [12] és a Sugeno [13] típusú eljárás. Számos fenomenológiai modell alapul ezeken.

A prediktív modellek létrehozása során ezt a két módszert alkalmaztam. A rendszerek összehasonlítását elősegítendő, a bemeneti változók tagsági függvényei és partíciói azonosak voltak, csupán a kimenetek jellege volt eltérő.

A bementi változók szintjei tagsági függvényekkel való leírását a 2. ábra szemlélteti.



2. ábra Bemeneti változók partíciói

- a. x_1 tagsági függvényei
- b. x_2 tagsági függvényei

A felhalmozott szakértői tudás a szabálybázisban rögzíthető: így lehet leírni a bemenetek és a kimenetek közötti kapcsolatot. A következtető rendszer szabálybázisa látható az 1. táblázatban.

1. Táblázat Szabálybázis

Szabály	IF	x_1 , dB	AND	x_2 , dB	THEN	L_{Aeq_Mi} , dB	L_{Aeq_S} , dB
R_1		-		alacsony		y_1	47,20
R_2		-		közepes		y_2	57,45
R_3		-		magas		y_3	72,75
R_4		alapj. árat		alacsony		y_4	49,35
R_5		alapj. árat		közepes		y_5	60,20
R_6		alapj. árat		magas		y_6	72,65
R_7		alapj. + vent		alacsony		y_7	55,35
R_8		alapj. + vent		közepes		y_8	60,4
R_9		alapj. + vent		magas		y_9	72,3

A következtető rendszer utolsó lépése Mamdani féle eljárás esetén a defuzzifikáció. Sugeno típusú módszer esetén a kimenet crisp érték, így nincs szükség defuzzifikációra.

Korábbi tanulmányok [14] eredményei alapján a modellek összehasonlításakor Largest of Maxima defuzzifikációs eljárást alkalmaztam.

3 Eredmények és következtetések

A mérések során rögzített, és a modellek alapján számított eredményeket tartalmazza az 2. táblázat 1-9. sora, melyek a modellalkotáshoz használt beállításokat tartalmazza.

Megállapítható, hogy mind a Mamdani, mind pedig a Sugeno típusú eljárás alkalmazása esetén megfelelő pontosság érhető el az utastérben kialakuló egyenértékű hangnyomásszint számítása során; a reziduumok nagyságrendje $\pm 0,25$ dB a Mamdani, és $\pm 0,15$ dB a Sugeno típusú következtetés esetén. Ebből a szempontból jelentős eltérés nem állapítható meg a modellek között.

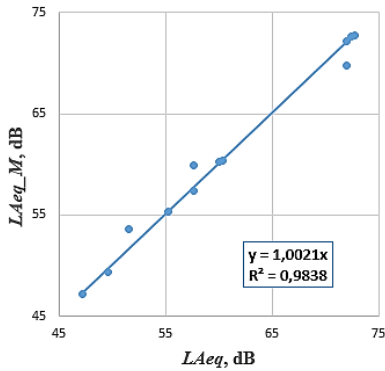
További konfirmáló mérés is végrehajtásra került, mely beállítások során a bementi paraméterek értékei az eredetileg vizsgált intervallumból származnak, de értékeik a modellalkotás során használt értékektől eltérőek (lásd 2. táblázat 10-12. sora). Ezek segítségével vizsgálható a modell megfelelése a teljes vizsgált paramétertartományon.

2. Táblázat Mért és számított eredmények összehasonlítása

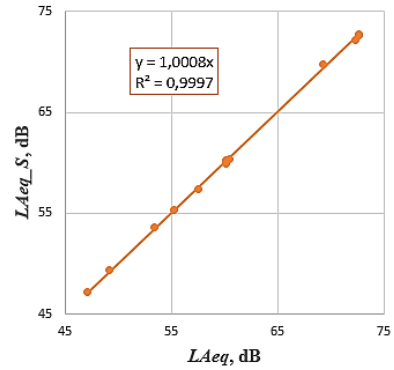
M. p.	x_1	x_2	L_{Aeq}	L_{Aeq_M}	ΔL_{Aeq_M}	ΔL_{Aeq_M}	L_{Aeq_S}	ΔL_{Aeq_S}	ΔL_{Aeq_S}
	dB	dB	dB	dB	dB	%	dB	dB	%
1.	18,4	71,2	47,2	47,2	0,00	0,00	47,1	-0,10	-0,21%
2.	18,4	80,5	57,45	57,6	0,15	0,26	57,5	0,05	0,09%
3.	18,4	95,6	72,75	72,8	0,05	0,07	72,7	-0,10	-0,07%
4.	44,5	71,2	49,35	49,6	0,25	0,51	49,2	-0,15	-0,30%
5.	44,5	80,5	60,2	60,0	-0,20	-0,33	60,1	-0,10	-0,17%
6.	44,5	95,6	72,65	72,4	-0,25	-0,34	72,6	-0,05	-0,07%
7.	53,6	71,2	55,35	55,2	-0,15	-0,27	55,3	-0,05	-0,09%
8.	53,6	80,5	60,4	60,4	0,00	0,00	60,5	0,10	0,17%
9.	53,6	95,6	72,15	72,0	-0,15	-0,21	72,3	0,15	0,21%
10.	18,4	83,1	59,9	57,6	-2,30	-3,84	60,1	0,20	0,33%
11.	44,5	74,8	53,6	51,6	-2,00	-3,73	53,4	-0,20	-0,37%
12.	53,6	91,7	69,7	72,0	2,30	3,30	69,3	-0,40	-0,57%

A modellalkotási és konfirmáló pontok együttes kiértékeléskor a Mamdani típusú eljárásról megállapítható, hogy a reziduumok nagysága $\pm 2,30$ dB (-3,84...3,30%). A Sugeno féle modell ennél valamivel jobb pontosságot eredményez, az eltérések -0,40...0,20 dB (-0,57...0,33%) értékűek.

Szintén vizsgálandó a modellek illeszkedése a mérési eredményekre. Ezt szemlélteti a 3. ábra, mely a számított értékeket a mért értékek függvényében ábrázolja. Amennyiben ezek megegyeznek, a pontthalmazra az identitás függvény illeszthető (45° -os egyenes, $y = x$ egyenlettel). Megfigyelhető, hogy a 3. ábra b részén látható Sugeno féle modell jobban közelíti az identitást, így pontosabb, kisebb eltéréseket mutat.



a.



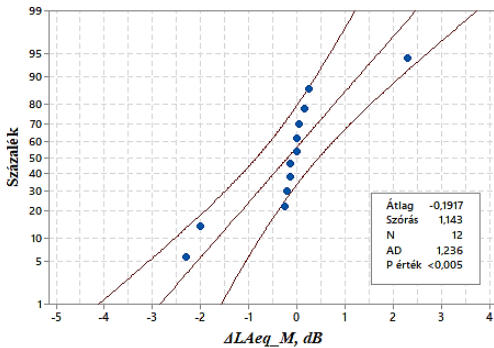
b.

3. ábra A modellek illeszkedése

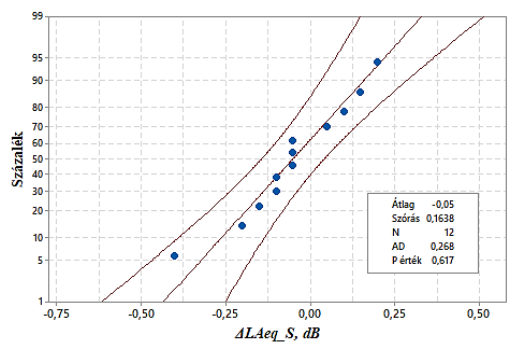
a. Mamdani típusú eljárás

b. Sugeno típusú eljárás

Az empirikus modellek vizsgálata során fontos szempont a reziduumok nagyságrendje mellett az eloszlás vizsgálata is, mely történhet normalitásháló segítségével (lásd 4. ábra).



a.



b.

4. ábra A modellek illeszkedése

a. Mamdani típusú eljárás

b. Sugeno típusú eljárás

Fenomenológiai modellek jósága akkor állapítható meg, ha a reziduumok normál eloszlást követnek 0 közeli várható értékkel és kis nagyságú szórással. A 4. ábra alapján megállapítható, hogy mindkét modell esetén a az átlag és a szórás kis értékkel bír. Azonban a 4. ábra a. részén, a Mamdani féle modell normalitáshálóján látható, hogy a reziduumok nem követnek normál eloszlást, mivel a P érték $< 0,005$. Ezzel szemben a b. résznél látható Sugeno típusú reziduumai normál eloszlást követnek (P érték = $0,617 > 0,05$).

Így a pontosság és a reziduumok szempontjából egyaránt jobbnak tekinthető a Sugeno féle eljárás alkalmazása az utastérben kialakuló hangnyomásszint számítására.

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Biometric Screenings and Health Initiatives: A Preliminary Study

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Abstract (Abstract Heading Style)

Wellness programs are becoming pervasive in the workplace. The following study captures employees' perceptions regarding wellness programs, health initiatives, and biometric screenings in a Hungarian company. As a result, nearly 95% of the respondents stated that biometric screenings are important; more than 88% expressed interest in participating in a screening event. More than 70% of the employees believe that it is the company's responsibility to safeguard the workforce's health. Approximately 90 % prefer an employer with health initiatives, and 61% trust an organization concerned about the worker's health.

Keywords: Biometric, Screenings, Occupational, Safety, Health

1 Introduction

Economy development can be achieved thanks to working activities. Employees should be considered the most valuable asset in a company. Hence, accidents, injuries, work-related illnesses, and fatalities directly influence the economy and impose a heavy burden on the family and society[1].

Occupational safety and health (OSH) management systems provide various benefits to the company and the workforce. Some of the advantages are enumerated below[2]–[4]:

Company

- As hazards, risks, and accidents are monitored and minimized. The company saves money in unplanned costs, health, insurance, fines, and compensations.
- The company's image, reputation, and value are created and enhanced. OSH initiatives show social responsibility
- The return on investment is high. For one euro spent in OSH practices, at least two euros return as profit for the business.
- OSH procedures maximize productivity and competitiveness and enhance sustainable development.

Employees

- Employees are healthy and motivated, which stimulates a multiplier effect in the workplace and their personal life to overcome poverty.
- Turnover and absenteeism are reduced while retaining trained staff, and job satisfaction is enhanced.

1.1 Wellness programs at the workplace

Wellness programs have become very popular among medium and large enterprises. They consist of a series of activities developed at the workplace, aiming to improve the employees' well-being [5]. These programs can be categorized based on the type of prevention efforts carried out. Table 1 shows the prevention efforts classification, the targeted population, and several examples.

Table 2: Classification of wellness programs based on the type of prevention efforts [6]

Type of Prevention	Target Population	Examples
Primary	Employees that are healthy or susceptible to preventable diseases	• Exercise
		• On-site fitness centers
		• Healthy eating
		• Adult vaccination campaigns
Secondary	Employees that are at risk due to certain lifestyle habits	• Weight and stress management programs
		• Smoking cessation programs
Tertiary	Employees that already have a health condition	• Weight loss programs
		• Disease management programs
		• Medication compliance programs

Biometric screenings constitute an essential component of wellness and health-promoting initiatives. These screenings are defined as measuring physical characteristics such as height, weight, body mass index, blood pressure, blood cholesterol, blood glucose, and physical exams taken at the workplace. These tests provide insight into the worker's health condition to arrange and put in practice prevention efforts[7].

The following work presents a preliminary study executed in a Hungarian company. Its main goal was to acquire information concerning employees' opinions and perceptions about health initiatives and the importance of workplace biometric screenings.

1.2 Antecedents

The research was done in a multinational company located in Budapest- Hungary. This company has a well-structured wellness program. The program consisted of several health-based activities such as tobacco cessation programs, disease screening, fruit availability in the workplace, on-site fitness activities, and discounts in gyms and physical activity centers. Additionally, this program has a web-based component, where the employees can register and be part of a virtual health network. In this community, health advice, interaction with other members, access to a mobile wellness application, and the possibility to pair fitness devices is provided. The company does not regularly offer biometric screenings. However, some biometric characteristics are collected and analyzed during health-oriented activities.

1.3 Objective and Rationale

This work aimed to explore the employees' perceptions regarding wellness programs, especially biometric screenings. It also captures their opinions and needs concerning wellness programs and ways to improve them.

Workers' involvement at every stage of wellness programs implementation promotes safety and health outcomes[8], [9]. Suggestion programs and surveys are beneficial because they collect data from the most reliable source. Workers are the people that know the most about their health, safety

necessities, and workplace hazards. Moreover, these programs empower employees and get them actively involved in safety and health initiatives[10], [11].

2 Methodology

The study comprised a thirty-one question survey, addressing the company's needs regarding data about the opinion, suggestions, and employees' requirements concerning wellness programs and health. The questions included demographic data, Likert scale questions, close and open-ended questions. The survey had four components:

1. Personal Information
2. Health Habits
3. Biometric screening questions
4. Workplace Health Initiatives

The survey was sent to the employees via a social networking service exclusively used at the corporation. It was available for two months, from December 2017 until January 2018.

3 Results

After retrieving and cleaning the data, eighty-nine respondents were used to presenting the data below. Descriptive statistics were applied to summarizing the data obtained in the survey. Microsoft Excel and SPSS were used for calculating means, standard deviations, percentages, and frequencies.

3.1 Demographic Data

The demographic data presented in Table 3 shows a slightly higher percentage of women compared with men. The average age is 37 years. Marital status is higher for married/ in a relationship while having children was reported by 36% of the sample surveyed.

