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CONTENTS

A New Paradigm: Industry 4.0

The efforts of people to develop science and technology have been continuous, but in the history of science and technology, some revolutionary moments can be distinguished. We do not discuss the Neolithic revolution represented by the transition from migratory people (hunters, gatherers), to sedentary people (plant cultivators and animal breeders), nor the changes in the production mode, where six revolutions are likely to be distinguished. For example, after 1100, the revolution in agriculture appeared by the use of metal grommets and tools; towards 1400, a commercial revolution takes place through the emergence of banks and new types of contracts; after 1600 a scientific revolution takes place; towards 1800 there is an industrial revolution based on the use of steam and the emergence of the division of labour; after 1925 a managerial revolution took place, through separation between business owners and business leaders, and after 1960 a revolution in services took place, which led to the industrialization of services.

Regarding industrial revolutions, W. Taylor Thom (Science and Engineering and the Future of the Man – 1961) identified six such revolutions: first – wheel discovery; the second – or smelting; third – the use of steam power; fourth – the production of chemicals; fifth – electricity; sixth – transport; seventh – electronics.

J. Gimpel (Industrial Revolution in the Middle Ages – 1975), noticed that between 1050-1350 throughout Europe there was a change in creativity, an „industrial revolution" as he called it. The monastic orders had a contribution during this period, the church has not yet imposed its dogmas on us. But after 1300 a decline in creativity is observed, it is less and less innovating desire, this because the economic and social need has disappeared. The Renaissance Era was a time of revitalization of science, but less of technique.

„The Fourth Industrial Revolution is still in its nascent state."
Gary Coleman (Deloitte Consulting)

But most researchers believe that industrial revolutions occurred after 1780. John Bernal (Science in History – 1954) identified three revolutions: the first revolution – the emergence of the steam engine (at the end of the 18th century); the second revolution – internal combustion engines (at the end of the 19th century); the third revolution – electronics (mid-20th century). But

Professor Mihai Drăgănescu (The Second Industrial Revolution – 1980) considers that only two industrial revolutions took place; the first was based on the steam engine (1780), and the second was after 1970 with the advent of microelectronics.

After 2012 we can speak of the fourth industrial revolution leading to Industry 4.0. In the fourth revolution, cyber-physical systems (computer-controlled coordination systems) are created, for example, have appeared the autopilot, automatic medical monitoring, driverless cars, autonomous robots, etc. The fourth revolution is based on cybernetics, mechatronics, artificial intelligence, genetic algorithms. And as a consequence now we talk about Marketing 4.0 Quality 4.0 Communication 4.0 and who knows what other areas will become 4.0.

But as the signals of an industrial revolution appeared about 50 years before the actual revolution (the steam engine appeared before the first industrial revolution, the electric battery before the second revolution, the electronics before 2012), it could be that we are actually witnesses of the Third industrial revolution as identified by John Bernal and probably started in 1980 as appreciated by Mihai Drăgănescu.

Sorin Ionescu
Editor-in-Chief

„Today, manufacturing is changing faster than ever before."
Brian Holliday
(Digital Factory)

The Sustainable University in the New Economic Context

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Technical University of Cluj-Napoca, Romania

Abstract

Higher education institutions bears a great responsibility for the local, regional and national environment impacting them as well as the graduates and their future decisions. The concept of a sustainable university should comprise all three fields of sustainable development: a healthy environment, economic performance, and social cohesion. All things considered, the universities from Romania need to focus their attention on incorporating sustainability principles into everyday activities and structures: management performance (vision, mission, strategy), education and research (programmes, curricula, teaching methods), operations, forming networks and reporting to stakeholders (sustainability indicators). This research proposes a methodology to translate how the theoretical concept of a sustainable university is translated into practical tools for coordinating continuous improvement efforts put into sustainability. The methodology is based on the PDCA cycle. Moreover, this paper encourages universities from Romania to improve their strategic objectives through the integration of sustainable development principles within their academic activities and strategies. Therefore, a new approach and tool for continuous improvement and assessment of sustainability can be implemented in higher education, in Romania, in total compliance with the requirements of European and international sustainability standards. In order to improve the quality of Romanian higher education and administration, several conclusions and recommendations have been suggested for the implementation of this new approach.

Keywords: sustainability, higher education, sustainable university

„Because of transformative technological development, now we are talking about the fourth industrial revolution."
Ban Ki-moon

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Introduction

Sustainability is receiving more and more attention in universities across the globe. According to the Declaration and Recommendations of the Tbilisi Intergovernmental Conference on Environmental Educational organized by UNESCO and UNEP and held in 1977, the fundamental principles of sustainability are: reorienting education towards sustainable development, increasing public awareness and promoting training (Agenda 21, 1992).

In 1992, the concept was promoted within the United Nations Decade of Education for Sustainable Development (UNDESD), proposing new opportunities in education and research such as formal education, public awareness and training. „To be effective, environment and development education should deal with the dynamics of both the physical/biological and socio-economic environment and human (which may include spiritual) development, should be integrated into all disciplines, and employ formal and non-formal methods and effective means of communication" (Agenda 21, 1992). Luis Velazquez *et al.* (2005) identified some factors that could obstruct the implementation of sustainable initiatives in higher education institutions, such as lack of awareness; interest and involvement; lack of funding; lack of support from university administrators; organizational system; lack of opportune communication and information; resistance to change and so on.

Higher education bears a great responsibility for the local, regional and national environment impacting them as well as the graduates and their future decisions. The concept of a sustainable university should comprise all three fields of sustainable development: social cohesion, healthy environment, economic performance. Sustainable social development (people) is aimed at the development of people and their social organization, in which the realization of social cohesion, equity, justice and well-being plays an important role. A sustainable environmental development (planet) refers to the development of natural ecosystems in ways that maintain the Earth and respect the non-human world. Sustainable economic development (prosperity) focuses on the development of the economic infrastructure, in which the efficient management of our natural and human resources is important (Grecu and Denes, 2011). The fundamental characteristics of higher education that emphasize its potential influence on sustainable development can be emphasized as follows: higher education tends to be more innovative and spontaneous and can promote the education for sustainable development most effectively and train others to carry out its aims, particularly in primary and middle schools; higher education has the expertise to offer more scientific and technological support in energy saving and emissions reduction and to contribute to the development of indicators and assessment systems, and the implementation of strategies for new technologies; higher education educates students in all professional fields, trains future government leaders and thus influences the development of future (Niu, Jiang and Li, 2010).

Universities have an important role in education for sustainable development because this concept incorporates the principles, values and practices of sustainable development into all aspects of education and learning. Education for sustainable development supports five fundamental types of learning to provide quality education and foster sustainable human development – learning to know, learning to be, learning to live together, learning to do, learning to transform oneself and society (Wals, 2009, p. 26). Moreover, education for sustainability is a new approach that we must all understand to allow browsing to a sustainable future. To facilitate this process, teachers learn new skills, including collaboration, negotiation and building partnerships with those works. As a result, the university tries to improve students' knowledge and awareness through curricula, relevant policies, study programs, and training (Grecu and Denes, 2011).

Literature Survey

Some references that approached the concept of sustainability in higher education are reported by Romanian researchers. Some representative results are further highlighted. In this respect, due to the extended development of technologies, many of the higher education systems combining both traditional learnings with e-learning as an alternative solution for sustainable lifelong education. Pamfilie *et al.* (2012) analyzed the influence of various elements specific to an e-learning platform upon user's perception, as it resulted from two kinds of research (the first focused on identifying bachelor student's perception about e-learning and the second focused on a group of people enrolled in an online master business program) performed, along the university year 2010-2011 in Bucharest Academy of Economics Studies. The results show that this form of education is considered to provide less knowledge and recognition and lower academic status, compared to the traditional campus form of study, especially by students but for people from business area enrolled in e-learning programs tend to appreciate their flexibility and accessibility. Recently, Novo-Corti *et al.* (2018) study how economics courses at higher education institutions from Romania can influence sustainable development based

on a sample of 1250 respondents – students, master and PhD – from the economic faculties of some Romanian universities. The results show also that the economic higher education system in Romania has started with small steps to adapt to the environmental requirements and the effort still required to be made are significant, since it is observed that all undergraduate, graduate and PhD require a change of attitude and mentality.

Grecu and Denes (2011) tried to find out if there is any difference in students' knowledge and awareness of sustainable development in university. Based on the comparison of the questionnaires addressed to the freshmen (students in the first year of studies) and seniors (students in the last year of studies) of the Engineering Faculty of Sibiu, the results show that very little is studies in faculty about sustainable development. Activities and habits of students related to sustainability and protecting the resources are low and the easiest method of information is an optional course in the faculty or involved in practical activities.

Cristu (2017) analyzed the situation of the universities in Romania between 2009-2015 from the point of view of sustainability. The results show a permanent decrease in the students' number as a result of the decrease of birth rate; the compression of the bachelor studies; the dropout the registered in the high school; the demands of the baccalaureate exam. Also, the decrease in the number of departments is the consequence of the decrease in students' number and the economic crisis. The decrease of the teaching staff is explained by the requirements of the national education Law no.1/2011 regarding retiring, as well as the obstruction of vacancy contest of the academic jobs. The Romanian Reform Program aims to implement to Romania's level the Europa 2020 Strategy objectives regarding the early drop out of school rate and the tertiary education among personages between 30-34 years.

Implementing a sustainable integrated management system in universities can be a step to a sustainable university but is not an easy endeavour. Pascu (2015) developed a sustainable integrated system based on effective knowledge management, the quality assurance principles and techniques and the project management approach. Following a structured, systematic approach reduces implementation time and guarantees consistent documentation. The top management of the university must have an overview of the entire complexity of the process. Universities can adapt or create a specific model for the integrated management system (with or without sustainable components).

All things considered, the universities from Romania need to focus their attention on incorporating sustainability principles into everyday activities and structures: management performance (vision, mission, strategy), education and research (programs, curricula, teaching methods), operations, forming networks and reporting to stakeholders (sustainability indicators) (Lukman and Glavič, 2007).

Because sustainability is a complex and multidimensional concept, this research outlines the key elements for understanding factors of sustainability in the context of a higher education institution from Romania.

The Strategy in a Sustainable University

The strategy is a source of the organization's value and must be focused both on increasing effectiveness as well as on increasing the organization's efficiency. According to the National Development Strategy of Romania, Horizons 2013 – 2020-2030, the strategy aims to achieve the following: to increase access to inclusive and quality education; to increase the rate of enrolment in the education system, and improve pupil comfort and a curriculum based on pupil development; to promote entrepreneurial culture and the necessary skills throughout the education system; to modernize infrastructure in the area of education training; to establish a regulatory framework for the running of continuing training programmes and to encourage participation in such programmes, involve companies in supporting employee enrolment in programmes; and support the education process through out-of-school and extra-curricular programmes in development on education for health, civic, cultural and artistic, scientific and ecological education, and education through sport. The best strategy is to maximize the results of an organization (Romania, The Department of Sustainable Development, 2018).

A sustainable university is defined as „a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfil its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable lifestyles". In fact, universities should define their own concept and definition of what a sustainable university is about (Velazquez *et al.*, 2006). Three components of a sustainable university must be integrated into the strategic vision of the university, namely (Pascu, 2015):

- Education as sustainability – introduction the sustainability to the education system. Educating the students from all disciplines in sustainability to create benefits for society;
- Knowledge transfer – transferring knowledge and collaborate with society, to make sure that society takes into account the social, economic and ecological dimensions of sustainable development;
- Interaction – promoting greater interaction between the political, public, and private sectors, by creating and developing knowledge through research and having a multidisciplinary approach.

Universities have focused on education for sustainable development and this form

of education should become an integral part of all quality education and inherent to the concept of lifelong learning. Also, the implementation of sustainability in higher education could begin by establishing criteria to evaluate sustainability.

There are many alternative methodologies that an organization could use to measure, control and monitor their activities in a sustainable way. The literature includes investigations of models and methodologies through which sustainability in the complex organization of a university can be analyzed, as well as measures the dimension of the sustainability variables, and their reporting. The methodologies have some common features: an ability to measure a decrease in energy consumption; the integration of sustainability goals in activities; the possibility to define things that happen outside the institutional barriers (the university is an actor in the social development process); the ability to incorporate perspectives of the main performance levels (environmental, social and economic) (Vagnoni, Cavicchi, 2015).

The Methodology

As we have not found a methodology based on the principles of sustainable development in universities from Romania, in the present paper we propose a methodology based on Plan-Do-Check-Act (PDCA) cycle which is a useful tool for coordinating continuous improvements efforts. Inspired by Velasquez *et al.* (2006), we identified four phases in the development of sustainability in higher education institutions, namely:

1. Developing a sustainability vision for the university – universities should define their own concept and definition of a sustainable university and they should make it specific to their university.
2. The mission – the mission statement should convey the inspiration and the motivation of the vision.
3. Sustainability committee: creating policies, targets, and objectives – in the sustainable university model, the committee is the main decision-making level and it helps people responsible of those initiatives by disseminating and receiving information, coordinating initiatives, obtaining funds and ensuring its policies are implemented. This committee must be formed with the representation of all key players in the university community such as students, academic staff, staff members, administrators and some representation of honourable members of the surrounding society. The creation of sustainability policies could be one of the most important tasks for the committee. „When a policy is absent or is developed with broad unit input, efforts are likely to be uncoordinated, and the result will be unfocused and short-lived" (Hammond, 1998).
4. Sustainability strategies – the sustainability initiatives of universities are organized into four strategies. The first strategy is sustainability on education in all its forms such as formal – undergraduate, graduate and certificate programs;

non-formal – conferences, seminars and workshops; informal – family, community, grassroots movements; distance learning. The second is sustainability on research: individuals, groups and affiliated centres and the third is the strategy for sustainability on outreach and partnership between the university and educational sector, governmental agencies, the private sector and NGO's community. The fourth strategy, sustainability on campus, is the most recent of all strategies for fostering sustainability in universities, also called „greening the campus".

Promoted by Edwards Deming, the PDCA cycle (*Plan-Do-Check-Act*), is a useful tool for coordinating continuous improvement efforts (Deming, 1950). The first stage of the PDCA cycle identifies what is going wrong and generates ideas for solving the problems of unsustainability. In the second stage, the people responsible for sustainability initiatives must evaluate the selection proposal on a small scale. This minimizes costs if the proposed changes do not work. Check refers to review if the proposed changes are achieving the desired result or not. The next step is to implement those ideas that are designed to solve the problem or to improve the efficiency of an initiative. However, the cycle is not stopped at the end of this step, but it continues to go through the cycle again for solving new challenges and problems.

The incorporation of policies for supporting sustainability is more usual than the incorporating of sustainability in missions. Energy and water conservation initiatives were favoured among people responsible for sustainability programs. Recycling program for organic or inorganic materials is a popular sustainability practice in higher

education institutions. However, it is important to understand that implementing the sustainable university model is a process of continual improvement in environmental, social, and economic performance that should be made through incremental steps.

On the other hand, Lukman and Glavič (2007) defined the key elements for the implementation of the sustainability system in universities. Considering the adoption of sustainability initiatives and its implication for university processes (administration, education, research and knowledge transfer), a number of issues need to be analyzed for a better understanding of a specific organization's approach, and a methodology needs to be proposed for implementation and the achievement of sustainability goals. The model of the Deming Cycle (Plan-Do-Check-Act) is presented in their research. The four steps in approach to a sustainable university are proposed, namely:

- Policy (Plan) – this policy consists of strategic elements such as the university's statement, including its mission, vision and goals, organizational structure, and strategy. The vision presents a starting point for policy development and needs to be ambitious, and future-oriented. Il also provides motivation extensions for all stakeholders. The mission is more realistic than the vision and determines the essential elements, regarding the strategy of an organization and its relationship to the environment. The goals should be very clear and easily understandable by all stakeholders and they should be specific and measurable in order for a sustainable future. A detailed plan should be made to achieve the proposed goals. The strategy incorporates life cycle assessment and sustainable growth. But, these sustainable initiatives (goals) and the implementation of basic documents cannot be achieved without the support at all levels, from the Rector to departmental leaders, from the students to citizens and other stakeholders in the process.

- Operations (Do) – referring to all activities of university life, and its environment. These activities are education, research and practice. These actions can be made by introducing specific sustainability programs, to innovation in products, processes and technologies, to reduce the environmental impact.
- Evaluation (Check) – this step includes standards and quality control and management methods and tools. Furthermore, the adoption of a number of indicators able to capture and measure the environmental, social and economic performance of the university shall be introduced.
- Optimization (Act) – can be defined not only as of the implementation of a process of innovation and development to improve the university's performance, but all these improvements should be included in a university's sustainability report. It should comprehend a cost-benefit analysis of spending, saving, best practices, and societal performance. Also, it is necessary for a university to become involved in local and regional development.

