Open source and industry 4.0 influence on the transport and enrgey sector

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Abstract: **Influce of 4.0 industry on the transport and energy sectors is fundamental and increasing. Within the past few decades, a new period has emerged, referred to as Industry 4.0. It takes the digital technology from recent decades to an entire new level with the assistance of interconnectivity through the web of Things (IoT), access to real-time data, and therefore the introduction of cyber-physical systems. Industry 4.0 offers a more comprehensive, interlinked, and holistic approach to all or any forms of manufacturing. Transport does not manufacture but its product is tangible and measurable and inevitably falls under the broad spectrum of influence of the Industry 4.0. The energy sector on the other hand is under vastly growing expectations to secure the humankind wellbeing. The global energy sector faces a triple challenge to come in the next 20–30 years where it needs to rely on the new technologies and industry 4.0 developments. It needs to adapt to climate change and its effects it also needs to ensure that energy supplies remain secure and reliable. If the energy supplies are interrupted or made scarce this immediately affects economy and every-day life. Achieving all of the above draws the third pillar of effort – how to cyber-secure all 4.0 industry achievements and thus prevent it from being misused being it economically or politically.**

Index terms: **4.0 industry, open source, transport, energy, IoT; Industrial Research, Innovation Management, New Product, Technological Innovation;**

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I Introduction

Looking into the influence of open source and industry 4.0 on the transport and energy sector one needs to briefly look at the overall framework that industry 4.0 lays out for all spheres of life.

In the past few decades, a fourth industrial revolution has emerged, known as Industry 4.0. Industry 4.0 takes the emphasis on digital technology from recent decades to a whole new level with the help of interconnectivity through the Internet of Things (IoT), access to real-time data, and the introduction of cyber-physical systems. Industry 4.0 offers a more comprehensive, interlinked, and holistic approach to all types of manufacturing.

Speaking of manufacturing Transport does not manufacture a product as such. Its product is the service of moving of people and goods. This is a tangible and measurable result therefore it is a kind of manufacturing and inevitably falls under the broad spectrum of influence of the Industry 4.0. The same is valid for the energy sector that is very closly interlinked to transport.

Transport plays a vital role in today's economy and society and encompasses a large impact on growth and employment. The transport industry directly employs around 10 million people in Europe and accounts for about 5% of gross domestic product (GDP). Effective transport systems are fundamental for the EU companies' ability to compete within the world economy.The quality of transport services has a major impact on people's quality of life. On average 13.2% of every household's budget is spent on transport goods and services. Having outlined its importance, it should be kept in mind that transport also depends heavily on oil resources and represents an important source of CO2 emissions.

In this sense quite understandably the policy-makers in the EU recognize that the major challenges to achieve high effectiveness in this sector is linked to techno-economic analysis of emerging technologies to help analysis of:

- impacts on transport demand,
- costs,
- emissions,
- congestion,
- accessibility and economic impacts.

4.0 industry being applied in transport helps to connect physical with digital, and allows for better collaboration and access across departments, partners, vendors, product, and people. Industry 4.0 empowers business owners to raise control and understand every aspect of their operation, and allows them to leverage instant and thus improve processes and drive growth.

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II UNDERSTANDING INDUSTRY 4.0

Understanding the worth of Industry 4.0 goes via

1. Supply chain management and optimization—Industry 4.0 solutions give businesses greater insight, control, and data visibility across their entire supply chain. By leveraging supply chain management capabilities, companies can deliver products and services to plug faster, cheaper, and with better quality.

2. Predictive maintenance/analytics—Industry 4.0 solutions give manufacturers /this includes transport and energy sector/ the power to predict when potential problems are visiting arise before they really happen.

3. Asset tracking and optimization—Industry 4.0 solutions help manufacturers become more efficient with assets at each stage of the availability chain, allowing them to stay an improved track on inventory, quality, and optimization opportunities referring to logistics. This means more economic approach to resources and therefore and overall green-er approach to the functioning of the transporation systems.

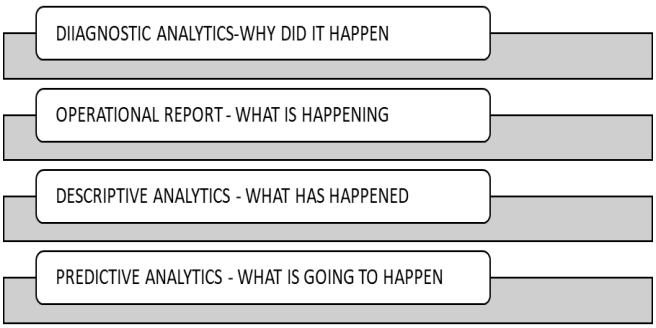

Fig.1, Analytical sophistication of 4.0 Industry
Source: The Author

Transport and energy sector produces tangible and mesaruble products and results, therefore open source 4.0 industry is directly applicable and is expected to have a huge impact on their future.

