

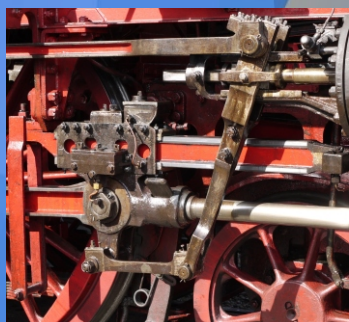
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Methods and approaches for creation of digital twins of cyber-physical systems

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Abstract: The idea of creating and using digital twins has been strongly influenced by the process of integrating artificial intelligence methods with big data analytics of data from Internet of Things (IoT) devices. The concept of "Digital Twin" has become increasingly influential and culminating in the field of CPS. The main objective of the study is to define the basic requirements to the digital twins for cyber-physical system and based on the different definitions and components of digital twins, to summarize and analyze approaches, methods and tools used for their development. This analysis should serve as a basis for the development of a methodology for creating digital twins for cyber-physical manufacturing systems in the process industry.

Keywords: DIGITAL TWIN, CYBER-PHYSICAL SYSTEMS, INTERNET OF THINGS, MODELING, SIMULATION

1. Introduction

Transforming industrial production by merging digital technologies and the Internet with conventional industry is crucial to increase its competitiveness. This transformation is possible only on the basis of the development and validation of the theory of cyber-physical systems (CPS). Cyber-physical systems (CPS) are the integration of computational and physical processes. They use embedded computers and networks for the purpose of monitoring and feedback control of physical processes [1]. Through cyber-physical systems, the physical world connects with the virtual world to form the Internet of Things, Data, and Services. Some of the most promising applications of CPSs are cyber-physical production systems. The advanced CPSs are characterized by high dimensionality and complexity, including a variety of decision-making capabilities and control logic. The degree of communication of these systems with physical processes is also increasing, based on algorithms with increased efficiency and robustness. The amount of program code based on logic significantly exceeds traditional control algorithms.

In recent years, the concept of "Digital Twin" (DT) has become increasingly important and culminating in the field of CPS. The digital twin is a digital copy of the physical part of the CPS in real time and represents a bridge between the digital and physical worlds. The idea of creating and using digital twins has been strongly influenced by the process of integrating artificial intelligence methods with big data analytics of data from Internet of Things (IoT) devices.

The main goal of the research, presented in this paper, is to develop an approach and methods for creating digital twins of cyber-physical production systems. The project includes several main tasks related to some of the biggest challenges facing cyber-physical systems and their digital twins, such as: (1) defining the requirements for digital twins of cyber-physical systems; (2) analysis of the existing approaches and methods for the development of digital twins, as well as of the proposed software tools.

The paper is structured in 4 parts. After the introduction, in part two, a short analysis of the currently used definitions of the concept "digital twin" is presented and basic characteristics of digital twins are discussed. In order to achieve highly efficient, reconfigurable and resilient CPPS, in Part 3 the basic requirements to their digital twins are summarized and the basic tasks for their fulfillment defined. Part 4 presents an analysis of the currently used approaches, methods and tools for creation of digital twins for CPPS. The analysis should serve to create a methodology for creating digital twins of cyber-physical production systems for process industry.

2. Digital Twins – basic definitions and characteristics

2.1. On the definitions of digital twin

In recent years, the concept of "Digital Twin", which first appeared in aerospace technology and was proposed by NASA in 2010, has become increasingly influential and culminating in the field of CPS [2]. For the time being, there is no established definition of the term "Digital Twin", as there is a great variety among them, both in terms of functionality and areas of application. In [3] an analysis of the literature references on the topic of "Digital Twin" is done and their application in various fields discussed. A total of 29 definitions of the term "Digital Twin" are presented, cited in 75 literature references, most of which are scientific publications after 2016. It is noteworthy that the vast majority of definitions are applicable to the digital twins used in manufacturing. The analysis of the definitions shows that the concept "digital twin" is represented by the keywords "Virtual, mirror, replica" in 11 definitions, as "Integrated system" - in 5 definitions, as "Simulation, test, prediction" - in 4 definitions and such as "Clone, counterpart", "Ties, links" and "Description, construct, information" - in 3 definitions.

A similar study was conducted by Semeraro et al. in their systematic literature review of DT paradigm in [4]. They analyze the concept of Digital twins and define 5 clusters based on 30 different definitions. The key expression on which the definitions in cluster C1 are based is "life cycle phases", emphasizing the connections between the physical and virtual parts in all phases of the product life cycle. To this cluster belongs the first definition of the term "digital twin", published in 2004 by Grieves [5]. Definitions in cluster C2 define the DT as "the cyber part of Cyber-physical system", but unlike CPS, which focuses on the 3C capabilities (computing, communication and control) DT is focused on virtual models. At the heart of DT are models and data while at the heart of the CPS are sensors and actuators. The definitions in cluster C3 use the terms data, information and knowledge, while those in Cluster C4 reflect aspects of modeling the physical part and especially behavioral models. Cluster C5 brings together definitions that view DT as a "virtual system".

In order to clarify the concept of "digital twin", it is extremely important to draw a parallel with the concepts of "digital model" and "digital shadow". The digital model is a digital representation of a specific physical object, and there is no automatic data exchange between them. A change in the state of a physical object does not cause a change in the state of the digital object. The digital model can use manually entered data for the physical object, as shown in Fig.1. Manual data flows are illustrated in Figure 1 with dotted lines. Dense lines show automatic data flows. In the digital shadow, there is a one-way automatic data exchange from the physical to the digital object. In this case, the change in the state of the physical object causes changes in the digital one as well. Finally, with the digital duplicate, there is a two-way automatic data exchange, and any change in the state of the

physical object causes a change in the state of the digital and vice versa.

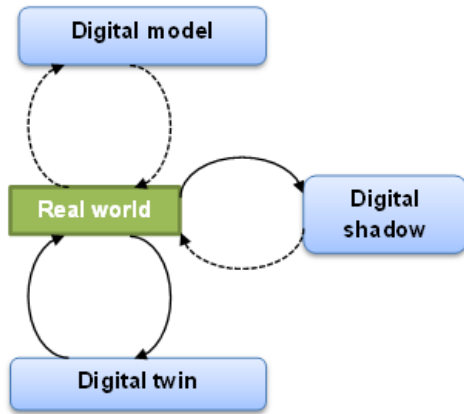


Fig.1: Digital model, Digital shadow and Digital twin

The digital twin involves the creation of digital simulation models of physical and technical objects that are dynamic, updated and changed according to the life cycle of the physical object [6]. Such dynamically updated models are able to constantly receive new information about the measurements from sensors of the physical part of the CPS, from sensors of the control devices and from the environment. The digital twin differs from traditional CAD / CAM models and is not just a simulation model, but a living, intelligent and constantly evolving model that follows the life cycle of physical part and covers various functionalities such as monitoring, control, optimization of processes, prediction of states and simulation of new configurations in connection with the maintenance and production of new products. The DT processes are possible through its continuous interaction, communication and synchronization with the physical twin. Higher hierarchical systems summarize new and past data and change model parameters [7]. The dynamically updated CPS model is essentially its digital twin.

2.2. Basic components of digital twins

The five-dimension digital twin model is illustrated in fig.2 and includes the following components: Physical entities (PE), Virtual entities (VE), DT data, DT services and Connections in DT. PE may be seen as the foundation of the DT and consists of devices and/or equipment and/or products. VE are counterparts of the PE and their different models such as geometric, physical, rule and behavioural adequately reflect the PE. The digital twin handles a wide variety of data with different backgrounds, different time scales and degrees of importance. DT data are the main driver of the digital twin. Services are an important component that significantly expands the functionality of digital twins, offering services related to modeling, simulation, optimization, monitoring, diagnostics, planning, forecasting and more. Finally, the digital twin is characterized by six connections, namely: (1) PE – service connection, (2) PE - Data connection, (3) PE – Model connection, (4) Model – Data connection, (5) Model – Service connection and (6) Service – Data connection. Through these connections the communication between the other four components is realized.

The Fourth Industrial Revolution uses device connectivity to make the concept of digital twins a reality for manufacturing processes. The digital twin creates a testing environment for products and control systems that impacts real-time data, which is critical to production accuracy, efficiency and security.

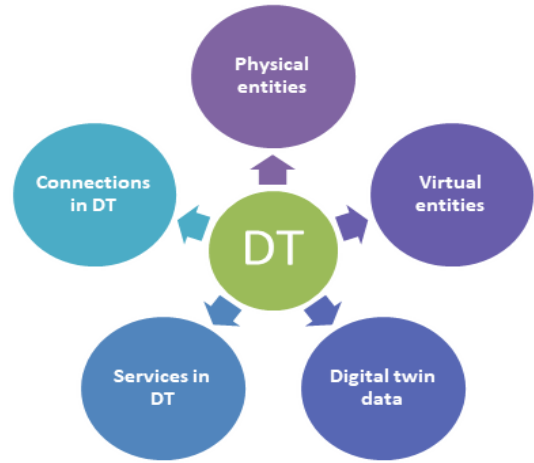


Fig.2: Basic components of DT

3. Requirements to the digital twins of CPPS

The main objective of the study is to summarize, analyze and apply approaches, methods and tools used in the development of digital twins of cyber-physical production systems that meet the following basic requirements [8]:

- Able to adapt to heterogeneous environments;
- They are able to work in the conditions of distributed networks: i.e. they must collect, transmit and store in a reliable way all the information provided by intelligent sensors and actuators through the use of the Internet of Things;
- Use modular open architecture;
- Include human-machine interfaces to provide access to specific information, to provide information analysis and to integrate easily accessible and reliable services to inform decision makers in real time;
- Be error tolerant: provided by encapsulating forecasting models in the control loop and checking the correctness of automation systems.

Achieving the above defined requirements to the developed digital twins is connected with solving the following main tasks:

- Creating and deploying a set of simulation models that have a specific purpose and range of validity. For this purpose, it is proposed to use the approach of model-driven development.
- Providing data and information on the various stakeholders.
- Achieving interconnectedness through semantic technologies.
- Automatic transformation of models between the different phases of the life cycle and creation of preconditions for verification of digital twins.
- Ensuring a connection between the real and digital worlds by ensuring synchronization between measured data and virtual presentation.
- The digital twin can be an element of the product itself and delivered with it, or it can be a stand-alone service that forms its own business models.
- Closing the feedback loop, not only in relation to the real system, but also to the earlier stages of the life cycle, can significantly improve the quality of development.

