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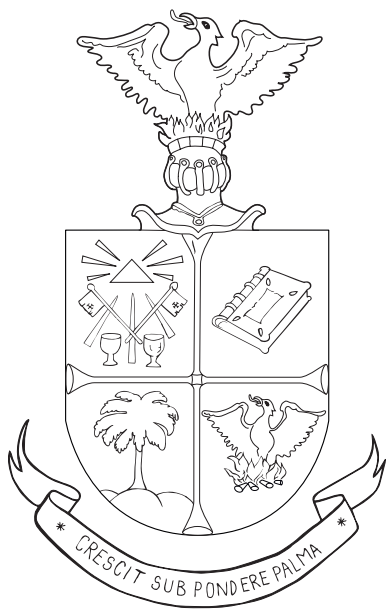

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Károli Gáspár Református Egyetem Állam- és Jogtudományi Kar

Innovative solutions of Industry 4.0 – special attention to green logistics and autonomous vehicles

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1. Introduction

The aim of the study is to provide a research summary that analyses the various aspects of logistics and supply chain management from a sustainability perspective, with a particular focus on reverse logistics and autonomous vehicles.

Industry 4.0 is an exciting phenomenon not only for researchers but also for business professionals. Many of its technologies exists for decades, but networking provided by the Internet and Internet of Things (IoT) devices, and utilization of data generated by these systems take process transparency, optimization and efficiency to a new level.[1] Industry 4.0 has one of the biggest impacts on the automotive sector.[2]

Concerning sustainable development we have to reach back to the interpretation given by the Brundtland Committee in 1987, according to which ”sustainable development is a development that satisfies the needs of the present without threatening the chances of future generations to satisfy their own needs”.[3]

The climate change with its effects is being felt more and more, the threat of the finite nature of resources and the matter of the urgent necessity of energy safety made it clear that decreasing fossil fuel use on a global scale must become unavoidable. Therefore, the operational framework of companies must be established so that it is in line with present expectations. Harangozó also refers to this in his paper, when he emphasizes that in

1 Nagy Judit – Oláh Judit– Erdei Edina– Máté Domician– popp József: The Role and Impact of Industry 4.0 and the Internet of Things on the Business Strategy of the Value Chain The Case of Hungary. *Sustinability*, 2018, 10(10), 3491.

2 Demeter Krisztina– Losonci Dávid– Nagy Judit– Horváth Bálint: Tapasztalatok az ipar 4.0-val egy esetalapú elemzés.*Vezetéstudomány*,2019, 50(4), 11.

3 *WCED (1987): Our common future*.https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf(2019. 04. 16.)

different company functions (for example production management, logistics, innovation management, finances, accounting and marketing) there are several partial goals that can be compatible with the goal of decreasing the carbon footprint and for the realization of which it can be useful to quantify the corporate carbon footprint integrating it in the corporate IT system and communicating it".[4]

According to Kerekes,[5] the Brundtland definition of sustainable development has an important ethical nature, since it aims at reaching equality between generations and considers the matter from the perspective of "humans" and not of nature. Sustainable development "assumes ecological, social and economic sustainability as a simultaneous harmony".

Supply chains are being networked. The joint interaction of several factors also influences the number of supply chains the individual companies have to have a role in.[6] Complex processes happen when companies that specialized due to globalization become parts of a network.[7]

The aim of this paper is to point out how self-driving vehicles can support sustainability and how they affect the economy and the legislation.

2. Research method

In the recent years, our research has focused on analyzing the sustainability and competitiveness aspects of logistics and supply chain management.We reviewed domestic and international theoretical literature and processed case studies, synthesized technical books on the topic developed byresearch institutions in supply chain management education.

For this paper, we conducted several in-depth interviews with practitioners, and we also use the results of an own-organized conference workshop to highlight the varied effects of self-driving vehicles.

