Business Digitization in the European Union

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Abstract. *Digitalization nowadays can stretch in all aspects of the functioning of a business. Therefore, given the available technologies, the speed at which businesses merge with the digital world dictates the comparative advantage a like company can harness over its competition. However, integrating digital means into businesses can come at a considerable cost. Moreover, this creates a dichotomy between digitalizing an already existing and thriving company functioning on traditional channels and the creation of new fully digitalized enterprises. This paper aims at revealing the relevancy of digitalization in the business world by evaluating the cost efficiency of going digital or starting digital across economic sectors for enterprises in the European Union from 2017 onwards. The argument of designing a business from scratch in an automated and smart digitalized style is much more comprehensive in a connected globalized world. The intricacies stretch far beyond the pure digital and business areal since most transactions happen internationally. The borderless approach creates a demand for all aspects of a business to work cohesively. Therefore, business operations such as accounting, legal actions, storage, delivery, and marketing must be corroborated with business operations as they are conducted in an increasingly digitalized manner. Through analyzing secondary data, statistics and case studies about the level of business digitalization across sectors in the European Union, this paper targets to reveal which are the fast evolving sectors in terms of digitalization for businesses and the most effective way in which digitalization creates increased value for business. The countries of the European Union experience different levels of digital technology integration, it peaks in Denmark while, Romania, Bulgaria and Poland are situated at the other end of the spectrum. Manufacturing is the sector with the least amount of digital updates across the sample while communications, computer programming, travel agencies, and accommodation services surge in the digital arena. There is a direct correlation between the size of the company and its propensity to exploit opportunities in digital transformation. However there is a new aspect of the speed at which small mainly digital companies acquire acumen and therefore profit. This paper synthesizes the fastest growing digitalized sectors in the European Union and highlights opportunities for old and new businesses.*

Keywords: businesses, digitalization, ecommerce, opportunities, economy, globalization.

Introduction

Nowadays the business world is taken by storm in the light of all technological advancements. Therefore, new processes emerge to cater for previously unmet needs or to replace completely old procedures used across the business world. However, there is a dichotomy between the integration of new processes into an otherwise traditional approach corporation and the birth of new enterprises that oftentimes start from the use of new tools.

The aim of this paper is to emphasize the implications of digitalization at company level and across sectors of the economy starting with 2017 in the European Union.

In times of sudden unprecedented uncertainties such as the on-going covid-19 pandemic (World Health Organization, 2020) the prerequisites of fulfilling daily needs change. That is way not only as a business but as well as a consumer, the means of acquiring the essentials have been dramatically impacted. With traditional approaches one could manage by physically moving, seeing and choosing from a wide spectrum of places products and services, unless limited by obvious resources such as time and finances.

Whereas being hindered by compelling circumstances both businesses and consumers might have to reorganize. The concept of reorganization implies that the means with which the process can be achieved are known. Hence it is a matter of choosing focused direction towards effectively knitting technologies to capture enough know-how to make a business function with the technology at hand.

In order to use the available technologies to their best advantage, companies and governments must invest in buying the new machinery and devices as well as skilling their operators to better integrate new means. Thus there is a discrepancy between which companies and institutions are able to afford the re-organization of their production facilities, train personnel and buy licensing for new software.

Since the transition to the digital world has been gradual some corporations have been able to function using their old means and skillsets of workers. However, given that new generations have entered the work force as well as the consumer market has shifted to younger generations, the innovation has been driven by consumer needs and by the existence of new technologies to ease traditional work processes. That is why new companies that have started their market presence by simply using digital means have had and can take advantage of a prolific situation.

Moreover, during 2017-2020 in the European Union the digitalization of business has become an increasing priority in order to increase their competitiveness on a global scale. The European Commission has powered initiatives to gather statistics in order to support member states in the creation of policies that would favor EU companies to reassess their digital strategies and to capitalize on perspective gains (*Digital Transformation Scoreboard*, 2018).

Literature review

What is digitalization?

Digitalization denominates the processes of converting data into a computer format interface thus allowing traditional process such as storing information and performing commands within a manufacturing environment to be realized in a simple and orderly manner by using performant IT equipment and software (Hedstrom, M., 1997)

Due to advances in technology new capabilities emerge in aiding human's work and leisure activities. Ensuring the right equipment and skills in maneuvering the hardware and software is essential in establishing the new era presence of companies, customers and state institutions.