Figure 1 – *Process and elements of a sustainable university*
(Source: Lukman and Glavič, 2007)

A Case Study

According to the EU strategic plan, Romania is currently implementing, as all other member states, the Europe 2020 Strategy (http://ec.europa.eu/europe2020), a general vision that proposes three main priorities:

- The smart growth: developing an economy based on knowledge and innovation (supported in particular by the „An Innovation Union", „The Moving Youth" and „The Digital Agenda for Europe strategic initiatives");
- The sustainable growth: promoting a more resource-efficient, greener and more competitive economy (supported in particular by the strategic initiatives, such as: „Resource-efficient Europe" and „An industrial policy adapted to the globalization era");
- The inclusive growth: promoting a high-employment economy to ensure social and territorial cohesion (supported in particular by the Strategic Initiatives: „An Agenda for New Skills and Jobs" and a „European Platform for combating poverty").

In this context, the Technical University of Cluj-Napoca (TUCN) aims to integrate into the components of its academic activity the strategic European, national and regional approaches. For 2016-2020, the mission of TUCN is conducted in the following directions:

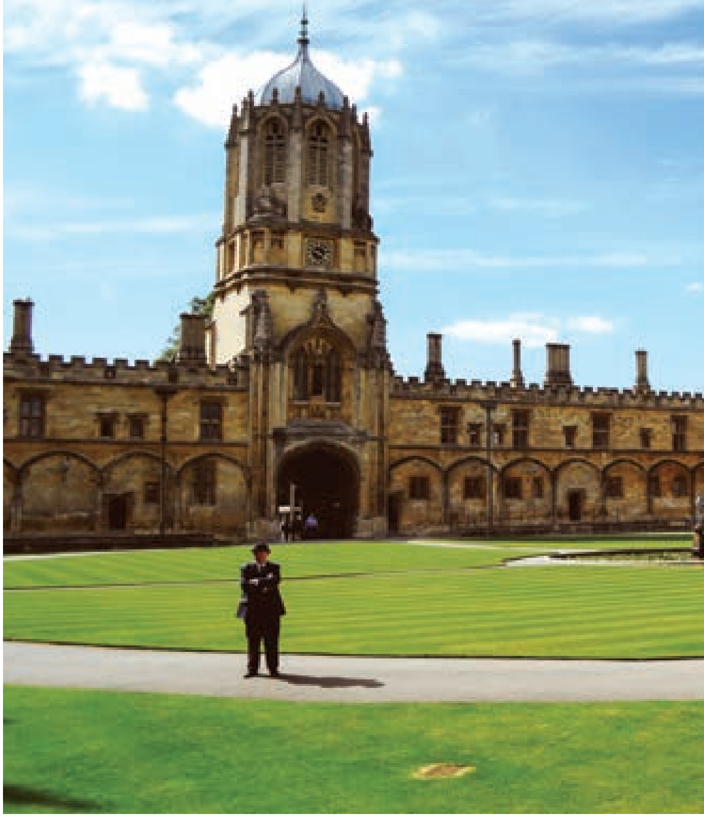
- The human resources education through bachelor, master, doctorate programmes and continuing education based on the paradigm „education through research and for research";
- The relevant knowledge generated through research, innovation and artistic creation, pursuing results that bring prestige and visibility to the university and are also transferable to products, technologies and solutions;

- The commitment to society, by assuming the role of „active citizen" in the local, regional and national community;
- Connecting the academic community to the European and global one, facilitating the access of the local and regional community to the globalized flow of knowledge and values.

The integration of sustainability in the universities from Romania can be viewed as a change of the strategic objectives within the vision and future objectives of the university activity. These strategic objectives could be reflected in four main areas, namely: education, scientific research, society and management.

According to the 2030 Agenda for Sustainable Development, the university requires policy changes within the integration of sustainability through organizational structure, statement, and strategy. To become an institution that integrates sustainable development principles, the mission of TUCN could be conducted in the following directions for the next years 2021-2030:

- Modernize the education system by adopting the methods of teaching and learning to the use of information technology and increase the quality of education;



- Expand the concept of sustainable development in formal university education as a principal and a specialization and highlight the role of interdisciplinary research in the development of a sustainable society;
- Organize technical education into specially designed and equipped campuses; train qualified teaching staff; create a curriculum tailored to the needs of the labour market by developing partnerships, including with the business community;
- Expand the network of community-based permanent education centres by the local authorities; continue to involve companies in supporting employee enrolment in such programmes;
- Encourage sustainable lifestyle in the university (2030 Agenda).

After the first stage of the PDCA cycle, for the next stage (operations), some university activities could be implemented in small steps at the level of some departments and services of the university, for example: civil engineering, electrical engineering, mechanical engineering, materials and environmental engineering and so on. These activities could be conducted in the following directions:

- The reduction of costs for utilities in all university buildings;
- The reduction in consumption of energy by a heating system in campuses;
- Establishment and implementing some projects for the use of renewable resources;
- Dematerialization of administrative processes;
- Rationalization of supply processes and waste management;
- Sustainability oriented projects at the national, regional and international levels;
- Implementing sustainability in the educational and research processes;
- The improvement of the libraries on-line services through an increase in electronic sources.

In the next stage, evaluation includes the review if the proposed activities are achieving in the desired result or not. The evaluation step includes management methods and tools (benchmarking, Quality Function Deployment-QFD, Balanced Scorecard). For example, in sustainable electrical engineering, the TUCN is implementing a pilot project named DR-BOB in its own buildings. The main objective of this project to develop an energy monitoring and targeting system, along with a Demand Response (DR) program. The concept of DR is related to reductions in electricity bills but, now, it is actually much more complex and refers both to decreasing or increasing energy consumption. A total of 12 TUCN buildings have been selected to evaluate the total energy efficiency potential during the DR-BOB project (Bargauan *et al.*, 2017). Also, the sustainability-oriented project at the local, regional level is the BISNet Transylvania – project. The general objective of

BISNet Transylvania project is to increase competitiveness and innovation capacity in two regions of Romania (namely the North-West and Central regions), by providing integrated business and innovation services, focusing on regional priorities and by developing the local network capabilities. In addition, recycling is a popular sustainability practice at university.

Finally, the next step is to solve those activities already identified in the evaluation step and improving new solutions. Management decisions are adopted, based on this step. In order to encourage innovation and sustainable development, it is necessary for a university to become support for cooperation with production and service sectors and foster sustainable production and consumption practices. All of these solutions should be included in a university's sustainability report which can be presented and published annually.

However, the cycle is not stopped at this level. It is always necessary to go through the cycle again for the next level. Each cycle brings the process to a higher level. The Deming cycle is a spiral, leading to continuous improvements.

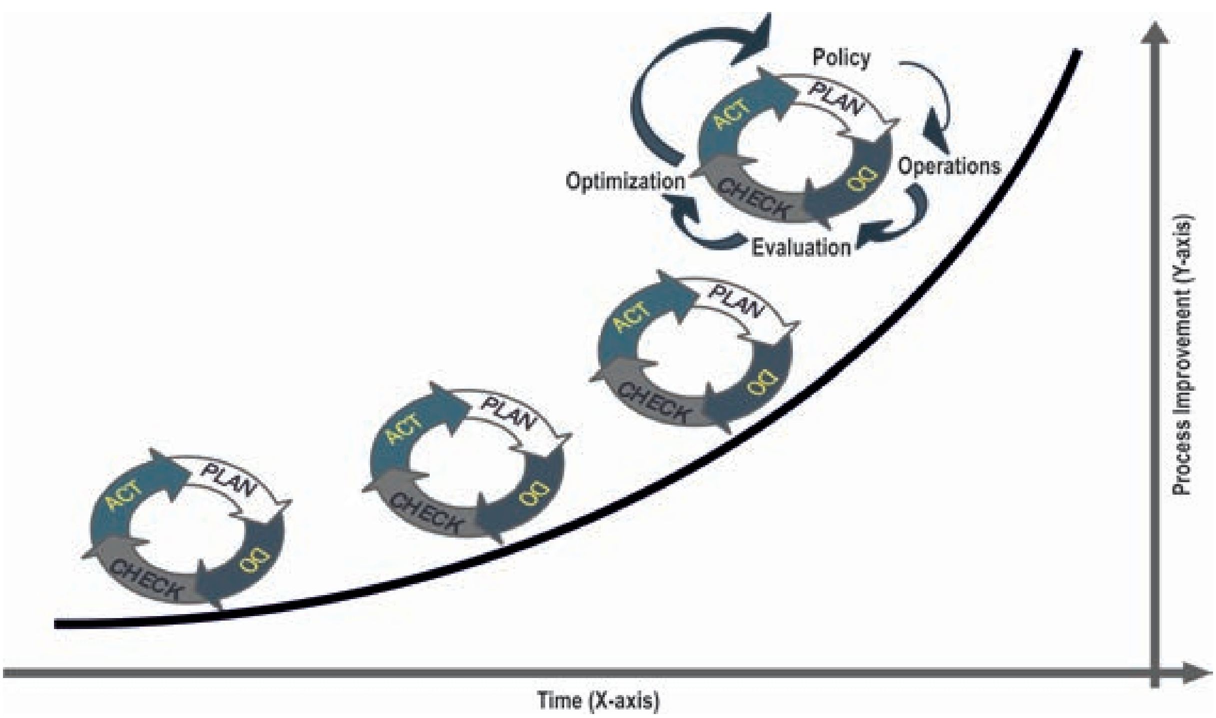


Figure 2 – *The PDCA cycle of a sustainable university*

Discussions

Inspired by Velazquez *et al.* (2006), who proposed a model of the sustainable university, and Lukman and Glavič (2007), who identified the key elements by making use of the Deming spiral, in the present paper we have described the PDCA cycle. The first step of the PDCA cycle points out plans for future development. After this step, day-to-day activities are emphasized, based on management decisions. The third step evaluates those results achieved in the previous steps. The last step of the cycle refers to improvement and indicates those optimization activities, which influence managerial decision-making.

Several directions have been identified for implementing sustainability in the academic environment alongside with a set of measures that were suggested for the systematic transition to the sustainable university model. These directions are in line with Romania's National Sustainable Development Strategy 2030, adopted by the Romanian Government and consist in the following initiatives: modernizing the education system by adopting the methods of teaching and learning to the use of information technology and increase the quality of education, expanding the concept of sustainable development in formal university education, organizing technical education into specially designed and equipped campuses, creating a curriculum tailored to the needs of the labour market by developing partnerships with the business community, expanding the network of community-based permanent education centres by the local authorities and encouraging sustainable lifestyle in the university.

Thus, a new approach and tool for continuous improvement and assessment of sustainability can be implemented in higher education, in Romania, in total compliance with the requirements of European and international sustainability standards. The implementation of the sustainable university model requires more effort by the top management of the university and additional funds and resources must be allocated for sustainability initiatives. Moreover, the inclusion of sustainability principles into university practices is needed, as well as an evaluation and optimization process.

Conclusions

In order to improve the quality of Romanian higher education and administration, several conclusions and recommendations have been suggested for the implementation of this new approach, such as the reduction of costs for utilities in all university buildings; establishment and implementing some projects for the use of renewable resources; dematerialization of administrative processes; rationalization of supply processes and waste management; the improvement of the libraries on-line services through an increase in electronic sources and implementing sustainability in the educational and research processes.

This research proposes a methodology to translate how the theoretical concept of a sustainable university is translated into practical tools for coordinating continuous improvement efforts put into sustainability. Moreover, this paper encourages universities from Romania to improve their strategic objectives through the integration of sustainable development principles within their academic activities and strategies.

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„We must develop
a comprehensive
and globally shared view
of how technology is
affecting our lives."
Klaus Schwab
(World Economic
Forum)

Blockchain Ecosystem in the Financial Services Industry

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Abstract

The emergence of disruptive technologies such as blockchain in the financial services industry is causing „high tension" among systemic market players. Leading financial institutions are experiencing increasing discomfort with the entry of new high-tech competitors into niches that they have traditionally dominated for centuries. The advent of blockchain as a new high-tech ecosystem could not only change the institutional profile of the financial industry but also alter the nature of financial deals, reshape the trading patterns and relationships between counterparties. The research focus of this paper includes questions such as: is the blockchain ecosystem capable of dramatically disrupting the financial services industry, which segments are likely to be affected, and what is the expected nature of the changes. The methodological toolkit used is based on literature review and use cases analysis that examines the expected positioning of blockchain in selected segments of the financial industry. The interaction between the distributed ledger and smart contracts as components of the blockchain ecosystem provides good opportunities for optimizing financial market trading. The results of the study show that blockchain technology application is expected to lead to automation of key processes, increased security, transparency, speed in transaction execution and elimination of unnecessary financial intermediation. The analysis also shows that blockchain's application is facing technological, legal, regulatory and ethical challenges and barriers.

Keywords: blockchain, distributed ledger, smart contract, financial services, disruptive technology

„We cannot wait until there are massive dislocations in our society to prepare for the Fourth Industrial Revolution."
Robert J. Shiller
(Nobel laureate)

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Introduction

Blockchain undoubtedly has the distinctive characteristics of disruptive technology, according to the classic interpretation of this term (Bower, Christensen, 1995; Zeleny, 2012). The market phenomenon „disruption" is identified with an effective response to competitors, the finding of new growth opportunities and a better understanding of customer needs (De Meijer, 2019). There are numerous reasons to consider blockchain as a type of technology which, with enviable audacity and ease, is capable of changing the „rules of the game" and replace today's big „players" in the financial industry.

The concept of blockchain was born only a decade ago, and like any new technology, its capabilities have not yet been fully explored. A study conducted by Janaviciene and Fomin (2019) based on data from 58 relevant articles indicates a growing interest of the scientific community in blockchain application in the context of economics, management, and finance. Opinions of authoritative sources on these issues range from apocalypse forecasts to optimistic euphoria about the capabilities of the new technology. In the spirit of the pessimistic scenario, Deutsche Welle (2019) broadcasts a documentary with the provocative headline „The end of banking, as we know it?". Doubts about the survival of banks are also being mentioned in an article headlined „Blockchain and disruption in the financial world: Will banks survive?" (De Meijer, 2019). However, a publication in the renowned Harvard Business Review proclaims blockchain as a technology that „could slash the cost of transactions and reshape the economy" (Iansiti & Lakhani, 2017). In the White Paper series of the World Economic Forum (2018), experts assess the impact blockchain could have on global trade over the next 10 years to an impressive sum of 1 trillion dollars. The cumulative investments in blockchain startups have already exceeded 1.5 billion USD in 2017, and forecasts suggest that in 2025 the added value of blockchain will grow up to $ 176 billion (Growth of Blockchain..., 2018).

Experts foresee that the new technology will revolutionize the financial services industry and banking as the Internet and social networks have reformed communications over the last two decades (Perez, 2015; Swan, 2015). There is no doubt in the effectiveness of blockchain as that technology „accelerates the transfers of assets around the world down to few seconds with minimal transaction costs" (EVRY, 2016). In addition to allowing the so-called peer-to-peer transfers, blockchain eliminates the need for intermediaries responsible for the settlement or clearing. Like any new and less-known technology, blockchain provokes mixed feelings and sometimes diametrically opposed opinions among the financial community. Against this background, the banks' reactions spark curiosity since it is unclear whether they will perceive blockchain technology (BT) as a threat with a destructive potential to their status quo, or as an opportunity that will open new horizons for development. Some experts believe that technology can cause a wave of transformations and innovations that both financial institutions and their customers could benefit from (Collomb & Sok, 2016). However, the top executives from the German Berenberg Bank are much more sceptical. In their opinion, blockchain is an overhyped technology that faces some major challenges, referring to the lack of examples of successful stories (Kelly, 2017). Scepticism about BT's future can be opposed by the example of the required timeframe between making the important technological inventions and their actual application. As many people know, from 1939 to 1942, Professor John Atanasov, University of Iowa and his student Clifford Berry invented the world's first model of the electronic digital computer with regenerative memory. This discovery „matured" for almost half a century before it became an integral part of our daily lives. Another common example is the creation of the Internet in the 1960s and the beginning of its popularization as a global communications network in the mid-1990s. Whether and when a new technology will bear fruit and what the extent of its integration will be are complicated questions, whose answers require an analytical look at the cycle and phases of innovative technology development – a problem that is the focus of analysis in the next sections.

The Essence of the Blockchain Ecosystem

There is a very close connection between the terms 'blockchain' and 'distributed ledger', but the two are not quite identical.

The functional nature of a blockchain can be described as a distributed ledger (DL) with supported identical copies on multiple computers controlled by different users. Distributed ledger technology (DLT) is associated with an innovative approach for recording, sharing and storing data in multiple registers (ledgers). Moreover, this technology allows synchronized recording and storage of data between different users on a shared network at the same time. In fact, the idea of a distributed database is not new. At least not all DLs, by theory, use blockchain (Natarajan, Krause, Gradstein, 2017). What nourishes the attractiveness of DLT is the possibility for many users to share a simple, easily accessible and constantly audited database (Casey *et al.*, 2018). Therefore, blockchain can be characterized as a technological structure using DL, which stores and exchanges data, packaged in separate blocks and linked together in a digital chain.