4 Harangozó Gábor:*A karbon lábnyom koncepció szerepe a vállalkozásfejlesztésben*. 129-146. http://kgk.uni-obuda.hu/sites/default/files/11_Harangozo-Gabor.pdf,2016 (2019. 11. 02.)

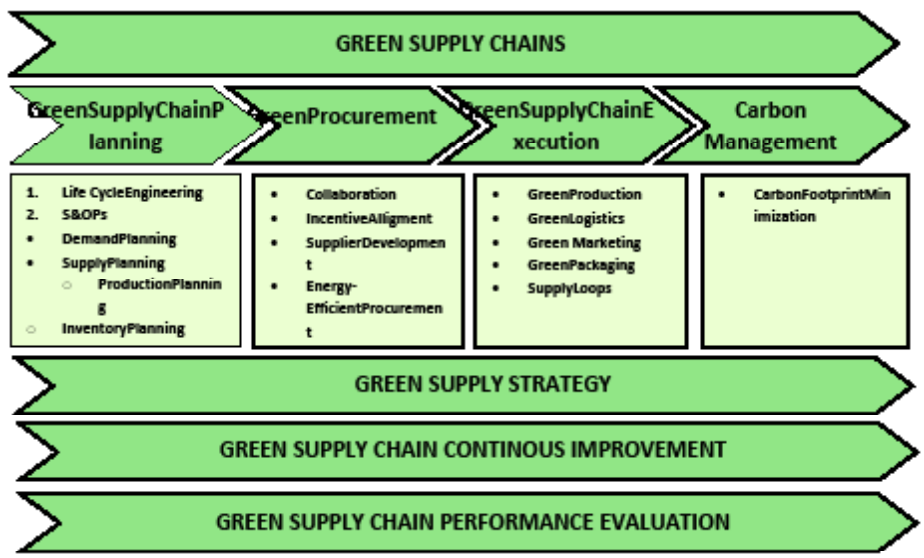
5 Kerekes Sándor: *A fenntartható fejlődés európai szemmel.* In: Gömbös Ervin(ed.): Globális kihívások, milleneumi fejlesztési célok és Magyarország. Budapest, Magyar ENSZ Társaság, 2008, 51-60.

6 Kozma Tímea:*Szereplők, folyamatok, kapcsolatok az ellátási lánc mentén.*In: Logisztikai évkönyv. Budapest, Magyar Logisztikai Egyesület, 2018, 23-35.

7 Tóth Róbert –Gyenge Balázs: *Az ellátási láncok kialakulása és az ellátási lánc menedzsment értelmezése.* In:Logisztikai évkönyv. Budapest, Magyar Logisztikai Egyesület, 2018, 36-45.

According to the basic concept of our research, the reverse/green logistics concerns a small segment from the green supply chain, besides which for example green supply chain design, green supply chain realization and carbon management can be found. According to Pónusz and Kozma,[8] the basic concept of Green Supply Chain belongs to Emmett and Sood,[9] it provides one of the most complex and thorough perception in the topic. The SCOR model[10] is in accordance with it, and we analyze how thedifferent company areas in the entire supply chain realize sustainability, that is, the green supply chain concept.[11] It studies processes in a complex manner, considering the multi-directional flow of materials and reverse processes, and it is also the basic model of our research.[12]

Figure 1.: Green supply chain. Source: Emmett-Sood, 2010[13]



8 PÓNUSZ Mónika–KOZMA Tímea: Zöld ellátási láncok és innovatív megoldások. *Logisztikai Trendek és Legjobb Gyakorlatok*, 2017, 3 (2),61-66.

9 EMMETT, Stuart– SOOD, Vivek: *Green Supply Chains, An Action Manifesto*. Carnwall, (UK), Wiley,2010, 14-17.

10 SCOR Software Model Framework 2.0. Forrás: Supply Chain Council, 2006, 3. Updated on March 15, 2013. SCOR Software Model Framework (Supply Chain, Strategic Management).

