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Review of Industry 4.0 and forecasting its future within trends in logistics and development of legislation[1]

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Abstract

The increasing integration of the Internet of Everything into the industrial value chain has built the foundation for the next industrial revolution called Industry 4.0. Industry 4.0 is currently a top priority for many companies, research centres, and universities and is a part of fast changing business environment. Therefore it must be clearly focused on the future trends since fast changing environment forces companies to be flexible and to adapt quickly. New trends in logistics as well as in the field of legislation and demand for greener products and sustainable solutions will undoubtfully shape the future of industry 4.0. This paper is therefore focused on development of industry 4.0 in relation with megatrends in logistics as well as with development of legislation related especially with environmental protection.

Keywords: Industry 4.0, logistics, supply chain, technology forecasting, trends, legislation

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INTRODUCTION

The industry of 21st century Europe faces significant challenges. The ever-decreasing raw material supply, the rising energy prices and the demographic changes necessitate the modification of the existing model. The intensifying competition, which is mostly driven by the increasing productivity of the Asian industry and innovation makes it clear that the production industry needs solutions with which they can efficiently respond to challenges (Kagermann, 2013).

The manufacturing and production systems have been gradually complemented with information technology support tools in recent decades, as increasingly complex technological solutions, production in often multiple locations and the coordination of supporting logistics processes started to pose a more and more complex challenge. Accordingly, 90% of all production processes are now supported by IT tools. The increasingly dominant role of IT in companies have changed lifestyles and working environments and its significance is unquestionable.

Miniaturization and the development of communication technologies enables the blending of the physical and virtual world and gives way to the so-called CPS – Cyber-Physical System. Industrial production becomes integrated into an intelligent environment that is referred to in reference literature as smart factory. Based on this technological evolution, Germany announced the arrival of Industrie 4.0, also called the fourth industrial revolution. (Kagermann, 2013)

Development of industry 4.0 as well as logistic activities and supply chains is strongly connected with future trends. Thinking about the future and future events is part of human nature; people have always been curious about what lies ahead. This was the basis for the 'success' of the Greek oracles in ancient times when forecasting the future was less about predictions than about shaping politics and present-day decisions. While it is true that the future is unpredictable, some developments can be forecasted to at least prepare for the possible events in the future and attempt to shape it (Cuhls, 2003).

With technological forecasts, high-quality data on future logistics and industry 4.0 development can be obtained that can help shaping companies policy and vision. If forecasts are carried out systematically, professionally and periodically, the shaping of energy policy measures is more effective, can achieve greater positive effects and be more consistent with the overall development paradigm (Obrecht – Denac, 2016). When forecasting includes scenario analysis, measures for the future contingency can be identified already today and consequences can be avoided more effectively.

The need for formal techniques was not felt until the mid-20th century. While we can pinpoint the origins of systematic technological forecasting to around 1950, and its forerunners to 1945, the existence of a more widespread interest in special techniques take place in 1960 (Czaplicka-Kolarz et al, 2009 and Jantsch, 1967). Nowadays almost all companies in the logistics sector use at least some actions related with defining future trends and making their business more effi-

cient. There are more and more changes related to environmental protection. Because of stricter environmental legislation and increasing public awareness on environmental constrains caused by logistics and industry, companies must be prepared on changes and adapt as well as become more environmentally friendly before it is too late and they start to lose their customers. Therefore monitoring legislation and environmental protection acts could also be defined as a part of strategic planning and defining company's future.

The logistic chain must not just focus on environmental protection, but increasingly it must work towards becoming a "sustainable business" (GreenPort, 2010). In last decade, the issue of environmental protection and climate change has turned from a niche issue discussed by a closed circle of learned specialists into one of the most serious concerns of our times. The EU has not only been leading international efforts to combat climate change, it has also developed an integrated climate and energy policy, including a number of headline political targets and a detailed action plan on how to achieve them (Winterstein et al. 2008).

This paper therefore focuses on industry 4.0 in relation with trends in logistics and legislation related with environmental protection.

2. METHODOLOGY

This paper presents a review of current state of industry 4.0, future trends in logistics and direction of legislation development on the field of environmental protection. Collected data consists mainly of secondary data and findings of different researchers. Secondary data was collected with compilation method from various scientific and professional papers, researches and project reports focused on the research topic industry 4.0, logistics trends and stricter environmental legislation related on green logistics development. Gathered data were cross-compared and commented to present basic findings in all three studied areas and to combine all these findings in new perception related on green logistics trends in industry 4.0.