The next section of the report presents an analysis of the existing approaches, methods and tools used to create digital twins for cyber-physical systems.

4. Overview of techniques and platforms for creating digital twins

4.1. Methods and Techniques for sensing and measurements of physical part

To create high-precision digital twins, physical world information obtained through measurements and sensors is needed. It is necessary to use advanced principles and tools to measure a large number and variety of parameters that must be collected in real time. Various algorithms for primary data processing, for indirect estimation of non-measurable parameters, for data reconciliation, structural analysis, etc. can be referred to the used methods.

4.2. Methods and Techniques for improvement of physical part

As discussed in section 2.1 of the paper, the digital twins can improve the performance of PE. The main means for this are the advanced control systems, which are also very diverse in terms of principles of operation, structure, type of energy used by drive and power systems, and more. In addition, various services for planning, scheduling, optimization, etc. can be used, which contribute significantly to the improvement of PE.

4.3. Methods and Techniques for digital twin modeling

The modeling and simulation of cyber-physical systems and their components (embedded, mechatronic, etc.) is considered an important stage in the design, development and operation of CPS and their components. One of the most successful approaches used for CPS design is model-based design [9] and model-driven development [10], where models play a significant role in the design process.

Models and data are the core of the digital twin. However, creating virtual models as well as combining and analyzing data are complex tasks, which require in-depth knowledge in many areas. The following formalisms and tools are used to model and analyze various aspects of the DT:

- Equation-based models in tools such as MapleSim [11] and Modelica [12], suitable for modeling the physical part of the system,
- Function block models in tools such as Simulink [13], suitable for the design of control and simulation systems;
- Finite-state machines and labeled transition systems in tool such as LTSA [14] are best suited for modeling decision logic and communication protocols;
- Hybrid dynamic models in tools such as SpaceX [15] are useful for analyzing abstract unified continuous dynamics behavior and discrete switching modes;
- Network simulation models in a tool such as OMNeT ++ [16], useful for analyzing the properties of communication networks, such as packet loss and communication delay;
- Software models in tools such as SPIN [17], useful for analyzing whether the logic of the solution is implemented correctly.
- Various approaches and tools based on the UML profile for systems engineering SysML [18] and UML profile for real time embedded systems MARTE [19].
- Method for defining the requirements to the digital twin of cyber-physical systems using the "Requirements diagrams" of the UML profile for system engineering SysML
- Methods and models for formal verification and validation of digital twins for cyber-physical production systems - in the field of verification, research is focused mainly on model checking, based on timed logic and different types of automata: timed, hybrid, as well as their combined use. As tool for verification, the use of UPPAAL [20] for verification of the digital twin gives reliable results.

4.4. Methods and Techniques for DT data management

The digital twin is driven by data, it is its core. All phases of the data life cycle are included, such as: data collection,

transmission, storage, processing, merging and visualization. Data is obtained in different ways - from software applications, from hardware and from the network. When working with data, different technologies and methods are used. This can be classified into groups, corresponding to the life cycle phases. Data storage is inextricably linked to databases, which are finding it increasingly difficult to cope with large volumes of data, their heterogeneity and unstructured character. Big data methods, NoSQL and NewSQL databases, as well as cloud storage are increasingly used. The data processing is related to the selection and extraction of useful information. For this purpose a wide variety of methods are available, such as: the rich palette of statistical methods, methods of machine learning, different types of neural networks, analytical processing systems and more. Data fusion can be performed by digital twin at different levels (raw data, feature level or decision level) by working with data from different sources and using various methods of artificial intelligence, Kalman filters, fuzzy sets, vector support machine, etc. The last phase of the data management life cycle is the visualization of the data, the purpose of which is to present in summary or detailed form specific information. There is a wide variety of visualization forms, such as different types of charts, histograms, charts, boards, and more. The principles of visualization are also different, such as based on geometry, pixels, icons based on layers, images and more.

4.5. Methods and Techniques for DT services

Services in the field of creating digital cyber-physical twins integrates knowledge and engineering principles from the fields of computer science, control theory, electrical engineering, electronics, mechanics, artificial intelligence and a number of engineering disciplines in order to enrich cyber-physical science with appropriate methods and techniques as special attention is paid to their application as services in 3 areas of cyber-physical production systems: (1) As a means of solving various tasks for monitoring, maintenance and increasing the reliability of equipment; (2) As a means of analyzing the behavior and commissioning of equipment and devices, and (3) As a tool for decision making through engineering and statistical analysis.

Different conventional simulation tools are available, such as those using the finite element method, the Monte Carlo method and various CAD / CAE systems, such as Dassault Systemes [21], Matlab / Simulink, Verosim [22] and others. However, the emphasis is on software tools that cover the entire development lifecycle, meet the requirements of Industry 4.0 and are based on semantic meta-models, such as AutomationML [23] and the MAYA project. Among the most popular and used tools are Predix [24], IoTIFY [25], BoschIoT Suite [26], Seebo [27], ThingWorx Operator Advisor [28], etc., which must be analyzed in order to select a suitable tool for the development of digital twin of batch reactor.

4.6. Methods and Techniques for connections in DT

The suggested methods for the six connections in the digital twin are shown in Fig.3.

The development and implementation of digital twins is still in its infancy, so the first tools for their development are owned by large companies such as GE and others. The following well-known digital twin platforms and tools are of the greatest importance for the production area:

- „Predix“ of General Electric [24];
- „Mind Sphere“ of Siemens [29] – it adopts Industry 4.0's concept of connecting machines and physical infrastructure via the cloud
- „Thing Worx“ of PTC [28, 30] – is focused on collecting data from IIoT/IoT devices and presenting a user interface that facilitates data analysis,
- „Watson IoT platform“ of IBM [31] – it is available as a universal tool for data from IoT devices that can be used to control

systems in real time through data, collected from millions of IoT devices.

All the above mentioned platforms are paid. Also of interest are some open platforms, such as the Ditto project in Eclipse [32] and Imodel.js, developed by Bentley Systems [33] that is a platform for creating, accessing and building digital twins.

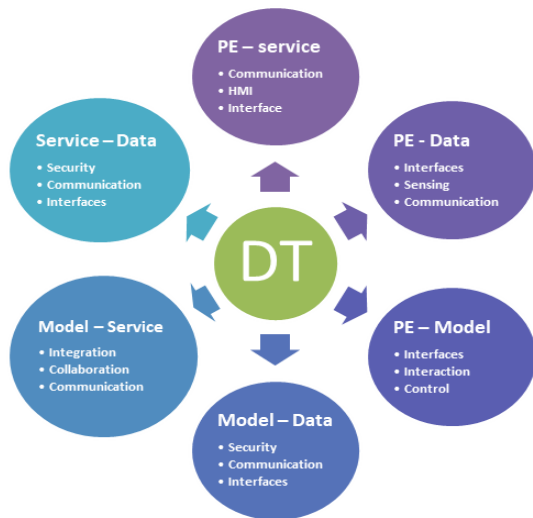


Fig.3: Connection methods

4.7. Platforms and tools for digital twins

Conclusions

The study presented in this paper includes an analysis of the requirements for digital twins of cyber-physical production systems, an overview of the approaches and methods for creating digital twins of cyber-physical systems, as well as a comparison of different approaches. The next step is the development of approach and methods for creating digital twins of cyber-physical systems, as well as for their formal verification and validation. An important stage in research project is the creation of a digital twin of a specific cyber-physical system, implemented as a pilot demonstrator.

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Information data management in big data.

Case study: E-Albania government portal.

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Abstract: Big Data is becoming one of the most important technology trends. It presents a potential that is radically changing the way organizations use their information to be closer to customers by organizing in a way that benefits from the customer experience and transforms their business models.

Although Big Data is an ever-climbing trend in terms of industry, its meaning is still hidden by many conceptual ambiguities. The term is used to describe a wide range of concepts: from technological ability to storage, aggregation, data processing and finally their generation. In this paper the focus is at Big Data, because they are the technology of the future and in one way or another, they are affecting every field of industry. Furthermore, companies are increasingly trusting the possibility of using data as a valuable business asset to benefit and bring a competitive advantage compared to other companies. In the paper is presented also a SWOT Analysis that is conducted about Big Data information showing the strengths, weaknesses, opportunities, and risks that they carry. Also are presented the challenges of Big Data Technologies for the future. At the end of the paper, there are conclusions and recommendations about the topic.

KEYWORDS: TECHNOLOGY, DATA MANAGEMENT, BIG DATA, INNOVATION, BUSINESS MODEL

1. Introduction

Nowadays, digital technologies are transforming the social and economic aspects of public and private institutions. It would be simpler to think that any innovation in data management is a new beginning and detached from the past. However, most of the new phases or flow of data management is built on their predecessors. Data management should include advances in technology in hardware, storage, networking, and computer models such as virtualization and cloud-computing. All these technological factors are transforming the way we manage and utilize data and for this reason Big Data is the latest trend emerging due to these technological factors. Big Data is important because they enable organizations to collect, store, manage, and control data, to gain the right knowledge. They serve to control this data at the right speed and at the right time. The purpose of this paper is the analysis of high-capacity data otherwise known as Big Data and further their classification by also analyzing real cases. Great importance is also given to the areas that this data affects in business or industry and the challenges for the future. The paper gives information about the Big Data concept and their management, and a case study for the e-Albania government portal and the potential for using Big Data. Also, the importance of Information Data Management in Big Data, where the impact of this data in businesses or industry is also studied. E-Albania portal generates large volumes of data and the collection of various data such as time spent on the site, frequency of visits, number of transactions performed per visit, location of users and so on is very important.