There are hundreds of concepts and terms that relate to Industry 4.0, but here are some foundational words and phrases, related to the sectors in focus, to know as they will become very widely used when we discuss transport and energy. They are as follows:

- **Enterprise Resource Planning (ERP):** Business process management tools that can be used to manage information across an organization.
- **IoT:** IoT stands for Internet of Things, a concept that refers to connections between physical objects like sensors or machines and the Internet.
- **IIoT:** IIoT stands for the Industrial Internet of Things, a concept that refers to the connections between people, data, and machines as they relate to manufacturing.
- **CAVs:** Connected and Autonomous Vehicles
- **(MaaS):** Mobility as a Service
- **transport-on-demand:** services, booked by passengers, offer flexible and efficient solutions for specific groups, serving low-density areas or periods with lower demand for mobility.
- **contactless payments:**
- **Artificial intelligence (AI):** Artificial intelligence is a concept that refers to a computer's ability to perform tasks and make decisions that would historically require some level of human intelligence.
- **Digitization:** Digitization refers to the process of collecting and converting different types of information into a digital format.
- **Cloud computing:** Cloud computing refers to the practice of using interconnected remote servers hosted on the Internet to store, manage, and process information.
- **Real-time data processing:** Real-time data processing refers to the abilities of computer systems and machines to continuously and automatically process data and provide real-time or near-time outputs and insights.
- **Ecosystem:** An ecosystem, in terms of manufacturing, refers to the potential connectedness of your entire operation—inventory and planning, financials, customer relationships, supply chain management, and manufacturing execution.
- **Digital Transport Corridors ecosystem** - the ecosystem will accelerate transport and logistics processes by creating new opportunities for interaction between participants in existing industries and the formation of the Eurasian digital ecosystem

New types of technology and service delivery model such as:

- Mobility as a Service (MaaS),
- transport-on-demand,
- autonomous vehicles,
- contactless payments,
- big data and analytics

will significantly change how customers experience transport and make their travel choices.

Some of these shifts will happen quickly, while some are more likely to occur over a longer period of time. What is clear is that while transformation within the transport sector will be rapid, it will also be unpredictable as new

services and paradigms emerge and take-up of these services increases.

What is most unpredictable since the Covid-19 pandemic how big the demand will be of these services. Some reserchers show that this will accelerate the 4.0 Industry influence on the sector by creating and boosting new demands which will be addressed by new technology.

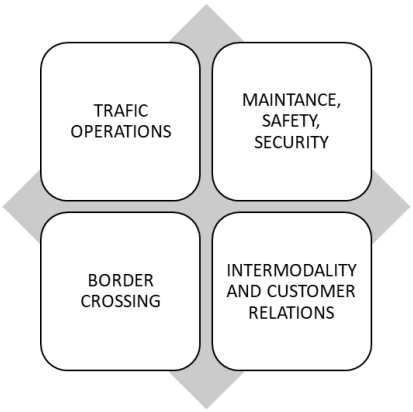

Fig.2, Smart Solutions. Source: The Author

Speaking of unpredictability, the ground transpor sector for instance has been significantly disrupted b technology, through the adoption of ridesharing platform such as Uber. Regulatory changes requiring ride shar drivers to register as a business has seen a strong growth i business numbers across the industry. The next wave o disruption is expected to affect transport modes, wit ridesharing platforms transitioning into boats, helicopter and scooters.

Autonomous vehicles are expected to become widel available into the future as well, however regulator changes will be required to enable these to become a lon term disruptor. Autonomous vehicles and Connected and autonomous vehicles (CAVs) have the potential to disrupt all industries connected to transport, including tourism. CAVS will navigate on a fully autonomous software, making driver engagement obsolete.

It is predicted that widespread adoption of autonomous vehicles for urban tourism could lead to potential benefits including:

- reduced traffic congestion and emissions,
- improved car hire processes,
- reduced parking requirements and cheaper taxi fares.

The expectation is that the visitor economy could be gradually transformed if autonomous vehicles could become fully automated and mainstream, leading to a future where small autonomous vehicles navigate urban attractions and replace traditional 'hop-on hop-off' city tours. However, this is likely a long term impact as there are significant regulatory burdens to navigate in the short to medium term.

The global automotive sector is going through a period of unprecedented change, with new technologies and business models that will change the way we own and use vehicles. The shift to Connected and Autonomous Vehicles (CAVs) will mark the biggest change to how we travel since the invention of the motor car.