3. RESULTS AND DISSCUSSION

3.1 INDUSTRY 4.0

Automotive industry is among aerospace currently one of most developed. Lean philosophy, as such has been developed in the Toyota production system (TPS) in late 1980' by Taichii Ohno but has dramatically changed over the last years. There have been developed new technics and tolls and also lean inside companies is now perceived as throughout philosophy, in contrast to concept JIT or f. e. 5S. One of modern topical issues is also environment which on first sight does not cooperate with the lean concept.

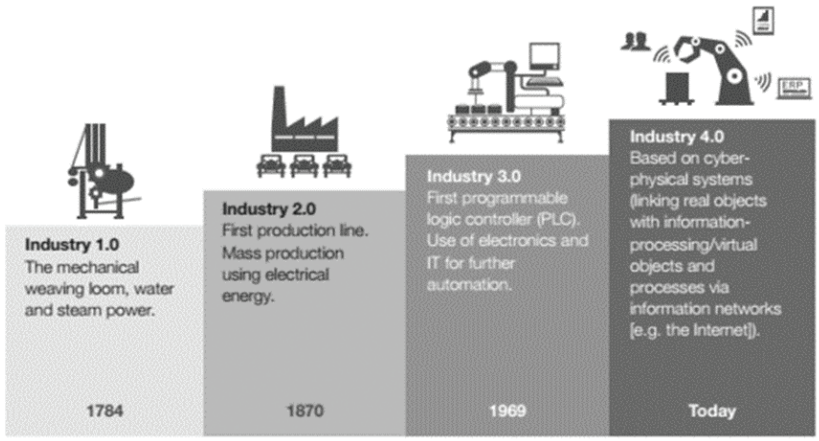
Automotive industry plays an important role in European economy. 6.9% of the EU's entire GDP comes from this industry1. 5.3% of the employees of the EU, approximately 12.9 million people work in this sector. 3 million of them are highly qualified manpower. On an annual basis, 16.2 million vehicles (cars, trucks and buses) are manufactured in the 290 vehicle factories in 25 countries of Europe. Automotive industry is the largest investor in research and development (32 billion EUR). These companies – wherever they are present – have an effect on regional development, and the international corporations directly connect the towns of their sites to the global economy (Enyedi 2012). The series of innovations, developments in information and communication technology (ICT), Cyber-physical systems (CPS) and the introduction of tools and services in the production process are the most important for regional competitiveness.

The increasing integration of the Internet of Everything into the industrial value chain has built the foundation for the next industrial revolution called Industry 4.0. Although Industry 4.0 is currently a top priority for many companies, research centers, and universities, a generally accepted understanding of the term does not exist. As a result, discussing the topic on an academic level is difficult, and so is implementing Industry 4.0 scenarios (Hermann et al.2016).

The convergence of industrial production as well as information and communication technologies has made Industry 4.0 as one of the most frequently discussed topics among practitioners and academics (Draft – Horch, 2014).

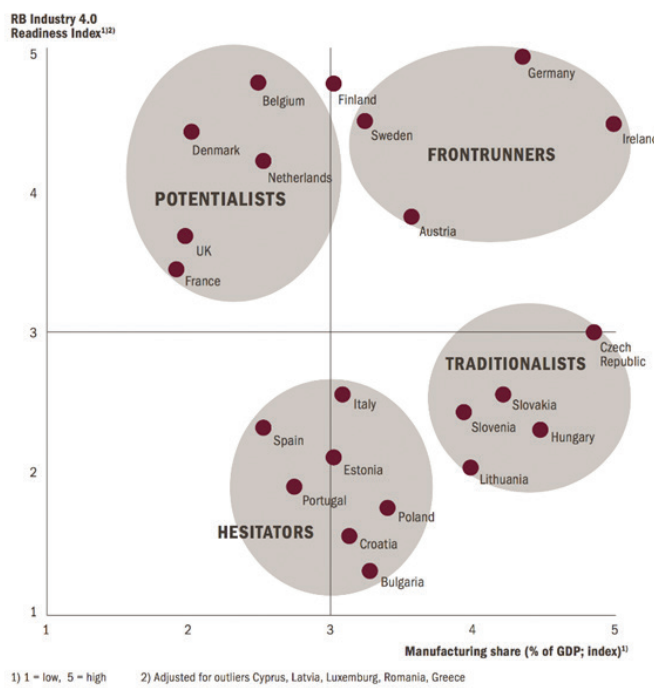
The fascination for Industry 4.0 is twofold. For the first time an industrial revolution is predicted a-priori, not observed ex-post (Draft and Horch, 2014).. This provides various opportunities for companies and research institutes. The economic impact of the industrial revolution is supposed to be huge, as Industry 4.0 promises substantially increased operational effectiveness as well as the development of entirely new business models, services, and products (Schrauf – Berttram, 2014). Industry 4.0 has become by now a global slogan and its ideas can be recognized in the industry development and industry digitalization policies pursued by individual countries and the priority of which is to improve the competitiveness of the given country (Kagermann 2013) by enhancing its innovation capability and digitalization.