Blockchain uses encryption and sophisticated mathematical algorithms for irrevocable transcripts and data synchronization,

protected against subsequent manipulation. In the financial services industry, a third party generally assumes the care of authentication, confirmation, and storage of transactions. Most often, these are institutional intermediaries responsible for the clearing and settlement. The database they maintain is centralized, with controlled access to information. The main idea of using DLT is to make the history and complete transaction chronology accessible and viewable online by all authorized users on the network (Buitenhek, 2016). Each participant in a transaction has a valid copy of the transcripts on the network, which may affect, for example, the ownership of an asset and the complete timeline of the transactions performed with it. The system of operation of the registry is fully decentralized and contains time-trackable information for each individual transaction (Petrasic & Bomfreund, 2016). Another major advantage of DLT is the speedup of settlement and the time required to complete transactions. This leads to a significant reduction in transaction costs, as they are performed peer-to-peer between correspondent parties without the need for validation or other types of intervention by a trusted third party. Another important point is the need for reconciliation and coordination when transactions are accounted for in different ledgers. With this said, blockchain is estimated to be able to reduce accounting infrastructure costs of investment banking amounting in between 8 and 12 billion USD annually.

The underlying principle of DLT blockchain is the shared storage of information, which results in virtually zero risks of data loss. Transaction security is achieved through authorization and encryption processes. If any particular 'node' in the system is defective, the information will not be lost irrevocably but will be preserved in its entirety and completeness, since every other participant has a copy of exactly the same database. In addition, the transaction log is stored in the DL, not just the end results (such as current balances), which protects the system from manipulations or falsification of data. A digital signature from the participants in the deal certifies the validity of the transactions. Signed transactions are sorted into separate blocks and each block in this chain is assigned a unique so-called „hash" code generated by computers using a complex mathematical formula. Making changes to transactions will change the hash code of the block where they are stored. Furthermore, these changes are reflected simultaneously in all blocks in the chain. Thus, a possible change will be first registered immediately and secondly – immediately identified and traceable by all participants in the network. One of the most significant advantages of using blockchain in banking is the automation of the Know Your Customer (KYC) process. KYC activities and customer onboarding currently take credit institutions more than 26 days to materialize (Thomson Reuters, 2017). This period can be drastically shortened as participants can perform KYC activities in real-time, establishing the corporate digital identity through the functionality of the DLT base (McWaters *et al*., 2016).

The productivity of the technology could be multiplied by the resourceful combination of blockchain and smart contracts. The idea of implanting smart contracts fits in well with financial transactions where there is a link between fulfilling contractual terms and making real transactions. Nick Szabo (1997) first introduced the term „smart contract" and compared it to a vending machine in order to illustrate the principle of its operation. In the context of blockchain technology, smart contracts are computer programs recorded in DL that represent a sequence of self-executing engagements, which ensure the automated execution of contractual terms (Gheorghe, Țigănoaia, Niculescu, 2017).

What makes the use of smart contracts valuable is the ability to eliminate third parties' intermediaries – agents or trustees. The „blockchain-smart contract" combination forces the execution of transactions in accordance with the contractual terms. This minimizes the likelihood of a conflict between the parties and opens a door to the automation of payment processes. The autonomy that is at the heart of smart contracts allows them to function independently, without the need for routine control over the proper and accurate implementation of their clauses. Apart from autonomous, smart contracts also are self-sufficient, which means that they do not depend on the funding of their issuers (Van Oerle, Iemmens, 2016). Significantly, they provide greater security and the ability to trace legally valid transactions, thereby greatly facilitating the work of regulators (Petrasic, Bomfreund, 2016). In addition to the automated execution of real transactions, „smart" contracts „seize" the functions of the central registry, as they remove the need for an intermediary agency to perform clearing and settlement operations through independent information concerning the transaction confirmation. Instead, smart contracts can be programmed to manage the entire cycle – from negotiation to completion of the transaction without human intervention, while regulators receive up-to-date information on the activity performed.

Development of Blockchain in the Financial Services Industry

According to McKinsey, blockchain as innovative technology is positioned at the boundary between the „Pioneering" and „Growth" phases (Higginson, Nadeau, Rajgopal, 2019). Gartner (2018) provides a different interpretation of the development cycles of emerging technologies, according

to which technological innovations go through five stages. The first stage, called the „Innovation Trigger", is associated with the initial emergence of new technology. The following phases are the „Peak of Inflated Expectations" and the „Trough of Disillusionments", which are related to the initial boom and hype expectations of the emerging technology and the subsequent decline in enthusiasm. Reaching the final two phases – „Slope of enlightenment" and „Plateau of productivity" means that the technology has attained a mature stage in its development, in which it is expected to unleash the true potential of its productivity.

According to Gartner (2018), „blockchain in banking and investment services" in 2018 has already passed „Peak of Inflated Expectations" and is positioned near the border with the next phase of „sobering" illusions. One logical interpretation of this positioning is that after the euphoric stage has passed, there is a phase of „awareness and landing", in which initial enthusiasm is replaced with realism and criticism. Not all blockchain applications are placed under a common denominator in terms of the time they need to go through all stages of development and become an integral part of everyday life. In this regard, it is estimated that a period of 5 to 10 years is required before the mass application of blockchain in the financial trade. Given the nature of the problems that need to be resolved and the barriers needed to be overcome, it is more probable that the expected time needed to „put into service" the technology be closer to the upper limit of this time horizon (Petorv, 2019). The basis for such a forecast is the presence of obstacles of different natures, whose removal can be a difficult task. One of the most serious problems is the expected response of major stakeholders. The emergence of disruptive technologies such as blockchain could be seen as a threat to the status quo of the so-called „systemic" market players and face their fierce resistance. There are concerns among financial institutions, with the justification being that blockchain applications will cannibalize their profits, eliminate them from the market, lead to financial losses and even bankruptcies (McKinsey, 2018). The accumulating skepticism about blockchain is fueled by the vague results of cost-benefit analysis, the varying degree of interest of the key players involved in the process, the slow progress and the lack of real-life examples of implementing blockchain innovation (Higginson, Nadeau and Rajgopal, 2019). The other side of this coin is that financial institutions can accept the challenges of new technology not as a threat that will „throw" them out of the financial market, but as a technology tool

that can be used by both them and regulators to facilitate transactions, enhancing the security and speed of information sharing and reducing operating costs.

Results and Discussion

A reasonable question about the degree of infiltration of new technology is in which segments of the financial market do prerequisites for blockchain application exist? Deloitte (2017) have systematized a construction of symptoms that indicate the necessity to apply blockchain to a certain segment. For example, a single segment could be suitable as a blockchain application field under the prevalence of the following circumstances: heavy documents turnover between participants, predominantly manual transaction processing, delayed settlement, the presence of a claim that allows different parties to change the terms of the transaction, and the lack of transparency in their negotiation. Following this logical approach with an extended perimeter Table 1 lists 16 indicative symptoms that serve to identify segments where there are prerequisites for blockchain application.

Table 1 – *Indicative symptoms for blockchain application*

1	Clearing and settlement is done by intermediaries and takes a long time
2	Information asymmetry exists
3	Possible data loss
4	High risk of fraud, falsification, misrepresentation
5	High administrative costs
6	Two or more mediators in the deal
7	High mediation fees
8	Parallel storage of transaction information and high cost of data synchronization
9	Complicated document turnover
10	Mostly manual processing of documentation
11	The time-consuming process of preparation, concluding and executing a deals
12	Missing automation of key processes
13	Issues with authorization and validity of transactions
14	Problems establishing ownership of assets/collaterals
15	High expenses for KYC activities; expensive and time-consuming customers onboarding
16	High compliance expenses

The next step is to select a part of the traditional segments of the financial industry to test the probability of using blockchain technology by checking for the presence or absence of indicative symptoms in the selected segments. Eight key segments have been selected based on the most commonly used focus on blockchain technology use cases – global payments, trade financing, capital market trade, syndicated loans, project financing, insurance, mortgage and retail lending, private and corporate banking. The results of the test for the presence of symptomatic indicators in the selected segments are presented in Figure 1.

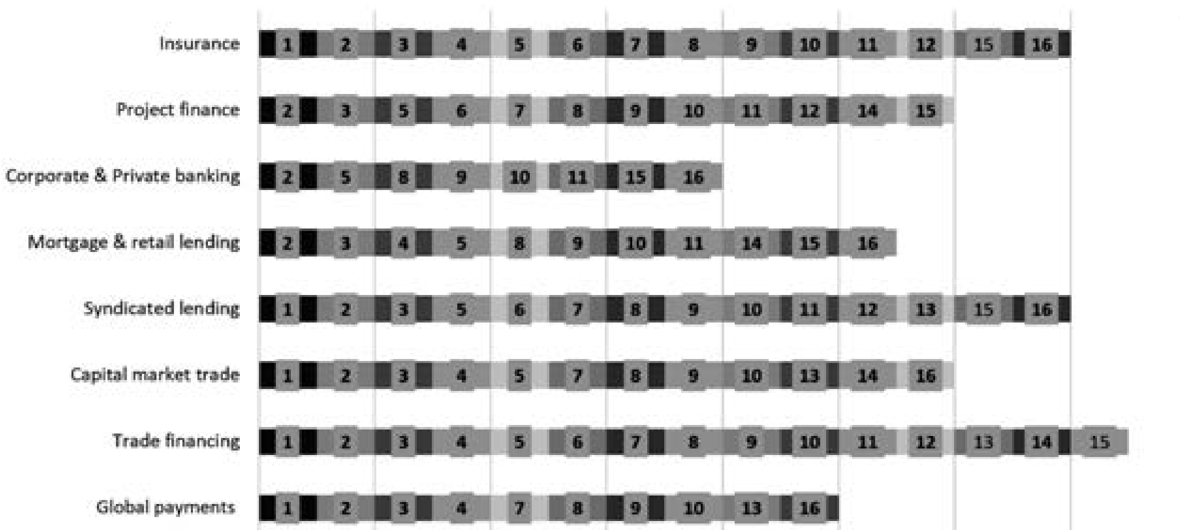

Figure 1 – *Number and type of indicative symptoms*

From the analysis in Figure 1 we can generalize several arguments for a massive blockchain penetration into segments such as Trade financing, Capital market trade, Syndicated lending, Project financing and Insurance. The prerequisites for this are the complex transaction structures, the multiple parties involved, the burdensome workflow, and the manual processing of transactions. The presence of indicative symptoms of numbers 2, 8, 9 and 10 in all studied segments is also impressed. This shows the high importance of factors such as „Information asymmetry", „Parallel storage of transaction information and high cost of data synchronization", „Complicated document turnover" and „Manual processing of documentation".

The expected positive effects of blockchain application in the affected segments are systematized in Table 2.

Table 2 – *Expected benefits and outcomes of blockchain implementation*

Expected benefits	Expected results
Accelerate settlement and complete or partial elimination of intermediaries	Increased operational efficiency
Increasing transparency by eliminating unequal access to information	Limiting information asymmetry
Increased security and crash protection of the information system	Prevention of data loss
Digital signature and encryption make unauthorized access to the system impossible	Reducing the risk of frauds and falsifications
Reduction of administrative procedures	Reducing administrative costs
Removal of redundant intermediaries through using smart contracts	Reducing unnecessary intermediation
Substantial reduction of mediation	Reducing or eliminating the mediation fees
Effective storage and synchronization of data in distributed ledger	Reducing the costs of data synchronization
Alleviation of the procedural complexity of the transactions	Facilitating the document turnover
Minimize manual processing of data and documents by automating key processes	Reduced costs due to minimization of manual processing of documentation
Smart contracts provide automated transaction procedures	Reducing the time needed to prepare, concluding and executing a deals
Automation of key processes from negotiation to completion of the deals using smart contracts	High accuracy, correctness and accelerated organization and execution of transactions
Providing authorized access and authorization through encryption and generating hash codes	Increased level of transaction security
Clarity and transparency about different property rights and ownership of assets/collaterals	Increased level of security for traded assets and collaterals
Automated or simplified KYC procedures and customer onboarding	Reduced costs of KYC activities and customer onboarding
Automation of compliance procedures and anti-money laundering measures	Reduced compliance expenses

Blockchain's implementation is expected to result in significant reductions in operating costs, increased transparency, reduced procedural complexity of transactions, automation of key processes, and minimization of manual data processing. BT could significantly facilitate regulatory authorities and supervisors by providing them with up-to-date and reliable information about completed transactions. One of the substantial socially significant benefits for the supervision thanks to the introduction of the new technology is the „Anti-money laundering" feature (Valkanov, 2019). Regulators will easily be able to trace the origin of funds and transaction history in DL without having to request and process numerous declarations and reports from the participants in the transactions.

Despite the expected positive effects of blockchain implementation, there are some concerns, raised by the disruptive potential of the new technology, that provoke tensions among financial intermediaries. The mass application of BT faces unresolved problems of a technological, legal, regulatory and ethical nature. The problems of technological nature are due to the specificity of blockchain functioning. Encrypting records in DL may make it impossible to access the system in the event of a lost password. The high energy intensity of the so-called mining, which provides the necessary decentralization of the blockchain ecosystem, remains unresolved. The legal challenges can be summarized as follows: although DL entries are credible and immutable, there still isn't a detailed legal regulation of transactions made on the blockchain platform. For example, if there is a dispute between two parties or lawsuits, it is not clear how this will affect the status of their transactions. The necessary legal framework will also allow regulatory authorities to exercise their supervisory role more effectively.

The automation of KYC activities may also be questioned if there is no compatibility between the partners for the establishment of a single rating system. The assessment of the costs and benefits of using technology between financial players may vary significantly. This may cast doubt on the benefits of participatory co-operation and the return on investment in technology. Many ethical questions emerge when computer algorithms replace the human factor. Automation undoubtedly contributes to the operational efficiency of key processes, but inevitably leads to job cuts.

Conclusions

Blockchain has all the hallmarks of disruptive technology that has the necessary potential to make inevitable technological changes in the financial industry. The traditional financial trade is characterized by inefficient, slow and costly procedures in offering ever more sophisticated financial products, including a chain of intermediaries and still predominantly manual document processing. This causes difficulties in dealing with a growing information array and an increase in operating costs. Settlement and clearing still not done fast enough and cause additional costs in multiple transactions. Digital technology penetration in the financial sector is an irreversible process that threatens to disrupt the status quo and the leadership of the major financial institutions-mastodons. Severe competitive pressure from new market players confronts mastodons with unprecedented challenges in their history.

As an innovative technology, blockchain is expected to cause dramatic transformations in the financial services industry. The results of the analysis show that the application of blockchain can cause a number of positive effects on financial intermediaries and their clients. Comparing the expected effects of selected indicators in key segments, it is concluded that blockchain application can significantly increase the operational efficiency of routine financial transactions. The effectiveness of BT is also reflected in the acceleration of clearing and settlement, increased transparency, safety and a significant reduction in the volume of manual manipulations in transaction processing.

As a disruptive technology, blockchain can eliminate unnecessary financial intermediation, but it can hardly eliminate the institutions that offer financial services in one go. Under increasing external competitive pressure, all intermediaries will be encouraged to offer high-quality innovative products and services in a new market environment with greater security, transparency and significantly reduced costs. The analysis of the key functional parameters of a blockchain shows that from a purely technological tool it can become a survival philosophy and an important component of the strategic plans for the development of financial institutions. Successfully overcoming the barriers to BT application is a challenge and a prerequisite for an evolutionary leap. From this point of view, steps can be taken in the following sequence: financial intermediaries to actively experiment with blockchain startups and test pilot projects in real market conditions in selected segments; it is necessary to create appropriate conditions for the legal infrastructure for the operation of the blockchain; launching initiatives to build a single rating system that enables an automated KYC process.

Fritz Zwicky, the creator of the method ***Morphological Analysis*** and discoverer of Black Holes, was born in Varna

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„Digital is the main reason just over half of the companies on the Fortune 500 have disappeared since the year 2000."
Pierre Nanterme
(Accenture)

Risk of the New Control Systems

Titu-Marius I. Băjenescu

La Conversion, Switzerland

Abstract

The aim of the paper is to provide the fundamental notions on the methods and tools of risk analysis aimed at ensuring, developing and guaranteeing trust in any organisation and on any project. International standards for quality, environmental, health and safety management, risk management, decision analysis, and gaining synergies are thoroughly analysed.

Keywords: risk, risk analysis, risk management, risk identification, quality management, decision analysis, reliability

Introduction

Risk is a measure of the probability and consequence of uncertain future events (Figure 1). It is the chance of an undesirable outcome. That outcome could be a loss due to fire, flood, illness, death, financial setback, or any sort of hazard, or a potential gain that is not realized because a new product did not catch on as hoped, your investment did not produce expected benefits, the ecosystem was not restored, or any sort of opportunity is missed. What usually creates the „chance" is a lack of information about events that have not yet occurred. We lack information because there are facts we do not know, the future is fundamentally uncertain, and because the universe is inherently variable. Let's call all of this „uncertainty" for the moment. Risk is everywhere, and you do not have to look very hard to find risk.