It is widely accepted that the future of industry is going digital, that is why the European Union through its strategy-Digitizing European Industry (DEI) ratified in 2016, (The Digital Economy and Society Index -DESI, n.d.) has committed to complement national strategies through its platform to boost innovation across European firms along the digital curve in order to maintain their relevancy in a global context marketplace.

Moreover, the DESI annual reports enlists the availability of integrating new technologies from an infrastructure point of view and other, across the European Union terrain and tracks advances made by individual member states in the fields. Remarkable mentions include:, industry 4.0 related technologists (Michela Piccarozzi, Barbara Aquilani, Corrado Gatti, 2020), digital public service as in Figure 8- businesses and citizen gain efficiency by functionality and minimization of time spent by benefiting from a streamlined public service, broadband coverage,

mobile take-up, wi-fi connectivity, e-commerce, emerging technologies: blockchain, high-performance computing, quantum technology big-data computing; cybersecurity et al.

The Forth Industrial Revolution

The Forth Industrial Revolution or Industry 4.0 refers to revolutionizing the way business function through connecting their physical manufacturing with the digital and the internet of things and the process of integrating through digital cohesion all departments of a corporation. Thus through more process such as: machine learning, big data, AI, smart factory, cyber-physical systems there is a significant cohesion in how large-scale machinery can create and adapt through their progressive software to perfect and diagnose operations without human supervision or intervention (*What is Industry 4.0—the Industrial Internet of Things (IIoT)?*, 2020).

Scholars have found that the Industry 4.0 poses challenges for large corporations as they have both departments and process to physically and workers procedures to adapt to. On the other hand small corporations have the opportunity to integrate operational processes, computing capabilities and adaptable manufacturing technology as the speed at which the small companies can integrate new age know-how dictates their advantage on the market (Rüßmann, Lorenz, Gerbert, Waldner, Justus, Engel, Harnisch, 2015).

Re-development of education to train the new workforce in the Industry 4.0 times (Thuy Duong Oesterreich, Frank Teuteberg, 2016) must be considered so as to have continually learning workers who can cope with big data and analytics, simulations, autonomous robots, system integration, internet of things, cyber security, cloud computing, augmented reality, additive manufacturing (Sulaiman Olusegun Atiku, 2020) while they might work in *virtual groups* remotely.

E-commerce

The concept of e-commerce implies the usage of computing and digital technologies in order to integrate all aspects of a business procedure so as to integrate business operations with clients and supplies in a comprehensive manner in order to increase the productivity of the organisation (Chaffey Dave, 2007). The level of technical specificity has updated business operations performed previously. Moreover, e-commerce was and it is the tool that is transitioned all businesses into a digital era.

Building notoriety is essential in galvanizing a market segment, thus e-commerce helps business boost their collective perception. Early adopters of digital means capitalize on their over-time built up experience and online presence and subscribers.

Technology disruptors

Nowadays, strategies for the future dictated by new technologies companies, such as the launching of new the Starlink satellites network by the company Space X (<https://www.starlink.com/>, 2020), whose strategy is to provide affordable and good Internet connection to all parts of the world by the end of 2021. As well as its competitor's strategy Blue Origin (Jonathan O'Callaghan, 2019) to launch a constellation of internet satellites-the number is 3,236 for Telesat- Canadian communication company. Such an endeavor could attract up to 4 billion users on the internet, providing media companies, online gaming, and e-commerce product companies a corridor to a network of new clients (Michael Sheetz, 2019).

This would render the world in a ultra-connected new reality, with enormous opportunities given by connectivity and would push the boundaries of developing even further technologies such as completely autonomous driverless transportations (*5G network as foundation for autonomous driving*, June 5, 2020) for both people and goods which is Telekom's strategy to provide the availability of Internet connectivity by 2025 through the new 5G technology.

Emerging robot developing companies such as Hanson Robotics (<https://www.hansonrobotics.com>, 2020) work towards building smart human-like conscious machines that would enhance their abilities to compete information and emulate human behavior while being connected to high speed internet where they can retrieve data bases from and compute new input both online and physically.

Opinions have argued that in the light of technological developments the point of singularity might be achieved by humanity in a relatively short span of time. Singularity referest to a moment when technological capabilities become so advanced that they surpass human cognitive capacities (Vernor Vinge, 1993). Though it is insightful, the debate remains perspective and philosophical sine that point in technological advancements has not been reached to date. Nontheless, changes in technologies today are both exciting and challenging as they gradually impact all aspects of life.