11 PÓNUSZ– KOZMAop. cit.61-66.

12 KOZMA Tímea– PÓNUSZ Mónika: *Az ellátásilánc-menedzsment elmélete és gyakorlata - alapok: Alapösszefüggések a hálózati versenyelőnyök és értékláncok mentén*. Gyöngyös,Károly Róbert Kutató-Oktató Közhasznú Nonprofit Kft., 2016,181.

13 PÓNUSZ– KOZMAop. cit. 61-66.

3. Research findings

3.1. *Effects of autonomous vehicles*

Standards for autonomous vehicles include optimized fuel consumption (reduced fuel costs) and reduced emissions, increased transport efficiency and reduced accident rates to achieve higher road safety.[14] Owing to fewer accidents and optimum use, self-driving vehicles can have a longer lifespan than today's cars, so you will have to buy new ones less frequently. According to research by Clements and Kockelman,[15] if accidents are reduced by 25 percent in the United States, auto repair shops will lose $ 7.5 billion in revenue and the decrease of income will be $ 5.75 billion in health-care institutions. Autonomous vehicles, when optimized, will not only lead to fewer accidents, but also fewer irregularities, which could also reduce the revenues of the authorities from penalties. According to Clements and Kockerman, a 50 percent reduction in the level of fines imposed for misconduct will result in a loss of revenue of $ 5 billion at government level in the United States.

Fewer accidents will also transform the insurance market. 90% of the value of a car today is hardware, that is to say, embedded materials, while software content is 10%. The driver is clearly responsible for the car, as is the insurance company. However, since the decision in self-driving vehicles is made by the software, insurers will also have to adapt to the situation and contract with manufacturers and software developers to take responsibility for the programs.[16] The operation of self-driving vehicles also raises a number of legal and ethical issues,[17] e.g. how does a vehicle decide in a critical traffic situation? Addressing this issue is at least as much a part of the everyday formalization of autonomous vehicles as it is of improving the technological conditions of the vehicles and the service infrastructure. The bargaining position of insurance companies will change. According to KPMG, the car insurance market may fall by up to 60 percent.[18]

14 Bonnefon, Jean-Francois– Shariff, Azim–Rahwan, Iyad:The social dilemma of autonomous vehicles. *Science*, 2016, 35(3),1573-1576.

15 Clements, Lewis–Kockelman, Kara:Economic effects of automated vehicles*. Transportation Research Record*, 2017, 26(1), 106-114.

16 Ibid.

17 Bőgel György:Gépi etika, gépi morál*. Logisztikai trendek és legjobb gyakorlatok*, 2017, 3(1),6-10.

18 Albright, Jerry –Bell, Alex–Schneider, Joe–Nyce, Chris: *Automobile insurance in the*

Increasing software content in vehicles also raises another issue. With nearly 40 percent of the value of a vehicle already in software, current automakers need to think about their role as software developers, and have to be aware of competitors in the market, such as Apple, Google, and Microsoft, who are themselves experts in the field.[19] This phenomenon will lead to a major transformation and reorganization of the automotive industry in the long run, and manufacturers are currently trying to acquire the missing capabilities through acquisitions.

All in all, it is still a decade or two before fully autonomous vehicles become widespread, but intermediate solutions (Society of Automobile Engineers' levels 2, 3, 4) have already been implemented or are almost ready for deployment, infrastructure development and legal regulation waiting. The analysis of the impact of autonomous vehicles on other sectors of the economy is therefore very timely and requires intervention.

3.2. *Practical experiences with self-driving vehicles*

Self-driving vehicle technology has been around for a long time, just think about military unmanned aerial vehicles or those studying extreme weather conditions, perhaps Mars or the robots involved in other scientific experiments.[20] However, hardware and software developments over the past decades have made it possible to build large and complex systems for autonomous vehicles.