2. The Importance of Information Data Management in Big Data

The Big Data Architecture is designed to cope with processes such as: obtaining, processing, and analyzing data that are too large or complex for traditional database systems. The threshold at which organizations can enter the Big Data field depends closely on the capabilities of users and the tools they own. For some this limit may be hundreds of Gigabytes while for other hundreds of Terabytes. To better understand Big Data we need to understand the features they carry otherwise known as Big Data Vs. In the period of the creation of Big Data three were the most popular features that personified these types of data. The potential that data carries must be understood, along with the most challenging features, before embarking on a particular Big Data strategy. For an optimal strategy it is best to pay attention to each feature of Big Data, as each of them affects in one way or another in business. Attention should always be paid to the value that the business receives from the use of data. [1]

The importance of Big Data does not depend on how much data we have, but what we do with that data.

They include data from every source which must be analyzed to find answers that enable:

cost reductions, time reductions, new product development and optimized offerings.

When Big Data is combined with powerful analytics, business-related tasks such as:

- Identify the root causes of failures, issues, and defects in near real time.
- Generating coupons at the point of sale based on the customer's buying habits.
- Recalculation of risk portfolios in minutes.
- Detect fraudulent behavior before it affects the organization.



Fig. 1. 10 Big Data Features

The figure presents the most important areas where Big Data Analysis is needed.



Fig. 2. The most important areas where Big Data Analysis is needed

3. SWOT Analysis of Big Data Technology and Challenges expected in the future

3.1. Strength

- Big Data is the technology of the future.

Organizations are incorporating Big Data into their processes and are reaping the benefits of this decision. Numerous market and data analysts are of the opinion that the use of Big Data and their analysis (Big Data Analytics) would double the chances for the business to be more profitable in any kind of market that exercises its activity.

- Big Data manage the feedback that customers have about the company [2]

Another strength that Big Data has is the ability to manage the large amount of data that comes as a result of the appreciation that consumers have about the company (customer feedback). This flow of data has come as a result of social networks (social media) as their customers are more free to express their opinion.

- Big Data can also be presented as a form of Marketing for companies

Social networks have a direct impact on the marketing of companies. In the case of Facebook and Instagram, data is generated about the behavior of users depending on the likes they have or the people or sites they follow and then ads are suggested depending on the results obtained. This is a mutual benefit between companies that create ads and sites in internet or social networks.

3.2. Weaknesses

- Big Data technology requires high additional costs

Big Data Analysis is becoming more and more popular and a standard part even necessary for modern business processes. For this reason, for small and medium enterprises there will need to be more training and knowledge transfer, so that they be able to analyze the data they collect to gain a better insight into what their customers want and need.

-Technology that is closely related to data quality and analytics capability. [7]

Another weakness of Big Data is the risk that the conclusions and information collected from the data will be of poor quality. With the vast amounts of data available in this type of analysis, data analysts can mistakenly create false connections between data sets of the opportunities they represent. So, understanding the available data and the quality of the data being analyzed can be a major weakness, especially if analysts do not have much experience in the field from which the data set was collected.

3.3. Opportunities

-Big Data Analytics is a very good career opportunity

The possibilities from the point of view of a professional specialized in data management with high capacity (Big Data) are numerous. Big Data Analytics is not limited to a single language or a framework. It combines advanced statistical skills with programming skills, and there are many potential languages that can be specialized. Furthermore, a data analyst career will require the use of Excel to clean, organize, manipulate, and visualize data. Excel is one of the essential tools for data management, so some knowledge gives priority to performing an analytical data job.

With the provision of data, finance, sales, marketing and Business Intelligence (BI) as the most popular areas of work for Data Analysis specialists, the opportunity to use skills in multiple industries increases. Students and young people who have a penchant for computers and are excellent communicators looking to make above average revenue, should see a Big Data Analytics as a very good career opportunity.

3.4. Threats

- Big Data technology can cause many concerns about the privacy of social network users or company clients.

As data collection becomes more and more common, there is a risk that some of this data may be misused. For example, in the field of healthcare, if a third party was analyzing data, the data should be

clean with certain identifying information. Allowing someone's name or other personally identifiable information to a group Data sent outside the company can not only endanger the client, either from identity theft or fraudulent scheme, but it can also have an impact on the company that releases the information.

-Big Data is presented as intellectual property.

Third parties may have rights to the databases, software or algorithms used to analyze the datasets. The business must ensure that they have adequate licenses not to infringe on the intellectual property rights of another party.

4. E-Government and the potential for using Big Data, Case Study: e-albania portal

With the latest development of information technology, governments are increasingly relying on computer information systems for monitoring and decision making. Information and Communication Technologies (ICT) play an important role in achieving a strategic goal for a more efficient government. E-Government refers to the use of modern technology resources, such as the Internet, mobile, etc., to improve the electronic services provided to citizens and businesses. The main benefit of e-Government technology systems is seen in the construction of a society where information is easily accessible through the public online services provided. [4]

E-Government is an instrument of a pro-information society built in the form of governing principles, strategies, systems and tools that enable the use of ICT in the interaction between key elements of society - government, citizens and businesses - to strengthen democracy. and support development.

4.1. Government portal e-albania.al

E-Albania is developed as a multifunctional portal and is considered as a stop where citizens and businesses are provided with electronic public services. Services are provided 24 hours, 7 days a week. The portal started as an investment of the European Union in 2009. In the early stage, it was very simple including 6 electronic services and 4 systems connected to the government interaction platform. The portal connects to the Government Interoperability Platform, which is the basic architecture that combines hardware, software and services that enable interaction between all connected systems of government institutions.

Interoperability platform: enables the exchange of data between systems in state institutions. The aim is to increase the number of institutions that are part of the interoperability platform, to improve the current services for the exchange of data between institutions and to develop new services for the exchange of data between institutions. The uninterrupted flow of information through the interoperability platform reduces the time required for the transfer of information between state institutions which facilitates the flow of electronic information which is necessary to provide the necessary public services to citizens and businesses.

- The e-albania portal already lists more than 600 services that government institutions currently provide to citizens and businesses. Some of these services are transactions and are offered through various online systems.

- Now, in 2022, there are 240 institutions connected with e-government portal. This is not just a number, but a clear indicator that reflects the usefulness of this portal how Albanian institutions provide online services to citizens and their businesses.

E-Albania is offering hundreds of electronic services to citizens and businesses as well. Many of these services like certificates and health cards have made their lives easier by saving users time and money. Many public institutions that are responsible for providing these online services interact and exchange real-time data with each other using the interoperability framework. During 2018, over 50 million transactions were conducted through the official interaction platform. The existence of this platform is the reason why today in Albania over 30 different documents can be downloaded directly from the portal equipped with a digital stamp. The impact of this

development has been tangible and significant in reducing paper use.

The e-Albania portal provides analytical data on a regular basis for each month, which better serve the transparency of the work done for the portal, the enrichment of the menu, its maintenance and functionality; various institutions that are represented in e-albania with their services, but also different media and NGOs for different work, study, etc. needs.

Table 1. The most used services of the e-albania portal (Source: AKSHI)

Visit to the portal
New registered users
User in mobile application
Total number of uses of electronic services
Services

4.2. E-albania platform and the need for advanced analytical methods

This information constitutes a national asset and should be managed and analyzed in a way that can be used not only to ensure government transparency, but also to increase national economic benefits. Access to the e-albania platform generates large volumes of data and the collection of various data such as time spent on the site, frequency of visits, number of transactions performed per visit, location of the user and so on. analyzing this information and simultaneously analyzing the web, policymakers can develop metrics to monitor the effectiveness of the e-albania platform. There are a total of 74 state databases, of which 45 are registered as state databases, while others are in the process. Despite the fact that many government institutions in our country have digitized their systems, in many cases, these systems have been developed without a communication strategy between them, with the sole purpose of meeting the internal information needs. Current technological transformations and the need for fast, accurate, transparent and up-to-date information for citizens and businesses, require these systems to interact with each other sharing large volumes of data. Not all pieces of data in e-Government can be processed using traditional analytical methods due to their characteristics, large volume, processing speed and diversity.

5. Conclusions

1) Why is the study of Big Data technology important in theoretical terms.

- One must understand the potential that data carries, along with the most challenging features, before embarking on a particular Big Data strategy.
- For an optimal strategy it is best to pay attention to each feature of Big Data, as each of them affects in one way or another in the business.
- Attention should always be paid to the value that the business derives from the use of data.

2) Conclusions drawn from the case studied: Government portal e-albania

- Using Big Data, governments can significantly improve decision-making, based on the information available and the analytical techniques used to gain real-time knowledge from fast information processing.
- Albania lacks adequate infrastructure for Big Data generation and management. Policymakers in Albania should consider Big Data as a step towards moving towards development.
- Although the e-albania government portal has not yet reached the level where high-capacity Big Data are managed, we can say that the first steps are being taken towards this Data Technology as it is e-albania manages high levels of data being closer to the users the citizens of Albania.

3) Conclusion drawn after the realization of the SWOT Analysis in relation to Big Data Technology

- Big Data combines modern advances in information technology to collect, store and analyze volumes of data in a very fast time. However, as long as the amount of data available and the technology allow for unenforceable applications, care must be taken to ensure that the analysis is well done with appropriate safeguards to safeguard the client's privacy.

4) Recommendations for the use of Big Data Technology in Albania With the rapid growth of data that Albanian institutions manage to produce and collect, the time has come to record and implement various projects in Big Data. These projects can be adapted to the conditions of our country and are not claimed to be the size of completed projects in technologically developed countries. Also, the way of managing these projects and the final result they will give may not be on the same level with technologically developed countries, but this does not mean taking the first steps around this direction.

Some recommendations for initiating Big Data Projects in Albania:

- Creating a database or register where all information assets are located
- Improving the cyber research infrastructure that enables innovation in Big Data
- Implementation of various pilot projects in the field of Big Data
- Realization of all these stages focusing on privacy, security, and ethics
- Close reciprocal relationship between the public-private sector and academic institutions for education and training of young professionals or those who want to develop their career around Big Data Technologies.

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Decentralization of the Internet of Things in Industry 4.0

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Abstract: Rapid progress in the field of industrialization and informatization methods has led to huge progress in the development of next-generation production technologies. The Internet of Things (IoT) is a pervasive technology, and now it is used in all areas of everyday life, from healthcare to technological production. The new industrial revolution began with connected technologies supported by the Internet of Things. However, the security of the Internet of Things is still an open question since in case of unauthorized access, data from sensors can be changed, for example, by a user with authorized access rights, which can lead to unforeseen consequences.