„I think the human race made a big mistake at the beginning of the industrial revolution, we leaped for the mechanical things, people need the use of their hands to feel creative."
Andre Norton

* Correspondence to: tmbajenesco@gmail.com

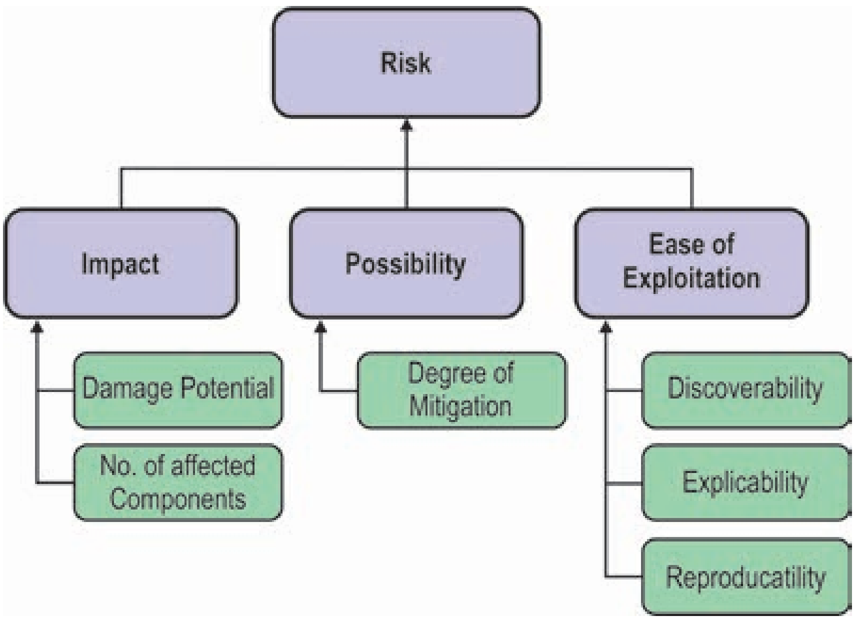


Figure 1 – *Components of risk*

The International Organization for Standardization (ISO, 2018) defines risk as to the effect of uncertainty on an organization's objectives. This is clearly broad enough to include uncertain opportunities for gain. Risks of uncertain gain are often called *speculative risks*. ISO 9000:2015 includes the definition of risk as the „effect of uncertainty on an expected result." ISO 31000:2009 includes the definition of risk as the „effect of uncertainty on objectives." For the purposes of the ISO standards, risk includes considerations of financial, operations, environmental, health, safety, and may impact business or society objectives at strategic, project, product or process levels. There is more agreement on the practice of risk analysis than there is in its language. Creating a reliable product that meets customer expectations is risky.

Reliability risk now has a place to fit into the larger discussions concerning the business, market, and societal risk management. Reliability risk is a major component of the risks facing an organization. Witness the news making recalls in recent years.

Our work as a reliability engineer has not been bound by a focus on product or process development, we have long considered the impact of unreliability on customers, and the impact on business objectives, such as warranty and profit. Risk management blends elements of quality, reliability and business management to create a framework for comprehensive consideration and management of the many possible 'unwanted' or 'unexpected' outcomes. As for reliability professionals, we already regularly use the tools to identify risks, the tools to mitigate or eliminate risks, and the tools to estimate future likelihoods and consequences of risks. We are in an excellent position to lead the discussion about risk within our organization and industry.

Customers want the benefits created by your product. They want the time savings, the reduce yield loss, they want the simplicity, coolness, speed, etc. Customer buys your product to solve a problem, they do not buy it to simply enjoy the features.

The features have to do something of value. They have to provide a benefit. If your product fails, the feature doesn't work. Customers do not realize the benefit they expected. In short, your customer wants your product to work as expected. When asked a customer, will tell you they do not want to have product failures.

As a reliability professional, you are conveniently looked to for leadership. You are expected to use your knowledge and skill to solve problems. To help teams solve problems; to improve the reliability performance of your system and across your industry. Have you ever worked on a project with no deadlines, unlimited resources, and boundless scope? Probably not.

You may have worked under the guidelines of a quality triangle (Figure 2), also known as a project management triangle, iron triangle, or project triangle. Why is that? Why the limits to our ability to create a product or improve a system? First, the world we work and live within has limits. We have only so much time for work, only the available resources, and limited knowledge. We do the best with what we have to work with at the time.

Figure 2 – *The quality triangle*

The Reliability of the Equipment

The trilogy „safety – reliability – risk" that is at the heart of the debate on the notion of risk. Risk and the two associated concepts of safety and reliability are often confused and the purpose of this paper will be to dissociate them in order to give each of them the meaning that it deserves is clean. „Security – safety", „reliability" and „risk" constitute the conceptual reference trilogy of the domain, „security" also being associated with „protection". These terms express the fear of irreversibility. The reference to security also expresses the utopia of independence with regard to multiple vulnerabilities that are ours. The concepts are distinct, but risk management is now tending to bring them closer together. This is particularly the case for security.

The concepts associated with security are insurance, safety, police, surveillance, etc. discipline, order, sheltering and those associated with security are also the assurance of security and also the police, surveillance, discipline, order, enforcement, etc., the shelter making it difficult to distinguish them.

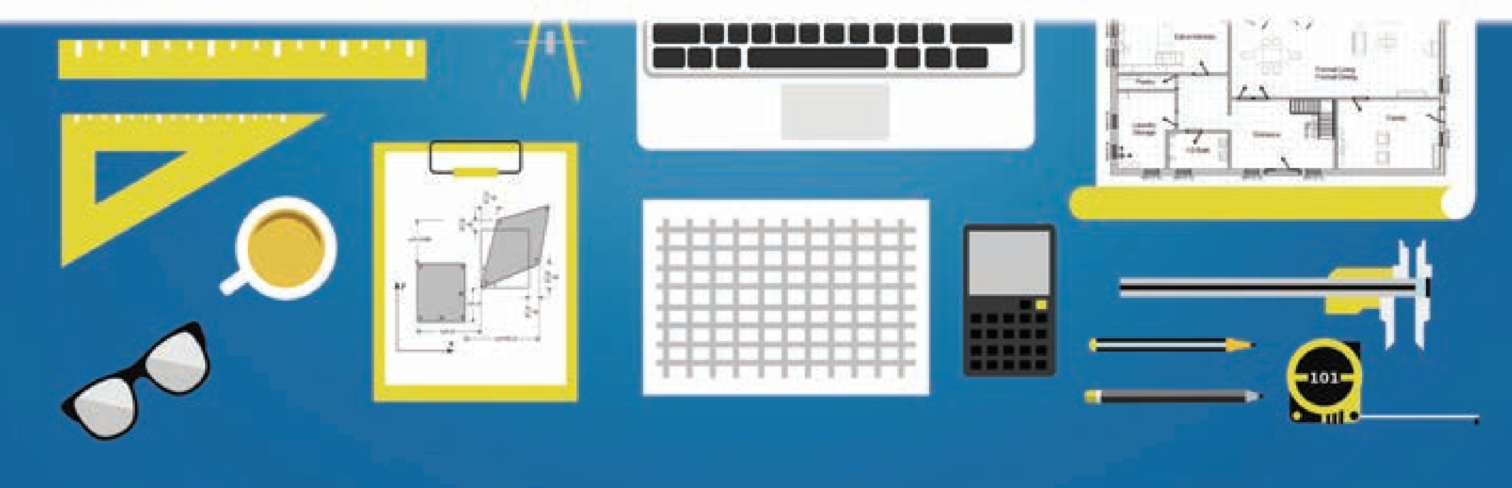
„Security – safety", „reliability" and „risk" constitute the conceptual reference trilogy of the domain, „security" also being associated with „protection". These terms express the fear of irreversibility. The reference to security also expresses the utopia

of independence with regard to multiple vulnerabilities that are ours. The concepts are distinct, but risk management is now tending to bring them closer together. This is particularly the case for security and operational safety.

Another correlate of the risk issue is reliability. This is probably the notion that has the most been integrated into the management tools that are inherited from scientific and technical management. The definition the reliability adopted by the International Electrotechnical Commission (IEC) and most of the specialists is as follows: „Characteristic of a device, expressed as the probability to perform a required function under specified conditions for a specified period of time". The term is recent but the problem is as old as the technique.

Reliability calculations are the basis for the forecast calculations required in the design phase of equipment. The main idea of reliability calculations is that, whatever the configuration, it would always be possible, knowing the reliability of each element (component or sub-assembly), to determine the reliability of the assembly. The conditions of introduced in the definition of reliability itself, include both the physical environment in which the device is to operate and its environment technical. The intrinsic reliability depends on the reliability of the components, the project or design, and finally of the realization of technical aspects of the device. Operational reliability is the product of intrinsic reliability, through the cost/income ratio.

The broad concept of resilience evokes the idea of something that resists pressure without too much deforming while being able to return to its original shape. Today, it is the word through which refers to flexibility in order to promote social adaptation. Born from American social psychology, he would tend to express that those who are resilient will adapt while others will have to resort to the psychologist. For S. Tisseron however, the word *resilience* is first of all ambiguous because „it masks the character always extremely



fragile of the defences developed to deal with trauma" and their variety. But it also indicates the project to deal with the trauma that benefits both the individuals who generate them and to value those who bounce back at the expense of those who generate them surround.

Definition: The risk R („risk") is a function (f) with the parameters event frequency F („frequency") and magnitude C („consequence"), i.e. R = f(F, C).

In contrast to general language understanding „Risk = Danger" includes the technical term risk always the frequency of an (undesirable) event and its extent. This definition corresponds to content according to standards and ordinances (Aven, 2003, Băjenescu, 2018, Băjenescu 2015). However, probabilities are assumed here, which are neither mathematically mandatory nor generally not included in risk analyses is common. The conditions of introduced in the definition of reliability itself, include both the physical environment in which the device is to operate and its environment technical. The intrinsic reliability depends on the reliability of the components, the project or design, and finally of the realization of technical aspects of the device. Operational reliability is the product of intrinsic reliability, through the cost/income ratio. Business and building everyday processes increasingly on the „information and communication technology" (ICT).

There are two important components to a risk: an undesirable outcome or consequence and the chance or probability it will occur. Risk is often described by the simple equation:

Risk = Consequence x Probability

- Risk is everywhere. Risk is sometimes confused with safety. The problem with a notion like safety is that someone must decide what level of chance or what magnitude of consequence is going to be considered safe. That is a fundamentally subjective decision, and subjective decisions rarely satisfy everyone. Risk, by contrast, can be measurable, objective, and based on fixed criteria.
- Some risks are more serious than others.
- Zero risks is not an option.
- Risk is unavoidable.

Therefore, we need risk analysis to *(a)* Describe these risks (risk assessment). *(b)* Talk about them (risk communication). Risk analysis is a framework for decision making under uncertainty. Risks vary in the magnitudes of their consequences and the frequencies of their occurrences.

Because uncertainty gives rise to risk, the essential purpose of risk analysis is to help us make better decisions under conditions of uncertainty. This is done by separating what we know about a decision problem from what we do not know about it. We distinguish five essential steps to a good risk identification process:

- Identify the trigger event.
- Identify the hazard or opportunity for uncertain gain.
- Identify the specific harm or harms that could result from the hazard or opportunity for uncertain gain.
- Specify the sequence of events that is necessary for the hazard or opportunity for uncertain gain to result in the identified harm(s).
- Identify the most significant uncertainties in the preceding steps.

Risk Management

Risk analysis is an emerging science, and it is a decision-making paradigm. As a paradigm, it is capable of producing knowledge about risks and risky activities in the real world. As a science, it also produces knowledge about concepts, theories, frameworks, methods, and the like to understand, assess, communicate, and manage risks. Terje Aven (2003) makes a powerful argument for risk analysis as a new emerging science. Although it is rapidly developing, it is not yet widely regarded as a science unto itself. As a science, it also produces knowledge about concepts, theories, frameworks, methods, and the like to understand, assess, communicate, and manage risks. Risk analysis should address all these things as a paradigm for decision making under conditions of uncertainty (Figure 3).

Figure 3 – *Tasks of risk analysis*

What makes risk analysis a science and a paradigm? *(a)* It is based on good science. *(b)* Risk analysis considers social values. *(c)* Risk analysis addresses uncertainty produces. *(d)* The purpose of this paradigm is to begin to make good decisions by finding and defining the right problem. *(e)* Because of its focus on uncertainty, risk analysis is well suited to continuously improving decisions. Risk analysis provides information to decision-makers; it does not make decisions.

Discussions of risk management almost always centre more on risk than management. How to measure value at risk is often regarded as more important to risk management, for example, than how conflicts between shareholders, creditors, and managers contribute to the need for risk management and inhibit its effective implementation. Risk management, in short, is traditionally viewed as the necessary evil by which firms try to quantify – and, if possible, avoid – financial Armageddon.

To view risk management as a novel, independent form, or even secondary to general management is to miss the whole point. If anything, risk management is first and foremost about sounding general management. In that sense, risk management is an organizational function and business process is hardly new. Principles of sound general management have been around quite a while, and applications of those principles to risk management are not a particularly recent phenomenon. In many ways, risk management itself is a substitute for equity capital. Without a solid understanding of why risk management makes sense, the design of a risk management strategy and the implementation of that strategy can easily fall flat. Risk management is the process by which an individual tries to ensure that the risks to which she is exposed are those risks to which she thinks she is and is willing to be exposed in order to lead the life she wants. This is not necessarily synonymous with risk reduction.

The distinction between business and the financial risk clearly rests on a slippery slope. Not only does it vary from one firm to the next, but it also depends not on the quality of information the firm actually has, but rather on the firm's perceived comparative advantage in digesting that information. Risk management is a process of problem identification, requesting information,

evaluating risks, and initiating action to identify, evaluate, select, implement, monitor, and modify actions taken to alter levels of unacceptable risk to acceptable or tolerable levels.

More informally, risk management is the work one has to do to pose and then answer the following kinds of questions:

1. What's the problem?
2. What information do we need to solve? That is, what questions do we want risk assessment to answer?
3. What can be done to reduce the impact of the risk described?
4. What can be done to reduce the likelihood of the risk described?
5. What are the trade-offs of the available options?
6. What is the best way to address the described risk?
7. Is it working? (Once implemented)

Risk assessment is a systematic process for describing the nature, likelihood, and magnitude of risk associated with some substance, situation, action, or event that includes consideration of relevant uncertainties. Risk assessment can be qualitative, quantitative, or a blend (semi-quantitative) of both. It can be informally described by posing and answering the following questions that build on the Kaplan and Garrick triplet (1981):

1. What can go wrong?
2. How can it happen?
3. What are the consequences?
4. How likely is it to happen?

The safety and/or performance of an engineering system is invariably the principal technical objective of engineering design. In order to achieve some desired level of reliability, proper methods for its evaluation are, of course, required. As this must invariably be done in the presence of uncertainty, the proper measure of reliability or safety may only be stated in the context of probability. Indeed, consistent levels of safety and reliability may be achieved only if the criteria for design are based on such probabilistic measures of reliability. Engineering reliability and its significance in engineering design is a rapidly growing field; the most recent and practically useful developments are presented in this paper. It goes without saying that problems of safety and reliability arise because of uncertainty in design. The quantification and analysis of uncertainty are, therefore, central issues in the evaluation of reliability and the development of an associated reliability-based design.

Decision Analysis

Making technical decisions is a necessary part of engineering planning and design: in fact, the primary responsibility of an engineer is to make decisions. Often, such decisions have to be based on predictions and information that invariably contain uncertainty. Under such conditions, risk is virtually unavoidable. Through probabilistic modeling and analysis, uncertainties may be modeled and assessed properly, and their effects on a given decision accounted for systematically. In this manner, the risk associated with each decision

alternative may be delineated and, if desired or necessary, measures taken to control or minimize the corresponding possible consequences. Decision problems in engineering planning and design often also require the consideration of nontechnical factors, such as social preference or acceptance, environmental impact, and sometimes even political implications. In these latter cases, the selection of the „best" decision alternative cannot be governed solely by technical considerations. A systematic framework that will permit the consideration of all facets of a decision problem is the decision model.

Quality management is the structured and conscious setting of activities in order to fulfil the expectations of interest partners (patients, employees, legal entities, referring physicians, relatives, politicians, companies, etc.) in the best possible way or to ensure and further develop needs-based and economic care of patients at a high level. Systematic clinical risk management according to ONR 49000ff (an Austrian standard) is embedded in the existing quality management Integration of quality and risk management – ISO 9001:2015.

For small and medium-sized enterprises as well as for larger enterprises, the ISO 9001 is one of the most widely used certification standards for management systems. It is designed for companies almost have to demonstrate ISO 9001. In addition, there is an increasing interest of companies in a risk management function. This function, companies are gaining in robustness in order to be able to rely on a successful to look at the continued existence of the company. Consequently, companies build their own risk management on and off.

However, isolated solutions should not be created. Promising for success is an integrated risk management approach, in which risk management is integrated into all functions, is integrated. A link to quality management is ideal, as there are similarities in content and methodology.

ISO 9001 was revised at the end of 2015. As an essential change, the ISO requires now a risk management system. Therefore, this revision is a good opportunity to risk management and to integrate both functions more closely.

In the context of the revised ISO 9001, a company should implement a risk management system which systematically deals with opportunities and risks. This succeeds, by identifying, analyzing and evaluating potential opportunities/risks and appropriate control measures planned for dealing with opportunities/risks will be.

A robust asset management structure is supported by three pillars of competency including management, engineering, and information (Figures 4 and Figures 5). Asset management is a term derived from the financial industry, where its concepts are applied to investment portfolios containing stocks, bonds, cash, options, and other financial instruments.