The sphere where European companies and intuitions have to be competitive is becoming edgeless as technologies become boundless. Technologies are pushing the limits of how companies function, how customers buy, how countries are run. Technologies impact regulations in terms of trade and international buying and selling operations and delivery (Bozz-Allen& Hamilton,2000, pp. 28-39). Thus technology is the disruptor that is quickly impacting our human existence.

The EU as a highly regulated body, works to keep legislation up to date to insure the best protection for consumer and their online privacy especially through the Data Protection Directive (*REGULATION (EU) 2018/1725*, 2018), which has taken an important acknowledgment of new technologies and has updated legislation in the field..

Methodology

By analyzing secondary data, case studies, and statistics concerning business digitalization in the European Union territory across economic sectors and within a time span (Saldana Johnny, 2003), this paper aims to highlight the fast growing sectors with respect to digitalization in the business arena and to point out how digitalization can create value for business and people.

The relevancy of this analysis is to highlight potential opportunities for companies in terms of investing in people and technologies that would create the framework for productivity in the new digital age and render profit, as well as for individuals who could benefit from choosing emerging fields of study and training.

The hypothesis are formulated to take into considerations the secondary data selected thus integrating all conditions that form the economic and technological environment in the European Union during the 2017-2020 timeframe.

Research hypothesis

The following are the research hypothesis:

There are opportunities in digitalizing already existing companies across sectors due to the existing technologies

New digital companies are easy to create and would gain market share quickly.

Digitalization may occur for some sectors due to high costs of changing machinery and training personnel.

Manufacturing sector is harder to digitalize because of increased costs of robotic technology and skilling employees

Case study

Previous research conducted on companies operations in two distinct industries, the media sector and the automotive sectors to inquire about differences and similarities in the endeavors that may challenge and impact the value creation of the companies reveal though the interviews conducted at company level the following: digitalization is regarded as important in both sectors, the perspective opportunities arising from digitalization into a business model innovation are perceived according to their respective stance in the value network, in both industries the identified challenges were the organizational capacities and employee competence (Rachinger, Rauter, Müller, Vorraber, Schirgi, 2019).

Results and discussions

Within the European Union space a few particularities regarding businesses and sectors with regard to digitalization can be observed from the European Commission's Digital Economy and Society Index annual reports (The Digital Economy and Society Index -DESI, n.d.) during the 2017-2019 time interval. Significant trends can be highlighted with respect to company size and economic sectors that have been developing within this period in the European Union. The annual reports aim at collecting statistics from the territory and business world in order to aid lawmakers and national authorities to develop significant strategies in aiding European industry.

Annual endeavors of the European Platform of National Initiatives (EU businesses go digital: Opportunities, outcomes and uptake, 2018, p.5) aim to galvanize efforts of lawmakers, investment decisions, workforce training system for innovative skillsets to advance technology implementation at the European community level.

From a workforce point of view, according to Figure 1. More than 70 % of larger corporations with more than 250 employees afford to employ Information Communication Technology specialists while less than 50% of medium size companies with around 50-249 employees do employ Information Communication Technology specialists and less than 15% of the small enterprises- 10-49 employees have Information Communication Technology specialists employed. This trend has been relatively constant during the time interval 2012-2018 in the European Union space with a slight decrees of employing capacities for small and medium enterprises in the year 2018.

In what regards company size, small and large enterprises have different levels of adopting of digital technologies in 2018. As Figure 2. illustrates, social media adoption is similar in proportion for both large and small companies while electronic information sharing, supply chain management, customer relationship management, cloud, e-commerce, cross-border e-commerce, marketplace e-commerce, big data are proportionately less represented for small corporations compared to large enterprises.

However, in terms of company size, as Figure 3. shows, 74,42% of the companies with less than 10 employees adopt specific technologies , 68,29% of the companies with 10-49 employees adopt specific technologies and medium and large corporations adopt specific technologies in the percentage of 57,89% and 50,00% respectively.

In what the company age is concerned (Figure 4.) companies functioning for 0-2 adopt specific technologies up to 75%, companies aged 3-5 years old adopt specific technologies up to 83,33% and companies aged between 10-15 years old top the list at adopting specific technologies with a 85,71 percentage while 58,93% of companies functioning for up to 15 year and more adopt specific technologies. This 2018 statistic shows that companies in the European Union, regardless of the age of functioning have adopted specific technologies in more than 50% of cases.