Table 3. Demographic Data Preliminary Research

Characteristic	Value
Gender (%)	
Male	46,1
Female	53,9
Mean Age (Standard Deviation)	36, 69 (9,168)
Marital status (%)	
Married/ In a relationship	76,4
Single	23,6
Children (%)	
Yes	36
No	64

3.2 Health Information

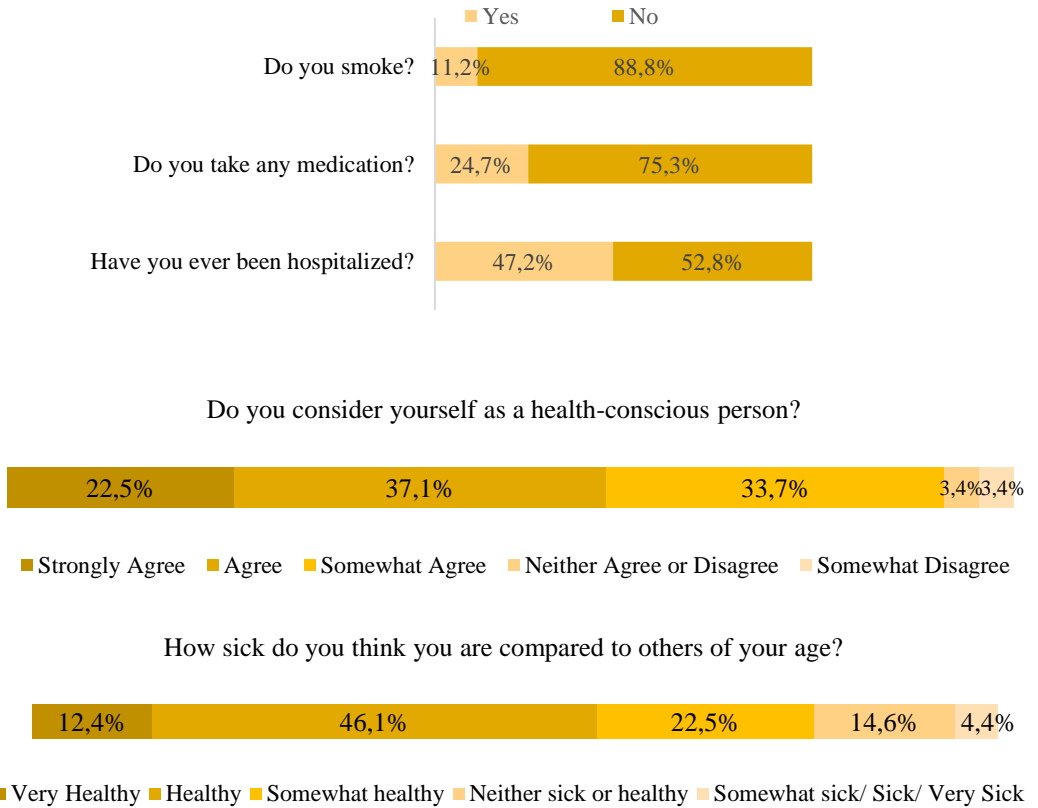
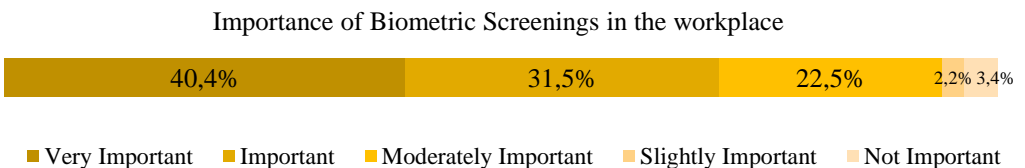


Figure 1. Health data preliminary research

Regarding health data, Figure 1 shows several health habits and perceptions among respondents. Health habits such as smoking and medicine intake present low percentages, while hospitalization is 47%. Concerning health perception, 81% of the respondents think that they are healthy, and nearly 94% agreed that they are conscious about their health.

3.3 Biometric Screenings



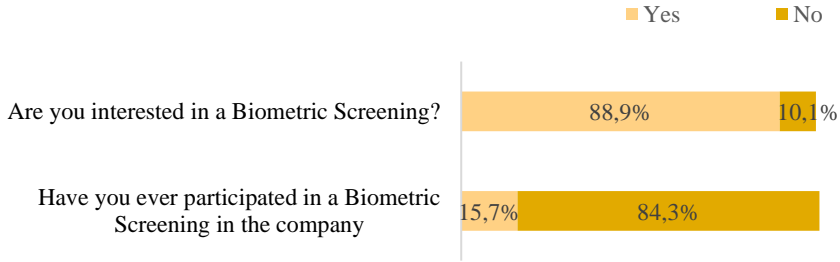


Figure 2. Biometric Screening Information Preliminary Research

Figure 2 presents data regarding the respondents' opinions about biometric screenings. More than 90% believe biometric screenings are important in the workplace. Concerning willingness to participate, nearly 89% are interested in being part of a biometric screening event while only 15.7% participated in screenings inside the company.

3.4 Wellness Initiatives

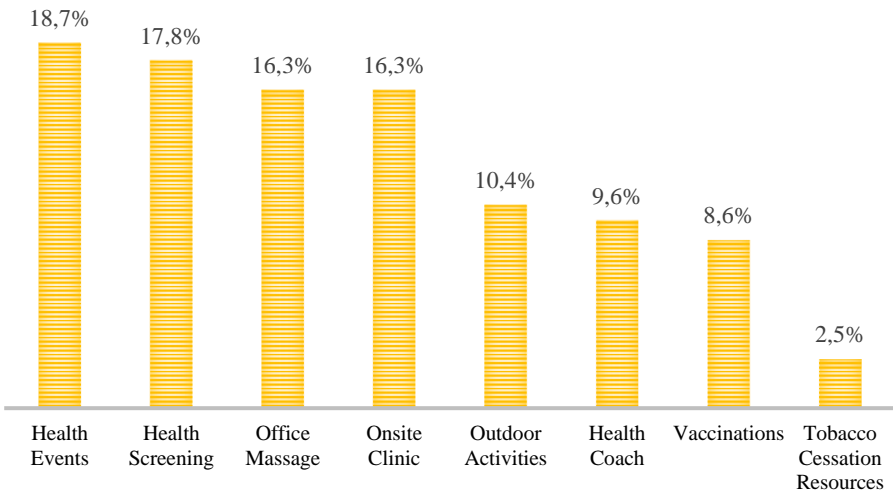


Figure 3. Wellness programs importance

Figure 3 ranks the importance of different wellness programs, according to the respondents. Health-related events, screenings, and health coaches are ranked higher than other activities such as tobacco cessation resources and vaccinations.

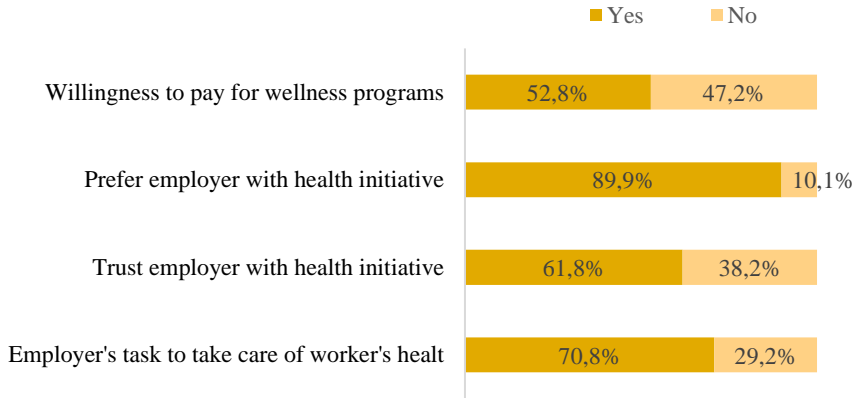


Figure 4. Wellness program opinion

Figure 4 shows several impressions regarding wellness programs. Concerning the employer's opinion about wellness programs, the respondents' preference was for a company that pays attention to their health. Additionally, more than half of the respondents are willing to pay for this type of program.

3.5 Other data

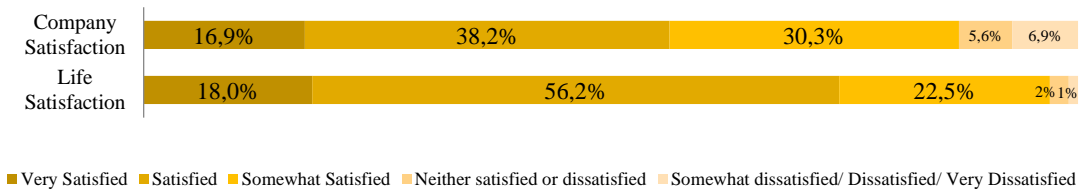


Figure 5. Company and life satisfaction

Figure 5 displays information concerning the respondents' level of satisfaction in life and the company. More than 85% answered that they are satisfied with the company with a minor percentage dissatisfied while nearly 97% are satisfied with their lives, and just 1% is dissatisfied.

4 Discussion

The importance of this preliminary research was to acquire a baseline regarding different aspects of wellness programs, especially biometric screenings. The survey administered to the employees gathered their perceptions, opinions, and suggestions to make the wellness initiatives, including biometric screenings, as valuable for the company as they are for the employee.

The survey's participation rate was low; 89 of the respondents were used to present the results. Even though wellness programs' availability and initiatives are continuously increasing in corporations[12], workers' participation is low[13], [14]. For this particular survey, more advertisements and an extended period to collect data could have given better results. Also, targeting

groups such as young[15], [16], or health-conscious employees[17] can increase participation rates.

This survey helped the company know about the employees' perceptions of health programs and their primary needs regarding its health initiatives. For example, a high percentage of the respondents trust and prefer an employer concerned about the workforce's health. Moreover, employees mainly suggested health-based wellness programs such as screenings and health coaches.

One of the survey's critical findings was the importance of these screenings for the employees regarding Biometric Screenings. More than 90% of the respondents think biometric screenings are very important, important, or moderately important. Furthermore, a significant percentage of the respondents expressed their interest in participating in this type of event while just nearly 16% participated in a biometric screening in the company. Therefore, it opened an opportunity to plan and execute a biometric screening event.

5 Conclusions

The study presented below summarized the employees' opinions concerning work wellness initiatives and created awareness about the importance of biometric screenings in an organization. The effectiveness of OSH initiatives in place or the introduction of new ones at an organization can be easily assessed by revising the biometric screening results. The results can indicate which OSH interventions benefit the workforce health over time, which ones need to be changed or updated by evaluating biometric markers such as blood pressure, weight, cholesterol, and more.

Biometric screenings are just one step to attain workers' health and safety. They do not replace an appointment with a physician but motivate a better lifestyle by making informed decisions about their health and change into healthy and safer behaviors. Its results need to be integrated with other components such as work processes and hazard assessments to providing motivating, satisfying, and quality jobs.

As for the upcoming trends in wellness programs nowadays. Tracking devices such as smartwatches or mobile fitness applications that collect the number of steps, heartbeat, calories burned, distance, and hours of sleep are gaining popularity among big enterprise companies. These devices can also accommodate each employee's different health necessities, such as pregnancy, diabetes, high cholesterol, blood pressure, or fitness, to create a program that motivates them and shows health improvement. Moreover, the usage of wearable tracking devices as part of a wellness program suggests a statistically significant reduction in body mass index values in employees [18].

The impact of sedentary jobs on workers' health is catching the public's attention. Health policies are trying to shape the work environment, but they do not provide enough incentives to the corporations. Biometric screenings can be the initial point for improving health and giving the employer motivation by offering data that can impact safety that, in the long term, reduces costs and improves the workforce's morale and the company's image.

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Az önvezető autók és az elektromos meghajtás közlekedésbiztonsági kihívásai és lehetőségei és az 5G hálózat kapcsolata

The road safety challenges and opportunities of the connection between autonomous driving cars and e-mobility and the 5G network

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Absztrakt

Az egész országra történő valódi 5G hálózati lefedettség kialakítása és annak különösen a közlekedésre kifejtett hatásának kérdései nagyon jelentősen befolyásolhatják Magyarország fejlődését az elkövetkező években. A jelenleg kiépült és elérhető távközlési hálózati infrastruktúra felhasználása nem adhat megfelelő alapot arra, hogy teljes körű lefedettség ki tudjon alakulni, mind megfelelő kapacitású és késleltetett adatátviteli lefedettség, mind az elektromos árammal történő ellátottság területén. Most a gyorsaság fokozottan számít, az európai országoknak is fel kell gyorsítani az infrastruktúra kiépülését, ha a távközlés terén versenyben szeretnének maradni és meg kell küzdeni azokkal a kihívásokkal, amit az elektromos meghajtás elterjedése okoz. A doktori kutatási témámhoz¹² szorosan kapcsolódó terület az önvezető járművek által keltett műszaki lehetőségek mielőbbi beépülése az ITS [4] [5] ökoszisztémába kapcsolódva a közlekedés egészének a digitalizációjához.

Kulcs szavak: 5G, kiscellás rendszerek, DSO, autonóm közlekedés, ITS ökoszisztéma

Abstract

The development of real 5G network coverage in the whole country and the special issues of its impact on transport in particular could have a very significant motivation on Hungary's development in the next years. Unfortunately the use of the current telecommunications network infrastructure would not provide a sufficient optical basis for full coverage, both in terms of adequate capacity, and with lack of terms of electricity supply either. Speeding of development is more important now, and European countries also has to speed up the development of telecommunication infrastructure if they want to remain competitive in the telecommunications sector and to meet the challenges posed by the proliferation of e-mobility. This area is closely related to my doctoral research topic too. The early integration and connection of the technical possibilities created by autonomous-driving vehicles into the ITS Ecosystem in-line with the global transport digitalization.