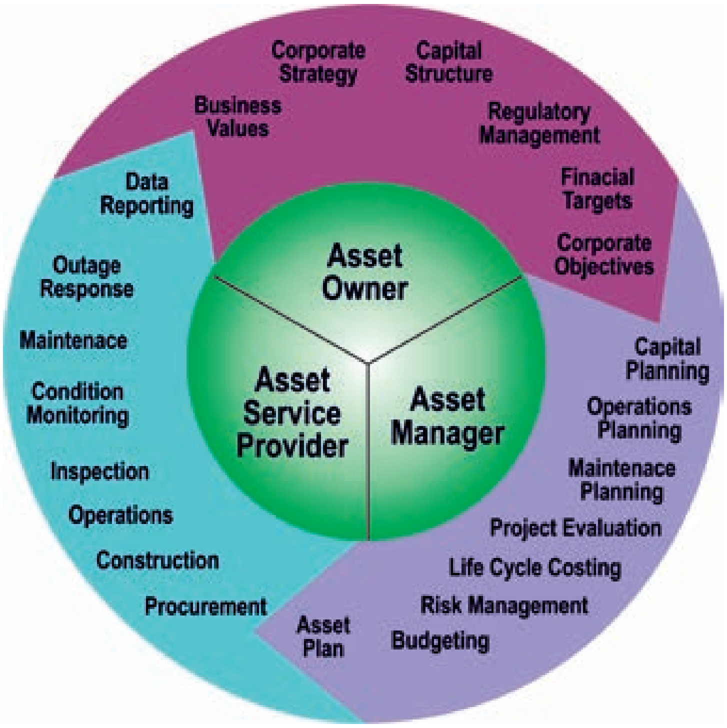


Figure 4 – *Functions of asset management*

Fundamental to financial asset management is the trade-off between risk and return. Investors identify acceptable risk. Asset management techniques are used to achieve this level of risk for the highest possible return. Building these competencies is daunting when viewed in isolation. Far more difficult is developing cross-functional expertise so that management, engineering, and information skills can be addressed in a mutually supporting manner. At a minimum, this requires knowledge of the concerns, jargon, and methodologies associated with each pillar.

Figure 5 – *Process of asset management*

The expansion of the existing quality management system to include the functions of Risk management can provide entrepreneurs with the necessary synergies. Because Quality management is primarily concerned with the necessary quality in the company – that processes are adhered to and those customer requirements are met products/services are fulfilled.

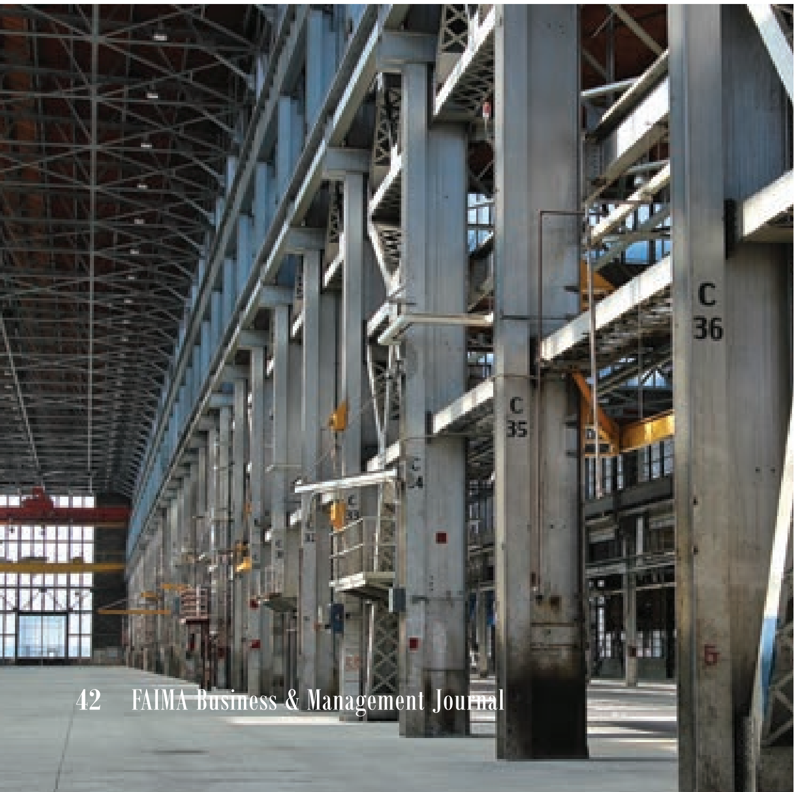
Risk management, on the other hand, is in demand when dealing with opportunities/risks and has a look into the future. All in all, both functions try to achieve the following with preventive measures to ensure the success of the company.

The quality management system can provide the necessary input for internal to provide the facts. On the other hand, the risk management system can also identify opportunities/risks or identify quality deficiencies that have not yet been identified by classical quality management, have been recorded. In addition, the functions can exchange information, so that a larger wealth of experience is created. As a result, a company can further improve its quality as well as achieve a higher achieve effectiveness and efficiency in both functions. This, in turn, leads to securing and increasing the value of the company.

However, ISO 9001 does not clearly show how companies can implement risk management or which methods/instruments they should use. For this, the ISO provides a company-specific design. A practice- or industry-dependent design is recommended.

The ISO 31000, for example, which provides orientation points, provides a remedy. Quality management has already developed a number of instruments that can nevertheless be used to find risk management.

For companies, it is not only essential to have a risk management system for certification according to ISO 9001, but they can also benefit particularly from the economic benefits of the benefit. Therefore, the use of a risk management system for companies is and should be no „annoying" certification obligation. Rather, it is a value-creating approach to look at.



Conclusions

The scientific foundation of risk assessment and risk management is still somewhat shaky on some issues; both theoretical work and practice rely on perspectives and principles that could seriously misguide decision-makers. It is hoped that the present discussion can inspire more researchers, building a strong platform for risk, risk analysis, risk assessment, risk management, and reliability risk, meeting current and future challenges (Aven, 2015). The risk field needs more researchers that have the passion and enthusiasm to bring the field to the next level.

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„The only success of Industry 4.0 is that it's on everyone's lips."
Ulrich Grillo
(Federation of German Industries)

Factors Affecting the Use of Smartwatches

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Abstract

The world of electronics is constantly in the state of evolution, a world where smartwatch devices have already begun to work quickly and have already replaced much of the classic watches. In Romania, smartwatches have become a basic accessory for young people or businesspeople, but they also began to arouse the interest of other categories of people. The goal of this paper is to determine the factors affecting the intention to use smartwatches, focusing attention on young people's perceptions of the functions or advantages of using smartwatch devices. The authors started from the original TAM model and added some external variables to test which of them largely influences the intention to use and buy a smartwatch. The results of this study highlighted that for young people, enjoyment is one of the key variables that strongly influence the perceived usefulness, the intention to use a smartwatch, and also the attitude toward using the smartwatches. The variable that least influences the adoption of these smart devices turns out to be social conformity.

Keywords: smartwatches, wearables, technology adoption, technology, technology acceptance model (TAM)

Introduction

The technology evolves every day and with this, the attitude of the individuals regarding its use changes. Smart cars, smart homes, smartphones, smartwatches, and other smart devices began to take control of our lives, becoming more than tools to make our lives easier, but a way to externalize our minds or get rid of certain responsibilities.

From a simple accessory to a device that creates addiction is a small step, which is why people should pay attention to what

„Industry 4.0 means machines using self-optimisation, self-configuration and artificial intelligence."
Jamie Hinks
(Techradar)

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kind of smart devices they use and especially how they use them. An example of such an accessory is the smartwatch, one of those devices that have started to replace the classic wristwatches, becoming an extension of the mobile phone itself.

A smartwatch is a minicomputer that can be worn on the wrist of the hand, having components like those used for a smartphone. It is more than a fitness bracelet and more than a sport watch, having an operating system, which means that you can install and configure applications, like on a smartphone.

And just as smartphones began creating dependency, the use of smartwatch started to control our lives. This is one of the reasons that made the researchers turn their attention to the analysis of smartwatches and the factors that affect the individual's behaviour regarding the use and purchase of these devices. The researchers started from the analyse of the Technology acceptance model (TAM), where the intention to use a technology is determined by attitude toward using and perceived usefulness, while the attitude toward using is influenced by both perceived usefulness and perceived ease of use (P&S Market Research, 2018) and include a variety of factors that can influence the adoption of technologies.

The problem identified by the authors of this paper is that besides those external variables that were analysed, the attention should be focused on the users mood, feelings, psychological and social changes they are going through when they use such a smart device (Barbu *et al.*, 2019a).

In this regard, the goal of this paper is to analyse the most important factors affecting the adoption of smartwatch technologies, results that would be interesting for academics, manufacturers of smartwatches or those who want to commercialize such products.

Literature Review

Over the years, technologies have suffered numerous transformations and, with these, problems about their acceptance by the users have also appeared. Researchers studied the degree of acceptance of various types of technologies, the most known theories, in this case, being the theory of diffusion of innovations, the theory of reasoned action (TRA), the theory of planned behaviour (TPB) and the technology acceptance model (TAM).

The theory of diffusion of innovations (Rogers, 1983) highlighted the fact that relative advantage, complexity, compatibility, trialability, and observability are the key factors that affect user acceptance behaviour. The theory of reasoned action (TRA) and the theory of planned behaviour (TPB) are based on the individuals perceptions, where TRA was used to predict and explain behaviour across a large number of domains (Davis, 1989), while by using TPB (Ajzen, 1991), researchers could explain the conditions in which individuals do not have complete control over their behaviour (Taylor & Peter, 1995).

Technology Adoption Model (TAM) was developed to investigate the impact of technology on user behaviour (Davis, 1986, 1989, 1993), focusing on two important constructs that affect the users intention to use a technology: Perceived Usefulness and Perceived Ease of Use. Perceived Usefulness indicates if the analysed technology will improve the users performance, while Perceived Ease of Use indicates if the analysed technology will be used without effort. Over the time, the TAM model was modified by some researchers who claim that according to the type of the technology, there are also other variables that influence the acceptance level of a technology (Venkatesh and Davis, 1996, Davis *et al.*, 1989, Venkatesh, 2001), in the literature existing different approaches of the TAM model (Adams, Nelson and Todd, 1992; Mathieson, 1991).

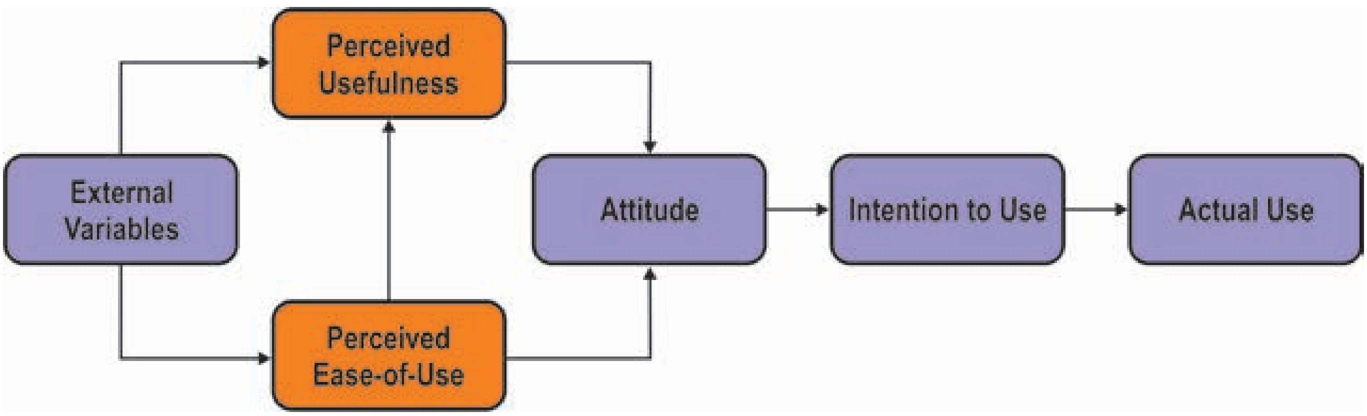

Figure 1 – *Davis Technology Acceptance Model (TAM)*
(Source: Davis *et al.*, 1989)

One of the most interesting technologies that is still used on a common object that we wear every day is the smartwatch technology. A smartwatch is a smart device that you can wear on your wrist. The technology that is used for this device transforms the classic wristwatch into a wearable computer that is most often an extension of the mobile phone.

Having the same base of technology used by mobile phones, which are beginning to easily control our lives and behaviour, smartwatches have also come to the attention of researchers (Pascoe, 2006). Since Apple Watch was released (Etherington, 2015), a lot of people including technology bloggers or even researchers have been writing more articles about smartwatches and their impact in our lives (Bernaerts *et al.*, 2014). Nevertheless, considering that the smartwatch has begun to be not only an accessory but also a luxury product, it is necessary to identify the main factors that influence the individual behaviour and their intention to purchase those kinds of products (Barbu *et al.*, 2019a).

In this regard, the authors analysed other TAM models that were used to describe the acceptance of smartwatch technologies. By doing this research, there were identified some constructs that have been used several times to indicate the factors that influence the individual's behaviour and their attitude toward buying a smartwatch. The problem was, however, that there is no comprehensive overview of these factors to determine if they only affect the final behaviour of the individuals or if they also interfere with each other.

For example, familiarity with smartwatches was used as a control variable to analyse the individual's intention for using smartwatches (Coupey *et al*., 1998; Kent & Allen, 1994). Observability is another variable that can influence the adoption to buy a product (Hsiao, 2017), this item presenting the degree to which the benefits of an innovation are visible to other people.

Social aspects, physical aspects or cognitive activity are also variables that influence individual's behaviour (Buenaflor & Kim, 2013; Chen & Shih, 2014). For example, people that are curious about new ideas enjoy trying new technologies or new ways of communication. (Butt and Phillips, 2008; Correa *et al*., 2010). Thus, it can be said that this variable could influence the level of task technology fit for smartwatch technologies.

On one hand, Familiarity with Smartwatch Technology (FST) is a construct that influence direct or indirect the users experience with technology (Coupey *et al*., 1998; Kent and Allen, 1994), while there are some studies that highlighted the fact that compatibility of such device with individuals lives influence peoples intention to buy a product, especially when we are talking about online shopping or mobile banking services (Vijayasarathy, 2004; Mallat *et al*., 2009).

Nowadays, smartwatches can be considered a luxury jewel, this device being associated with fashion and wealth concepts. Different qualitative research analyses the buying behaviour of luxury brands by analysing concepts such as vanity (an excessive concern and/or a positive view of physical aspect/personal achievement) (Netemeyer *et al*., 1995) or the need for uniqueness (Cho, Kim, 2016). Some studies prove the relationship between task characteristics and people's attitudes toward using a smartwatch (Chen and Nath, 2004; Hsiao, 2017). Through Task Technology Fit (TT) construct, we wanted to see if the young people's perception about the way the functionalities of a smartwatch are suited for their activities, technological or social need, could influence the perceived usefulness or the perceived ease of use of a smartwatch.

On the other hand, the way people feel about the advantages of using such a smart device could influence their level of adoption regarding smartwatch technology (Hsiao, 2017). Taking into account that a smartwatch can be used for communication, information, payment transaction or entertainment one (Zigurs, Buckland, 1998), it is interesting to study of individuals perception about smartwatches functionalities (F) cam influence the attitude toward the adoption of smartwatch technology (Chen, Nath, 2004; Kim, Ammeter, 2014).

Thereby, the authors have formulated several hypotheses (Table 1) by analysing external variables such as Task Technology Fit (TT), Functions (F), Familiarity with Smartwatches Technology (FST), Relative advantages (RA), Openness to experience (OE), Enjoyment (E), Compatibility (C), Visibility of Smartwatches (V), Social influence (SI), Fashion-Technology Perception (FTP), Design aesthetics (DA) or Social conformity (SC).

Table 1 – *The hypotheses of the study*

Code	Hypotheses
H1	There will be a positive relationship between the perceived usefulness of a smartwatch and the attitude towards using a smartwatch.
H2	There will be a positive relationship between the perceived usefulness of a smartwatch and the intention to use a smartwatch.
H3	There will be a positive relationship between the perceived usefulness of a smartwatch and the perceived ease of use.
H4	There will be a positive relationship between the perceived ease of use and the attitude towards using smartwatches.
H5	There will be a positive relationship between the attitude towards using a smartwatch and the intention to use a smartwatch.
H6	There will be a positive relationship between task technology fit and perceived usefulness of a smartwatch
H7	There will be a positive relationship between task technology fit and the enjoyment of using a smartwatch.
H8	There will be a positive relationship between the functions of a smartwatch and the perceived usefulness.
H9	There will be a positive relationship between the functions of a smartwatch and the perceived ease of use.
H10	There will be a positive relationship between the familiarity with smartwatches technology and task technology fit.
H11	There will be a positive relationship between the familiarity with smartwatches technology and the enjoyment of using a smartwatch.
H12	There will be a positive relationship between the familiarity with smartwatches technology and the perceived ease of use.
H13	There will be a positive relationship between the familiarity with smartwatches technology and the compatibility of using smartwatches.
H14	There will be a positive relationship between the compatibility of using a smartwatch and the perceived ease of use.
H15	There will be a positive relationship between openness to experience and familiarity with smartwatches technology.
H16	There will be a positive relationship between openness to experience and the relative advantages of a smartwatch.
H17	There will be a positive relationship between openness to experience and the enjoyment of using a smartwatch.
H18	There will be a positive relationship between design aesthetics and the enjoyment of using a smartwatch.
H19	There will be a positive relationship between design aesthetics and fashion technology perception.
H20	There will be a positive relationship between enjoyment and the perceived ease of usefulness.
H21	There will be a positive relationship between the relative advantages of a smartwatch and the attitude towards using a smartwatch.
H22	There will be a positive relationship between the relative advantages of a smartwatch and the intention to use a smartwatch.
H23	There will be a positive relationship between fashion-technology perception and the social conformity.
H24	There will be a positive relationship between fashion-technology perception and the social influence.