Keywords: IOT, BLOCKCHAIN, DECENTRALIZATION, INFORMATION SECURITY

1. Introduction

At the moment, centralized servers are used to collect data from IoT devices, which are an additional attack vector and should also be protected, because if the server is unavailable, data from the devices will not enter the database or in case of unfair hosting on which the servers are deployed. Some of the protection methods may be quite effective, but they do not give much guarantee. At the moment, there is a trend towards decentralization, which is gradually coming to replace the client-server architecture, which is much more widespread at the moment. Unlike the client-server architecture, the decentralized blockchain architecture has several security advantages [1-2]:

- trust is based on a mathematical model and is supported by cryptographic methods
- natural immunity to single point of failure (SPOF)
- immunity to replay attack

However, there are several problems related to the performance and scalability of classical blockchain models, such as Bitcoin, Ethereum etc. The alternatives proposed by other researchers [3] do not consider such features of the field of medicine as:

- connection with other data, since it is necessary to know to which patient data relate to
- more efficient data storage mechanisms

2. Preconditions and means for resolving the problem

The main goal of this work is to create a more efficient blockchain model that can close the above problems. To consider any options, it is necessary to find out how the blockchain works. When each transaction occurs, it is recorded as a "block" of data, these transactions show the movement of an asset, which can be tangible (product) or intangible (intellectual). The data block can record information of your choice: who, what, when, where how much and even the condition — for example, the temperature of food delivery. Each block is connected to the blocks before and after it, these blocks form a chain of data as the asset moves from place to place or changes hands. The blocks confirm the exact time and sequence of transactions, and the blocks are securely linked to each other to prevent any block from being modified or a block inserted between two existing blocks. Each additional block reinforces the verification of the previous block and, consequently, the entire blockchain. This makes blockchain forgery obvious, providing the key strength of immutability. This eliminates the possibility of an attacker interfering and creates a transaction registry that you and other network participants can trust. An example of a blockchain scheme is illustrated in Fig. 1 [4].

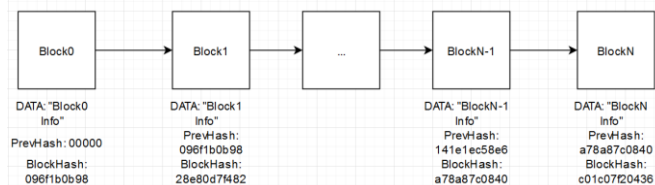


Fig. 1 Example of blockchain principles.

In the basic architecture of the blockchain, each transaction needs to be verified which cannot be altered. The blockchain is a Peer-to-Peer network of connected devices, when a transaction is added, it is transmitted to all nodes available in the network. After all nodes received transaction a validation of transaction is started, usually blockchain network uses SHA-256 algorithm for hash generation. After successful validation the block is going to the ledger chain and added existing blockchain, this process illustrated at Fig 2 a-c.

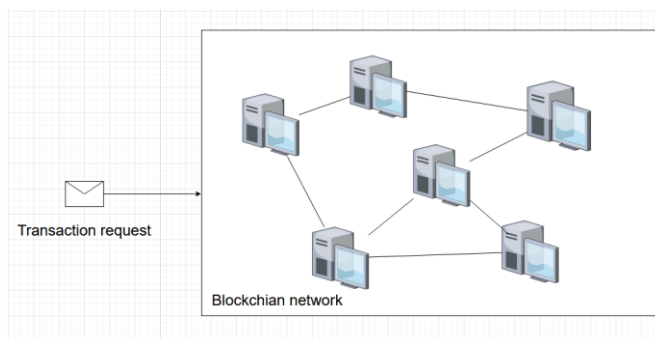


Fig. 2a Transaction request in blockchain network

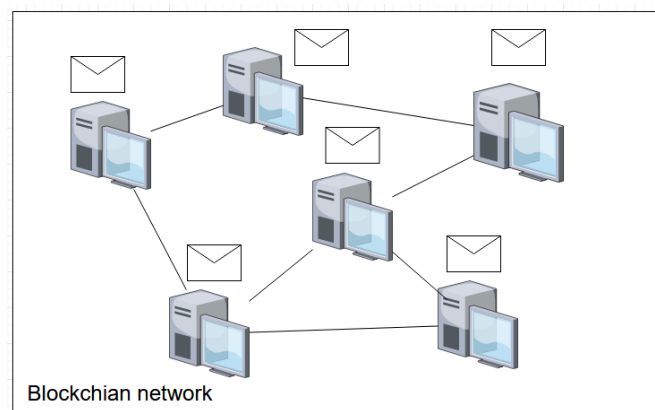


Fig. 2b Transmission of transaction in blockchain network

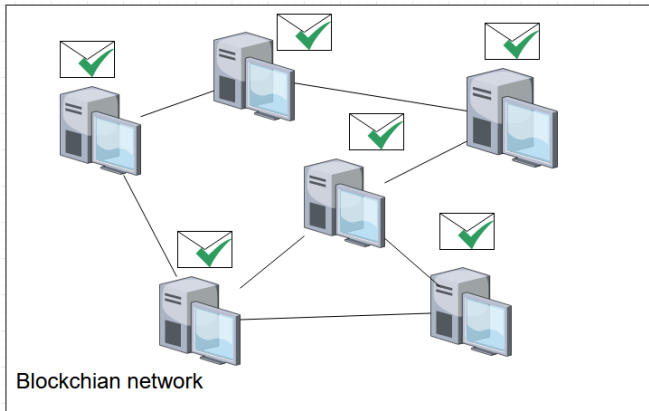


Fig. 2c Validation of transaction

There also several types of blockchain:

- public
- private
- permissioned

In public blockchain anyone can join and contribute to the network. Anyone can read, write, and audit the ongoing activities on the public blockchain network, which helps a public blockchain maintain its self-governed nature. But there is also a downside of that approach because this type of blockchain becomes more and more power consuming the more participants join it.

Private blockchain allows only verified participants by authentication or verified invitation. It also allows execute the consensus protocol that decides the mining rights and rewards and maintenance of the shared ledger.

Permissioned blockchain is a combination of public and private blockchain with customization options.

3. Solution of the examined problem

An important factor is the data for which interaction is planned, at the moment data are considered as: blood pressure, cholesterol level, glucose level, AST, ALT. The data in the blockchain will be generated based on the device identifier and the data read by the sensor.

In the case of applying a conventional model to IoT devices, several problems arise:

- IoT devices don't have as much storage space for the entire blockchain
- the computing power of the devices does not allow for more complex computing processes

In this regard, it is proposed to transfer the entire formation of the blockchain to decentralized servers according to the model described below in Fig 3. This will solve the problem that it is necessary to perform calculations, as well as store data on an IoT device.

The network permissioned and almost private, that is, for each new device, its registration in the network is required. IoT devices will be in the "external" layer from which requests will be submitted to the cloud, the server is selected depending on its availability, thus decentralization can still be ensured and protection from SPOF is provided. the only drawback of this approach is the fact that you may have to do additional configurations that may not be supported by some devices. The channels are the points where IoT devices will transfer data, also they are representing connections between hospitals which can be located on a different cloud.

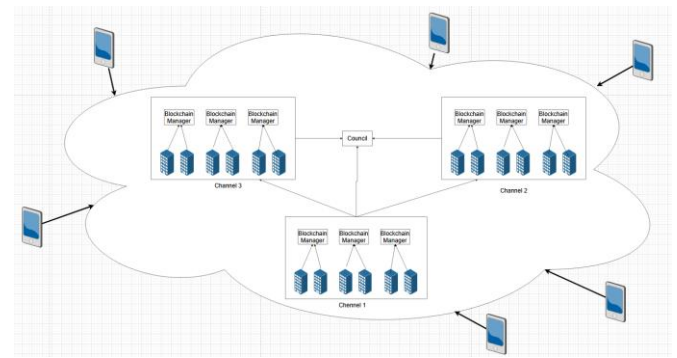


Fig. 3 Proposed blockchain model

Blockchain managers are used to generate and compress data to blockchain, they also act as sources for smart contracts, since it stores a replicated copy of the blockchain network.

The validation of the network blocks is handled by the "council", it contains N devices performing validation, thereby providing SPOF protection in case one of the nodes is unavailable for validation by the "council". The "Council" has mutual access with "blockchain managers" this is shown in Fig 4.

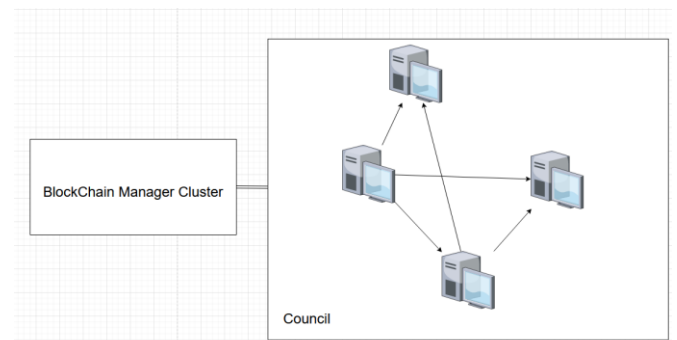


Fig. 4 Council scheme.

Based on the diagram in Fig 3 and Fig 4, the following interaction is planned:

- The IoT device sends a request to add to one of the channels
- One of the blockchain managers forms a request and sends it for validation to the "council"
- After validation, the blockchain is updated for everyone
- If another medical professional needs to apply for some data from sensors, for example for research, he can do it using smart contracts

4. Results and discussion

The result of this work was an alternative model for decentralized and more secure storage of medical data. The model covers the entire cycle of data circulation, from sending from IoT devices and ending with the secure receipt of data by a third party using smart contracts.

However, there are points that require additional consideration. For example, how many blockchain managers and members of the "council" are needed for the best performance and how to calculate amount of them? What configuration should these devices have?