Figure 1: Historical development of Industry 4.0 (RSA Sollutions. 2015)



We would like to highlight a study in order to address the relative position of Hungary versus Slovenia, regarding their readiness for the upcoming digital transformation: the Roland Berger Industry 4.0 Readiness index (Roland Berger, 2014).

Figure 2: Roland Berger Industry 4.0 Readiness index (Roland Berger 2014)



The index uses the following sets of indicators when creating a so-called country ranking.

1. Industrial excellence:
    a. production process sophistication
    b. degree of automation
    c. workforce readiness
    d. innovation intensity
2. Value network:
    e. high value added
    f. industry openness
    g. innovation network
    h. internet sophistication

The attached figure (Figure 2) uses two dimensions: the vertical axis represents the previously mentioned Roland Berger Industry 4.0 Readiness index while the horizontal axis is the manufacturing's share of the GDP. The chart suggests, that with one of the highest shares of manufacturing in the GDP, Hungary is relatively highly dependent on manufacturing, while, based on the observed indicators, it rather stays behind its European competitors as far as digital transformation readiness is concerned. (Roland Berger, 2014). *Traditionalists* are primarily from the countries of Eastern Europe. They still live from their former industrial base having to some extent even now healthy structure

3.2 FUTURE TRENDS IN LOGISTICS

Forecasting future logistics trends can be very complex since it is very hard to say what will become an important trend with global impacts and what will only be a »fashion fad«. One of the leading publications in this area is "Logistics trend radar", published annually by DHL to enlighten different socio-economic and technology trends relevant especially for logistic companies.

Future logistic will be shaped by mega and micro trends, which will be seen especially in flexible start-ups that almost do not have any assets and are therefore highly adaptable. Five most important innovations in logistics can be summarized as (DHL, 2016):

First is autonomous logistics with autonomous vehicles and drones. This topic has undoubtfully got the most media attention. Autonomous vehicles are already developed and ready to use in closed loops such as warehouses, airports etc. Next step is to test them on public roads. Drones have already been identified as appropriate for delivery of goods by Amazon (Amazon Prime), for delivering medicines in distant locations, for visualisation and monitoring of degraded or by natural disasters affected areas as well as for monitoring radiation e.g. in Fukushima.

Second innovation is Internet of things (IoT) and its potential of connecting, monitoring and managing electronic devices connected with internet. It is evaluated that over 50 billion devices will be connected by 2020 and this will result in 1.9 trillion dollar worth new business opportunities. Due to safety regulations and related risks, IoT has currently more interest on for households and their appliances but will be implemented also in logistics sector.

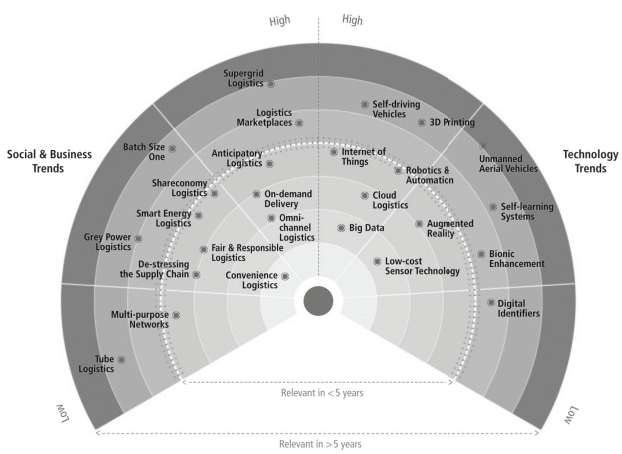
Third chance is represented in collaboration of humans and machines. Machines will join human work force. Studies revealed that smart glasses technology increases efficiency for 25 % and are positively accepted by users. This can also be expected in robotics and automation, which is still very interesting for logistics sector with new robots will be cheaper, smaller, more flexible and easier to programme.