Keywords: 5G, small cell systems, DSO, autonomous transport, ITS Ecosystem

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1 Bevezetés

Régóta komoly probléma, hogy hogyan lehetne megoldani a hálózati lefedettségéből adódó inhomogenitási problémát. Több fórum is foglalkozott ezzel a témával, már a magyarországi Közmű Kerekasztal létrehozásakor is felvetődött ez a kérdés a 2000-es évek elején. A legintenzívebben a 2009-ben merült fel, hogy hogyan lehetne kialakítani Magyarországon az alternatív hazai hálózatfejlesztést. Erről a kérdéstről részletes információ elérhető egy korábbi publikációban [8]. Az elmúlt években, a doktori kutatási program keretében is, szembesültünk azzal a problémával, hogy a távközlési hálózatok rendelkezésre állása változatlanul nagyon heterogén az országban. A szakmai várakozás az autonóm járművek mielőbbi elterjedését prognosztizálják, azonban a kialakult távközlési szolgáltatók számára - mint kereskedelmi szolgáltatóknak – az ezt figyelembe vevő üzleti modell nem feltétlenül jelent belátható időn belül megfelelő megtérülést és profitot. Ezért valószínűsíthető, hogy az 5G hálózatok kialakításánál nem feltétlenül lesznek érdekelték KPI¹³ -ok betartására, nem fognak investálni az ország egész területét homogénen lefedő rendszer kialakításába.

2 A jelenlegi helyzet bemutatása

A Magyarországon kialakult 4G lefedettség EU szinten is kiemelkedőnek tekinthető a sűrűn lakott területeken, de ezt nem mondhatjuk el a rural területekről illetve a településektől távoli területekről. Már régebben felmerült az az ötlet, hogy érdemes lenne az alaphálózatot, amely egy nagy lefedettséget jelentő optikai hálózatot jelent valójában, függetleníteni a kereskedelmi szolgáltatásoktól, mintegy kiiktatni ezen a területen az infrastruktúra alapú versenyt. A fejlesztés legfontosabb motivációja, hogy az egész országra kiterjedő valódi 5G hálózati lefedettséget kell kialakítani, amelynek a közlekedésre kifejtett hatása jelentősen befolyásolhatja Magyarország fejlődését az elkövetkező években. Az az innovatív vezető szerep, amelyet az eddigi kutatásokkal a közlekedés területén Magyarországon elértünk, nem tudnak majd hasznosulni, ha nem lesz mögöttük valódi 5G hálózati lefedettség az egész országban. A már kiépült távközlési hálózati infrastruktúra felhasználása nem adhat megfelelő alapot arra, hogy teljes körű lefedettség ki tudjon alakulni, mind a megfelelő kapacitású adatátviteli lefedettség, mind az elektromos árammal történő ellátottság területén, mivel ezek a tornyoknak sem elhelyezkedésük, sem kapacitásuk nem kielégítő.

A hazai fejlesztési lehetőségeket feltérképezve [1], több alternatív hálózat kialakítási lehetőséget vizsgáltuk meg. Ezek közül költséghatékonyságban jelentősen kedvezőbb és gyorsabb megoldást adhatna az elektromos elosztóhálózatra alapozott és az ország nagy területét lefedő multicsoves száloptikájú alaphálózat kialakítása. A Distribution System Operatorok (DSO-k, azaz Elosztóhálózati Rendszerüzemeltetők), akik az elektromos áram elosztását végzik - a közszolgáltatási főtevékenységet kiegészítő jogszabály szerint - a megfelelő feltételek teljesülése esetén, kötelesek túrni a hírközlési hálózatok elhelyezését a közcélú hálózaton.

Ma már a Nemzeti Digitális Stratégia szakmapolitikai kérdései közé tartozó kérdéssé vált [2]. Ezzel a fejlesztéssel egy új, komplex nemzeti infrastruktúra jöhetne így létre, amely illeszkedne az EU stratégiákhoz. Ez költséghatékony, gyors és biztonságos megoldást jelentene, valamint olcsóbbá és gyorsabbá tehetné az 5G hálózati szolgáltatások kialakítását.

Az 5G alaphálózatával egyszerre ki lehetne alakítani a végfelhasználói FTTH hálózatot is. Ezen kívül, a smart metering/grid alkalmazásokat is áramhálózat üzemviteli célokra létre lehetne hozni. További innovatív smart megoldások (okos város) kialakításával, pozitív biztonsági hatásokat is el lehetne érni.

Később ezen a vonalon indultak el a DJP fejlesztések és a SZIP projekt is, amelynek

¹³ <http://www.codeplayon.com/2018/10/5g-technology-key-performance-indicators-kpis/>

köszönhetően ma már települési szinten nagyon jó távközlési infrastruktúra alakult ki. Azonban, ez nem tudja kielégíteni az 5G által támasztott műszaki követelményeket.

Jelenleg a technológiai fejlődésnek köszönhetően újra olyan helyzet alakult ki, amely alapjaiban fogja megváltoztatni a távközlés helyzetét az országban. Ezért célszerű volt újra átgondolni a lehetőségeket, és találni egy olyan valós alternatívát, amely elősegítheti az alapcél elérését, hogy homogén távközlési, infokommunikációs lefedettség alakuljon ki. Az EU fejlesztések is ebbe az irányba mutatnak, és szinte az egész világon felfokozott várakozás tapasztalható az 5G hálózat kialakítása iránt.

A DSO-k, akik az elektromos áram elosztását végzik - a közszolgáltatási főtevékenységet kiegészítő jogszabály szerint - a megfelelő feltételek teljesülése esetén, kötelesek túrni a hírközlési hálózatok elhelyezését a közcélú hálózaton. A kutatási program legfontosabb eredménye, hogy magasszintű egyeztetések eredményeként sikerült a Nemzeti Digitális Stratégia szakmapolitikai kérdései közé ezt témát felvetetni. Ezzel a fejlesztéssel egy új, komplex nemzeti infrastruktúra jöhetne így létre, amely illeszkedne az EU stratégiákhoz. Ez költséghatékony, gyors és biztonságos megoldást jelentene, valamint olcsóbbá és gyorsabbá tehetné az 5G hálózati szolgáltatások kialakítását. Az 5G alaphálózatával egyszerre ki lehetne alakítani a végfelhasználói FTTH hálózatot is. Ezen kívül, a smart metering/grid alkalmazásokat is áramhálózat üzemviteli célokra létre lehetne hozni. További innovatív smart megoldások (okos város) kialakításával, pozitív biztonsági hatásokat is el lehetne érni.

Az új infokommunikációs rendszerek elfogadtatásához nagyban hozzájárul a megnövekedett társadalmi szintű bizalom, a várakozás és a nemzetközi pandémia válsághelyzetben betöltött szerepük pl. távmunka, távoktatás, távgyógyítás stb. Erre hivatkozva gyorsabban meg lehetne teremteni azokat az új infrastrukturális alapokat, amelyek a korábbi piaci várakozásokkal csak elhúzódva alakulhattak volna ki. Elsősorban, a mindent lefedő optikai hálózati infrastruktúra kialakítását kell felvenni a prioritások közé. Az egész országra történő valódi 5G hálózati lefedettség kialakítása, és annak különösen a közlekedésre, az iparra és az egészségügyre kifejtett hatása nagyon jelentősen befolyásolhatja Magyarország fejlődését az elkövetkező években. A jelenleg kiépült távközlési hálózati infrastruktúra jelentős változtatások nélkül nem adhat megfelelő alapot arra, hogy teljes körű területi lefedettség tudjon kialakulni. Egyszerre kellene teljesülnie, hogy megfelelő kapacitású és késleltetésű legyen az adatátvitel, valamint az elektromos árammal történő ellátottság is megfelelő legyen.

A kutatás során több állírával is találkoztunk az 5G hálózat fejlesztésével kapcsolatban. Pl. a koronavírus-járványt összekapcsolták az 5G hálózat fejlesztésével. Ez olyan szintre eljutott, hogy Angliában és Hollandiában szerelőket támadtak meg és adótoronyokat gyújtottak fel emiatt. Tudatosítani kell a társadalomban, hogy az 5G-vel kapcsolatban több szakmai világszervezet felügyeli a fejlesztéseket, hogy azok minden szempontból megfeleljenek a biztonságos egészségügyi normáknak. Ilyen szervezetek az ICNIRP¹⁴ és az IEEE-ICES¹⁵. Az általuk meghatározott biztonsági határok jelentős plusz határértékkel is számolnak, habár ezek nélkül sem találtak egyetlen olyan 5G tulajdonságot, amely veszélyes, vagy akár csak aggályos lehetne az egészségre.

A kutatásunk során megvizsgáltuk az 5G technológia előnyeit, pl. hogy minél hatékonyabban lehessen videót letölteni, videókonferencián részt venni, vagy olyan minőségben nézhetjük meg a közvetítéseket a képernyőnkön, mintha mi magunk is ott lennénk. Az 5G elterjedését további nagyon komoly gazdasági érdekek teszik igazán szükségessé, mert a negyedik ipari forradalomnak, rövidítve Ipar 4.0-nak kialakulása miatt lesz rendkívül fontos. Ez a távközlési fejlettségi szint elengedhetetlen lesz a robotika, az önvezető autók, a virtuális vagy kevert valóság, vagy a mesterséges intelligencia létrehozása és fejlesztése szempontjából, nem beszélve arról a sok milliárd

¹⁴ <https://www.icnirp.org/en/publications/index.html>

¹⁵ <https://www.ices-emfsafety.org/>

egyéb IoT-eszközről, amelyek felhasználása teljesen új alapokra fogják helyezni a civilizált társadalmakat.

Az 5G hálózat kialakításánál a legnagyobb problémát a nagykapacitású adatátviteli optikai hálózat és az aktíveszközök áramellátásának a biztosítása jelenti. A Magyar Közút Nonprofit Zrt. adatai szerint, a magyar úthálózat hossza meghaladja a 200 ezer fkm-t, minden egyes km²-re átlagosan kb. 2 km hosszú közút jut. Azzal számolva, hogy kb. 112 méterenként egy-egy antennának kellene lennie, ehhez körülbelül 1 millió (kisméretű) antennára és 200 ezer folyókilométeren (fkm) többszörösen redundáns optikának kellene lennie az utak közvetlen közelében, hogy az 5G hálózat kialakítható legyen. Ismertettük, hogy a DSO-hálózatok mentén hogyan lehetne kialakítani, olyan multicso infrastruktúrát, amely egyrészt védett környezetben tudna működni, másrészt meghibásodás esetén könnyen javítható lehetne. A kapacitások elosztásánál ki lehet olyan üzleti modellt alakítani, amely révén a kereskedelmi szolgáltatók mindegyike igénybe tudni venni ezt az alap infrastruktúra szolgáltatást. Ezzel a fejlesztéssel egy új komplex nemzeti infrastruktúra jöhetne létre, amely illeszkedne az EU stratégiákhoz, költséghatékony, gyors és biztonságos megoldást jelentene. Olcsóbbá és gyorsabbá tenné az 5G hálózati szolgáltatások kialakítását.).

3 A kutatás eszközei és módszertana

Mi szolgálja jobban az ügyfelek és az ország érdekét, ha bizzuk a piac törvényeire, vagy ha egyéb megfontolások is érvényesülhetnek ezen a téren? - kérdést jártuk körbe.

Az infrastruktúra szempontú megközelítésből látszik, hogy a közcélú szolgáltatásokat összhangba kell hozni a magánvállalkozások által nyújtott lehetőségekkel. A korábbi vezetékes hálózati infrastruktúra modell ma már módosításra, átalakításra szorul. Az államoknak van az alpinfrastruktúra területén a legmeghatározóbb szerepe, mert a hálózati infrastruktúra építkezések alapvetően közterületeken történnek és a DSO hálózatok esetében a szolgalmi jog bejegyzések is rendezettek. Azonban ilyen jellegű hibrid infrastruktúrára a magyar jogszabályi háttér még nem alakult ki. Más szabályozás vonatkozik az elektromos hálózatra és a hírközlési hálózatra. Ezen a területen további hazai kutatási és szabályozási teendők is vannak. Ennek érdekében - a szakirodalom rendszeres tanulmányozásán kívül - felvettük a kapcsolatot hazai és nemzetközi kutatókkal, döntéshozókkal, illetve olyan piaci és kormányzati szereplőkkel, akik különböző mértékben érintettek (stakeholders) lehetnek az 5G hálózat hatékony kialakításában. Részt vettünk előadóként és hallgatóként jelentős szakmailag releváns konferenciákon. A KTI Kutatói Klubban 2020. májusában tartott előadáson a közlekedési szakma felől sikerült pozitív visszajelzést és megerősítést kapni arról, hogy az általunk végzett kutatásra van tudományos értelemben fogadókészség, támogatottság és együttműködési szándék. A nagy kormányzati rendszerek kialakításánál korábban szerzett saját tapasztalatainkat is jól fel tudtuk használni a kutatás során.

4 A legfontosabb eredmények

1. A kutatási program legfontosabb eredménye, hogy a döntéshozóknak sikerült megmutatni a problémára adható hatékony megoldást. A lehetőségek közül sikerült kiválasztani egy olyan megoldást, amely nem jelent ohmikus (1.ábra) kapcsolatot, így a multicsoves optikai száltartók az elektromoshálózatnál a felsővezetékek közvetlen közelében szerelhetők, a meglévő infrastruktúra érdemi átalakítása nélkül. A környezet számára is teljes mértékben elfogadható ez a megoldás, mert szinte „észrevétlenül” ki lehet vele építeni az 5G alaphálózatot. A további előnye, hogy a kivitelezés ára töredéke lehet a jelenlegi zöldmezős infrastruktúra építéseknek, és több célra is használható megoldást tud nyújtani hosszútávon.