Research Design and Methodology

The purpose of this paper is to determine the factors affecting the intention to use smartwatches. For the conceptual framework, the authors developed their models proposed (Barbu *et al.*, 2019a; 2019b).

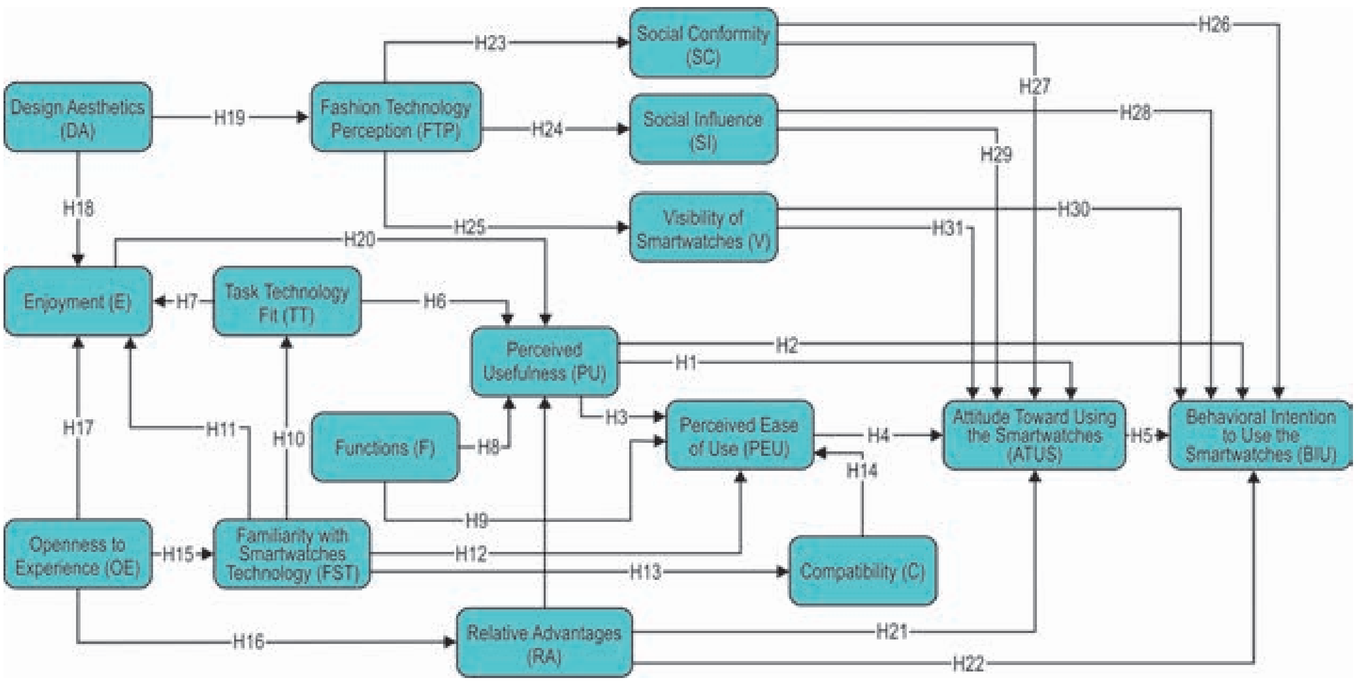

Figure 2 – *The hypotheses of the model*

In order to analyse the relationship between the external variables and the variables from the original TAM model, the authors measured these variables on a 5-point Likert-type scale ranging from 1 (Strongly disagree) to 5 (Strongly agree).

The external variables mentioned before were obtained by mediating several variables. For example, PEU construct was obtained by mediating 4 items: PEU1 – Its easy to learn to use a smartwatch; PEU2 – Using a smartwatch is intuitive; PEU3 – Smartwatches are easy to use; PEU4 – Interaction with a smartwatch is enjoyable (adapted from Chuah *et al.*, 2016; Kim and Shin, 2015). In the same way, the following constructs were formulated: PU – 4 items (adapted from Chuah *et al.*, 2016; Park and Chen, 2007); ATUS – 5 items (adapted from Wu *et al.*, 2016; Davis, 1986; Wang *et al.*, 2009); BIU – 3items (adapted from Wu *et al.*, 2016; Park and Chen, 2007); FST – 2 items (adapted from Chuah *et al.*, 2016; Shehryar and Hunt, 2005); RA – 7 items (adapted from Hsiao, 2017; Davis, 1986, Wang *et al.*, 2009); C – 7 items (adapted from Hsiao, 2017; Wu *et al.*, 2016; Davis, 1986; Wang *et al.*, 2009); OE – 5 items (adapted from Hsiao, 2017); TT – 3 items (adapted from Hsiao, 2017); F – 8 items (adapted from Hsiao, 2017); E – 4 items (adapted from Wu *et al.*, 2016; Sun and Zhang, 2006), V – 2 items (Adapted from Chuah *et al.*, 2016; Fisher & Price, 1992); SI – 4 items (Adapted from Wu *et al.*, 2016; Van der Heijden, 2003; Verkasalo *et al.*, 2010), FTP – 3items (Adapted from Chuah *et al.*, 2016), DA – 2 items (adapted from Hsiao, 2017); SC – 5 items (adapted from Hsiao, 2017).

Data were collected during May 2019 from a group of young students with ages between 18 and 35, from a technical university in Bucharest.

Results

For this study, the authors analysed the respondent's perceptions about the adoption of smartwatch technologies, using SPSS 20.0 software to process the data. The results indicate that 56% of the respondents who own a smartwatch have a Samsung smartwatch, 27% have an Apple one, 12% a Huawei smart device, while the rest have Motorola or Asus smartwatches. For the analysed sample of 104 people, 60.6% of the respondents do not own a smartwatch, while 30.4% own a smartwatch. These results highlighted the fact that Samsung and Apple are the most favourite brands for smartwatches.

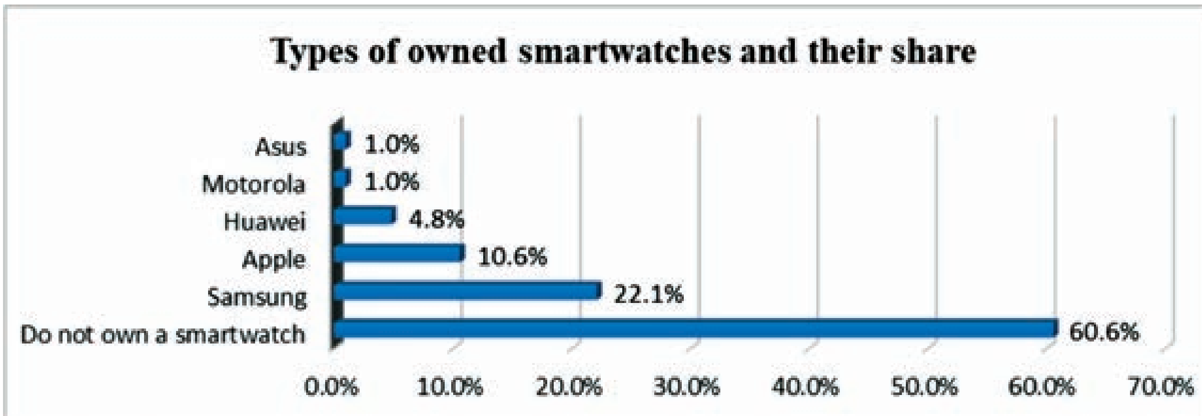

Figure 3 – *Types of owned smartwatches and their share*

The internal consistency of the used items was tested, the results showing a good level of reliability (Hair *et al.*, 2007), all the Cronbach's Alpha coefficients having values between 0.715 and 0.94.

The study continued with the analysis of the Pearson Coefficients whose values were interpreted using the Evans guide (Evans, 1996), where values between 0.40 and 0.59 indicate moderate correlations, values between 0.60 and 0.79 indicate strong correlations, very strong correlations were indicated by values between 0.80 and 1.0, while values under 0.40 indicate very weak correlations.

All correlations presented in Table 3 are significant at the 0.01 level (2-tailed).

Table 2 – *The Cronbach's Alpha Coefficients*

Variables	Cronbachs Alpha	N of Items
PU	.934	4
PEU	.886	4
ATUS	.942	5
BIU	.843	3
E	.896	4
FST	.809	2
F	.932	8
TT	.847	3
C	.902	7
RA	.910	7
OE	.820	5
V	.846	2
SI	.904	4
FTP	.715	3
SC	.936	5
DA	.793	2

Table 3 – *Correlations between the original TAM variables and other considered variables – part 1*

	PU	PEU	ATUS	BIU	C	RA	F	TT	E
PU	1	.482**	.775**	.742**	.708**	.776**	.725**	.590**	.763**
PEU	.482**	1	.691**	.559**	.530**	.478**	.497**	.638**	.548**
ATUS	.775**	.691**	1	.835**	.712**	.753**	.716**	.617**	.837**
BIU	.742**	.559**	.835**	1	.707**	.749**	.766**	.579**	.818**

There are strong correlations between Perceived Usefulness (PU) and Attitude Toward Using the Smartwatches (ATUS), the Pearson coefficient being 0.775, and between PU and Behavioral Intention to Use the smartwatches (BIU) ($R = 0.742$, $p < 0.01$). Also, PU is strongly correlated with Enjoyment (E), Compatibility (C), Relative advantages (RA) and the Functions (F) of the smartwatches. In table 3, it can be seen that between PU and Familiarity with Smartwatches Technology (FST) and between PU and Design aesthetics (DA) there are moderate correlations, while the rest of correlations between PU and other items are very weak or are missing.

Perceived Ease of Use (PEU) is moderate correlated with the most variables presented in table 4 and table 4, except variables ATUS and Task Technology Fit (TT), where PEU is in strong correlation with them ($R = 0.691$; $R = 0.638$, $p < 0.01$) and also variables Social influence (SI) and Social conformity (SC), where there are no significant correlations ($R = 0.270$, $p < 0.01$, $R = 0.052$, $p > 0.05$).

Table 4 – *Correlations between the original TAM variables and other considered variables – part 2*

	FST	DA	OE	V	FTP	SI	SC
PU	.507**	.476**	.344**	.289**	.395**	.270**	.052
PEU	.438**	.503**	.471**	.579**	.514**	.290**	–.046
ATUS	.497**	.532**	.422**	.440**	.368**	.251*	.078
BIU	.490**	.527**	.337**	.319**	.293**	.305**	.076

On one hand, there are very strong correlations between Attitude Toward Using the Smartwatches (ATUS) and Behavioral Intention to Use the smartwatches (BIU) ($R = 0.835$, $p < 0.01$), and between ATUS and Enjoyment ($R = 0.837$, $p < 0.01$). On the other hand, BIU is very strongly correlated with Enjoyment, the Pearson coefficient being 0.818. Furthermore, between ATUS and Familiarity with Smartwatches Technology (FST), Design aesthetics (DA), Openness to Experience (OE) and Visibility of Smartwatches (V), there are moderate correlations, all of them being significant at the 0.01 level (2-tailed).

The correlations between the considered items that were taken into account in this study are presented in table 5.

Table 5 – *Correlations between variables*

	E	FST	TT	OE	C	RA	F	V	SI	FTP	SC	DA
E	–											
FST	.610**	–										
TT	.500**	.342**	–									
OE	.427**	.386**	.378**	–								
C	.727**	.627**	.694**	.502**	–							
RA	.750**	.531**	.702**	.417**	.874**	–						
F	.693**	.332**	.612**	.304**	.670**	.730**	–					
V	.408**	.157	.405**	.398**	.243*	.303**	.374**	–				
SI	.464**	.444**	.159	.234*	.332**	.362**	.210*	.392**	–			
FTP	.403**	.370**	.439**	.392**	.453**	.374**	.389**	.656**	.470**	–		
SC	.181	.306**	–.042	.027	.092	.16	–.001	.083	.493**	.275**	–	
DA	.484**	.259**	.590**	.300**	.566**	.596**	.536**	.435**	.164	.321**	–.14	–

Note: **. Correlation is significant at the 0.01 level (2-tailed)

The results highlighted the fact that the Relative Advantages of using a smartwatch are in a very strong correlation with the compatibility of the user with this device. Thus, users who believe that using a smartwatch is compatible with their lives, also believe that smartwatches gave them a lot of advantages compared to a normal watch. Also, Relative Advantages are strongly correlated with Enjoyment, and Task Technology Fit, these last 2 variables being also strongly correlated with others like Familiarity with Smartwatches Technology (FST), Compatibility (C), Relative advantages (RA), Functions (F).

In the next phase, the authors wanted to test if there are any differences in correlations between gender and the analysed variables. They observed that for males, between Familiarity with Smartwatches Technology (FST) and the main variables of the original TAM model there are moderate and strong correlations that are significant at the 0.01 level (2-tailed).

On one hand, Behavioral Intention to Use the smartwatches (BIU) is more influenced by the Visibility of Smartwatches (V) ($R = 0.595$, $p < 0.01$) and Fashion-Technology Perception (FTP) ($R = 0.524$, $p < 0.01$) for males than for females. On the other hand, for females, there is a moderate correlation between BIU and Design aesthetics (DA) ($R = 0.548$, $p < 0.01$). DA is also a key variable for females that also influence PU, PEU, and ATUS.

For males, PEU is influenced by Compatibility (C) ($R = 0.591$, $p < 0.01$), Relative advantages (RA) ($R = 0.620$, $p < 0.01$) and the Functions (F) ($R = 0.558$, $p < 0.01$) of the smartwatches, while for females, PEU is influenced by Visibility of Smartwatches (V) ($R = 0.645$, $p < 0.01$) and Design aesthetics (DA) ($R = 0.517$, $p < 0.01$).

Table 6 – *Different correlations between variables from the gender of the respondents*

Correlations	Male				Female			
	PU	PEU	ATUS	BIU	PU	PEU	ATUS	BIU
PU	1	.618**	.794**	.726**	1	.331*	.750**	.751**
PEU	.618**	1	.823**	.783**	.331*	1	.563**	.380**
ATUS	.794**	.823**	1	.860**	.750**	.563**	1	.825**
BIU	.726**	.783**	.860**	1	.751**	.380**	.825**	1
E	.767**	.760**	.861**	.841**	.748**	.336*	.813**	.793**
FST	.593**	.638**	.658**	.552**	.394**	.22	.336*	.376**
TT	.653**	.556**	.601**	.623**	.533**	.698**	.623**	.545**
OE	.436**	.433**	.386**	.364**	.239	.484**	.432**	.283*
C	.766**	.591**	.707**	.687**	.656**	.465**	.711**	.691**
RA	.773**	.620**	.731**	.670**	.784**	.364**	.771**	.772**
F	.677**	.558**	.746**	.789**	.764**	.433**	.685**	.763**
V	.325*	.559**	.524**	.595**	.290*	.645**	.394**	.163
SI	.19	.389**	.259	.330*	.340*	.137	.219	.253
FTP	.519**	.543**	.513**	.524**	.278*	.491**	.238	.13
SC	–.048	–.058	–.019	–.119	.124	–.069	.148	.191
DA	.359**	.488**	.377**	.498**	.566**	.517**	.640**	.548**

Note: **. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Conclusions

The results of this study highlighted that for both males and females, enjoyment is one of the key variables that influence the perception toward using a smartwatch or the intention to buy such a smart device. Thus, manufacturers or sellers should try to develop new ways of transmitting that feeling that triggers the desire of wearing a smartwatch. For example, some testing campaigns or advertising spots where companies present the joy of people who already use a smartwatch could influence the intention of young people to buy these devices, the result consisting of the purchase of smartwatches. Also, by using such strategies, manufacturers and sellers could improve the level of familiarity with smartwatches technology that is another important variable for the analysed model.

When was analysed the behaviour intention to use a smartwatch, it was observed that young males are more likely to buy or wear smartwatches that young females. Their intention to use a smartwatch was influence by the functions and the relative advantages of the device, the way the tasks performed by a smartwatch have been fulfilled by smartwatch technology, compatibility with such a technology being also important in the relationship with the buying attitude.

For young females, besides the functions and the relative advantages of the device that influence their intention to use a smartwatch, the design plays an important role. For those who own a smartwatch, functions like monitoring the diet or the health are the most used, while for both males and females, using a smartwatch is a faster way to access the phone notifications. Thus, the smartwatch becomes the ideal solution to be permanently connected with others, easily and conveniently, satisfying needs such as curiosity or comfort.