Fourth chance is related with retail logistics. We can expect deliveries of anything, at anytime, anywhere to anyone. Customers are more and more informed and use different "online" and "offline" channels. Logistics must adapt to this trends with multichannel and personalized solutions. Trend dictates elimination of last mile logistics, related with high costs towards automatization (in Slovenia there are GLS and Pošta Slovenije post boxes on gas pumps) as well as delivery in trunks and delivery with drones.

Fifth trend is focused on integrating environmental protection in general development paradigm. Stricter legislation and increasing environmental awareness force companies to be greener. Customers demand green and socially responsible solutions. Focus is to generate added value with environmental components and to implement circular economy. As a case Freitag bags can be presented since they are produced from waste truck tarpaulin or Fairphone cell phones, produced from environmentally undisputable materials.

Social and business as well as technology trends related to logistics sector are presented on Figure 2 as well as their relevance through time.

Figure 3: Social and business and Technology trends in logistics (DHL, 2016)



However the riskiest areas identified are a) data security and b) vulnerability of IT in case of frauds and cyber-attacks. As seen on Figure 2, different business opportunities can be identified among social and business trends as well as among technology trends. According to demographical changes (older population) and stressful environment, grey power logistics and de-stressing of supply chains as well as shared economy will gain more power. Fair and responsible logistics will become important in the next 5 years as well as anticipatory logistics with the goal to minimize costs and to increase customer loyalty. Batch size will be reduced due to more personalized solutions. On the side of technology trends there are numerous trends that will affect industry 4.0 such as augmented reality, sensors, cloud logistics, bionics, self-learning systems, 3D printing and especially IoT as well as self driving unmanned vehicles. All of these seems to be very distant at the moment, but logistics managers must be aware of fast changing business environment and especially changing customer demand which they have to forecast correctly and apply appropriate business models and business actions to gain the most benefits.

3.3 FOCUS OF »GREEN« LEGISLATION DEVELOPMENT

One of the key features of environmental protection is the existence of 'negative externalities'. These occur when the private cost of an action, like driving a car or burning coal to produce energy, is lower than the cost of that action to society, e.g., in terms of pollution (Winterstein & Tranholm Schwarz, 2008).

The transportation sector plays a pivotal role in contemporary societies, consequently, traffic pollution in many cities around the globe causes up to 70% of total carbon emissions (UN HABITAT, 2011). The concept of alternative transportation technologies and alternative energy resources has arisen as a potential long-term solution for achieving an environmentally friendly future and has become "an embraced goal" of many countries around the world (Bockarjova and Steg, 2014).

Since under these circumstances the market fails to allocate costs correctly, private stakeholders lack the incentive to invest sufficiently in environmental protection. As a result, the market produces too much pollution. This market failure can be remedied by ensuring that economic operators take the social costs of their action duly into account (i.e. 'internalise' those costs) and, consequently, reflect them in the final prices of their products. The environmental policy should be based on the principle that 'the polluter should pay. Indeed, if pollution becomes a real economic cost, companies will tend to maximise their profits by reducing this cost component and, therefore, reduce pollution at the same time. Also, if polluting goods are more expensive, demand will revert to less polluting sectors offering cheaper and more ARTICLES environmentally friendly goods, thus creating new markets for eco-industries (Winterstein & Tranholm Schwarz, 2008).

Green issues are now a significant part of many companies' logistics strategy and more customers are interested in alternatives, more eco-friendly transportation

options. New regulations are also coming from the governments that put higher demands on the industry (Nevhagen, 2014).

Public intervention aimed at putting the 'polluter pays principle' into practice generally takes the form of either regulation — setting environmental standards at a level sufficiently high to eliminate negative externalities — or market-based instruments. In the EU, among the most favoured market-based instruments are taxes, charges and tradable permit schemes because they provide a flexible and cost-effective means of correcting this market failure.