Építési technológiák: Multicső vs. ADSS kábel

Multicső elhelyezése – innovatív megoldás - közcélú hálózat oszlopain

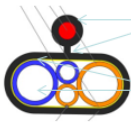
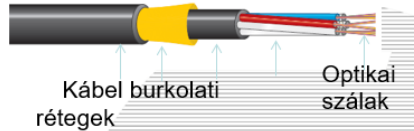


Fig8 - Feszítő szál+csőköteg burkolat (mechanikai rögzítés és védelmi funkció)
Védőcső – optikai kábel tartó funkció

Függesztett multi-csőves megoldás (távközlési alépítménnyel egyenértékű szerkezet)

- Teherhordó szál (Fig8) terhet visel
- Csövek csak az optikai kábeleket védik
- Telepítés két részből áll
 - Oszlop előkészítés és Multicső telepítés – villamosipari szakismeret
 - Optika befűtés

ADSS (All-Dielectric Self-Supporting) alapú hagyományos rendszer kiépítése



Önhordó optikai kábel – ADSS megoldás (távközlési kábel)

- A kábel szerkezet terhet visel, és a védi a szálakat
- Telepítés két részből áll
 - Oszlop előkészítés – villamosipari szakismeret,
 - ADSS telepítés – HK-i szakismeret

1. ábra Nem ohmikus kapcsolat alternatívái DSO hálózatokon (az ábra a [3] alapján készült)

2. A javasolt módszerrel az 5G hálózatok gyorsan és biztonságosan kiépülhetnek, amely kulcsfontosságú Magyarország és az EU versenyképességének fokozásához. Az így kialakított hálózat a nemzetbiztonsági védelmi szempontokat is figyelembe tudja venni.

3. A gyorsan fejlődő hálózati technológia komplex megközelítést igényel, ezért preventív módon hatékony és a kockázattal arányos biztonsági intézkedéseket kell tenni, előtérbe helyezve a beépített biztonságot és az adatvédelmet, mind az 5G infrastruktúra és mind a végberendezések tekintetében is.

4. A teljes ellátási láncra és az összes vonatkozó berendezésre kiterjedően az 5G hálózatot és a hozzá kapcsolódó egyéb elektronikus hírközlő hálózatokat életciklusuk teljes ideje alatt folyamatosan védeni kell. Erre a célra nagyon hatékony megoldás lehet a DSO hálózatoknál már kialakult gyakorlat és védelem felhasználása.

5 Konklúzió

A DSO hálózatok felhasználása az 5G alaphálózatok gyors kialakítására költséghatékony, gyors és biztonságos megoldást jelentene, valamint olcsóbbá és gyorsabbá tehetné az 5G hálózati szolgáltatások kialakítását is. Az 5G alaphálózatával egyszerre ki lehetne alakítani a végfelhasználói FTTH hálózatot is. Ezen kívül, a smart metering/grid alkalmazásokat is áramhálózat üzemviteli célokra létre lehetne hozni. További innovatív smart megoldások (okos város) kialakításával, pozitív biztonsági hatásokat is el lehetne érni. Ebben a folyamatban a kutatási programom eredménye nemzetgazdasági szinten hasznosulhat.

6 További lehetőségek

A kutatás továbbvitele szempontjából komoly lehetőséget jelent a Pilóta Nélküli Rendszerek (drónok) követése, és a velük végzett műveletekre vonatkozó szabályokról és eljárásokról szóló EU

2019/947 végrehajtási rendelet, amely új alapokra helyezi ezekkel az eszközökkel való tevékenységek végzését. Egyre inkább igény jelentkezik a drónok felhasználására az egészségügyben, a mezőgazdaságban, az ipari és a biztonsági megoldásoknál [6] [7]. A kutatási terv továbbvitele lehet, hogy ebbe a munkába bekapcsoljuk az 5G hálózat DSO-kra építő hatékony kiépülését.

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Security awareness in the education system

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Abstract.

In my paper, I present the threats related to information security and, in this context, the possible solution for the development of a security awareness approach and its integration into the education system. I present the opportunities offered by gamification and octal as a potential educational methodology for teaching security awareness. During the research, I surveyed the safety awareness of the previous two generations, Y and Z.

Keywords: Security Awareness, Education, ICT.

1 Introduction

Today, almost 5 billion people actively use the Internet. [1] This number is growing rapidly, as is the amount of data created by humanity. However, in most cases, the growth of user-generated and managed data is not followed by measures to protect the integrity of the data. Cyber attacks against various data centers and server parks are almost commonplace. Unfortunately, as a simple user, there is not much we can do against these since we do not retain most of the data.

With a few simple methods built into our data management process, we can increase the security of the data we create and manage. With this, we can make it harder to acquire, and they can access it to do, or they can just harder to get our data and our increasingly look for easier targets. However, we also need to be aware that if the attacker (s) need our data, they are almost not deterred by anything.

There is a price to protect our data, and we have to give up some of the convenience features. For example, if we do not use a code, pattern, or biometric identifier to unlock our mobile phone, the data stored on it will not be appropriately protected.

For this reason, I find it necessary to set complicated passwords or identifiers to protect our information. Don't follow those who still believe that the top three passwords are 123456, password, or 12345678 are the best choice. [2]

Utilizing information security solutions that are improperly or not at all can harm users. Due to poorly chosen virus scanners, there have been blackmail attacks in recent years that have made the contents of your computer's hard drive inaccessible and only resolved after payment of the ransom.

With poorly protected data, identity theft can be carried out, and new contracts can be made on behalf of the victims. The Insurance Information Institute (USA) has been collecting statistics on the effects and results of this attack method for several years. It showed that in 2018 more than 40% of the abusers entered into new credit agreements on behalf of the victims.[3] However, the attacks did not necessarily obtain personal or financial information directed. Their potential goal is to use the free resources of computers to perform a task/attack that requires more computing power.

In many cases, large companies and organizations have not even applied adequate security

systems to protect information. Think of the privacy issues of Facebook-Cambridge Analytica, or Julian Assange-Wikileaks, or recent hacking attacks. The latest known example made the entire server park of the Hungarian Development Center unusable.[4]

As a user must pay attention to better protect the data and media devices there, you need to know the dangers and care that should be drawn to them. By doing so, you can increase your own and our security awareness.

Information security threats can be brought to the attention of the education system from the very beginning. Most of the Alpha generation starting their studies started using ICT tools at an early stage [5] but are not aware of the dangers involved.

During my research, I sought a solution to introduce them, the members of the Alpha Generation, to the threats to their data, their devices, and the possible security measures. My goal is to integrate safety awareness into their daily lives and not see the bad in it.

2 Implementing and raising awareness of security culture

Not only the Alphas but also members of the previous generations Y and Z are already using info communication (ICT) tools, which is why there is an urgent need to develop an appropriate information security culture. I think it is essential to have proper guidelines for the safe use and storage of their personal data and devices.

In my research, I have taken into account the nine principles formulated by the Organization for Economic Co-operation and Development (OECD) in the field of developing a culture of information security. These principles apply equally to different users, students, teachers, with appropriate responsibilities for their role. All users benefit from awareness, education, information sharing, and training, which can result in a better understanding of security and better security practices.

The first of these is the principle of awareness. This includes knowledge of our environment. Everyone should know how the information system is structured, its benefits, and its risks and dangers. Students should be introduced to the other side of the coin, with possible consequences and outcomes. There are many examples of security risks ranging from blackmail to personality theft.

In the United States, The Federal Trade Commission follow up complaints about abuses of consumer fraud and identity theft that were filed in the federal, state, and local law enforcement bodies and private organizations. Between 2015 and 2018, approximately 3 million registered fraud cases were committed each year, with an average of 15% of identity thefts (Fig. 1.).

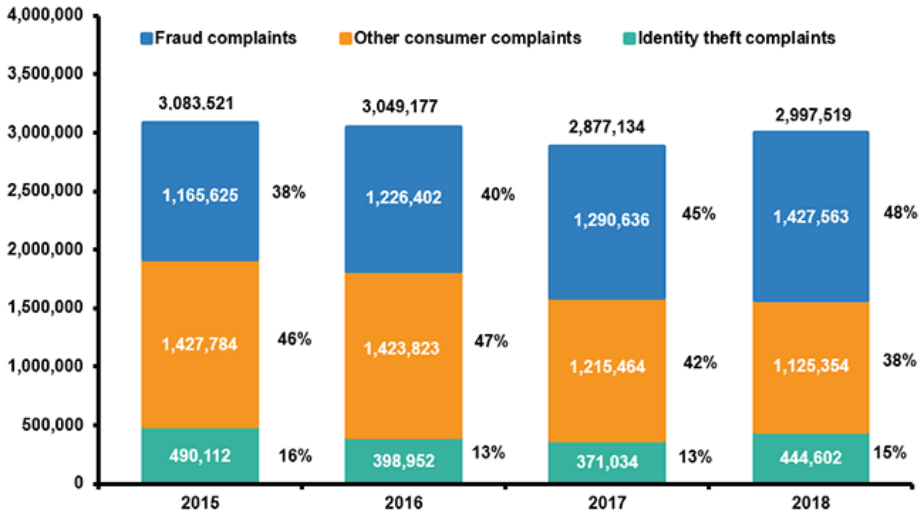


Figure 10. Identity Theft And Fraud Reports, 2015-2018

In many countries, it has happened that somebody has received too much negative attention in social media, for that reason, commit himself to do the wrong things (school shooting, suicide). Let us be aware of the power of information and pass on this thought to future generations.

The second principle is the principle of responsibility. Each user, operator, developer, or owner of an ICT System is responsible for the security of the network in different areas and to different degrees. In order to maintain safety, each actor must be aware of his or her own responsibilities.

The basic principle of response measures consists of two main parts. The first is to detect, prevent, and respond to unexpected security incidents in a timely manner. The second main part is the continuous exchange of information on detected vulnerabilities and threats.

The ethical principle to respect the legitimate interests of others and to be aware of the impact our actions, or even lack thereof, may have on other users.

The principle of democracy states that information security solutions must be in line with the values of a democratic society and support the free flow of ideas and ideas. Furthermore, there should be no restrictions on the protection, transparency, and openness of personal data.

The principle of risk assessment is that when designing our security systems, we must first and foremost assess the actual external and internal risks. From the assessed risks, the threats, vulnerabilities, and their effects on our own organization and on others must be identified. It is also an important step to determine the level of tolerated / tolerable risk.

Based on the principle of security planning and implementation, all elements of the information network must be designed with optimal security in mind. The plan must consider minimizing potential hazards and risks and minimizing impacts. In determining the level of protection should be sought proportionality of risk, observing the principles described above.

The security management principle is that all our organizational tasks must be based on risk assessment and follow our dynamically changing security status. We need to investigate future threats and disruptions. Security management shall include the ongoing review and maintenance of information security components, policies and regulations.

The ninth and last principle is the principle of reassessment. This principle essentially summarizes the previous eight principles. In our changing security environment, we need to

continually review and reassess the security of information systems and networks and make appropriate changes to security policies, practices, measures, and procedures. More and more threats and vulnerabilities are emerging that need to be addressed.

The adoption of these nine directives and comply with the instructions provided to promote the formation and development of a safety culture in the society. Our information security environment is continually changing, and newer and newer risks are emerging. Security awareness plays an essential role in the development of a safety culture. Dr. Kornélia Lazányi, in her article "The Security Culture," said:

“So, in addition to knowledge and competences, awareness and intentionality are a necessary element of a safety culture. Security awareness is an individual's sense of danger that extends not only to personal but also to organizational security. ”[7]

In my opinion, the broader interpretation of the organization here can be applied to society. From this point of view, the knowledge needed to develop a safety culture could be passed on to students in the education system. This is the first opportunity to introduce information security threats and the measures needed to counteract them. The following chapter describes these hazards, their effects, and the methods of protection against them.

3 Threats to, and impact on, and appropriate management of ITC users

Unauthorized access to data is considered when an unauthorized person (s) access or modify our data. This usually includes obtaining a user ID and the associated password but includes obtaining a personal identification badge. Its impact can be multifaceted, ranging from simple data access to classified information security incidents. You can protect against this by using hard-to-guess passwords and by setting up risk-based security systems.

In recent years, there have been several major international examples (Facebook, Uber, AOL, etc.) of getting or cracking passwords [8]. The ordinary user will continue to use 123456 as a password or any personal information that may be associated with it, such as birth date, pet name, etc. If an attacker is explicitly seeking to gain access to our data, he will use a brute force program that first attempts to log on to the system using passwords generated from data associated with us. It is possible to protect your passwords from getting and deciphering by using a well-formed combination of lowercase-uppercase-number-special character.

Viruses are tiny little malware whose purpose is to accomplish a specific task, be it destruction or extortion. In most cases, they come from some bootable files on our ICT device. By starting the application, the virus is already activating itself and performing a specific task or a command. Mobile phone viruses have also proliferated in recent years, mostly on Android devices, thanks to open source. To protect against them, it is possible to have an up-to-date database antivirus application. At the same time, I would like to emphasize that we do not allow the installation of programs from unknown sources in a security-conscious manner.

Worms are malicious software that exploits and spreads malfunctions in our devices or network security settings. Their primary goals range from deleting files to building a zombie network (botnet). For example, the Conficker worm forced the French Air Force on its knees because they could not send flight planes to fighter jets. [9] You can defend against this by constantly updating your security software on the network and ICT tools.

Trojan horses are seemingly useful programs that, in addition to their visible function, also perform dangerous functions. They typically come to our devices from infected websites or emails.