The UK is for instance -one of the world's leading centres for automotive engineering, technology and innovation and has a strong position in the development and testing of CAVs.

Market Intelligence Report 2019: Connected and Autonomous Vehicles South Korea offers significant opportunities for British connected and autonomous vehicle (CAV) companies with both the public and private sector investing heavily in innovative CAV technologies. Korea's state-of-the-art ICT infrastructure is already world class and full, nationwide 5G coverage is expected to be achieved by 2022.

This strength in network technology, along with the country's globally competitive automotive sector, offers a strong foundation for rapid commercialisation ofself-driving vehicles and makes Korea a highly attractive market for UK CAV technology and solution providers.

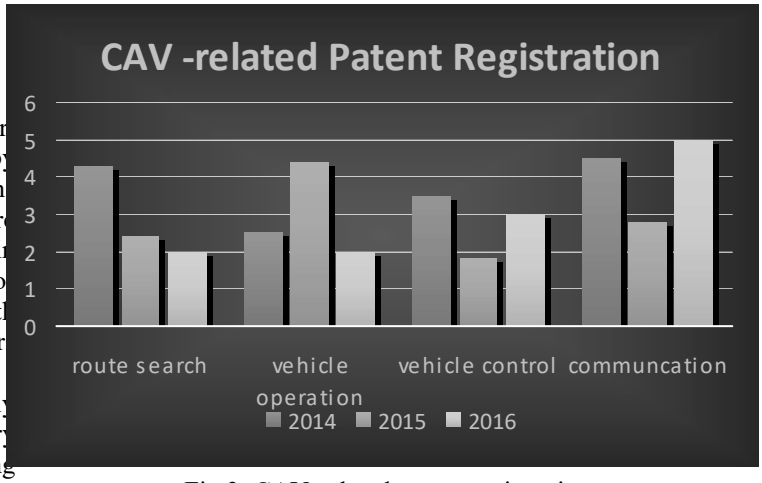

Fig.3, CAV-related patent registration
Source: Korea Patent Information Promotion Center

The potential economic and social benefits from CAVs could be vast, potentially including:

- Increased accessibility and mobility, for example for the elderly or disabled.
- Improved road safety, including the potential to reduce the number of fatalities.
- Productivity gains from improved connectivity on the move, and from vehicle autonomy freeing drivers to engage in other activities.
- Environmental benefits from reduced congestion and increased fuel efficiency.
- There are further add on social effects, for example, there may be large efficiency benefits from introducing automated deliveries to remote areas.

Consistent and reliable connectivity is a visible prerequisite for this.

Development of the EEU Digital Transport Corridors Ecosystem Concept. - The ecosystem will

accelerate transport and logistics processes by creating new opportunities for interaction between participants in existing industries and the formation of the Eurasian digital ecosystem, as well as creating common information resources and services in transport and logistics. A research was carried out for this project, resulting in the concept design and a draft roadmap for the full implementation of the project. Currently, the practice is being studied and the number of participants in the platform is expanding; problems and requirements in the organization of services and the core of the ecosystem are being discussed with businesses.

4.0 Industry bridges physical production and operations with smart digital technology. It helps to process massive data to form a more holistic and better connected ecosystem for transport companies.

The energy sector has been an early adopter of digital technologies. For instance power utilities were digital pioneers, using emerging technologies to facilitate grid management and operation. Oil and gas companies have long used digital technologies to boost deciding for exploration and production assets, including reservoirs and pipelines.

The industrial sector has used process controls and automation for many years, particularly in heavy industry, to maximise quality and yields while minimising energy use. Intelligent transport systems are using digital technologies to boost safety, reliability and efficiency.

Being transport or energy sector all such companies and organizations are different and all of them face a standard challenge—the need for connectedness and access to real-time insights across processes, partners, products, and people.

Industry 4.0 tools are about revolutionizing the way business operates and grows, exemplar of the above is that the opportunity it provides for predictive maintenance, especially important to the enegry sector.

Predictive maintenance reduces the time needed to repair or recondition plant equipment in energy plants. AI is applied to predictive maintenance, as well as intelligent IoT sensors and embedded control solutions. It all provides advanced additional value between company and customer and achieves significant maintenance cost savings. Estimated effect of use of predictive maintenance can reduce downtime by up to 50% and save 10% to 40% on equipment maintenance costs within the energy sector.

Predictive-maintenance environments include a platform to model, simulate, test, and deploy the solution. Vibration, temperature, and pressure are just some of the parameters that can indicate equipment status and identify potential failures. Monitoring techniques are normally used on equipment like compressors and pumps.