In 1995, Porter and van der Linde argued that pollution equates to inefficiency and that inefficiency is in turn a source of economic disadvantage. Thus pollution prevention represents an opportunity for business entities to improve their financial performance through, for example, enhanced productivity and innovation (Burritt and Christ, 2016).

Transport has a high impact on the environment and is the largest industrial source of CO_2 emission. The European Commission has developed policies and presented several communications, with new concepts such as co-modality, to reduce the impact of goods transport on the environment. Further Directives are being developed that could have a strong influence on how the Chain needs to be managed in order to ensure compliance and to satisfy the imperative of sustainability. A mix of regulatory measures and stimulating measures (bonus and malus) will set the context for transport operations. So far, however, the regulatory system may be considered relatively limited, but an increasing number of initiatives are likely to be introduced specifically to reduce CO_2 emission from transport. Almost all measures concentrate on companies with a role in the supply chain and only a limited number focus on management of the logistic chain in total.

Recent experiences show that influencing activation of sustainable measures on the chain as a whole delivers far more effective results than targeting the individual companies that make up the components of the chain. First estimates show that, in terms of reducing impacts, results from pressure on the chain as a total system can be 30% to 50% more effective than if every company involved undertakes the initiative separately. Therefore, to make a logistic chain sustainable, it requires co-operation between all partners with an operational task in the supply chain, private as well as public.

One concrete example is the new regulation from International Maritime Organization regarding the Sulphur content in ship's fuel within the Baltic Sea Region. From 1 January 2015, the Sulphur must be below 0.1%, compared to the year 2017 1 percent. Generally, the new environmental regulation has caused great concern to the countries and is a great challenge, not only to the shipping industry, but also to ports within the Baltic Sea Region.

Switching to more expensive low Sulphur fuels may reduce the competitiveness of the sea transport drastically and lead to a modal backshift from sea to road. It might even change the directions of logistics flows in Europe in order to avoid the SECA and also involve simultaneous development of specialized facilities in ports (Nevhagen, 2014).

For a variety of reasons that by now are well documented in the literature on business and the environment, firms adopt policies and behaviours not specifically required by government. Five reasons have been proposed for viewing environment as a core for business function akin to finance or marketing and thus a source of opportunity: differentiating products, managing competitors, reducing operating costs, redefining markets, and managing risk and uncertainty. Managing the supply chain for environmental reasons serves nearly all of these ends. It may differentiate products by adding credibility to processes or product designs. It may reduce operating costs by encouraging process efficiencies among suppliers, eliminating waste disposal and treatment, reducing liabilities from materials contained in suppliers' products, and other measures. Regulating the supply chain provides a strategy for managing competitors by forcing the competition to adopt similar policies. A major reason firms regulate supply chains is to reduce risk and uncertainty. They are less likely to lose critical suppliers due to violations of environmental laws or exposure from negative publicity. They may create reputation capital with consumers, communities, and agencies, and reduce defects or environmental hazards in products (Fiorino – Bhan, 2012).

4 CONCLUSION

The increasing integration of the Internet of Everything into the industrial value chain has built the foundation for the next industrial revolution called Industry 4.0. Future development as well as forecasting trends has therefore become even more relevant than in the past. New technologies and new business models bring new benefits but only if implemented at the right time and on the right place. Customers demand personalized solutions and flexibility and even current market leaders must be aware that their current market share and position will not last if they do not adapt to the new future situations. Future logistics will undoubtfully be based on lean, green and innovative approaches throughout the whole supply chain instead of owning logistics assets and infrastructure.

Several key issues will have to be solved before companies and governmental bodies can deliver a genuinely integrated environmental management system for the complete supply chain. Major considerations are agreement on methods of calculating carbon and other emissions for benchmarking and demonstrating compliance and transparency in order to create trust between competing companies. Quality management systems, certainties on legal positions with respect to liability, the level of knowledge of all partners involved, and a totally new systems approach will also be necessary. In order to set up sustainable logistic supply chain management within industry 4.0 each part of the chain will need to establish its own systems and organization to an appropriate standard and in a format that can be configured towards integration with all stakeholders (GreenPort, 2010).

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