Their most important task is to acquire data and build botnet networks. The best-known of these trojans was Zeus, which used it to collect bank access information between 2007 and 2011, causing \$ 70 million damage [10]. You can protect yourself with an up-to-date antivirus program.

Spyware and malware, like the previous ones, are designed to obtain a user's personal or banking information. A variant of these is the recent appearance of "ransomware". Its impact can range from "simple" data theft to infecting government-owned computers. Protect yourself against them is difficult due to continuous development, use of up-to-date antivirus and anti-malware applications are recommended.

Other threats include junk mail (spam), hoaxes, and adware. A common feature of these is that they "bombard" the user with messages based on the email address or downloaded utility provided on an infected website. These have the greatest impact on resources and comfort. The only way to protect against this is to only register on a trusted website.

Phishing pages are created in most cases by copying Internet banking pages linked to financial institutions. In a received email, the user is asked to log in to their Internet bank and change their password because of a security incident. A link to the password reset page is placed in the email, leading the unsuspecting user to a page that is hauntingly identical to the original page, where he enters the requested information and delivers it to attackers. The basis of defense against this fraud is alertness and caution.

If you feel that a problem has occurred, please contact your system administrator, ICT Service Provider, or authority, depending on the magnitude of the impact of the information security incident.

4 Direct threats related to information security

Shoulder surfing is one of the most prominent immediate threats. Many people still store their passwords on paper sticking to their monitor or area, but it is not uncommon for a credit card to have a PIN on it. Abusing our passwords or identifiers can cause others to act on our behalf, which can have serious consequences. You can create or modify documents and make financial transactions. The defense against this is straightforward, do not write down your passwords and identifiers right next to the user interface or remember them. [11]

The next danger is fraudulent fraud or social engineering. In this case, the attackers manipulate their victim by various psychological methods and force them to enter their password and ID. Typically, a request for information reconciliation over the telephone is made about an information security incident. However, phishing emails may also be included. The effect of the acquired ID-password can be varied depending on the pair. It is easy to protect against it; do not give us your passwords or IDs.

It is also important to point out the dangers of stealing and scrapping IT assets. In many cases, the loss of negligently managed assets causes a major privacy problem. A lot of data can be recovered from the memory or storage of improperly managed scrap computers, phones. Sensitive organizations, therefore, typically do not dispose of device mass storage devices, but physically destroy them.

The last two common threats to information security, dumpster diving, and the inappropriate use of social networks. The former provides the necessary information from the trashed paper. In the latter, the user shares personal or official information on social networks, and from this information, many conclusions can be drawn. For example, an apartment may be empty or robbed during a long vacation.

The most obvious (and most cost-effective) solution to preventing the threats listed above is to raise awareness of the dangers. The following chapter summarizes this.

5 Awareness, gamification

Through (security) awareness, users are prepared for the dangers they face and are presented with the right information management behaviors. This method allows them to manage their ICT tools responsibly and aware of the risks they are aware of in their daily lives. The knowledge provided by the well-formulated awareness method is embedded in the basic behavioral standard, thereby reinforcing the previously defined security culture.

Numerous studies have been conducted in several countries around the world on how the two "digital generations", Z and Alpha, could more effectively communicate information within the education system. In an inverted classroom concept created by Guy Retta and Marquis Gerald [12], students were taught with video lessons and podcasts (audio) instead of personal performance. It was found that the students so educated outperformed the traditional classroom students, finding the actual class in the classroom to initiate more interaction. However, there were still problems during the adaptation period of this research.

Researchers say that playful learning activities allow students to acquire knowledge, develop skills, and promote positive traits through games specifically designed for learning. In other words, this type of teaching, gamification, is a student-centered process. It can be used from primary school to higher education and even in adult education.

In the Z and Alpha generations, the most appropriate learning and teaching scenario are no longer teacher-centered but instead focuses on active student activity and interaction. Recent years

The spread of the e-learning method is also an excellent example of this and the ever-popular Kahoot! too. In the latter's online interface, students are able to respond promptly to questions asked in the context of education. The system evaluates the answers and gives feedback to the student and the teacher immediately.

Gamification, as an educational methodology, is a new approach to training. Students born in the digital age can be reached through new channels that are more accessible to them. The essence of this teaching method is that instead of direct channels, the lecturer and the student interact with each other through digital or online interfaces. Individual and group challenges, rewards, points and levels have also emerged as incentives. The teaching and assessment method is more personalized and differentiated according to their own abilities. [13]

Research clearly shows that gamification has had a positive impact on learning outcomes in various forms, such as lesson enjoyment, commitment, motivation, effectiveness, satisfaction, and a better attitude to learning materials. [14]

In the gamification toolbox, students are most motivated by achievable and reward points, leaderboards, digital badges and challenges [15]. Research shows that these four elements (reward, leaderboard, digital badge, and challenge) are essential if you want to create effective learning activities. These elements should be considered as closely linked and used together to support learning activities.

Experience has shown that in order to achieve a larger goal (points, badges), groups were formed and solved the challenges together. This increased their communication and created their first group roles.

Ranking as a tool has played an essential role in the teaching method, as the results seen there move forward and also motivate students to hold the position when they are on top, while others are more motivated to reach and chase on top. Besides, they are happy to share their achievements online.

Summing up the results of the gamification make students more active and motivated in learning, allowing them to achieve the best performance of the evaluation of learning. It follows that

such an educational methodology can catalyze commitment and motivation (internal and external) that are essential to creating quality learning.

5.1 Octalysis, the new wave

This teaching method is continually evolving, refining, and adapting to the expectations of the age. One direction of development is the learner-centered framework created by Yu-Kai Chou [16], octalysis, which identifies the eight basic motivational forces that energize and “keep in play” students. This human (learner-centered) design recognizes that people have emotions, uncertainties, and reasons for wanting or not wanting to do things, and therefore optimize their feelings, motivations, and commitment as opposed to industrial systems in everyday life.

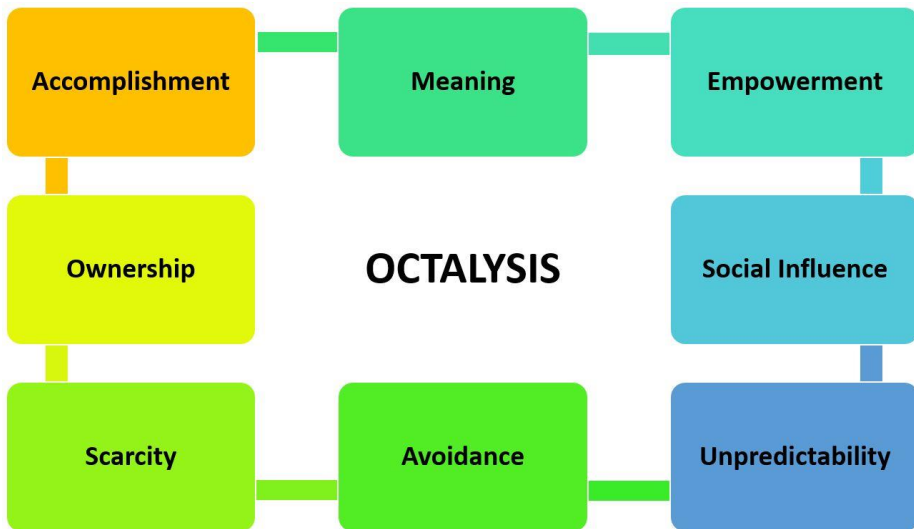


Figure 2. Octalysis framework with the eight core drives

Core drivers:

1: *Epic Meaning*: Volunteering for the community, not with external recognition, but with an internal reward.

2: *Development and accomplishment*: The inner driving force for progress, skill development, mastery, and finally overcoming challenges. However, it is important to recognize the challenge. A victory without struggle does not motivate. Scores, badges, and leaderboards are the most characteristic of this motivating force.

3: *Empowerment of creativity and feedback*: This feeling develops when students engage in a creative process, discover new things, and try different combinations, but they need to see the results and get feedback. A simple example is the Facebook Like button.

4: *Ownership and possession*: The need for ownership and the resulting comparability is a motivating force. The human desire to accumulate wealth and the overvaluation of physical and virtual objects (Facebook profile, number of Instagram followers) also belong.

5: *Social influence and relatedness*: This incentive power encompasses all the social elements that motivate people, including mentoring, social acceptance, company, and even competition and envy.

6: *Scarcity and impatience*: the fundamental drivers of something you desire, simply because it is extremely rare, exclusive, or inaccessible. Many people play with builder games where you have to wait for hours or days (torture breaks) to complete a building (but if you pay, you don't need to wait).

7: *Unpredictability and curiosity*: the main driver of ongoing commitment because it is not known what will happen next. When something is abnormal, our brains start to work wildly and pay attention to unexpected events. This is also the primary driver of gambling addiction.

8: *Loss and avoidance*: It motivates us to avoid something negative. Temporary, short-term opportunities make the most of this significant power because people feel that if they don't act right away, they lose the chance to act forever.

The octalysis-based education does not have much experience at the moment, but it seems to be a right direction. An outstanding feature of the system is the transparency and systematic nature of the curriculum. [17] Both gamification and octalysis can, in my opinion, provide a reasonable basis for developing a safety culture-building curriculum that raises security awareness.

6 Security Awareness Survey

In my research, I surveyed the safety awareness of these members of Generation Y and Z with 250 respondents from several regions of Hungary. Respondents were required to complete the following questionnaire.

Q1: Do you have a smartphone?

Q2: Do you use a password, pattern, biometric ID to unlock your phone screen?

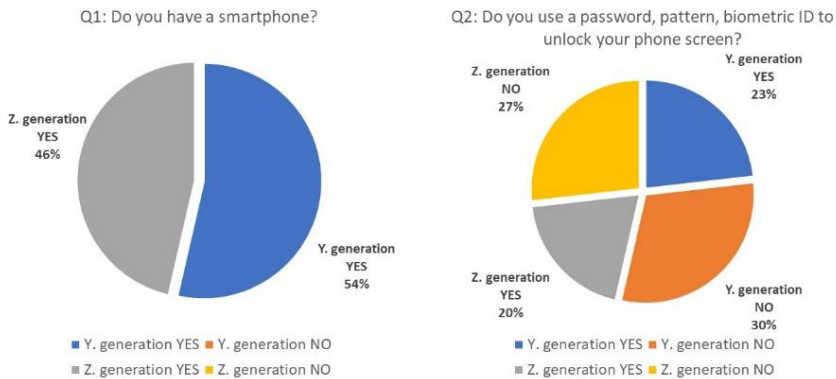


Figure 3. Evaluated safety awareness questionnaire responses (source: author's own)

Q3: Have you changed your unlock password or pattern over the past two months?

Q4: Have you changed your email inbox password in the last two months?

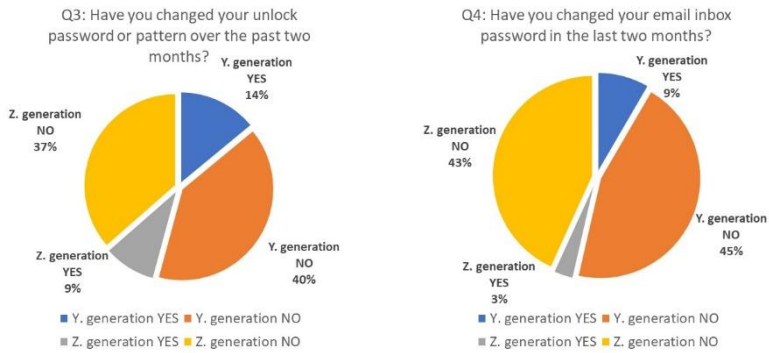


Figure 4. Evaluated safety awareness questionnaire responses (source: author's own)

Q5: Do you use the same password multiple times?
 Q6: Did you give this password to someone?

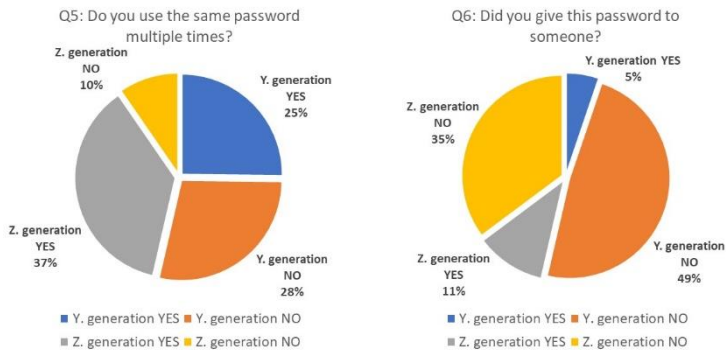


Figure 5. Evaluated safety awareness questionnaire responses (source: author's own)

Q7: Is your antivirus software up to date?
 Q8: Do you store your personal information on your computer?

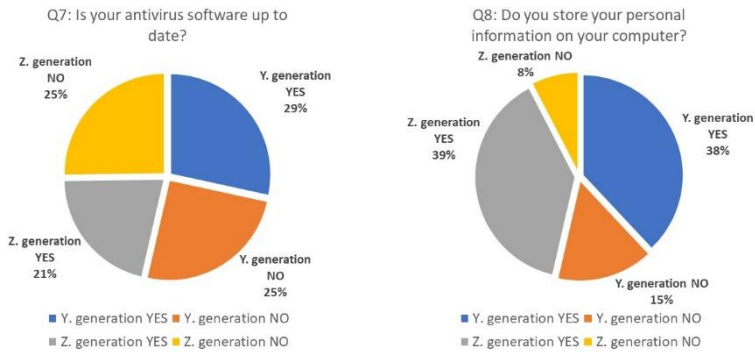


Figure 6. Evaluated safety awareness questionnaire responses (source: author's own)

Q9: Have you made a backup of them in the last two months?
 Q10: Do you use IT tools at work for private purposes?