It makes no doubt that Artificial intelligence opens up new possibilities. The transition to an intermittent energy production from renewable energy sources (RES) for instance, quite expectedly, increases the complexity of providing reliable energy supply.

The growing number of RES impede the necessary effort to control the system. The introduction of digital or smart energy systems is often proclaimed as a logical next step towards coping with this rising complexity. It seems convenient that the manufacturing industry, as one of the major energy consumers, is currently also in a process of a digital transition, the fourth industrial revolution.

According to some energy researchers, the three major areas in the expert discourse of industry's future potentials are:

- increasing transparency in the energy system,
- providing demand flexibility and
- increasing energy efficiency.

Industry 4.0 offers opportunities to save energy while improving energy productivity, and may help manufacturers remain competitive in tight markets. The transition to smart, connected industry will enable greater control of energy costs. Industry 4.0 can enhance business productivity by supporting:

- improved energy efficiency,
- optimised energy-use,
- and reducing carbon emissions.

Extensive monitoring is a prerequisite. Improving the energy productivity of processes relies on understanding energy use at each stage of production. Extensive digital monitoring infrastructure is not just an enabler of better energy management. It also allows precise control and enhanced integration – essential foundations of Industry 4.0.

Digital metering and monitoring equipment is increasingly affordable, and provides fine data resolution for assessment and optimisation.

Real-time energy management can help avoid high-standing energy losses. Industry 4.0 technologies also help optimise integration of renewables by enabling predictive demand management and storage strategies. This minimises the necessity for extra energy sources.

Over the approaching decades, digital technologies are set to create energy systems round the world more connected, intelligent, efficient, reliable and sustainable. Stunning advances in data, analytics and connectivity are enabling a variety of latest digital applications like smart appliances, shared mobility, and 3D printing. Digitalised energy systems within the future is also ready to identify who needs energy and deliver it at the proper time, within the right place and at the bottom cost. But getting everything right won't be easy.

Digitalisation is already improving the security, productivity, accessibility and sustainability of energy systems. But digitalisation is additionally raising new security and privacy risks. it's also changing markets, businesses and employment.

Policy makers, business executives and other stakeholders increasingly face new and sophisticated decisions, often with incomplete or imperfect information. Adding to the present challenge is that the extremely

dynamic nature of energy systems, which are often built on large, long-lived physical infrastructure and assets.

III Transport and energy under the 4.0 industry influence

Transport currently accounts for 28% of world final energy demand and 23% of worldwide CO2 emissions from fuel combustion. Final energy consumption for transport grows with most of the demand coming from road freight vehicles (36%) and passenger light-duty vehicles (28%).

Across all transport modes, digital technologies are helping to enhance energy efficiency and reduce maintenance costs. In aviation, the newest commercial aircraft are equipped with thousands of sensors, generating almost a terabyte of knowledge on a median flight. routes, while advances in satellite communications are enabling greater connectivity. The most revolutionary changes from digitalisation could are available road transport, where connectivity and automation technologies could fundamentally transform how people and goods are moved. The interactions among potential disruptions in road transport including the uptake of automated, connected, electric and shared (ACES) mobility will play a key role in shaping the longer term energy and emissions of the transport sector.

The consequences of ACES mobility for energy and emissions are highly uncertain. They're going to depend upon the combined effect of changes in consumer behaviour, policy intervention, technological progress and vehicle technology. Recent studies estimate a good range of possible outcomes.

IV Conclusion

Looking into some of the above mentioned effects of Industry 4.0 on transport and energy it seems that the sector is not only highly influenced by it but it should frantically speed up the implementation of all instruments it has to offer in order to be able to secure the normal functioning of all araes of everyday life.

Specifically, if we look into the energy sector, technical constraints may be the consequence of the slower digitization of previously isolated systems. This is particularly relevant in the case of critical infrastructure and Industry 4.0. Since industrial facilities, especially large ones such as petrochemical plants or power plants, are expensive to build and maintain, their development typically follows an incremental, plug-in approach: new technologies have been added on top of existing layers to ensure backward compatibility with equipment that could not be changed.

This situation has led to the simultaneous co-existence of modern IoT /Internet of Things/devices and legacy devices. The fact is that legacy devices were deployed when industrial facilities were still considered "closed environments" that were difficult to access remotely and were therefore designed without any particular form of protection against cyber-attacks. "Opening up" these infrastructures to the outside world to take advantage of the potential of the IoT therefore exposes potentially vulnerable legacy systems to cyber-attacks.

Adapting 4.0 indutry achievements is neccessery and seroious demand due to the new realities that come into play: increasing population, increasing pandemic risks, scarce resources and sevre climate change.

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