The results of this study should be interpreted with caution because the study is not without limitations. First of all, the sample consisted of only 104 young people, a fact for which this study should be considered an exploratory one. Second, for collecting the data, it was used a questionnaire, measuring the perception of the respondents. Taking into account that the sample consisted of young students from a technical university, the results could be influenced by the fact that they are more familiarized with technologies and their responses could be different than other young people who do not have the technical knowledge or do not like technology. Third, the age of the respondents could also be an important variable that influences the adoption to use a smartwatch, but the respondents from this sample were about the same age, which is why we could not say more details about how age could influence the individuals attitude toward using a smartwatch.

For future research, it will be considered different studies for businesspeople, sports enthusiasts and people who are very careful about their diet and health to determine if smartwatch meets all their needs and how it could be improved to become a really smart device for them.

Acknowledgement

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„We may not have known it was called Industry 4.0, but we've been doing it for years."
Heinz Jörg Fuhrmann
(Salzgitter)

The Effect of Technological Changes in Education

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Abstract

The purpose of this article is to highlight the profound global changes in the use of technology and the nature of work have urgent implications for how we educate young people and prepare them for the labour market. Employers are increasingly looking for youth who are flexible, adaptable, proactive, creative and collaborative, able to cope with industrialization. The Youth Employment Funders Group uses the term „soft skills" to describe a mix of skills (both non-cognitive and cognitive), attitudes, behaviours and mindsets, especially when referring to youth workforce and employment outcomes. In this article, we will look at how to adapt young people to learn the language of a particular job, industry or role is directly related to how smart they will sound and how well they will work in an environment and dramatically improve the chances of finding jobs because companies will first choose someone who needs less time to get them to speed.

Keywords: global changes, soft skills, teaching, technology, industrialization

Introduction

The severity of global youth unemployment and working poverty has rallied the international community and drawn attention to the need for high-quality, relevant youth skills development, as outlined in the Sustainable Development Goals. Globally, over 70 million youth are unemployed, and 156 million young workers are living in poverty. For young people to successfully contribute to the growth of emerging economies, their skills need to be adaptable to both the changing nature of work and the various opportunities that become available to them. Achievement of the Sustainable Development Goals is contingent on

> *„Industry 4.0 is more than just a flashy catchphrase. A confluence of trends and technologies promises to reshape the way things are made."*
> Cornelius Baur (McKinsey)

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the ability of young people to effectively and successfully transition into the workforce and retain employment over time. Their ability to master soft skills is key to being able to successfully navigate the various pathways of work (Cunningham, Villasenor, 2016).

There is a growing awareness that combined with technical and academic achievement, soft skills are critical to young people's success in the workplace and their development in all domains of life. But soft skills are poorly understood, not well assessed, and all too often overlooked in policy and institutional contexts, including education, training and the workplace. By highlighting the importance of soft skills and seeking to more deeply understand them, we can help ensure that all young people acquire these skills for employment and life success. Despite a proliferation of terms and frameworks for describing these skills, there is a remarkable consensus around the types of skills youth need and the broad parameters regarding how to develop them (Care E., 2016). While much is still to be learned about which interventions work best for youth populations in specific country contexts, a great deal is known about soft skills development principles, from fields as diverse as psychology, economics, business, education and health.

The Youth Employment Funders Group believes that the emerging evidence for soft skills acquisition justify increased policy dialogue, investment, coherence and scaled programmatic implementation. This report summarizes the areas of consensus on soft skills for policymakers, employers, educators, donors and civil society organizations. The report also identifies implementation and evaluation challenges, as well as promising avenues for investment in cost-effective, scalable and sustainable interventions

and in new knowledge to support these interventions.

In short, youth need soft skills: the broad set of skills, attitudes, behaviours and personal qualities that enable them to effectively navigate their environment, work with others, perform well and achieve their goals. There is a growing awareness of the value of soft skills to both employee productivity and the healthy development of young people in general. The development of soft skills is deeply intertwined with academic and technical skill development. Though soft skills are increasingly seen to benefit youth in all domains of life, these skills are poorly understood, not well assessed, and too often overlooked in policy and institutional contexts, including education, training and the workplace. Every industry relies on its own lexicon of terminology to operate and communicate. Often these are technical concepts, processes or acronyms that sound foreign to people new to a field.

Soft Skills for Youth

According to a recent World Economic Forum study „more than one third (36%) of all jobs across all industries are expected to require complex problem-solving as one of their core skills, compared to less than 1 in 20 jobs (4%) that will have a core requirement for physical abilities such as physical strength or dexterity (Figure 1, change in demand for core work-related skills, 2015–2020, all industries; share of jobs requiring skills family as part of their core skills set, %).

Furthermore, social skills, such as persuasion, emotional intelligence and teaching others, will be in higher demand across industries than narrow technical skills, such as programming or equipment operation and control (Care E., 2016). Content skills (which include ICT literacy and active learning), cognitive abilities (such as creativity and mathematical reasoning) and process skills (such as active listening and critical thinking) will be a growing part of the core skills requirements for many industries (Guerra, 2014).

Non-routine work tasks are increasing in proportion to routine work, requiring flexibility in thinking and behaviour. Similarly, in the United States, between 1980 and 2012, the number of jobs requiring social skills grew by nearly 10 per cent, while the number of math-intensive but less social jobs including many STEM occupations (Science, Technology, Engineering, Math), shrank by about three per cent.

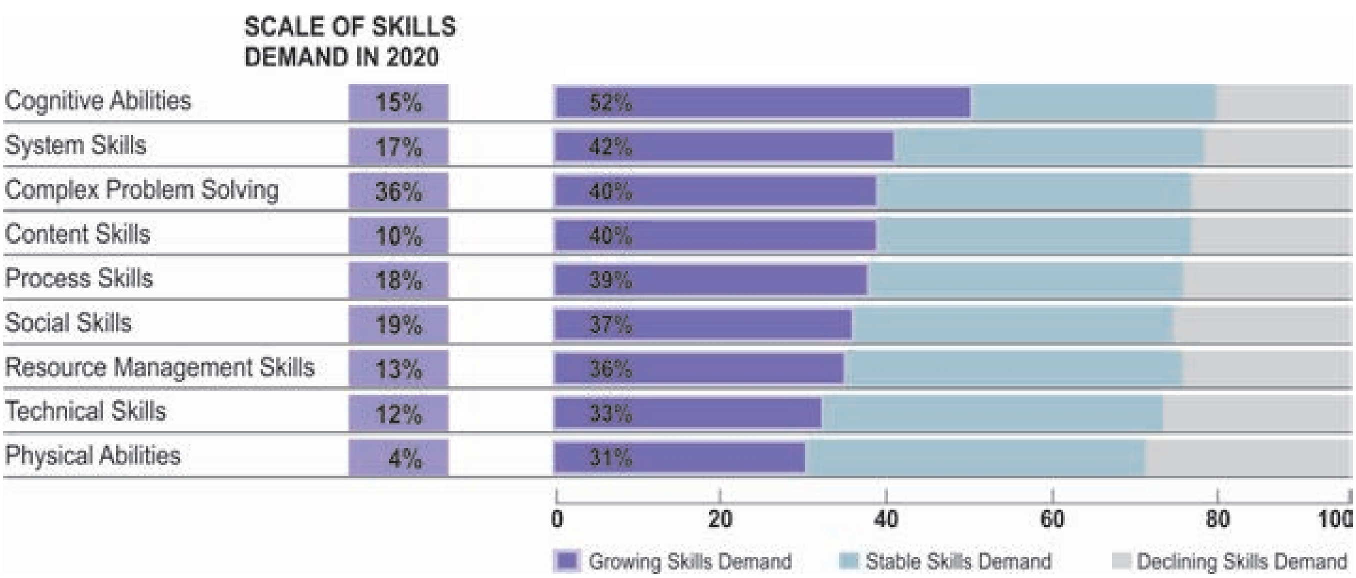

Figure 1 – *Need for soft skills large and growth across industries*
(Source: Sammans 2016)

Overall, the trend is toward the increased need for complex problem-solving and social skills. A recent World Bank analysis of 27 studies globally reveals that while employers value all skill sets, basic cognitive, technical, advanced cognitive, and socio-emotional, they especially value the latter two skill sets by wide margins. The study notes that: these results are robust across region, industry, occupation, and education level. Employers perceive that the greatest gaps are in socio-emotional and higher-order cognitive skills (Gates *et al.*, 2016).

Overall, there is a growing recognition among employers and educators that left-brain dominance such as technical know-how must be complemented, and is in fact deeply interwoven, with right-brain intelligence such as empathy, inventiveness, creativity, intrinsic motivation and growth mindset.

For employers, building a consistent and measurable business case for investment in soft skills development is crucial. Having a workforce of employees who have mastered key soft skills reduces employer costs in recruitment, training time and employee turnover, and improves employee performance on bottom-line business metrics, such as higher sales and better consumer service. An example from manufacturing is provided in Figure 2 (Galloway, 2017).

The Soft Skills Effect

Deepening awareness, understanding and commitment to soft skills across all stakeholders can trigger a virtuous cycle. Given the growing changes in the labour market, all stakeholders concerned with youth employment, schools, employers, communities and families, will need to significantly scale up the opportunities and support available to youth to develop critical soft skills. This means becoming more intentional about changing mindsets, relationships and practices of all these core stakeholders, and working across youth learning and employment systems to involve diverse partners in the private and public sectors as well as families and community-based organizations.

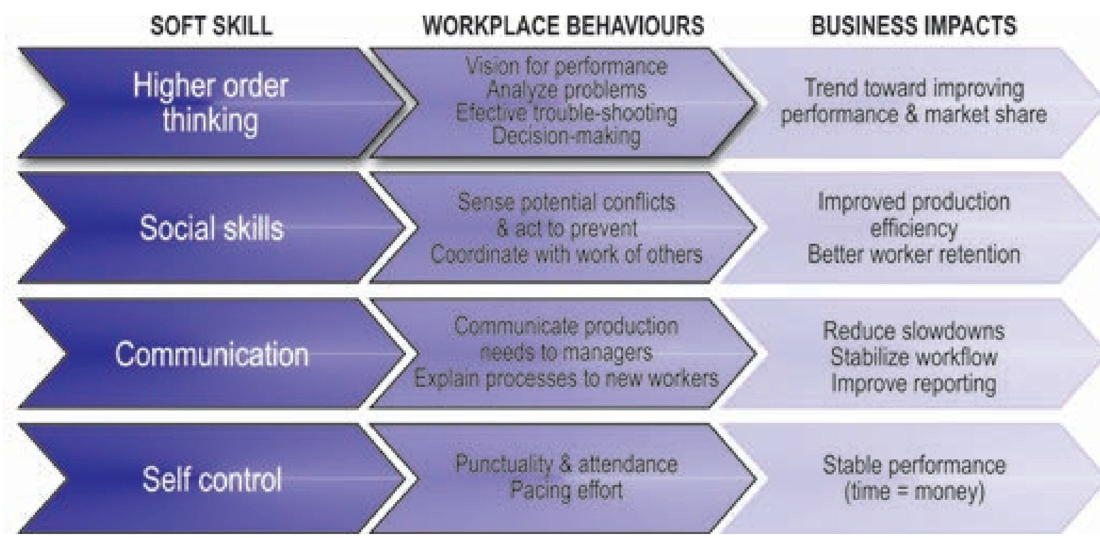

Figure 2 – *The impact of soft skills*
(Source: Sammans 2016)

The diagram suggests the dynamic, interactive and iterative nature of these processes. As awareness and understanding grows about the importance of soft skills among stakeholders, deeper commitment to the development of soft skills through a range of institutions emerges, and collaborative relationships are designed and implemented. This in turn further refines awareness, understanding and commitment (Kluve, 2017). As teaching, learning and employment practices adjust to reflect new relationships, better results are generated for youth.

For soft skills to be useful to both youth and employers, they need to be tailored to and practiced within actual workforce conditions and market demands. Demand-driven youth training models require careful collaboration with employers to design training and placement opportunities for specific skills.

The highlights the important role of social partners in contributing to the design, implementation and monitoring of education, training and lifelong learning policies and programs with a view to improving their responsiveness to the world of work. Out-of-school youth employment programs differ in their approaches. Some link demand-aware or demand-aligned classroom-based soft skills workshops with technical training and experiential work-based learning opportunities.

A newer generation of demand-driven, boot camp programs conduct screening and job matching before putting youth through a short, intensive soft-skills training focused on improving overall work performance. Both approaches are needed to meet the diversity of youth needs and readiness for the labor market, and there is some indication that the two approaches are increasingly intertwined (Lippman *et al*., 2015).

Soft Skills and Formal Education

A recent study of education systems in the developing world shows that governments are generally aware of the need to teach a greater breadth of skills, but have yet to implement this vision across all levels of the education system. Most ministries of education in developing countries know that they need to reinvent their schools to reflect learning needs and strive to meet the challenges of inadequate educational access for disadvantaged populations and school dropouts. While not the only solution, youth soft skills development can be a lever for addressing these multiple challenges. Reforms that build youth soft skills also enhance the overall quality and relevance of academic preparation and increase student and family engagement in learning (Chennells, Van Reenen, 2016).

Policymakers are progressively interested in scaling up learning outcomes across the entire youth cohort within countries, and the factors and dynamics that enable their learning and gainful employment. Inevitably, this requires modernizing or reforming formal education systems. For developing countries, the question of soft skills acquisition is layered onto the persistent challenge of providing education and training to rural and underserved young people, and to stemming school drop-out. However, these challenges are not necessarily at odds. Developing more engaging, relevant learning opportunities prerequisites to soft skills development, also have

the effect of keeping youth and their families engaged in education longer and ensuring that educational investment bears fruit in better employment prospects for youth.

The challenges that formal education systems in developing countries have in relation to youth soft skills acquisition are well known. Teachers are often hamstrung by rigid, high-stakes testing regimes, large class sizes and outdated curricula that focus on knowledge retention instead of real-world competencies. An understanding of adolescent development is not generally manifested in the curriculum or institutional culture (i.e., the quality and character of school life or program setting). Additionally, there are few extracurricular opportunities for youth skills development. Furthermore, professional development and school management systems may not support teachers in developing their own soft skills or in learning how to best foster them in students while simultaneously teaching academic and technical skills. These challenges hold true for technical and vocational training but may be mitigated where internships and work-based learning opportunities for students are offered (Dosi, Nelson, 2018).

We recognize that different formal general education systems may use the terms „socio-emotional skills," „transferable skills" or „21st-century skills." „Transferable skills" have been defined as „higher-order cognitive skills and non-cognitive skills that individuals use to be successful across different situations in work and life". They include soft skills such as problem solving, critical thinking, communication, collaboration, leadership, perseverance, empathy and emotional regulation, but also skills that are not job-specific, such as financial and information technology literacy and

entrepreneurship capabilities. „Employability skills" is often a term used to refer to a combination of soft skills and specific job-seeking skills such as interviewing and CV writing. Adolescent health programs may use the term „life skills" to refer to a mix of soft skills and sexual and reproductive health competencies. We also recognize the challenge of funding equivalent terms in different languages and for diverse cultural contexts.

Conclusions

In conclusion soft skills are the mix of skills, attitudes, behaviors, personal qualities and mindsets that individuals use to be successful across different situations in work and life. They are developed over an individual's life span in a dynamic way in concert with other skills such as academic, technical and practical life skills.

A key challenge that the soft skills field faces is the variety of terms used for very similar personality traits, skills and behaviors, a variety rooted in diverse academic disciplines and fields. For example, consider the notion of „self-control." While employers may use the terms „self-discipline" or „self-management," psychologists refer to „constraint," „self-regulation," „emotional stability," or its opposite, „externalizing behavior." „Self-regulation" is also heard in the fields of economics and education, but education also adds „rule-abiding," „manages emotions" and „pays attention". While this variation poses difficulties for monitoring and evaluation, the proliferation is also a refection of the dynamism and holism of the field, and the nuances and history of each discipline's involvement with soft skills.

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„Today many plants have yet to fully adopt the automation technologies of Industry 3.0."
Adrian Jennings (Ubisense)

The European Union and Changes in Technology

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Abstract

The statistics of the European Union in the field of science, technology and innovation cover a sufficiently important range. In this respect, the development of innovation, science and technology also implies a better and more consistent use of human resources. Science is part of the development of society. Only by developing science, that is, innovation, inventions, in all fields, is the foundation for the economic progress of each country ensured. Europe has a long tradition in the field of research and innovation, with numerous prestigious and highly efficient economic projects in the industrial, biological, pharmaceutical, telecommunications or aerospace fields. The extension of the influence of the research in the field of the economic sphere ensures protection of the environment, of the international business environment, of the improvement of the quality of the products realized in all the fields. In October 2010, the European Union launched the development program by 2020, the program being called the Innovative Union, which aims to develop the research climate in the field of energy, food security, health and quality of life of the population. In the European Union, innovations are monitored and implemented through this innovative Union. In this area, countries that are not members of the European Union have also been attracted, considering the attraction of other specialists for research and innovation projects.