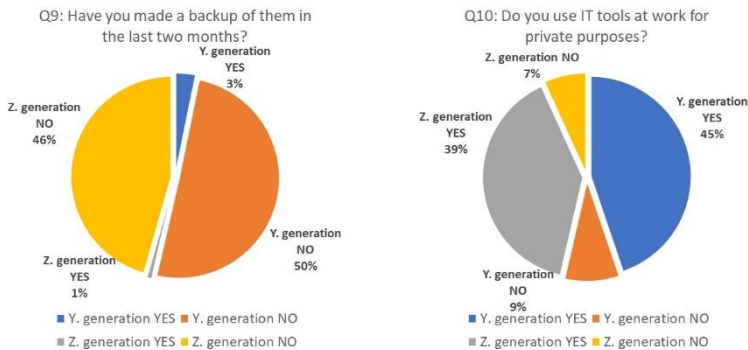


Figure 7. Evaluated safety awareness questionnaire responses (source: author's own)

As a result of the questionnaire, I made the following statements:

1. All respondents have a smartphone, but more than half (56-58%) do not properly protect their devices.
2. 74% and 79%, respectively, who have not changed their phone security solution in the last two months.
3. Over the past two months, 15% of Generation Y members have changed their mailbox password, which is used by 47% of users elsewhere. The same for Generation Z respondents, 7% and 80%.
4. 10% and 24% of the surveyed Y and Z generation users have already given this password to others.

5. 47% and 54% of the respondents, respectively, do not have an up-to-date antivirus system.
6. 71% and 84% of users store their personal data on a computer, but a small percentage (1-6%) of them have backed up in the last two months.
7. More than 83% of respondents also use corporate ICT tools for private purposes.

7 Summary, conclusions

During my research, I have found that most members of Generation Z and Generation Y do not adequately protect your personal information. However, nowadays, almost every movement we make, whether or not we communicate, with our consent or not, can impact our lives. I think the time has come to prioritize the security of our data over the convenience features. In my opinion, this process should be started from the ground up with members of the Alpha generation newly entering the education system, taking into account the needs of the digital age. Gamification and octalysis are the appropriate teaching methods.

In this topic, I plan to conduct further research on the relationship between smart cities and education, and the importance of adequate protection of biometrics.

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9 Figure index

1. Identity Theft And Fraud Reports, 2015-2018
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(download date: 02/07/2019)
2. Octalysis framework with the eight core drives (Source: author's own)
- 3-7. Responses to the Security Awareness Questionnaire (Source: author's own)



Élelmiszerbiztonsági szempontból kritikus pontok feltárása a klasszikus sörfőzés folyamatában

Exploring critical points for food safety in the process of classic brewing

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Összefoglalás

A kutatás célja, hogy feltárja az élelmiszerbiztonsági szempontból kritikus pontokat a klasszikus sörfőzési technológiai folyamat során. Amint ezek a befertőződési pontok feltárára kerültek, megoldást kell találni a megelőzésre, illetve alternatív lehetőségek felkutatásával új módszereket kell alkalmazni. A megfelelő technológia alkalmazása, a makulátlan higiénia és a gondos odafigyelés nem csak élelmiszerbiztonsági szempontból csökkentheti minimálisra a veszélyt, de az elkészült termék élvezeti értékét is növeli.

Erjesztés, pasztörözés, alapanyag-vizsgálat, technológia

Abstract

The aim of the research is to reveal critical points from the point of view of food safety during the classical brewing technology process. Once these points of infection have been identified, a solution must be found for prevention and new methods must be used to find alternatives. The use of the right technology, impeccable hygiene and careful attention not only minimizes the risk from the point of view of food safety, but also increases the enjoyment value of the finished product.

Fermentation, pasteurization, raw material inspection, technology

1 Bevezetés

Ahhoz, hogy fel tudjuk tární a kritikus pontokat, fontos tudnunk, milyen technológiai lépéseken haladunk végig a sörkészítés folyamatán. Ezek a folyamatok meghatározott hőmérsékleten, meghatározott időkereteken belül kell történjenek.

a. A sörfőzés lépései az árpától a sörig, technológiai szempontból

1. táblázat A sörfőzés lépései a malátától a csomagolásig, technológiai szempontból

Folyamat	Művelet	Idő	Hőmérséklet (°C)
Maláta őrlés	malátaörlés a héj leválasztása nélkül	1-2h	22
Cefrézés, sörlé elválasztás	forró víz hozzáadása	1-2h	30-72
Sörfőzés	sörlé és komló forralása	0,5-1,5h	>98
Sörlé fejtése	ülepítés vagy centrifugálás	<1h	100-80
Hűtés és levegőztetés	hőcserélő használata, levegőbuborékok befecskendezése	<1h	12-18
Fermentáció	élesztő hozzáadása	2-7 nap	4-22
Érlelés, kondicionálás	sör tárolása oxigénmentes tankokban, hűtés	7-21h	-1-0
Szűrés	centrifugálás, szűrés	1-2h	-1-0
Stabilizálás	pasztörözés és steril szűrés	1-2h	62-72 paszt. -1-0 szűrés
Csomagolás	töltés üvegbe, dobozba, hordóba, KEG-be, pasztörözés	0,5-1,5h	-1-szobahőmérséklet

1.1 Kutatás célja

Ennek a kutatásnak az a célja, hogy feltárja az élelmiszerbiztonsági szempontból kritikus pontokat a klasszikus sörfőzési technológiai folyamat során. Amint ezek a befertőződési pontok feltárára kerültek, megoldást kell találni a megelőzésre, illetve alternatív lehetőségek felkutatásával új módszereket kell alkalmazni. A megfelelő technológia alkalmazása, a makulátlan higiénia és a gondos odafigyelés nem csak élelmiszerbiztonsági szempontból csökkenti minimálisra a veszélyt, de az elkészült termék élvezeti értékét is növeli.

2 Tartalomelemzés - Kritikus pontok feltárása a technológiai folyamatok során



1. ábra A sörfőzés folyamata [6]

2.1 Hibás alapanyag

Ennek A sör legfőbb alkotóeleme a víz. Legtöbb esetben ezt a megfelelő alkotóelemekkel kezelve adják hozzá az őrölt malátához, ezzel biztosítva az állandó minőséget. Ezzel szemben a maláta sokféle veszélyt rejthet magában. Elterjedt alapanyaghiba a magas mikotoxin tartalom, mint például a fuzárium gomba [1]. Ezen mikotoxinok magas koncentrációja komoly egészségügyi kockázatot rejt magában [3] Szerencsére az Európai Uniói jogszabályok meghatározzák ezen toxinok maximális értékeit az élelmiszerekben [4]. A sörgyárakba legtöbbször a maláta már kész állapotban kerül be. Ha nem sikerült a gomba megjelenésének megelőzése a termelés során, kritikus pont a gyárba bekerülő alapanyag minőségének ellenőrzése [2].

2.2 A technológiai hőmérsékletek betartása

A nem kívánatos mikroorganizmusok elpusztítása fontos feladat a sörfőzés során. Éppen ezért folyamatosan figyelemmel kell kísérni a főzést, de legfőképpen a komlóforralás során a technológiai hőmérsékletek betartását [5].

2.3 Hagyományos főerjedés nyitott tankokban

Manapság egyre elterjedtebb a zárt erjesztőtartályok használata a főerjedés során is, de még mindig használatban vannak a nyitott erjesztőkádak is. Mindamelllett, hogy sokkal nehezebben szabályozható a hőmérséklet és a nyomás, sokkal magasabb a befertőződés veszélye. A levegőben található mikroorganizmusok könnyedén bekerülhetnek a fedetlen folyadékba, ezzel nem csak a sör mikrobiológiai összetételét megváltoztatva, de kiemelt veszélyforrást képezve veszélyes anyagok bekerüléséhez az erjedő sörbe [7]. Ma már szinte elképzelhetetlen, de a 80-as évek sörfogyasztó rétegétől még hallani olyan történeteket, melyben a kőbányai sör üvegében egeret találtak, pedig

külön embert alkalmaztak a gyárban, arra a feladatra, hogy távol tartsa a nem kívánatos rágcskákat a nyitott erjesztőkádák közeléből, illetve eltávolítsa a már mámoros állapotba került egyedeket.

2.4 Fejtés, pasztörözés

A termelés ezen szakaszán a sör nagyon sok új felülettel találkozik az eddigiekhez képest, ezért megnő a befertőződés veszélye [9]. Bármilyen felhasználási egységbe is kerüljön a kész sör, nagyon fontos a higiéniai szabályok betartása. Az újrahasznosított csomagolóegységeknél (visszaváltható üveg, KEG hordó) még több figyelmet kell fordítani a tisztaságra. A fertőzött sör nem csak élvezeti értékéből veszít (fény és oxigén érintkezésénél), de komoly élelmiszerbiztonsági veszélyeket is magában hordoz. Nem véletlen, hogy a nagyüzemi sörok legtöbbjét pasztörözik kiszállítás előtt. Ezzel megteremtik a mikrobiológiai stabilitást, elpusztítják az esetleges kórokozókat, viszont ezzel a sör veszít élvezeti értékéből [11]. E szempont figyelembevételével alkották meg a pasztörözetlen, rövid lejáratú idejű, de magasabb élvezeti értéket képviselő tanksöröket. Emellett történtek kísérletek a sör mikrohullamokkal történő sterilizálására is, mely szintén megbízhatónak bizonyult, sőt, még előnyei is vannak [10].

3 Eredmények – Megelőzési lehetőségek és megoldások

3.1 Alapanyagvizsgálat

Vannak sörgyárak, ahol teljes analitikai és mikrobiológiai labor áll rendelkezésre az alapanyagok és a készülő termékek jellemzőinek és tulajdonságainak folyamatos ellenőrzésére, nyomonkövetésére. Azonban ezek a lehetőségek nem mindenhol állnak fenn. Ebben az esetben célszerű a beérkező malátát beküldeni egy laboratóriumi vizsgálatra, hogy kizárható legyen a gabona befertőződöttsége. Amennyiben ellenőrzés nélkül, fertőzött alapanyag kerül a sörbe, azt onnan kivenni már nem lehet. Sokkal költségesebb a teljes készterméket utólagosan megsemmisíteni, mint előtte ellenőrzést végezni. Az EU határértékeket nem lépheti túl a toxikus anyagok jelenléte, és ha mégis ez történne, tilos visszahívítani a készterméket megfelelő minőségűvel. Így tehát mindenképpen javasolt az alapanyagok vizsgálata, mielőtt bármilyen folyamat is elkezdődne a sörfőzésből. A HPLC készülékekkel egyszerűen és gyorsan kimutatható a gabonában található fuzárium mennyiség [12].

Az alapanyagok beszerzési forrásaira is érdemes odafigyelni. Ha tehetjük, mindig válasszuk a hazait. Az olcsóbb alapanyag lehet, hogy a végén drágább lesz, ha kiderül róla, hogy fertőzött. Válasszunk mindig jó minőségű alapanyagokat, amiket mi is jó szívvel fogyasztanánk.

Egy másik lehetőség a gabona fertőzésveszélyének kiiktatására, ha helyettesítő terméket használunk alapanyagként. Manapság igen divatos lett a gluténmentes sör, itt is gabonapótló terméket használnak egyes esetekben [13]. Népszerű a búza, kukorica, rizs használata árpamaláta helyett.

3.2 Hőmérsékletkövetés

A sörfőzés során elengedhetetlen a megfelelő technológiai hőmérsékletek betartása. Gazdaságilag meghatározó tényező, hiszen a hűtés-fűtés igencsak energiaigényes folyamat. A nem megfelelő hőmérsékletek nem megfelelő végterméket szülnek, de ennél sokkal fontosabb, hogy a élelmiszerbiztonságilag is kritikus pont a komlóforralás, hiszen a nem megfelelő magasságig emeljük a hőmérsékletet, nem csak a komló kihozatala lesz rosszabb, de a sörlében megmaradt mikroorganizmusok sem pusztulnak el, amik az emberi szervezetre veszélyesek lehetnek. Nem csak a hőmérsékletre, de a technológiai idők pontos betartására is figyelni kell, hiszen, ha nem tart megfelelő ideig a hőkezelés, ugyanúgy hibázunk, mint a nem megfelelő hőmérséklettel. Ma már van

annyira fejlett a technológia, hogy az alapanyag hőmérsékletét a teljes gyártási folyamat során ellenőrizni és standardizálni lehessen. A gépesítéssel ez a veszélyforrás kiküszöbölhető.

b. Nyitott erjesztőtank elhagyása

Bár a nyitott erjesztőtartályokban készült sörnek van egy különleges ízvilága, amit zárt térben, nyomás alatt lehetetlen elérni, sajnos sok veszélyt rejt magában. Bármennyire is óvatosan és körültekintően, a higiéniai szabályokat maximálisan betartva próbálunk sört erjeszteni nyitott erjesztőkádakban, sajnos az élelmiszerbiztonsági veszély megnő. Ezért célszerű modern, cilindrikonikus kialakítású zárt erjesztőtartályokat használni a sör teljes erjesztési folyamata során, melyben mind a hőmérséklet, mind a nyomás szabályozható, és elkerülhető, hogy idegen anyagok kerüljenek a sörbe.