Moreover, the companies' development stage and position influences the proportion companies adopt specific technologies. Therefore as Figure 5. shows 100% start-ups adopt specific technologies, 78,79% of under development-growth phase companies adopt specific technologies, 47,06% of developed within national market companies adopt specific technologies, 60% of developed within the European market companies adopt specific technologies, and 67,50% of internationally recognized companies adopt specific technologies. This statistic situates the companies that are developed within a national market as the ones with the lowest percentage of adoption of specific technologies in the sample, this is pointing out potential vulnerabilities for companies in this development stage. While start-ups by definition employ the element of newness and innovation they are the most likely to benefit from adopting specific technologies in their operations.

With respect to the sectors in which the companies that are the most digital intensive in operations in the European Union space around the year 2018 as Figure 6. displays, computer programming and information sector is the most digital intensive at more than 60%, with telecommunications following closely at around 55% . At around 50% digital intensity travel agencies, tour operators and publishing, films, television and music through their nature are digitally intensive. However, the striking observation is that in the European Union the manufacturing sectors and subsectors are less than 30% intensive with respect to digitalisation.

The distribution of digital economy across the countries of the European Union during the interval 2014-2019 (Figure 7.) situates the community average at below 15% with Ireland topping the list at around 20% of its economy being digital followed by Lithuania, Latvia, Cyprus, Spain and Croatia at just above 15% of their economies being digital while the lowest positions are occupied by Romania, Germany, Greece and Bulgaria with a little above 10% of their respective economies being digital intensive.

The implementation of digital means in the European Union is highly dependent of the available infrastructure and use of it in terms of implementing digital strategies and operations within institutions and corporations of the European Union. Thus (according to Figure 8.) the market share of domain-specific visual languages (Sprinkle, 2004) decreased from 80% to 60% from 2006 to 2019, cable usage increased its usage, optical fiber technology (FTTH) debuted in 2012 and has also increased its usage up to 2019.

Evaluations of the statistical data validates the hypothesis formulated in this paper with the mentions that company size and company stage of development are factors that influence greatly the level of integrating digital technologies within the organisation.

Figures and tables

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Figure 1. Enterprises employing Information Communication Technology specialists in the EU

Source: *Integration of Digital Technology: Digital Economy and Society: Index Report 2019 Integration of Digital Technology*, 2019, pp.8)

Source: Eurostat

DESI Report 2019 – Integration of Digital Technology

Figure 2. Adoption of digital technologies/Company size in the EU

Source: *Integration of Digital Technology: Digital Economy and Society: Index Report 2019 Integration of Digital Technology*, 2019, pp.8)

Figure 3. Technology adoption by business size in the EU 2018

Source: *Digital Transformation Scoreboard 2018-EU businesses go digital: Opportunities, outcomes and uptake*, 2018, pp.32)

Figure 4. Technology adoption by company age in the EU 2018

Source: *Digital Transformation Scoreboard 2018-EU businesses go digital: Opportunities, outcomes and uptake*, 2018, p.33)

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Figure 5. Technology adoption by company development stage EU 2018

Source: *Digital Transformation Scoreboard 2018-EU businesses go digital: Opportunities, outcomes and uptake*, 2018, pp.33)

Figure 6. Sectors with high digital economic activity in the EU 2019 Report

Source: *Integration of Digital Technology: Digital Economy and Society: Index Report 2019 Integration of Digital Technology*, 2019, pp.7)

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Figure 7. Digital Economy Index(DESI)-growth 2014-2019

Source: *The Digital Economy and Society Index (DESI)*, 3 December 2019, pp.7)

Figure 24 Fixed broadband subscriptions – technology market shares in the EU (% of subscriptions), July 2006-July 2019

Source: Communications Committee (COCOM).

Figure 8. Fixed broadband subscription-technology market shares in the EU (% of subscriptions), July 2006-July 2019

Source: Digital Economy and Society Index (DESI) 2020 Thematic chapters, 3 December 2019, pp. 29)

Limits of the Study

The findings of the paper are limited to the available secondary data. The literature refrains between the realities of available technologies to digitalize work aspects, new technology creating companies' official statements, strategies and opinions for the future, perspective filed

opinions, particular academic case studies and information gathered from samples within sectors, annual reports of the European Commission on technology and digitalization.