Keywords: technology, innovation, research, development, patent

„We must deal quickly with the fusion of the online world and the world of industrial production. We call it Industrie 4.0."
Angela Merkel

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Introduction

The European Union, as constituted, aims to achieve economic results based on the development of all Member States, materialized in the macroeconomic indicators of results, as high as possible, as a prerequisite for raising the standard of living. The development of the industry at the moment is done by the improvement of the technology, by its robotization, that is by applying the standardized models and methods accessible under the conditions of the evolution of the European Union during this period.

Innovation is an essential element in the field of science and technology, as it enhances the research and development activity. The development of the innovation of science and technology implies a far superior use of the conditions existing in this field and by the use of highly qualified human resources. Of course, furthering the science of technology and innovation can only be achieved by applying in the respective fields to the specific activity, specific to each country. Only the development of this essential element, because it is innovative, can be obtained improvements of the technological processes, of the rapid evolution of the production, based on the achievements of science and its concretization in inventions and innovations, in order to ensure the fastest pace of evolution.

The European Union monitors the inventions and innovations it is trying to implement, carrying out large-scale projects involving all those countries that have a well-developed standard in terms of the level of innovation. The countries of the European Union must allocate more of the gross domestic product for the development of research and innovation. The big multinational companies have related departments or institutions that deal with research and innovation in that field, which involves the emergence of new and new inventions and innovations, which they put into practice, including changing the configuration of industry development. Therefore, it is wrong for those who ask the question of new industrialization in the 21st century (the year 2019), because the industry must not be reinvented, it must be standardized and improved through special economic processes.

Literature Review

Anghelache (2017) has made an ample analysis of Romania's economic and social evolution since it is a member of the European Union. Buesaa, Heijsa and Baumert (2010) studied the determinants of regional innovation in Europe. Cincera and Veugelers (2013) focused on the analysis of young innovative leaders in line with the research and development gap in the European Union. Cruz-Jesus, Oliveira and Bacao (2012) were concerned about European digital disparities in the 2008-2010 benchmark. Dachs and Pyka (2010) studied the factors that influence the internationalization of innovation. Farole, Rodríguez-Pose and Storper (2011) investigated the characteristics of EU cohesion policy. Isaic-Maniu, Anghelache *et al.* (2007) analyzed the evolution of research, development and innovation activity in Romania. Moncada-Paternò-Castello *et al.* (2010) researched the EU's corporate research and development system as compared to the non-EU performance. Pinto (2009) investigated the characteristics of the diversity of innovation within the European Union. Voigt and Moncada-Paternò-Castello (2012) assessed the possible impact of small and medium-sized enterprises with rapid growth in R&D on the European Union's economic structure in the 2020 horizon.

Research Methodology

The problem of science, technology and innovation is one of the first in the member countries of the European Union. Each country can improve its industrial standard by promoting research, the emergence of new inventions and innovations so that the restructuring in each branch of the national economy is carried out at a higher quality

level in terms of production value, but especially of the quality of the products made.

Of course, through the directives of the European Union, it is foreseen that in 2020 the financing in this area will be about 3% of the gross domestic product. In 2014 or allocated for research, innovation and economic development 284 billion, achieving an increase of 3.4% compared to 2013 and not less than 42% higher than in the last 10 years (2004–2014). In view of the growth of research and development, the European Union aims at another goal, agreed by the member countries, that this will lead to a special increase of the productivity of the work, by the appearance of new fields, to mean new jobs and of very high qualification, which it ensures the possibility of a continuous improvement of the evolution of the economy as a whole, and consequently of the living conditions, therefore also of the index on the quality of life.

The increases in the values of financing in the field of research, innovation, inventions have been positive in the last five years. Thus in 2015, 2016, 2017 and 2018, the average growth rate was 2.18 compared to the previous year. Of course, taking into account the continuous growth and the production, therefore of the gross domestic product, it means a quite sub-

stantial growth, but insufficient to reach the objectives to which all member countries strive to reach. In 2016 gross domestic expenditure for research and development was 303 billion euros, which represents a 40% increase compared to 2006.

The ratio between the general R&D expenditure and the gross domestic product represents a basic indicator of the European Union's strategy and it has grown year by year. However, for the next period, pointing out that a forecast until 2030 implies that all member countries of the European Union allocate at least 3-4% of the gross domestic product to ensure research, innovation and invention within national economies.

Expenditure on research and development for the performance sectors should be the concern of each country, of each government of the Member States of the European Union regarding their increase.

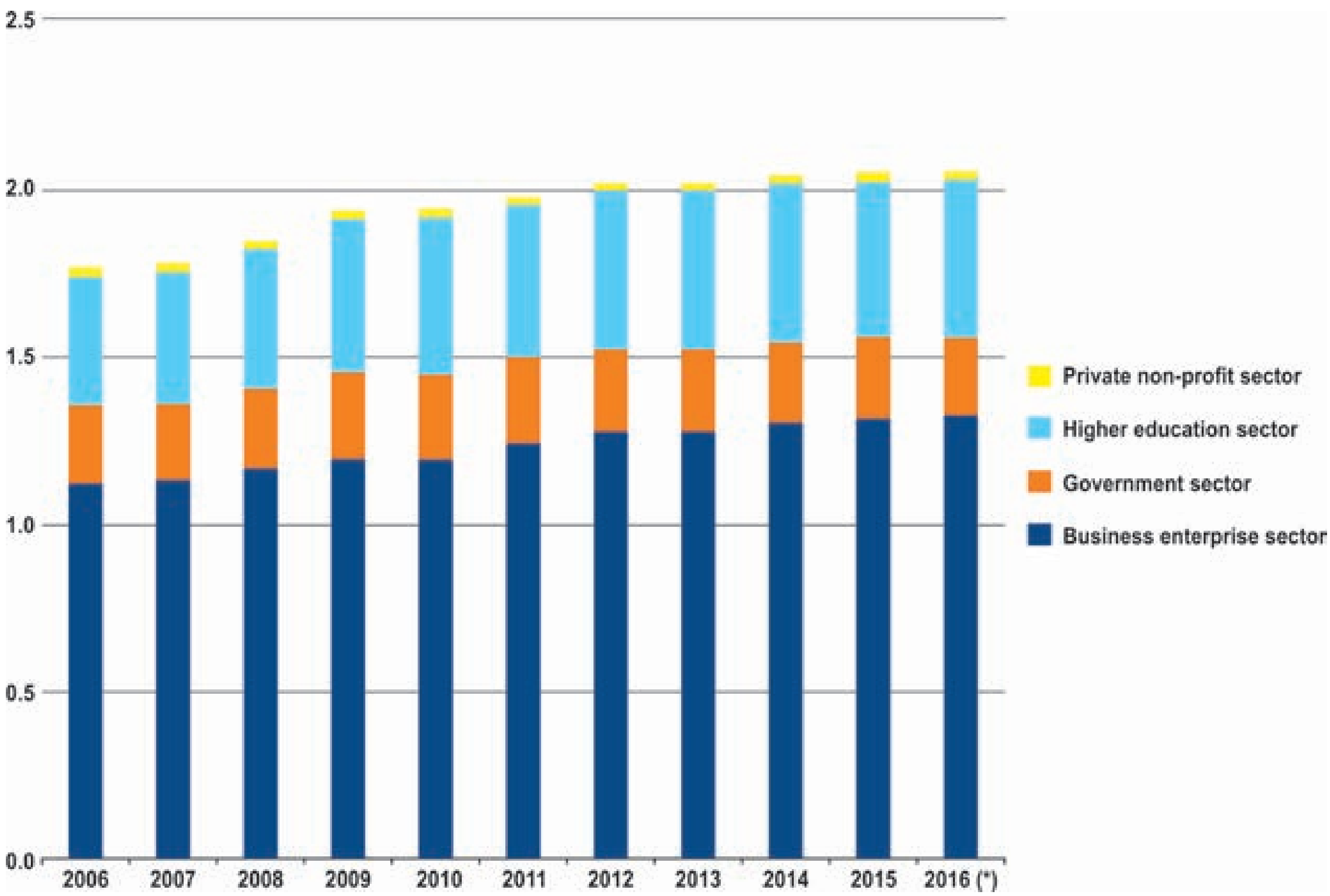

Figure 1 – *Gross domestic expenditure for research and development*
(Source: Eurostat Statistics 2016)

Figure 1 shows the gross domestic expenditure for research and development in the period 2006-2016. The data shows that in the Member States the R&D expenditures were realized at an ascending rate. Therefore, expenditures for R&D have increased in all countries. These were allocated primarily to the business sector, where it increased from 1.12% as it was in 2006 to 1.32% as it was in 2016, out of a total increase of 7.9%. Another sector to which important amounts have been allocated for the improvement of the research, innovation and development is the higher education system, at which the allocation level increased by 20.5% during 2006–2016, which means an average annual growth of 2,05 every year. Only these expenses managed to represent 0.47% of GDP. We must note that during the period 2007–2018 the same rapid pace of 2.1% annual growth was maintained compared to 2016, reaching 0.53% of the gross domestic product. It should be noted that although the intensity of research and development in the higher education sector has increased at a relatively higher rate, it has been more recent since 2010.

At the same time, we find that the relative importance of R&D spending in the ornamental and higher education sector is somewhat similar in terms of growth rate between the EU Member States, but differs from state to state, from country to country, considering the level recorded in the year that constitutes the basis of comparison for each of these countries. Of course, a number of countries such as Sweden, Austria, Germany, Denmark and Finland have advances in the allocation of R&D resources, but there are sufficient countries where the level of resource allocation for spending is still low.

An essential element in terms of research and development is the number of specialists working in these fields. The number of researchers and innovators attracted in these fields in the member countries of the European Union is increasing, meaning that if there were 1,760,000 researchers in 2014, their number increased in 2018 with 541,000 researchers, representing a share quite high.

In the field of personnel included in the research and development activity, we find that on the structure of the labour force in each country, the highest level was registered in 2018, Denmark 2.1%, Finland 1.95%, Luxembourg and others, which through this weight in the total labour force used shows a careful concern in the field of research and innovation. At the level of the European Union, at present 28 states, the average degree of coverage in the research activity of the total workforce was in 2018 of 1.15% of the total workforce. The fact is that out of the total number of researchers, a significant proportion was held by those aged between 20 and 29, who are basically graduates of the bachelor's and master's degrees, which is about 12.7% of the total staff in research.

Higher education is the one that needs to be refined, in the sense of integrative or non-integrative association with the research sector. In the major higher education institutions in the United States, Japan and a number of European Union member states, in Germany, the United Kingdom, France, first-rate higher education institutions have their own research departments and institutes and are associated with large national and international firms. Multinationals that thus provide increased support for increased spending on research and innovation.

Subsequent evolutions after this presentation grew at a slow pace, but they were still able to ensure a significantly higher evolution compared to the previous periods.

The share of business research has increased the most in Sweden, Austria, Malta, France, Germany, Denmark and Finland, with lags behind such as Greece, Bulgaria, Romania, Croatia, which are far from the position they need to have. Increasing the number of people involved in the applied scientific research in the research of immediate utility in production.

Another aspect is innovation and how it has evolved in the Member States of the European Union. From the total scientific research, as an immediate final result, the innovations represent that I have 49% of the total results of the scientific research. 28% of the Member States of the European Union carries out activities in the field of innovation that result in significant results in the development of the activity of economic enterprises of all degrees.

On the other hand, about 24% of the enterprises in the Member States of the European Union have used between 2010 and 2018, 25%, to introduce innovations in some activities that have had an immediate effect in increasing production in those sectors.

We can estimate that six out of ten innovation projects were used very effectively in the activity of the big producers, most of them in the economic field, ensuring a competitive growth of the economic results. Almost half of the innovation projects were of particular importance, the level of implementation in the economic-social activities being 52% in 2018.

Referring to Romania we find that in 2010 only 4.6% of innovations were attracted, and in 2017 the number increased to 4.9%. This shows that there is a slight concern of the state and private sector companies to work with research institutes, with researchers in the field of inventions and innovations, to whom they should ensure funding cooperation, but especially in the implementation of the research result, inventions and innovations.

The research is most often completed by obtaining manufacturing patents, which, even if they are not applied at a sustained pace, do not give essence to the expenses allocated for the research, and the less is not reflected in the growth of economic results. In this sense, starting from the fact that the patents reflect initiative and activity of exploiting the economic potential of innovations, which can lead to the restructuring of companies, enterprises, by using the innovative research result.

The indicators used indicate that the use of manufacturing patents has increased in most Member States. In 2014, 142,700 patients were used in the European Union, an increase of over 56% compared to 2010, and this number of patents increased to 153,000 in 2018. Of course, the states that have noticed this chapter in the use of innovations based on applicable patents, it follows that Germany, France, Holland, Sweden are the first place. Thus, in Germany, 20,700 patents were used, in France 9100 patents, in Italy 4200 patents, in the Netherlands 3200 patents or in Sweden 3400 patents. Of course in other non-member states, we find that manufacturing patents were 36,900 in the United States, 22,000 in Japan, 7,800 in China and 7,000 in South Korea.

The indicator of the use of inventions shows that they follow a high rate of application, but the data express that the total number of applications is different from one country to another. Thus, for example, a number of states register a high number of patents that result in increased production. The first study, from 2000 to 2017, shows that the application of patents in the economic activity of the Member States of the European Union was 51,541 patents in 2002, increasing to over 59,000 patents in 2007 having a decline during the crisis, reaching 57,000 in 2011, with a slight decrease to 56672 patents in 2012 which decreased even more in 2017, when 54642 was registered. Figure 2 shows patent applications at the European Patent Office, by country, 2012 and 2017 (one million inhabitants).

In conclusion, we can say that during the period after 2012, patent applications decreased by a rate of about 0.8%, which is also evident in the production registered by the Member States of the European Union.

Conclusions

Regarding the study carried out in relation to the evolution of science, we first observe an increase in the level of research and development, the involvement of an increasing number of personnel in these fields, the increase of innovations and patents applied in social and economic activities.

The figures analyzed to reveal the concern of the European Union that the strategy for the last decade 2010-2020 in this area is to reach the objective and to ensure a higher implementation of the results of research and innovation in the economic activity.

It is noted that the number of inventions, innovations and patents that have been applied in the economy of these countries has increased in the countries of the European

Union. Based on these innovations, a series of objectives of maximum importance were initiated, to which those countries that had a contribution through the projects realized at the beginning of the economic development have access.

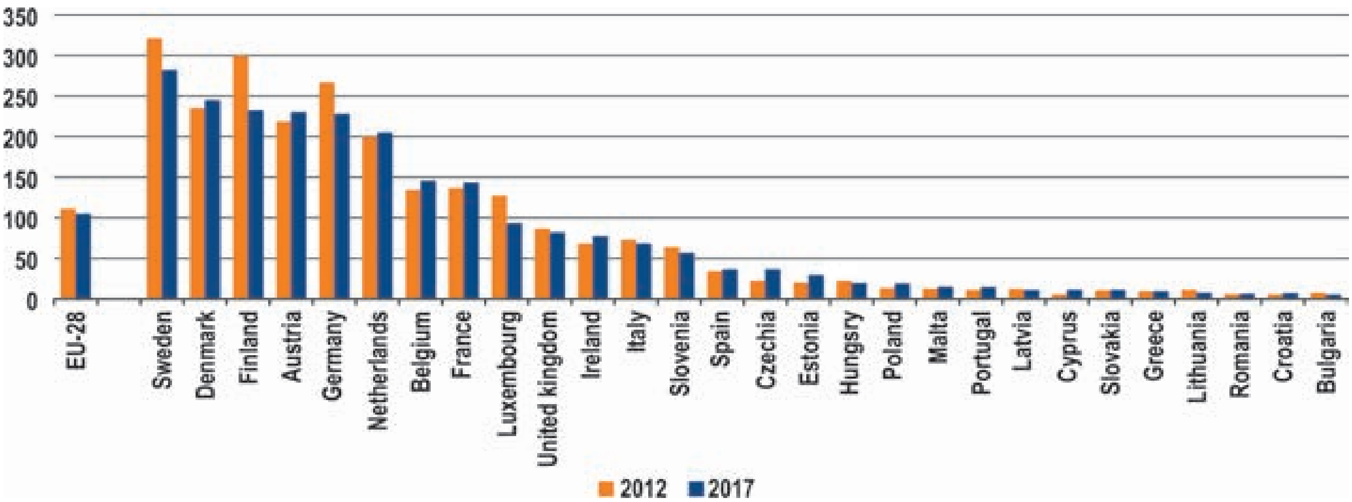

Figure 2 – *Patent applications*
(Source: Eurostat Statistics 2017)

Member States of the European Union that have died slower in the field of research funding, innovation, which did not then materialize in patents and licenses must make an additional effort. It concerns two directions, on the one hand, the approximation of the level registered by the Member States of the European Union that have a high level in this field, and on the other hand, Romania's participation in investments in economic-social objectives, based on the investments and patents of its own. production.

It should be noted that at present, a number of internationally patented innovations of some Romanians are currently being used in the other Member States of the European Union in areas other than those where the inventions were located. For Romania and other member countries of the European Union, there is a certain situation that some patents will not be able to find their ability because we do not have an industrial structure.

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„The Industrial Revolution moved at least as fast as Information Revolution, in the same time span, and had probably an equal impact."
Peter Drucker

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