5. Conclusion

This work suggests an alternative blockchain model that has the potential to be more efficient than other models. The proposed model was reviewed, its main modules were described. The source code and data can be viewed here: <https://github.com/DemonEach/med-blockchain-iot>

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Sorption phenomena on the surface of steel in solutions of nitrilotrimethylphosphonic acid

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Abstract: Corrosion behavior of plain steel in alkaline copper-containing solutions was studied. Cementation of steel is inhibited by formation of the passive film on the steel surface. Formation of the film is due to the reacting steel and complex of divalent copper complex with ATMP.

KEY WORDS: IMPEDANCE SPECTROSCOPY, ATMP, ADSORPTION, STEEL CEMENTATION INHIBITION

1. Introduction

When copper or copper-containing galvanic coatings are deposited onto a steel base, there is a risk of contact copper deposition after immersing an item in the electrolyte but before cathodic polarization is applied. Copper deposited in contact manner adversely affects the adhesion of the coating deposited later by impairing its adhesion to the steel base. Moreover, contact exchange results in contamination of the electrolyte with iron ions that can adversely affect the performance of the electrolyte, especially in case of the electrodeposition of alloys.

The most popular method to solve the issue of contact exchange in electrolytes for deposition of copper and its alloys involves binding copper ions into complex compounds [1-3]. At the same time, practical recommendations for the operation of alkaline cyanide-free copper plating electrolytes that are most common in the industry, such as loading parts into the electrolyte under current, indicate that these complexes are not strong enough to prevent the contact deposition of copper on a steel surface [4]. According to literature data, the stability constants of organophosphate copper complexes are comparable to the stability constant of the pyrophosphate copper complex [5].

In the development of an alkaline cyanide-free electrolyte for bronzing based on nitrilotrimethylphosphonic acid, it was noted that in the absence of external polarization, the formation of contact copper is not observed on the surface of a steel electrode even after prolonged exposure of steel to the electrolyte, though, in accordance with literature data on instability constants, its formation is possible. Thus, it can be assumed that the inhibition of the contact exchange reaction is due not only and not so much to the binding of copper into a complex ion but also to the adsorption processes on the steel surface involving the organophosphorus ligand.

This work deals with a study on the mechanism of inhibition of the contact reduction of copper on the surface of steel in solutions containing components of cyanide-free electrolyte bronzing.

2. Experimental

Experiments were carried out at solutions listed below

Solution 1. ATMP 0,25M, pH 10

Solution 2. ATMP 0,25M + CuSO₄·5H₂O 0,11M, pH 10

Experiments were carried out at solution temperatures of 20 and 55°C. The measurements were carried out in solutions without stirring or with stirring with a magnetic stirrer at 700 rpm.

Polarization and impedance measurements were performed using an IPC-Pro MF potentiostatic complex with an FRA-2 unit (Russia). The measurements were carried out using a temperature-controlled three-electrode cell with a volume of 250 ml. A silver chloride electrode was used as the reference electrode, and a platinum anode with an area of 3 cm² served as the auxiliary electrode.

To measure the currentless potential of the electrode, we used an IPC-Recorder (Russia) that allows one to record the potential variation over time. The measurements were carried out for at least 5 minutes until a constant potential was attained.

The frequency dependences of the impedance were obtained in potentiostatic mode at the open circuit potentials, with superposition of a harmonic signal with an amplitude of 10 mV in the frequency range of 20 kHz - 0.13 Hz. The impedance spectra obtained were processed and equivalent circuits that adequately reflect the experimental plots were simulated using the ZMonitor and DCS

programs.¹ Each measurement was carried out at least in duplicate.

3. Results and Discussion

The electrochemical impedance spectroscopy method is widely used to study the interface processes in electrochemical systems. The advantage of this method is not only that it allows one to estimate the corrosion resistance of a metal under the effect of various factors but also that information about the mechanism of reactions occurring on the metal being studied can be obtained.

Figure 1 shows the Nyquist diagrams obtained in the solutions studied. The lowest rate of corrosion processes and the greatest hindrance of charge transfer across the interface are observed in the cold solution in the absence of stirring (Figure 1A, curve 1).

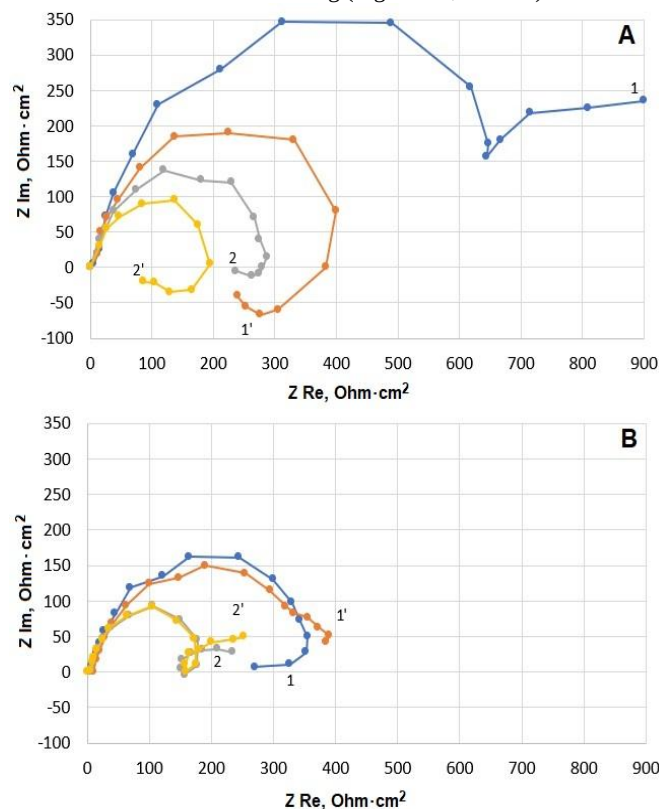


Figure 1. Nyquist plots. A - solution 1; B - solution 2; 1, 1' – 20°C; 2, 2' – 55°C; 1, 2 - without stirring; 1', 2' - with stirring.

According to the Pourbaix diagrams (Fig. 2), at about pH 10 iron dissolves either to give the Fe²⁺ ion (Fig. 2A) or the FeOH⁺ ion (Fig. 2B).

Under conditions of corrosion with oxygen depolarization in an alkaline medium, the near-electrode layer can be alkalinized by the reaction $O_2 + 2H_2O + 4e \rightarrow 4OH^-$ (1). Alkalinization can give rise to the formation of iron hydroxide films on a steel surface. The formation of a new non-conductive phase on the electrode surface causes an increase in the polarization resistance in the low-frequency part of the plot, which is consistent with the appearance

¹The **ZMonitor** and **Dummy Circuits Solver** programs were designed by V.E. Kasatkin specifically for use in combination with the IPC-FRA electrochemical complex.

of a second semicircle on the hodograph in the low-frequency region (Figure 1A, curve 1).

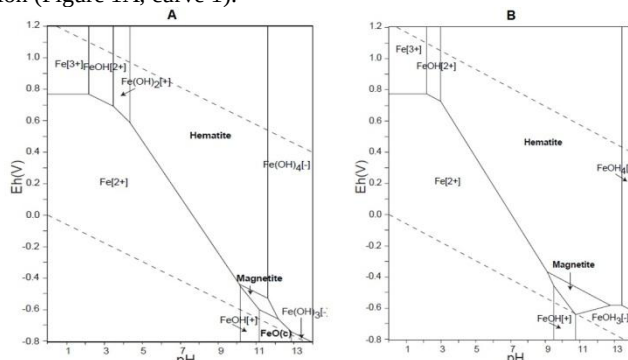
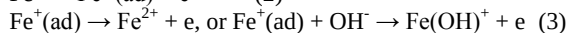
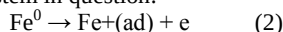


Figure 2. Pourbaix diagrams of the Fe-O-H system.

In accordance with the assumption that the charge transfer is hindered due to the accumulation of steel corrosion products in the near-electrode layer, stirring results in an increase in the charge transfer rate, as the decrease in the hodograph radius indicates (Figure 1A, curve 1'). This is due to the removal of dissolved iron into the solution depth and easier formation of iron-ATMP complexes. It should be noted that a distinct pseudo-inductive loop is formed in the low-frequency region of the hodograph obtained in the stirred solution. It is known from literature that this loop is associated with electrochemical processes that occur via intermediate stages and with the existence of an adsorption equilibrium of the products of these reactions on the electrode surface [7]. For example, the following stages are possible in the system in question:

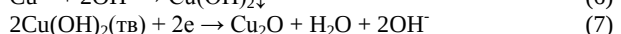
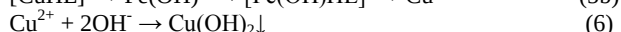
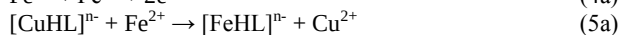
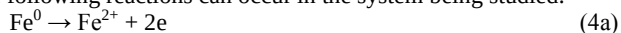


With stirring, i.e., under conditions of intense removal of hydroxide ions formed by reaction (1) from the surface, the adsorbed intermediate corrosion products ($\text{Fe}^+(\text{ad})$) do not form passivating hydroxide films, unlike in the unstirred solutions.

The nature of the hodographs obtained with heating (Figure 1A, curves 2, 2') is completely identical to that of the hodograph obtained in the cold stirred solution, but heating the solution facilitates charge transfer and increases the corrosion rate of steel to a greater extent than stirring. Stirring the hot solution intensifies the described processes even more, as indicated by a decrease in the radius of the hodograph loop (Figure 1A, curve 2').

The addition of copper ions to the solution significantly affects the impedance hodographs (Figure 1B). First, the presence of copper in the solution significantly reduces the radius of the hodograph arc, which indicates that the corrosion processes in the system accelerate. This acceleration is more significant in the hot solution (Figure 1B, curves 2, 2'). It should be noted that in the presence of copper ions, stirring nearly ceases to have a noticeable effect on the hodographs. This fact can be explained by the absence of diffusion limitations on copper ions in the solution. The main differences in the behavior of the system at different temperatures in the presence of copper ions are observed in the low-frequency region. Pseudo-inductive loops are observed on the hodographs obtained in the cold solution (Figure 1B, curves 1, 1'), indicating that adsorption layers are formed on the steel surface. In the hot solution, low-frequency loops are transformed to a so-called unresolved second semicircle, like in a cold solution without stirring (Figure 1A, curve 1), which may indicate that the nature of conductivity changes and stable passive films are formed on the electrode surface.