The study will focus on self-driving cars and lorries. While the testing, regulation and corporate pilot projects of self-driving trucks are in full swing, and their participation in logistics processes to service warehouse or production processes is a reality. In the case of (port) containers, for example, Réger[21] and Gál[22] cite numerous examples in their articles on logistics 4.0 and automated vehicles carrying out material handling. The topic of self-driving

era of autonomous vehicles. New York, KPMG, 2016. https://assets.kpmg/content/dam/kpmg/pdf/2016/06/id-market-place-of-change-automobile-insurance-in-the-era-of-autonomous-vehicles.pdf (2019. 04. 29.)

19 ADLER, Martin–PEER, Stefanie–SINOZIC, Tanja: *Autonomous, Connected, Electric Shared vehicles (ACES) and public finance: an exploративeanalysis*.Tinbergen Institute, Discussion paper TI 2019-005/VIII. 1-36.

20 WURMAN, Peter– D ANDREA, Raffaello–MOUNTZ, Mick:Coordinating hundreds of cooperative, autonomous vehicles in warehouses. *AI Magazine*,2008, 29(1), 9-19.

21 RÉGER Béla: A logisztika 4.0 kialakulása és a további fejlődés lehetőségei.*Logisztikai trendek és legjobb gyakorlatok*, 2017, 3(1), 11-15.

22 GÁL István*:* Elektromobilitás és digitalizáció a logisztikában. *Transpack*, 2018, 17(5), 52-54.

vehicles is very actual in Hungary as well, since the logistics profession suffers from shortage of drivers and warehouse personnel.[23]

As case studies, we use the experiences of a workshop organized at the 26thCongress of Hungarian Association of Logistics, Purchasing and Inventory Management, held on November 14, 2018. The speakers highlighted the topic from four perspectives: an overview of the legislative area, the infrastructure needs, opportunities, potential use and testing of self-driving vehicles, and the development side.[24]

3.2.1. Legal concerns of self-driving vehicles

Ensuring safety is not only the responsibility of vehicle manufacturers, but also the regulatory side must keep pace with technology

Sándor Udvary (KRE-ÁJK) addressed the topic of legal regulation and insurance at the Congress. Autonomous vehicles can bring a revolution in transport in the 21st century, which will have a huge impact not only on related economic sectors but also on legislation. Today, at the beginning of product launch, the orderly introduction of the product to the market, regulation is the primary task, but the outlines of liability and indirect insurance issues due to undoubtedly occurring accidents must already be considered. How does liability develop when new technology for self-driving software is tested in a virtual environment and causes an accident later in the real life? The task is to examine the possibilities of integration into the legal system, with the aim that the innovations bring social benefits.[25]

The author dealt with studying some of the technically dependent regulatory issues of autonomous vehicles.[26]

In her study Andrea Domokos[27] also looks at the emergence of modern

23 Szabó M. István: *Kiélezett munkaerőhiány a logisztikában – A targoncásoknak áll a világ*. www. gyartastrend.hu; http://gyartastrend.hu/logisztika/cikk/a_targoncasoknak_all_a_vilag (2019. 04. 12.)

24 Pónusz Mónika – Nagy Judit: Az önvezető járművek használatának infrastrukturális és jogi kérdései. *Logisztikai Híradó*, 2018, 28(6), 38-40.

25 Udvary Sándor: Sofőr nélkülbiztonságosabb? Az önvezető autók formálódó jogi háttere. *Ügyvédvilág*, 2016, 10 (4), 16-17.

26 Udvary Sándor: *Az önvezető gépjárművek egyes technikafüggő szabályozási kérdései.* In: Gellén Klára (ed.): Jog,innováció,versenyképesség. Budapest, Wolters Kluver, 2017, 67-78.