Conclusion

Corroborating all data and information exposed in this paper it can be concluded that business digitalisation is an on-going process in the European Union with ever increasing usage proportionately with the investments in the corresponding infrastructure.

Moreover, transitioning towards a digital European society happens gradually across sectors and its rhythm is dictated by the European member states individual initiatives and their corresponding historic economic sectors.

However, the European and national initiatives to both privately and publically invest in the implementations of new digital technologies renders significant opportunities for industries to access new benchmarks.

The study is relevant in highlighting the importance of digitalisation in the demand in new skillsets for workers and the demand of business processed reorganisation. Withal, the conclusions of the study are limited to the sample data analysed, opinions of scholars, private companies initiatives, and results of particular studies.

References

- Bozz-Allen & Hamilton (2000). *Foreign Legal and Regulatory Landscape: Its Effect Upon the Development and Growth of E-Commerce*, 3190 Fairview Park Drive Falls Church, VA22042, Retrieved from:
<https://books.google.ro/books?id=rPmccIRbfvUC&printsec=frontcover#v=onepage&q&f=false> , viewed June 5, 2020, (pp.28-39)
- Chaffey Dave (2007). *E-business and E-commerce Management: Strategy, Implementation and Practice* Third Edition, Pearson Education Limited, Edinburgh Gate, Retrieved from:
https://books.google.ro/books?hl=en&lr=&id=EOjG84UvrHMC&oi=fnd&pg=PR13&dq=e-commerce&ots=X9IHieXJyq&sig=o6bbxG9C89PRLdQ7_8frty5p93s&redir_esc=y#v=onepage&q=e-commerce&f=false , viewed June 10, 2020
- Coronavirus confirmed as pandemic by World Health Organization, (11 March 2020). Retrieved from: <https://www.bbc.com/news/world-51839944> , viewed May 10, 2020
- Digital Economy and Society Index (DESI) 2020 Thematic chapters* (2020), Retrieved from:
<https://ec.europa.eu/digital-single-market/en/desi> , viewed June 5, 2020
- Emöke Maembe (3 December 2019) , *The Digital Economy and Society Index(DESI)* (pp. 7.), UNCTAD Working Group on Measuring Electronic Commerce and the Digital Economy, Retrieved from:
https://unctad.org/meetings/en/Presentation/tdb_edw2019p02_Maembe.pdf , viewed June 5, 2020
- European Commission *The Digital Economy and Society Index (DESI)* (2020) Retrieved from:
<https://ec.europa.eu/digital-single-market/en/desi>
- Hanson Robotics (2020) Retrieved from: <https://www.hansonrobotics.com/> , viewed June 5, 2020
- Hedstrom, Margaret (1997.05.01). *Digital Preservation: A Time Bomb for Digital Libraries* (PDF). *Computers and the Humanities*. 31 (3): 189–202.),Retrieved from:

- https://deepblue.lib.umich.edu/bitstream/handle/2027.42/42573/10579_2004_Article_153071.pdf;jsessionid=B80E616EB35E71FCFA228A4100779CE6?sequence=1
- Integration of Digital Technology: Digital Economy and Society: Index Report 2019 Integration of Digital Technology* (2019), p.8, Retrieved from: <https://ec.europa.eu/digital-single-market/en/integration-digital-technology> , viewed June 5, 2020
- Jonathan O’Callaghan (February 1, 2019). *Blue Origin To Launch Satellites For Company Battling Space X And Others For Space Internet Supremacy* Retrieved from: <https://www.forbes.com/sites/jonathanocallaghan/2019/02/01/blue-origin-to-launch-satellites-for-company-taking-on-spacex-in-global-space-internet-battle/#5bdc3a2516a5> viewed June 5, 2020
- Laurent Probst, Virginie Lefebvre, Christian Martinez-Diaz, Nuray Unlu Bohn, PwC and Demetrius Klitou, Johannes Conrads, CARSA, Digital Transformation Scoreboard 2018 *EU businesses go digital: Opportunities, outcomes and uptake* (2018). Retrieved from: https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/Digital%20Transformation%20Scoreboard%202018_0.pdf
- Laurent Probst, Virginie Lefebvre, Christian Martinez-Diaz, Nuray Unlu Bohn, PwC and Demetrius Klitou, Johannes Conrads, CARSA (2018). *Digital Transformation Scoreboard 2018:EU businesses go digital: Opportunities, outcomes and uptake*), Retrieved from: https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/Digital%20Transformation%20Scoreboard%202018_0.pdf , viewed June5, 2020
- Michael Rüßmann, Markus Lorenz, Philipp Gerbert, Manuela Waldner, Jan Justus, Pascal Engel, and Michael Harnisch (April 09, 2015). *Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries*, Retrieved from: http://www.inovasyon.org/pdf/bcg.perspectives_Industry.4.0_2015.pdf , viewed June 5, 2020
- Michael Sheetz (April 7, 2019). *Here’s why Amazon is trying to reach every inch of the world with satellites providing internet*, CNBC.com, Retrieved from: <https://www.cnbc.com/2019/04/05/jeff-bezos-amazon-internet-satellites-4-billion-new-customers.html> , viewed June 5, 2020
- Michela Piccarozzi, Barbara Aquilani, Corrado Gatti, (22 October 2018). *Industry 4.0 and the Internet of things: changes in business model, strategy formulation and implementation, firm operations towards sustainable development and sustainability*, Department of Management, Sapienza University of Rome, 00161 Rome, Italy Retrieved from: <https://www.mdpi.com/2071-1050/10/10/3821/htm> , viewed June 10, 2020
- Rachinger Michael, Rauter Romana, Müller Christiana, Vorraber Wolfgang, Schirgi Eva, (2019). Digitalization and its influence on business model innovation Journal of Manufacturing Technology Management, Retrieved from: <https://www.emerald.com/insight/content/doi/10.1108/JMTM-01-2018-0020/full/html#sec003> , viewed June 10, 2020
- REGULATION (EU) 2018/1725 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No*

- 1247/2002/EC, 2018 (2018), Official Journal of the European Union, Retrieved from: <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1552577087456&uri=CELEX:32018R1725> , viewed June 5, 2020
- Saldana Johnny (2003). *Longitudinal Qualitative Research: Analyzing Change Through Time*, Altamira Press a Division of Rowman & Littlefield Publishers INC, Retrieved from: https://books.google.ro/books?id=7vs_1dnjmOgC&printsec=frontcover#v=onepage&q&f=false , viewed June 10 ,2020
- Sapace X, (2020). *Starlink*, Retrieved from: <https://www.starlink.com/>, viewed June 5, 2020
- Sprinkle Jonathan (2004). A domain-specific visual language for domain model evolution Journal of Visual Languages & Computing Volume 15, Issues 3–4, June–August 2004, Pages 291-307
- Sulaiman Olusegun Atiku (2020). *Human Capital Formation for the Fourth Industrial Revolution*, IGI Global Business Science Reference, Retrieved from: https://books.google.ro/books?id=ckmwDwAAQBAJ&pg=PA119&lpg=PA119&dq=R%C3%BC%C3%9Fmann,+Lorenz,+Gerbert,+Waldner,+Justus,+Engel,+Harnisch,+2015&source=bl&ots=KDO39GQh4W&sig=ACfU3U0CIV7PXSJ20XCFQVhKFUp_3csKew&hl=en&sa=X&ved=2ahUKEwiC28OP95PqAhWPfZoKHeIRBCYQ6AEwCnoECAkQAQ#v=onepage&q=R%C3%BC%C3%9Fmann%2C%20Lorenz%2C%20Gerbert%2C%20Waldner%2C%20Justus%2C%20Engel%2C%20Harnisch%2C%202015&f=false , viewed June 6, 2020
- Telekom.com, *5G network as foundation for autonomous driving*, Retrieved from: <https://www.telekom.com/en/company/details/5g-network-as-foundation-for-autonomous-driving-561986>, viewed June 5, 2020
- Thuy Duong Oesterreich, Frank Teuteberg (2016). *Understanding the implications of digitisation and automation in the context of Industry 4.0: A triangulation approach and elements of a research agenda for the construction industry*, Elsevier Computers in Industry, Volume 83, December 2016, (pp. 121-139)
- Vernor Vinge (1993). *Technological Singularity*, Whole Earth Review, Retrived from: <http://www8.cs.umu.se/kurser/5DV084/HT10/utdelat/vinge.pdf> , viewed June10, 2020
- What is Industry 4.0—the Industrial Internet of Things (IIoT)?*(2020), Retrieved from: <https://www.epicor.com/en-ae/resource-center/articles/what-is-industry-4-0/> , viewed June 10, 2020