The observed phenomena can be explained considering the concepts developed elsewhere [6, 8]. According to these concepts, the following reactions can occur in the system being studied:



The mechanism of formation of adsorption layers described by Eqs. (4) - (7) is supported by the results of XPS analysis of the surface layer of a steel sample kept for some time in solution 2 at 55°C that confirm the presence of mono- and bivalent copper compounds on the sample surface.

In addition to mono- and bivalent copper compounds, XPS spectra show that oxidized forms of iron, phosphorus, and potassium are present on the surface. This indicates that ligand molecules and iron dissolution products are also involved in the formation of passive films.

The results of elemental analysis are shown in Table 1.

Table 1: XPS analysis results

Element	Content, at. %
Carbon	62.19
Oxygen	27.43
Nitrogen	3.33
Phosphorus	0.77
Iron	4.08
Copper	1.48
Potassium	0.73

Conclusions

1. It has been found that the inhibition of copper contact deposition is due to the formation of passivating adsorption films on the steel surface.

2. It has been shown that the formation of passivating layers is due to the electrophilic substitution of copper ions by iron ions formed upon steel corrosion in an ATMP solution.

3. It has been found that the passivating layers comprise compounds of mono- and divalent copper, iron, phosphorus, and potassium.

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SQL vs NoSQL databases from developer point of view

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Abstract: Application developers mostly must choose between two main categories of the database: SQL (Structured Query Language) and NoSQL (Not Only SQL) to build their solutions. SQL databases, also known as relational databases, have been in use for a very long time and despite their age, SQL databases remain extremely popular with developers. Six of the top 10 results on DB-Engines' list of most popular DBMS are relational DBs (September 2021). In the meantime, NoSQL databases or non-relational databases, have gained popularity year after year. One of the most widely used NoSQL databases is MongoDB, ranked 5th on DB-Engines' list. In this article, we will explore what are the differences between SQL and NoSQL, and which database to use for application development.

Keywords: SQL Databases, NoSQL Databases, RDMS, Relational, Development

1. Introduction

There are many databases used today in the industry to develop software applications. Some of them are SQL (Structured Query Language) databases and some are NoSQL (Not Only SQL) databases. The conventional database is an SQL database system that uses a tabular relational model to store data and to organize their relationships between tables objects. The NoSQL database concept is the newer one, and those databases provide an architecture for storing and retrieving the data other than the traditional model used in SQL DBMS.

The programming languages and the type of the database are two most important decisions for a developer to develop a system. For the database first important decision is choosing a relational (SQL) database or a non-relational (NoSQL) database, and after that choosing the database engine. While relational databases are mostly used databases, they may not be suitable for large datasets and big data analysis. Big companies like Google, Amazon, etc, usually prefer the NoSQL database systems because they have very large datasets, and they need to implement their solutions on multiple servers and NoSQL are horizontal scalable databases.

However, choosing the type of database to develop a system is harder than it looks, because both the SQL and NoSQL databases have different functionalities and work on different architectures.

Choosing the right database can simplify application development, and a wrong choice can add troubles and difficulties. This article will help you expand your knowledge with an in-depth overview of SQL and NoSQL databases.

2. SQL databases

The SQL language is a programming language for relational databases, and it is an (ANSI) standard [1]. Some RDBMS companies like Oracle or Microsoft have extended this language with the procedural features of programming languages and provided some dialects, like PL/SQL (Oracle Database) and T-SQL (Microsoft SQL Server). The advantage of writing standardized SQL scripts is that we can use the same scripts to another SQL database and obtain the same result in case we have the same structure of the database (same objects included on scripts).

The most popular list of SQL databases includes Oracle, MySQL, Microsoft SQL Server, and PostgreSQL, which are also on the top of DB-Engines Ranking for a long time. Below, we'll describe some of the main features that make SQL so popular for most of the developers.

Organizing the database with a schema has its advantages and disadvantages because knowing the entities and values the application expects is very good, but it's not good with dynamic data scenarios based on end-user requests to our system. Having a schema means we can validate our data based on existing/new records, for example, an ID field on a table must be unique and should not be NULL (empty). We can also use a foreign key relationship between two tables, to keep the integrity of data,

meaning that a record can't reference another record that doesn't exist in the table of the database. A normalized database and validations/constraints used in databases make our data reliable.

With other features, like transactions, indexing, etc, SQL databases are very fast, reliable, and robust.

Most SQL databases are vertically scalable, which means that we can increase the load on a single server by increasing/upgrading hardware components of a server like RAM, HDD/SSD, CPU, etc. Some relational databases like Oracle, MS SQL Server, and DB2 RDBMSs also offer the support of horizontal scaling through Shared disk clusters. But if we have a relationship between records from different tables, we cannot store data on a different partition on different storage hardware because this will decrease the performance dramatically.

3. NoSQL databases

NoSQL databases are non-tabular databases and store data differently than relational databases. A misconception regarding NoSQL databases is that the "No" means no SQL instructions are used in the database, but the "No" is for "NOT ONLY". So, in NoSQL databases may find some SQL instructions/commands.

There are four different categories of NoSQL database:

- Document stores
- Graph databases
- Key-value stores
- Wide-column data stores

Some NoSQL DBMS, such as Cosmos DB, uses different categories, but NoSQL databases typically look very different from each other and are rarely interchangeable between them. One common thing that they generally are that they lose some robustness to have much more speed and scalability.

The "Document stores" type of NoSQL database is the most popular for application development. This type of NoSQL database is very similar to the traditional SQL databases, except there are no tables and relations to define a schema and no data normalization. The columns and rows are replaced by a collection of whatever is inside. Adding or removing a new data field to an existing entity is very easy, but existing entities will remain unchanged, and the changes are for new data. The same entity with different values can be stored multiple times and, the developer must take care of the application side because is very easy to make mistakes for the same entity with different fields.

NoSQL databases are used mostly in environments and conditions with dynamic data and scale, so they are much better compared to SQL databases for dynamism and scalability. Document store type runs on multiple servers, while relational databases are usually configured on a single server architecture or multi-servers using shared storage technology. Since "Document stores" type doesn't implement field validations and constraints

check, they're very fast. The most popular document store databases are MongoDB, Firebase, DynamoDB, Couchbase, and Cosmos DB.

The graphical database is a special type of NoSQL database that is a highly specialized type based on graphs theory. It consists of a set of objects, which can be a node or an edge.[10] The most typical use cases for graphical NoSQL databases are object mapping, social networks, fraud detection, etc. Some social websites, like Facebook, Twitter, or LinkedIn, which shows you friends/followers that your friends/followers know is a good example of those types of databases.

All objects in a graph NoSQL database are nodes, and the relationships between them are as edges. To find all the nodes (friends of friends), we would start with a fixed node and simply browse all the edges from this node. Firstly, we browse the edges of our friends, and then their friends' edges. For example, if we have 200 nodes (friends), and each of those nodes had 100 to 200 of its own nodes (friends), we must browse more than 20,000 nodes. We could go deeper recursively by browsing all edges of those nodes.

In a very big graph database does not take too much time to read all these nodes (friends of friends). A traditional SQL database can get stuck quickly by doing this and in a sample like a social network database it would need to compare millions of records, each with millions of records and so on. The most popular graph databases are Cosmos DB, Neo4j, and ArangoDB.

The key-value store type is the simplest NoSQL database. This type of database uses a key-value method to store data and the key-value store holds collections of key-value pairs where a key serves as a unique identifier. The key and the value can be anything, from a simple to a complex object. The key-value store type is not very widely used, but it can be used in cases such as storing session data. Memcached, Redis, and Cosmos DB are the most popular key-value store NoSQL databases.

The wide-column data store type of NoSQL databases is very similar to the key-value store type. In those types of databases, a key can be used to link many columns instead of having a single value for each key. Wide-column data stores type are very scalable compared to other types and can store up to thousands of Terabytes of data. Their use cases are for big data, like online sales, internet of things (IoT) data, etc. The most popular databases of this type are Bigtable, Cassandra, Cosmos DB, and HBase.

4. Differences between SQL and NoSQL databases

There are many differences between SQL and NoSQL database technologies, and to decide about what might be the best DBMS for our system we must understand very well all the differences. These include main differences in:

- **Language:** The biggest differences between SQL and NoSQL databases is the language used to process data and structure. Relational databases use SQL (Structured Query Language) as a programming language to define the structure of objects and manipulate data. This language is easy to learn, powerful and very useful. SQL is one of the most used programming languages which means it is a better choice, and it can be very useful for complex queries. But on the other side, it can be restrictive because SQL language requires to use of predefined schemas to determine the structure of data before using it. Also, all data must be in the same structure.[2] A change in the structure would be difficult and disruptive to the whole system. A NoSQL database uses a dynamic schema for unstructured data, and the data are organized and stored in many ways using NoSQL database categories like document-oriented, column-oriented, graph-based, or a Key-Value store category.[5] This flexibility helps the software developers store data without having a predefined structure. Also, each

document can have its structure and it can be different for each one, which means it is very easy to upgrade the system without taking care of the existing data.

- **Scalability:** The relational databases are vertically scalable, so we have possibility to change the load on a single server by increasing HW like RAM, CPU, SSD, etc. NoSQL databases are horizontally scalable, so we can process more requests by adding more servers. It is like adding more floors to the same building versus adding more buildings to the neighborhood [9]. Thus, NoSQL can become larger and more powerful, making these databases the preferred choice for large or ever-changing data sets [9].
- **Community:** SQL databases have a much bigger developer community compared to NoSQL databases. There are very many websites/forums available where developers can share their knowledge about SQL language and publish the different solution for the same case. Nowadays NoSQL databases are getting better and better every day, but we cannot say the same for its community, it is not as well defined as relational database's community because it is still relatively new. SQL database vendors offer great support for those databases. Also, a lot of experts certified by RDBMS vendors are there who share their experience with SQL databases for a very large-scale deployment but for some NoSQL databases still must rely on community support and the number of experts is still small for NoSQL databases.
- **Data Structure:** The relational databases are table-based, and it is fixed for all the records on the same table. The NoSQL databases are four types, key-value pairs, document-based, graph databases or wide-column stores. The relational SQL databases a better option compared to non-relational for software that require multi-row transactions such as a data entry application where relationship between data records is important.
- **Performance:** The NoSQL databases are not faster than SQL databases just as the SQL databases are not faster than them. The requests execution speed is depended on the context and not on the type of database. The relational databases are normalized, and the data is stored in logical tables to avoid data duplication and data redundancy. In this case, SQL databases are faster than their NoSQL counterparts for joins, queries, updates, etc. [4]. NoSQL databases are used for unstructured data which can be document-oriented, column-oriented, graph-based, etc.[4]. In this case, a particular data entity is stored together and not partitioned into different objects. So, performing read or write operations on a single data entity is much faster compared to relational databases.