3.3 Pasztőrözés fontossága, szállítás

A sör erjedése hosszú időt vesz igénybe, akár több hónapig is tarthat. Ezalatt számtalan lehetőségük van a mikroorganizmusoknak megtámadni a sört, ráadásul az erjesztés végén a tankoktól a csomagolóanyagba kerülésig hosszú utat tesz meg a sör, ahol számtalan veszélyforrás leselkedik rá. Ezen veszélyek kiiktatására szolgál a pasztőrözés folyamata, amely hőkezelést takar. Többféleképpen alkalmazható, pillanatpasztőrözéssel vagy alagútpasztőrözéssel, mindegyiknek megvannak a maga előnyei és hátrányai. Megjegyzendő, hogy az alagútpasztőrös eljárásnál a sör már az üvegben van, mikor bekerül, és a hirtelen hőmérsékletváltozás miatt az üveg könnyedén eltörhet, és a sörökbe üvegszilánkok kerülhetnek. Ha ezt a technológiát alkalmazzuk a csomagolósoron, célszerű egy szilárd test detektort felállítani az alagútpasztőr után, ami kiszűri az ilyen eseteket.

Fontos, hogy a tárolóeszköz, amibe a sör belekerül, és útjára indul a fogyasztóhoz, minden esetben tiszta legyen. Kiemelten fontos ez az újrahasonított eszközöknél, mint a visszaváltható üveg, vagy a KEG hordó. Ha nem megfelelően kerülnek elmosásra és kitisztításra, fennáll a befertőződés veszélye. Ma már egyre elterjedtebb a tanksörök fogyasztása, ami azt jelenti, hogy a gyárból egyenesen a sörözőkbe viszik a sört hatalmas tankokban, pasztőrözetlenül. Az eltarthatósága ezáltal nagy mértékben csökken, viszont a hőkezelés elhagyása miatt az élvezeti értéke nagy mértékben nő. Ahhoz, hogy a tárolótartályok ne szennyeződjenek, és ne kelljen hetente fertőtleníteni őket, a gyárak egy steril zacskóval bélelik ki a tankok belsejét, és közvetlenül ezen zsákokba töltik a sört, ami így nem érintkezik a fém felületekkel. A zsák kiürülése után eldobható, ami élelmiszerbiztonsági szempontból megnyugtató, ámde környezetvédelmi és fenntarthatósági szempontból aggasztó.

4 Konklúzió

A megfelelő élelmiszerbiztonsági szint a sörkészítés során elengedhetetlen. Kellő odafigyeléssel és gondoskodással kiküszöbölhető és megelőzhető a veszélyforrások javarésze. Fontos, hogy figyeljünk a megfelelő alapanyagra, és még a folyamatok elkezdése előtt ellenőrizzük az alkotóelemek megfelelőségét. Ha a hőmérsékleteket szabályozni tudjuk, szintén nagyobb biztonságban készülhet a főzetünk. Az elavult technológiai megoldások elhagyása nagy mértékben növeli az élelmiszerbiztonsági szintet, ezért célszerű a legmodernebb technológiákkal dolgozni, és semmi esetre sem lehetőséget biztosítani a befertőződés lehetőségére egy korszerűtlen technológiai megoldással. A termékünk elkészültét követően magas kockázatot rejt magában a csomagolás fázisa, ezért itt még nagyobb körültekintéssel érdemes kezelni a lehetséges veszélyforrásokat. Ha az apró részletekre is kellően odafigyelünk, biztosak lehetünk benne, hogy az elkészült sörünk élelmiszerbiztonsági szempontból kifogástalan lesz, és veszély nélkül élvezhetjük a hab alatt rejlő

folyékony aranyat.

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Risk management of biometric systems at international airports

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Abstract

Either biometric identification refers to the recognition of the figure according to the descriptions. Physically or interactively, biometrics came to change the idea of the personal guarantee from what we own and memorize to what we look like. This paper includes a survey over biometric techniques, tools used in many organizations and facilities generally, and aviation environment specifically. The survey argues the efficiency of biometric tools that we use daily. The survey also seeking for the audiences' opinions about biometric security and its ability to expose theft attacks. The main aim of this paper is to exam the security and efficiency at airports by analyzing the results of the survey to give better understanding to the struggles travelers must face from the moment they enter the airport until they reach to the airplane gate

Keywords: biometrics; security system; airport; risk management; biological; pattern recognition

1 Introduction

Biometrics is the measurement and statistical analysis of people's unique physical and behavioral characteristics. The technology is mainly used for identification and access control, or for identifying individuals who are under surveillance. The basic premise of biometric authentication is that every person can be accurately identified by his or her intrinsic physical or behavioral traits. The term biometrics is derived from the Greek words bio meaning life and metric meaning to measure [1].

Recently, the applications of biometric have started to move to real world applications after many years of developing in the research labs. Examples of this movement toward using biometric identity in real world applications are the big number of fingerprint sensors and the rapidly increasing interest in iris identification and face recognition as a technology that can be used in access control. Biometric applications are the main block in the developing of security applications in two main fields: the first one is related of protection of critical infrastructure. Surveillance systems and computer vision are the selected technologies to be used in this field. The second one is the Automatic Border Crossing (ABC) systems. Biometric technology is used here to replace police inspection of passports. Facial and fingerprint verification are the main data to be considered in this systems. Using cameras in critical infrastructure like airport is common in both fields to perform face identification. Facial biometry gives the possibility to monitor the object without its awareness, and that is the main advantage of using it over iris identification or fingerprint [2].

2 Risk management

The term of risk management appeared in the '50s of the last century to describe the effectiveness of acquiring insurance. Focusing on biometric identification the paper proposes risk management of biometric systems in airports. Risk management is directed to avoid adverse situations and minimize the loss of goods. Nowadays the risk is defined as the neutral or negative consequences of events. Sometimes it is defined as positive and negative consequence. Those events can be divided as chance (to get profit and utility) and risk (to get damage and loss). These are called dual events [3].

The recent reports of network security breaches and identity thefts further affirm the fact that a strong authentication method is in the need of nowadays. This has put the focus on biometric security, as it is the only effective way to prove an individual's identity. Biometric traits are inherent and unique to each individual and comprise physical and behavioral characteristics such as fingerprints, face, iris, voice etc. Therefore, biometric security systems can verify an individual's identity with utmost accuracy and reliability since biometric traits are part of the individual's being [3].

3 Biometric systems: theory and practice

Biometric authentication is the process that is used to identify oneself through one's behavior, anatomy, physiology (for example, through fingerprint or iris), or even vocal patterns [4]. To enable future use of one's biometric image, such image needs to be captured, encrypted and stored [5]. According to research, fingerprints form 52% of biometric systems in the whole world [6]. This popularity of fingerprint biometrics is because of the accuracy of fingerprint images [7]. An edge that the biometric authentication method has over other methods is on its requirement for the presence of the actual use for the verification process to take place [8].

It is expected that the usage of biometrics will grow rapidly in the 21st century, especially in countries such as India, South Africa, and Ghana [9]. These claims are supported by those who [7] support the idea that biometrics will be the ultimate authentication method. The growth in popularity of this technology may be attributed to its provision of a better and reliable access control compared to traditional systems. This assertion is also confirmed by those who state that biometrics improve security control and reduce fraud. Another reason for its growth could be the need to improve safety measures and curb acts of terrorism in public areas, such as airports [9]. For example, in Dubai, the airports have introduced at their border gates an automatic identification system called e-Gates. The system is used to scan facial and iris imprint to authenticate the passengers [10].

Malaysians are pioneers of biometric passports [11] (e-passports), which have curtailed the use of false travel passports in Malaysia [11]. Other use of biometric technology includes access to places, such as work or bank premises, and network resources, information protection [1].

4 Examples for some international airports where biometric technology is used

4.1 International Airport Dubai

At Dubai Airport, the passenger is registered for biometric identity inside the UAE. This system is the same system which is used across the federation's seven emirates: Abu Dhabi, Ras al-Khaimah, Ajman, Sharjah, Dubai, Fujairah and Umm al-Quwain. That can cause another queue at the airport, so there is more point should be added to improve the experience of the passenger. However, the launching of Apple's new Face ID solution makes registration of mass biometric at the beginning of a passenger's journey faster than ever before.

The passengers registered into a biometric system that was separated from the main infrastructure. For this trial, they implemented the MFlow system software from Human Recognition Systems (HRS), with hardware in the form of a handheld device from Tascant, which enables the efficient capture of iris, fingerprint, and face biometrics. The data was uploaded into the Cloud, and accessed through a secure database in Dubai [10].

4.2 Heathrow Airport

At the Heathrow Airport after a four-month trial period, air travelers in the UK gave their assent to a biometric security system. The trial used iris and fingerprint scans to screen more than 3000 passengers traveling from and to Hong Kong and Dubai. The goal of this trial was to test the feasibility of the system, which would check the passenger's details against various intelligence databases and, watch lists before allowing them to embark on the flight.

Before boarding the flight, the passenger has to scan his or her passport and right fingers at the self-service kiosk. Then the passenger's biometric details will be compared and if it is validated access will be granted. The enrolment system collected two iris images, ten fingerprints and a facial scan, which digitalized, and after that, it is stored in Radio Frequency Identification Card (RFID). This card was compatible with fingerprint readers installed at the immigration barriers at Heathrow, Dubai, and Hong Kong airports [12].

4.3 Amsterdam Schiphol Airport

A trial of biometric boarding has been started at Amsterdam Airport Schiphol and KLM. This trial will enable passengers to board their flight without the need to show their passport or boarding pass. Instead, passengers board the plane using a special gate that uses the facial recognition technology.

Passengers have to register first in order to board using facial recognition. In the waiting area near the gate, For this purpose a special registration kiosk has been added. In addition, the KLM staff will be ready to offer all the possible help [13].

4.4 Hong Kong airport

In Hong Kong International Airport (HKIA), travelers can use automated e-Security Gates those depend on facial-recognition technology.



Figure 1. E-Security Gate Source: <https://www.florasecurity.net/e-gate-system/>

Eligible travelers can use the electronic gates to scan boarding passes and their documents. Then these documents will be verified by facial recognition technology using the gates' embedded cameras. However, this process is still done manually by the airport security staff [14].

4.5 Orlando International Airport

Greater Orlando Aviation Authority (GOAA) is the first to deploy fully the U.S. Customs & Border Protection Biometric Entry and Exit Program. At the beginning of 2018, a cooperation between SITA, GOAA and British Airways and Customs & Border Protection (CBP) started to incorporate the US biometric departure check for British Airways customers. The trial's success has prompted the airport-wide implementation of the technology.

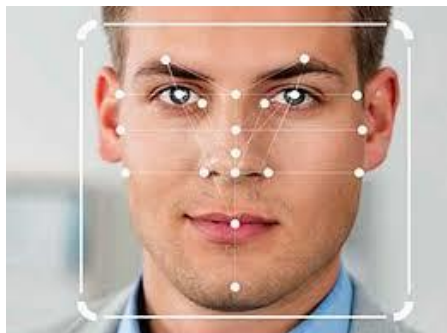


Figure 2. SITA facial recognition system Source: <https://americansecuritytoday.com/orlando-airport-implement-100-biometric-exit-sita-see-videos/>



Figure 3. SITA Biometric system at Orlando Airport Source: <https://www.phocuswire.com/SITA-Orlando-biometric-exit>

4.5.1 What is SITA system?

SITA provides IT solutions to airlines, global distribution systems (GDS), major travel management companies, online portals, railway companies and government border-management agencies. While it remains the only provider to deliver an integrated, seamless end-to-end, self-service passenger experience through solutions from check-in (passenger and baggage) to boarding to border security. 1.3 billion passengers have been checked in using SITA's common user terminal equipment (CUTE).

SITA also provides air-ground communications over an integrated network of more than 1,100 VHF data-link ground stations across more than 160 countries. It ensures 13,500 aircrafts are connected using SITA's aircraft communication services with 100 million type-B messages carried per day, 4.6 million flight plans delivered a year.

4.5.2 Entry and exit process:

The facial recognition verification process takes less than two seconds, with a 99 per cent match rate. CBP chose a facial biometrics system because it seamlessly integrates into the airport's current verification processes. By comparing the photographs of travellers with those that are already on file in Department of Homeland Security (DHS) holdings, no new data is required.

The exiting process is prior to boarding: CBP generates biometric templates of the historical images (including passport and visa photos) of travelers for a given flight and temporarily stores them in the Virtual Private Cloud. Each traveler approaches the departure gate during boarding to stand for a photo, which is captured by a camera operated by airlines/airport authorities.

The matching service verifies the traveler's identity by comparing the best photo taken prior to boarding to the historical images in the CBP database. Once verified, the passenger can board.

British Airways is said to have boarded flights of almost 240 passengers in around 15 minutes. The technology means passengers just need to look at the camera, no need to present boarding passes or passports at the gate. The system makes passenger boarding quicker and easier, while it also incorporates the new secure biometric exit checks [15]

4.6 Shannon Airport

Shannon Airport in Ireland has deployed biometric facial recognition technology to speed up its security screening process. Shannon Airport, which is operated by Shannon Airport Authority, is located on the west coast of Ireland 24km north of Limerick city. Last year, more than 1.75 million passengers passed through the airport.