27 Domokos Andrea: *Modern technológia kihívások a büntető anyagi jogban*. In: Homicskó Árpád Olivér (ed.): Technológiai kihívások az egyes jogterületeken.Budapest, Károli Gáspár Református Egyetem Állam- és Jogtudományi Kar, 2018,107-122. (Acta Caroliensia

technologies - the use of self-driving vehicles, drones - how criminal liability is determined and whether the criminal prosecution system needs to be changed due to the technological aspect of the crimes, introducing special sanctions. It examines the use of self-driving vehicles in its criminal law aspects, and the study deals with the risks of self-driving vehicles as it is possible to kill a person with a carputer, and the aspects of traffic offenses.[28]Considering, that one of the most formidable forms of crime: terrorism also has its own network system, it is useful to become familiar with the rules that operate it when dealing with it.[29]

3.2.2. Short case studies

In this chapter we introduce the experiences of ourworkshop organized at the 26th Congress of Hungarian Association of Logistics, Purchasing and Inventory Management, held on November 14, 2018 about the challenges of self-driving vehicles.

In addition to Waberer's developed IT systems, he places great emphasis on innovation and joins his partners in research and development of autonomous lorries. As part of this, it conducted successful, rigorous tests with Volvo in the area of platooning (convoy of self-driving trucks) on the M1 motorway. The company is also testing and applying alternative, environmentally conscious methods, such as intermodal transport (combining truck and rail freight). The group also has one of the continent's youngest and most environmentally friendly truck fleets[30], to certify its commitment to sustainability.

Waberer's-Szemerey Logistics Ltd., as a potential user of self-driving vehicles, also participated in the above platooing test with Volvo. In inter-warehouse movements, Waberer's-Szemerey is testing a self-driving truck for on-site movement between warehouses in a project with Knorr Brems. Waberer's is also looking for cooperation with Tesla (USA) and their delegation has already discussed with high-tech experts about potential testing options, as one of the largest logistics service providers in Europe.

Robert Bosch Elektronika Ltd.is involved in both the development and the user aspects of self-driving vehicles. The most tangible achievement of Industry 4.0 is automation and the interconnected and coordinated operation

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28 Ibid. 109.

29 Barabási Albert László: *Villanások. A jövő kiszámítható*.Budapest, Nyitott Könyvműhely, 2010, 237-238.

30 https://www.waberers.com, (2019. 04. 29.)

of different systems and human resources processes. An outstanding form and part of this, is an automated material handlingprocess, which replaces and/or supports the day-to-day operations of warehouse personnel. Implementing and developing Industry 4.0 solutions is also a priority for Bosch.

Bosch Mobility Solutions is specialized in developing technologies based on self-driving vehicles in many areas. It deals with automation and electric vehicles as well as connectivity. In 2016, this innovation-orientedbusiness accounted for 60 percent of total group revenue.[31] According to Michael Fausten, project manager for the company, by 2030, people will be able to completely take control of their cars and get it safely to their workplace, although it is true that the technology will first spread in the premium car segment.[32]

4. Summary

Global warming, increasing carbon dioxide emissions, water and soil pollution, and increasing energy use all contribute to environmental degradation. The worsening situation requires increasing attention not only from individuals but also from companies. Many companies have already recognized that environmentally conscious corporate governance not only benefits the environment but also has a number of market opportunities and a positive impact on the company's image.

Industry 4.0 enhancements e.g. autonomous vehicles are a good example of the dynamic interaction and collaboration between the scientific world and practical applications.

In this context, it is also clear in smart city concepts[33] that various areas such as legislation, infrastructural development, intelligent logistics solutions, such as self-driving vehicles, make a major contribution to sustainable green supply chains. To test these new technologies, we need new testing and validation methods and these require a test fields, and continued collaboration from the professional fields described above.

31 Fausten, Michael: *Automated driving – We'll still be able to feel the thrill of freedom*. www.bosch.com. https://www.bosch.com/stories/autonomous-driving-interview-with-michael-fausten/ (2019. 04. 24.)

32 Ibid.

33 More details onthe relationship of smart city and sustainability: Kovacs Róbert: *Local, community responses and the industrial technology revolution: competitiveness – smart city*. In:Lóth L. (ed.): Industry 4.0 – legal – social – economical challenges and responses. Budapest, Károli Református Egyetem, 2019.