5. SQL databases with dynamic data structure

Sometimes, NoSQL is the only option to choose to develop our system. However, some SQL databases added some NoSQL features while still being relational databases. For example, RDBMS such as Oracle and Microsoft SQL Server offer the possibility to use dynamic datatype like JSON or XML fields. They have the possibility to use indices and SQL queries on those values. Some other databases are a step further, they have the possibility to be horizontally scalable. Snowflake RDBMS is a decentralized SQL database, and it can be hosted in the cloud. This means SQL databases solved the challenge of SQL databases are just vertically and not being scalable horizontally while the uses just SQL statements. Snowflake moved up a whopping 107 spots in the DB-Engines ranking between September 2020 and September 2021, climbing to position 21 (five spots ahead of Cosmos DB). This is an interesting trend for so called NewSQL databases. CockroachDB and Spark SQL are also part of NewSQL databases.

6. How and what to choose

It is hard to choose the right database with all these databases. We often hear, "pick the right tool for the right job.", and the right tool is the tool the developers know better. Developing an application using a database that they do not know very well may impact negatively on the solution, while a well-known one may be sufficient to do the job. Based on what we decide to use a new database, we must ensure the developers must get the training and experience they need for it.

The relational databases are a very good choice for most systems. However, for more specific work, a NoSQL database may be the better choice because it can offer speed or simplicity for the development. For example, the Redis NoSQL database is very useful choice for caching. In case we are looking for a fast and scalable database and have robustness is not so important, MongoDB is the right choice.

Developers usually like try new tech, but what's trend to learn nowadays may be discontinued after a few years. This means, it will be challenging to support a discontinued database engine and replacing it with a new one is usually time consuming and very costly.

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The role of accountants for ethical and sustainable artificial intelligence adoption

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Abstract: *It is considered that artificial intelligence (AI) adoption will considerably amplify in the next decade and impact our lives in all three dimensions – environmental, social and governance. Therefore, deriving sustainable long-term value from AI mass implementation requires organisations to follow an ethical and responsible path. It is considered that accounting professionals will play a significant role in managing this process due to their commitment to ethics and ethical behaviour when performing the assigned tasks within the accounting and finance function. For instance, they might play an important part in complying with regulation and ethics policies, data management, including its quality and confidentiality, as data feeds AI, building understanding of how AI is used in the industry. Moreover, accountants could actively participate in cross-functional teams and efficiently communicate issues related to AI ethics and sustainability. In the light of the challenges from the mass adoption of AI, this paper aims at outlining the perspectives and opportunities towards the accountancy profession in the ethical and sustainable AI implementation in organisations.*

Keywords: ACCOUNTANCY PROFESSION, ARTIFICIAL INTELLIGENCE, ETHICAL AND SUSTAINABLE ADOPTION

1. Introduction

It is considered that artificial intelligence (AI) adoption will considerably amplify in the next decade moving from its laboratory stage towards a mass deployment. A recent survey of ACCA among accountancy and finance professionals reveals that an exponential growth of AI deployment from 12% to 86% is expected over the decade of the 2020s [1]. Therefore, deriving sustainable long-term value from AI mass implementation requires organisations to follow an ethical and responsible path.

It is considered that accounting professionals will play a significant role in managing this process due to their commitment to ethics and ethical behaviour when performing the assigned tasks within the accounting and finance function. They might play an important part in setting tone at the top on AI adoption, exercise professional judgement and challenge greenwashing. Further, accountants could take the lead in complying with regulation and ethics policies, data management, including its quality and confidentiality, as data feeds AI, building understanding of how AI is used in the industry. Moreover, accountants could actively participate in cross-functional teams and efficiently communicate issues related to AI ethics and sustainability [2].

In the light of the challenges from the mass adoption of AI, this paper aims at outlining the perspectives and opportunities towards the accountancy profession in the ethical and sustainable AI implementation in organisations.

2. AI impact on environment, society, and governance

AI adoption will impact our lives in all three dimensions – environmental, social and governance (ESG). Therefore, considering ethical implications for accountancy profession implies analyses in the ESG context.

Environment is one of the drivers of change that shape the sustainable organisation of the future along with economy, society, technology, and workforce [3]. There are few global initiatives in response to the environmental crises that reshape thinking and rearrange priorities. The roadmap for governments and wider stakeholders is the Sustainable Development Goals (SDGs), adopted by the United Nations in 2015. All 17 SDGs are integrated and call for action to “end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity” [4]. In addition, the Ten Principles of the United Nations Global Compact serve as a guideline for organisations to implement SDG agenda as well as to demonstrate their environmental responsibilities and the development and diffusion of environmentally friendly technologies [5]. In March 2021, the 52nd United Nations Statistical Commission adopted the System of Environmental-Economic Accounting (SEEA) – a new statistical framework that integrates economic and environmental data. It is considered a historical

step towards transforming the way nature is viewed and valued. António Guterres, the Secretary-General of the United Nations, affirms that “No longer will we allow mindless environmental destruction to be considered as economic progress” [6]. SEEA unifies standard concepts, definitions, classifications, accounting rules and tables for generating statistics and accounts that are internationally comparable [7].

All those initiatives are shaping the landscape and the main concern when considering the environmental impact of AI adoption is the energy consumption for running algorithms. According to Amodei et al. [8], the computing power used in the training of the largest AI models has been increasing exponentially. It doubles every 3.4 months and outstrips the 2-year doubling period, imposed by the Moore’s law. There are two issues that should be addressed: the massive increase of the data volume, on the one hand and the significant component of unstructured data, on the other. New terms as zettabytes, equal to 10^{21} bytes and yottabytes, equal to 1000 zettabytes, have been introduced as a response to the data explosion. Unstructured data comprises pdfs, video and audio files, emails, social media information, etc. and could provide rich and valuable insights [9]. Marr [10] states that unstructured data is growing at 55-65 percent annually. By the deployment of specifically developed, AI based analytical tools, the inherent meaning, biases, and sentiment could be revealed [11], [12].

With the augmented use of AI across sectors, the electricity consumption, needed for the initial set up of the system and for training the algorithms, amplifies. Furthermore, data centers need additional energy for cooling or other support processes. Therefore, AI deployment has carbon footprint as the production of the energy consumed results in emission of greenhouse gases [13]. An attempt for overcoming this issue is IBM’s initiative for responsible computing. According to Marc Peters, CTO for Energy, Environment & Utilities EMEA at IBM, a holistic approach is needed (fig. 1) [14]. For instance, the responsible code element requires efficiency of algorithms. The idea behind the clean code concept, also supported by ACCA [15], is to optimize code’s quality without high resource consumption.

When analyzing the environmental impact of applying AI, we should also consider how organisations manage and report their footprint on the environment. Unfortunately, misrepresentation and exaggeration of company’s sustainability performance becomes a common unfair practice [16]. The reason for this greenwashing may be the lack of one single global reporting framework of non-financial and ESG reporting [3].

But we should consider AI not only as part of the problem but also as part of the solution. Natural language processing (NLP) might contribute to achieve double materiality – a “guiding principle” in the GRI Standards [17] that was initially proposed by the European Commission in its 2019 Guidelines on Non-Financial Reporting: Supplement on Reporting Climate-related Information [18]. The double materiality concept enhances company’s corporate

reporting by requiring disclosures on the environmental and social impact of its activities. In particular, NLP might be used either for comparing company's reported green credentials with the data in the public domain (facts vs. what is said) and for analysing the industry using a variety of information sources to monitor the consumption patterns of the natural resources.

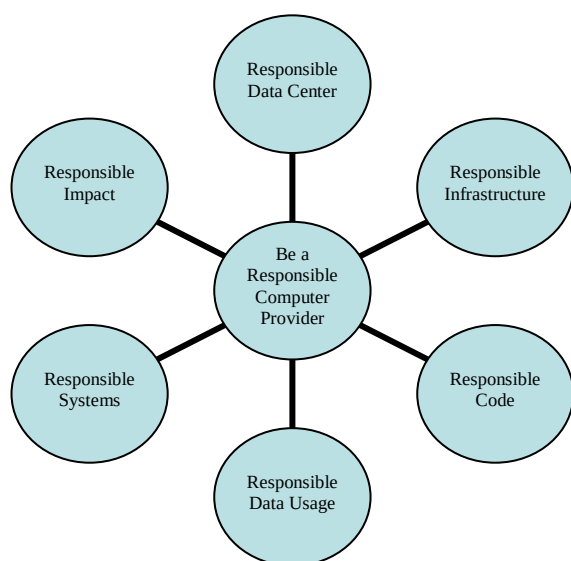


Fig. 1 Responsible computing

Source: [1] p. 13, [14].

Society is the second dimension in the ESG context that is strongly impacted by the AI deployment. We will discuss it by using the approach, applied in the joint survey of ACCA and the Chartered Accountants Australia and New Zealand (CAANZ) [1]. Firstly, the rights of the individuals should be considered. Secondly, the effect on the rights of the employees. An important aspect is also how AI affects the consumer's rights.