Using the facial recognition technology, the security personnel at the airport verify passengers by matching them to the documents they are presenting [16]

4.7 Ottawa Airport

To enter Canada through the Ottawa International Airport, travelers will use biometric kiosks. Instead of the paper customs forms those were used previously, the kiosks will be used to process new arrivals to the country. After disembarking, travelers will use the kiosks in order to enter their personal details, and then the kiosks will scan their faces and compare the images against those in their passports. Nowadays much of the process can be done on the plane by using a mobile app, proceeding to upload the data to the kiosks upon arrival [17]

4.8 Atlanta airport

In Atlanta's Hartsfield-Jackson International Airport, Delta Air Lines launched what it called America's first "biometric terminal". This technology was initially used at boarding gates. On Nov 29, 2018, it opened the nation's first curb-to-gate biometric terminal, which is expected to improve aviation security and keep moving travelers faster by taking only 2 seconds for screening. This program uses facial recognition technology in order to check-in pass through board flights and security without having to scan boarding documents or a passport in all of the airport's international terminals. This camera-based system compares scans of travelers' faces to a database of verified ID photos curated by US Customs and Border Protection (CBP) with a 98% success rate. For the busiest airport in the world, like Atlanta, it saves 9 minutes for the boarding process, which the time that the passengers will not be spending in lines in waiting to board the aircraft. Besides, to saving time, it makes airports and air travel safer in an era when aviation systems are targeted often by criminals and terrorists. [18]

5 Results

We can see from these examples that facial recognition is the most biometric system and it is used in many airports, and some cases it can be used along with fingerprint and iris, that we summarized in this table:

In addition, we can notice that iris is not that common and usually it is not used alone. As it is shown in table only Dubai International Airport is used the all three biometric systems together.

Table 1. Comparing the used biometric systems between different airports

Airport	Facial recognition	Fingerprint	Iris
International Airport Dubai	Used	Used	Used
Heathrow Airport	Unused	Used	Used
Amsterdam Schiphol Airport	Used	Unused	Unused
Hong Kong airport	Used	Unused	Unused
Orlando International Airport	Used	Unused	Unused
Ireland's Shannon Airport	Used	Unused	Unused
Ottawa Airport	Used	Unused	Unused
Atlanta Airport	Used	Unused	Unused

Source: Author own edit

6 Conclusion

The need for security is something that nowadays matters to all of us in the different fields and environments in which we are involved on a daily basis. This is possible thanks to the use of a biometric identifier for each passenger whose information is stored in a private and secure database and that will allow them to access all airport services and even pay in the stores attached automatically to their profiles. By digitizing this information, trends and behaviors of users can be analyzed to improve their future experience.

Airport operators and airlines are adding biometrics to boarding passes or frequent-flyer cards to improve security or streamline the traveling process. Most countries are starting to include biometric data (usually digital photographs and fingerprints) in passports and identity cards. It is likely that, soon, every traveler will encounter biometric systems at every stage of travel. If this happens, such systems must not only support their stated security aims, but travelers must be able to interact with them and find the user experience acceptable.

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Soft computing methods in cybersecurity

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Abstract

In this paper, the aim is to show how computational intelligence methods (fuzzy logic, neural networks, genetic algorithms) can be used for detecting and preventing the most common attacks (Evasion, Data Poisoning, DoS and DDoS) to test its performance and weaknesses against adopted malware and to identify advanced persistent threats early on its life cycle using prescriptive analytics. This research also propose some soft computing based general solutions to minimize the alert fatigue caused by generating too many false alerts by getting insights from security information and event management (SIEM) signals to make the prevention systems learn from the environment to keep false signals to a minimum

Keywords: soft computing, machine learning, cybersecurity, clustering

1 Introduction

The traditional threat-detection systems rely on heuristics and a set of static rules on a large set of system logs to detect the threats in the system. However, in such systems there is a need for specialists to analyse these logs. This is almost impossible today due to the large types of the wide variety of potential threats. Nowadays these traditional systems are being replaced by intelligent cybersecurity agents [1]. These new cybersecurity agents, which are driven by machine-learning, are able to detect malware, zero-day, and other advanced attacks persistently. Machine learning systems are used to predict potential attacks before they occur [2]. On the other hand, the preventive measures of these systems may fail in the face of complex threats and attacks. In these cases, the systems can recognize the initial stages and prevent it spreading on the supposedly protected system.

On 20, December 2020 the most devastating cyber-attack in history has taken place and still poses a grave risk to the U.S. public and private sectors, as well as other organizations around the world. A group of unknown hackers injected malware into ‘SolarWinds’ business system that manages networks and information technology infrastructure. This attack has spread like cancer and has affected Microsoft, FireEye, and the U.S. Treasury Department and they have different impact levels of severity. To understand how machine learning can be the best solution to detect such malware, we need to mention the attack stages [3].

- First, the attackers somehow made an entry point (back door) into the ‘SolarWinds’ system and did not take any action at this stage. Three versions of the software were signed with the malware.
- In the second stage, the attacker has controlled the system but did not move to the border network.

- Third stage is a read-only mode, which means that information is stolen without altering the data.
- In the final stage, hackers could take administrative permissions to have the ability to steal and alter the data.

Machine Learning security systems need to detect this malware at its initial level. When the attack moves to the third level in the previous attack the security system should react immediately to prevent the attacker from stealing data. In read-mode the attacker can use different network protocols, the FireEye report says that they used HTTPS, to transfer stolen data from the server (victim) to the criminal machines. This should be marked as anomalous action in the server by the security system. This can happen when the machine learning security system using computational intelligence methods that our responsible to mark these harmful actions, depending on the information gathering from network log files, and this can include: IP address of attackers, the network protocols uses to transfer data and the significance of the transferred data.

In these critical situations, the fast reaction of ML security system is just as important as the effectiveness of threat identification algorithms [4]. As ML security system is considered to be a real-time application and it works with a terabyte of log files, a powerful big-data analysis system is needed to obtain a fast response time. In this context it has to be indicated that there are two kinds response times related to such systems:

- The detection time: it depends on the complexity of ML algorithm used, and the analytical system used in the log files.
- The decision making time: the time required for the system to take appropriate measures against an attack. Security system reactions are related to the ratio of the anomaly of the suspected action on the system. This ratio can be determined using ML algorithms.

8 Advanced ML Detection Methods

8.1 Fuzzy logic

It is an approach to compute the degrees of truth but not ‘true or false’ meaning that we can use the uncertainty characteristic to analyse intrusions in any system. The fuzzy logic-based system can be able to detect an intrusion behaviour of the networks in case of efficient rule set. We can use an automated strategy to generate and optimize the fuzzy if-then rules, using frequent items in the training sets. Fuzzy sets play an important role in recognizing dangerous events and reducing false alarms level. In the past fuzzy if-then rules were need an expert to be defined. Recently, various methods have been suggested for automatically generating and optimize the rules without using the aid of human [5].

8.2 Neural Networks (NNs)

It is a group of AI algorithms usually used to minimize prediction error. These neural networks can be trained from processing examples, these examples can be taken from the log files of the system. Neural networks are trained based on specific example by calculating the difference between a prediction (actual output) and the desired output. Using the value of this error and weighted associations according to a learning rule the network can minimize the error to obtain an output similar to the desired output. This process is called supervised learning [6].

8.3 Genetic algorithms

These algorithms are commonly used to optimize the searching problems based on biologically inspired operators such as crossover, selection, and mutation. These special algorithms can optimize the previous two methods to be evolved toward better output (less false outputs). Genetic algorithms can be used as rule generation and optimization tools in the design of fuzzy rule-based systems. Also, the genetic algorithm could be used to Train Neural Networks to obtain high output accuracy [7].

The current aim of intrusion detection techniques is to use the previous mentioned ML algorithms to detect abnormal system actions to recognize harmful actions and reduce the false alerts caused by legitimate user activities.

8.4 ML modules for threats detection /Attack Patterns

Some examples of anomalous behaviour include:

- Using HTTP protocol (runs on 80/8080) on un-official ports.
- Reverse shell to open a backdoor on the system using common ports used by the servers.
- A lot of Http/Https requests come from clients' browsers compared to goes back to them.
- An encapsulated code as a part of the URL/user credentials.

A lot of UDP datagrams compared to TCP packages over the network.

Detection mode:

The mode is in which the IDSs should detect the threats in real-time. The IDS monitors the traffic over the network or read/stream the logs from a real-time monitoring system. The abnormality is detected based on the information obtained from the network using one of the advanced ML algorithms. In the case of learning mode, ML algorithms work on the samples of logs at specific intervals and check if they comply with some previous records for a specific date. If it detects a significant scatter, an alarm should be triggered [8].

Input: The network log file or open stream with network traffic monitor let says Wireshark.

Output: Make reaction by sirens sound and react depends on scattering rate of the event.

9 Proposed system

The proposed system takes its input from a log file updated by a real-time proxy server that connects directly to a server that serves some critical services. All network traffic to the server from outside will be directed throughout the proxy server to analyse all events and actions of clients. In this case four types of attacks need to be analysed:

Network-probe.

Denial of service attacks.

User to root attacks.

Remote to user attacks.

Since four types of attacks need to be analysed, there is a need for training data-set based on 4-types of attacks that would be used to train the ML-based system to classify the attack in real-time. Using the training data-set the system will identify the efficient attributes that would be used as ML rules for the tested algorithm. These rules are used to determine the type of real-time traffic if it is either abnormal or normal. Genetic algorithms would be used as a rule generator and optimizer tool in the design of both NNs and fuzzy logic algorithm [9], [10].

The key advantage of the proposed detection techniques is their ability to detect formerly unseen

and unfamiliar intrusion occurrences. The different steps involved in the proposed system for anomaly-based intrusion detection are described as follows:

- Classification of training data
- Generation strategy of NN/fuzzy-logic rules
- Decision module
- Classifies the runtime traffic

9.1 Threats Classification

i. Probing

A hacker scans the network or server to determine the services used by the system in such a way that could detect any CVE for any service on the system. This type of attack needs a little experience in network protocols and some technical experience.

Common probe tools: NMAP, PORTSWEEP.

ii. Denial of service attacks

A hacker flood a network or a system to make its services to be unavailable for authorized users. As an example a web application running on a server can handle a specific number of connections from customers if the hacker could occupy all these connections the service port would be able to receive any additional requests from real users.

Common DoS tools: LOIC, HULK.

iii. User to root attacks

An authorized normal user tries to gain administrator privileges in an unauthorized way by exploiting a gap in the system because of programming mistakes or common vulnerability of some services on the system.

Common user to root types: man-in-the-middle, SQL-Injection.

iv. Remote to user attacks

A hacker on a remote network tries to exploit a vulnerability to gain the access to the system as an authorized user.

Common user to root types: DNS Poisoning, Malware-Injecting, Missing Security Patches.

9.2 Clustering Algorithms for Cybersecurity

Traditional clustering analysis is like asking a specialist to make an analytical report from terabytes of a client's event-log about all potential threats in the system. The clusters conducted by the analyst could be used to determine the normal and anomalous actions. Using a machine to make such reports, we could eliminate human factor errors and make reports more efficient. The machine can traverse over the clusters immediately and make a decision if the pattern is malicious or normal. The clusters could contain multi-dimensional information to describe all potential attacks, then the machine could make a clustering analysis on the data to determine to which cluster this data belong [11].

The machine learning clustering process in a real-time application should be accurate and complete and the clusters should be updated automatically. The clustering algorithm depends on the relationship between input data. Thus irrelevant data could make problems and some noise. This noise should be eliminated in an efficient way.

9.3 ML analysis in real-time application

The planned system should run in real-time and work on a huge amount of data generated each second, consequently a fast big-data framework is needed that could handle the analysis processes and performs very fast. In the proposed system I will try to minimize the I/O and make it relay on in-memory processing, thus will use Apache Spark and take advantage of RDD/MLlib to test all ML techniques. In this way, practical machine learning pipelines can be tuned in a real-time environment.

9.4 Simulation Environment

The testing system environment would use AWS and Azure where the system will be built and the performance of the proposed ML algorithms against real-time attacks will be tested and some solutions will be suggested to increase their efficiency.

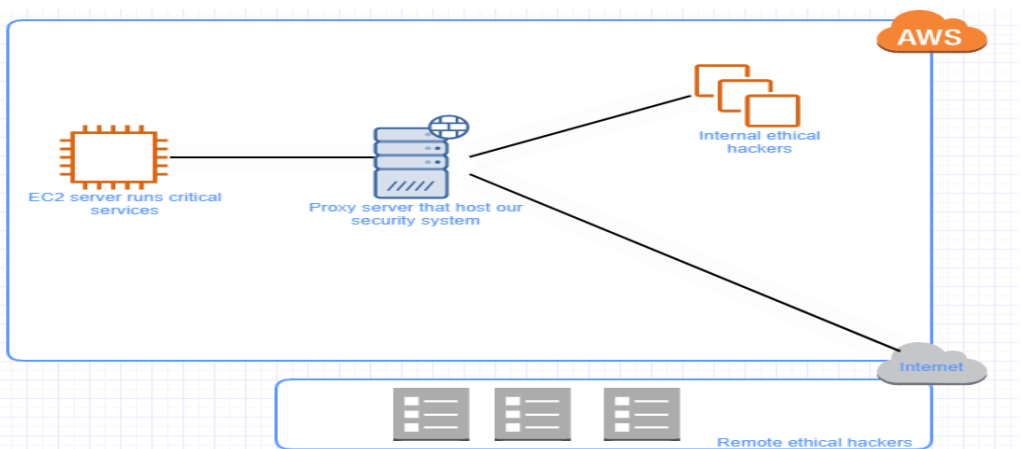


Figure 1. Testing Infrastructure

10 Conclusion

Large number of possible threats makes it impossible to analyse the logs by a human. Instead of the traditional threat-detection systems intelligent cybersecurity agents are applied because of higher efficiency. These systems are based on machine learning which are formed using soft computing methods. The proposed system takes its input from a log file updated by a real-time proxy server that connects directly to a server that serves some critical services. All network traffic to the server from outside will be directed throughout the proxy server to analyse all events and actions of clients. Using the training data-set the system will identify the efficient attributes that would be used as ML rules for the tested algorithm. These rules are used to determine the type of real-time traffic if it is either abnormal or normal. Genetic algorithms would be used as a rule generator and optimizer tool in the design of both NNs and fuzzy logic algorithm. The key advantage of the proposed detection techniques is their ability to detect formerly unseen and unfamiliar intrusion occurrences.

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