The empirical results of the same survey show that 43% of the respondents expect a positive impact of AI on their rights as individuals. Further, 64% of them think that the overall impact of AI on their standard of living will be positive compared to only 11% who define it as negative. But according to the same data source, only 32% of the respondents expect a positive impact on the level of inequality within society compared to 28% who think the effect will be negative. Despite the prevailing number of the AI advocates, we, as a society, should be aware about AI implications on inequality. Rising it within and among countries may cause health damages with a long-lasting or even irreversible effect for many. Some of the survey respondents view AI as a tool that might decrease corruption and increase government revenue, for instance by detecting tax evaders [1]. The right of employees might also be affected by AI deployment. The latter provides both challenges and opportunities. Humans losing their jobs against the machines seems to be only part of the story in the light of the new emerging roles and functions within organization boundaries. Moreover, employees' productivity is expected to increase and the boring activities – to decrease because of the AI impact on jobs and duties. But the future of employment is more complex as the winning strategy implies employees to be opened to the change and to develop new skills and competences to fit the new requirements of the labour market. The psychological aspect of the "AI taking over" matter should also be considered as humans need transparent and straightforward communication about AI disruptive impact on jobs. From the consumer's perspective, there are contradictory views when considering AI mass application that vary case by case. For example, the AI deployment in e-commerce could increase consumer choice but might be also intrusive if revealing some private aspects of the individual. One could also assess as negative

the use of AI tools for detecting human emotions or personality characteristics. Metz described one complicated use case with an insurance company that implemented AI-powered tool when taking decisions on its insurance claims [19]. The tool was used for identifying unexplained factors picked up from customers' video recordings. Though this "dystopian" use of AI was subsequently denied by the company, it raises question on the AI incorrect interference with a negative impact on the consumer's rights. The consumer trust is another aspect that calls for attention and accountants' ethics would play an important role for AI successful implementation by the company.

Governance is probably the most complex area in the ESG discussion, encompassing a variety of aspects, including some ethical and philosophical considerations. The question of whether a robot with a human-like traits would be considered as a piece of property or as an individual, when AI based technologies reveal their full potential, makes the issue even more complicated. The AI impact on human values is also a big concern as algorithms are affected by ideas, cultures, and values. For instance, the "individualism vs. collectivism" dilemma that shapes some culture characteristics of the society, might influence the development of algorithms by the perception of what is right or wrong. The regulatory landscape is another important aspect of the AI and governance discussion. The need of relevant rules and requirements to regulate the use of AI should be considered at least at national level. The summary of the current state of AI regulations is provided in table 1.

Table 1 AI governance around the world

Australia	An AI Action Plan is released in 2021. It sets out a vision for Australia to be a global leader in developing and adopting trusted, secure, and responsible AI.
Brazil	The National artificial intelligence strategy aims at stimulating AI research and innovations with an emphasis on the ethical use of AI technologies.
China	Local AI regulation on AI promotion in Shenzhen.
New Zealand	Looser, principle-based approach is applied to avoid the compliance burden and not to impede innovations.
Singapore	Model AI Governance Framework introduced in 2019 and currently updated.
UK	No AI-specific legislation though AI application is in the government's lens and an overarching legal framework will be developed in the future.
US	National AI Initiative Act became law in January 2021 at federal level. It aims at boosting AI research and application for nation's prosperity and security.
European Union	A risk-based, market-based approach is advocated. A legal framework that ensures the safe use of AI and at the same time facilitating innovation and investment in AI technologies is proposed.

Source: [1] p. 26, [20], [21], [22], [23], [24].

Based on the summary, provided on table 1, we can conclude that there are two applied approaches that shape the national regulatory landscape when referring to AI deployment – a principle-based and a rule-based. We should also note that the regulatory environment is very dynamic as many countries try to encourage AI applications and stimulate their economies but at the same time safeguarding human rights and the safe AI use. In addition, the international coordination is crucial [20] and probably global standards that deal with AI implications are part of the solution. A very significant aspect of the AI regulation is to achieve a balance between innovations and regulations. Regulation should not hinder AI deployment, but it is important to consider the financial and non-

financial aspect of technology application, the level of the required human oversight, the level of automation, etc. Transparency, especially for those whose data power the algorithms, is another important aspect of AI regulation. A good practice of how to cope with this issue is the public register introduced in the cities of Amsterdam and Helsinki. It keeps an updated record of what AI has been applied and how, thus helping the public to understand most of the AI implications, including the government policy. Mechanisms for receiving feedback to assess public attitude towards AI deployment might also contribute for the more transparent AI use.

The ethical considerations of AI deployment also imply a proper tone at the top highlighting the significant role of the management in prioritizing ethics together with company's profits. According to an analysis of several profound data sources, a responsible AI system should agree with at least the following eight guiding principles in terms of the ethics policy: fairness, accountability, sustainability related to the long-term impact on people and planet, transparency on the AI use and the AI-based decision making, human oversight over AI-based technologies deployment, ethical use of data, safety and robustness regarding functioning of the AI systems, and compliancy with the applicable standards and law [1], [18], [20], [21], [22], [23], [25].

The ethical and sustainable AI adoption requires the management to consider where AI might add value for the organisation. A focal point for the AI deployment decision should be the long-term results rather than just following the industry trend. AI adoption needs a strategic approach and would vary by business case. All the risks, benefits, and costs for the company, associated with the AI implementation, should be considered. Accountants and other professionals in the finance function are expected to play a significant role in performing the cost-benefit analyses as well as in assessing the long-term value for the business.

3. Ethical implications for accounting professionals of AI deployment in the ESG context

The ethical implications for accountants of AI adoption will be reviewed separately for each of the ESG segments based on the empirical results of the ACCA & CAANZ study [1]. When considering the environment dimension, two basic assumptions should guide their role in the ethical and responsible AI deployment. First, accounting experts may apply their professional competence and due care when engaging vendors to assess the impact on environment. Second, they might contribute for more objectivity in presenting company's green credential and thus overcoming the negative effects of the greenwashing. Moreover, they might contribute to the ESG reporting requirements compliance and the needed upskill to follow and comply with the new regulations in the area. Lutamyo B. Mtawali, Sustainable Finance Lead at IBM, highlights that accountancy and other finance professionals have a critical role in AI adoption from the financial reporting perspective. They are responsible for the complete, accurate and valid financial reporting pertaining to ESG considerations. Furthermore, they must ensure compliance with the relevant regulatory frameworks and standards on ESG, sustainability and/or climate [1], p. 17.

When considering the social implications for ethical AI adoption, there is a public interest obligation for accountants to under-represented and vulnerable groups. Avoidance of "participation washing" [26], for instance, may require accountancy professionals to inform and collaborate with outside parties. In addition, when considering the rights of employees, integrity is essential in communicating the AI impact in straightforward way. Confidentiality of customer data as well as integrity when communicating the AI use in a transparent manner are also ethical implications of AI adoption.

The ethical considerations for accountancy profession in regard of the governance dimension in the ESG agenda are numerous and more complicated compared to those already discussed. They are summarised in table 2.

Table 2 Ethical implications for accountants of AI deployment in the governance segment of the ESG agenda

➤ Professional judgement is required when dealing with specific AI situations. It can not be replaced by a compliance-based checklist.
➤ Professional standards to ensure compliance with AI evolving regulations should be developed and applied.
➤ Professional competence and due care obligation exists for responsible AI deployment and top-down leadership approach should be applied within the organisation.
➤ Professional compliance with the AI ethics policy of the organisation is required.
➤ Objectivity is needed in the assessment of AI application costs and values in the long term.
➤ Professional competence and due care obligation exists for enabling oversight and delivery mechanisms.
➤ Professional competence and due care are needed to ensure sufficient AI knowledge to engage with and interrogate AI vendor offer in the context of the business need.
➤ Professional competence and due care are essential in applying control and monitoring mechanisms
➤ Confidentiality and professional standards are needed for the efficient data management (data minimisation, data confidentiality and data quality) in compliant manner.
➤ Professional competence and due care are essential for understanding what the AI system is doing. Integrity in not outsourcing accountability to the algorithm.
➤ Professional competence and due care obligation exists for setting up mechanisms for protection and redress in case of AI system failure.
➤ Professional competence related obligation exists for continuous learning and development.

Source: [1] p. 10, pp. 24-37.

Based on the summary of ethics implication for accountants, provided in table 2, we might conclude that accountants are challenged by the implementation of AI-based technologies and have to develop the needed professional knowledge and competences for AI ethical adoption.

4. Conclusion

AI-based technologies impact organisations and challenge business leaders in many aspects. Ethics considerations are now on focus as the technology evolves and the management should handle a variety of ethics related situations for the first time. As the accountancy profession is deeply grounded on the fundamental ethics principles [27], it can rely on this when embracing the challenges of AI ethical and responsible adoption. Accountants might play a significant role in the transition to greener economies, sustainable environments, and equitable societies. The profession continues to change and overcoming the ethics implications of AI deployment requires accountants to continuously enhance and level up their skill set.

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Effect of Using Rock Wool on Mechanical and Physical Properties of Oriented Strandboard (OSB)

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Abstract: In this study, the effect of using different ratios of rock wool on the mechanical and physical properties of OSB (Oriented strandboard) boards, according to the place of use and properties of OSB. For this purpose, 18 mm x1220 mm x2440 mm (control, A1, A2, A3) at a density of 600 kg/m³ using rock wool in three different (10-20-30%) ratios, in proportion to the weight of the middle layer of the chipboard obtained from 100% maritime pine (*Pinus maritima*) wood. OSB/2 test boards were produced. OSB/2 test boards obtained as a result of using different proportions of rock wool were tested according to the relevant standards. According to the test results, when the mechanical and physical properties (tensile strength in the vertical direction, bending resistance, modulus of elasticity, swelling properties and free formaldehyde values) are compared with the control board, it has been determined that 10-20% rock wool can be used in the production of OSB/2 boards to be used as insulation board. Accordingly, rock wool reinforced composite OSB boards can be preferred as insulation boards in the wood panel industry.

KEYWORDS: ORIENTED STRANDBOARD, ROCK WOOL, MECHANICAL AND PHYSICAL PROPERTIES.

1. Introduction

The oriented strand board (OSB) market size was estimated at over 31 million cubic meters in 2021, and the market is projected to register a CAGR (The compound annual growth rate of more than 4% during the forecast period (2022-2027) [1]. Roughly 95% of OSB produced in North America goes to the construction industry. In Europe, about 50% of OSB is consumed for residential buildings [2]. OSB is widely used as a structural wood panel for floors (including subfloors and underlays), walls and ceilings. It is used for interior fittings, furniture, shuttering and packaging and also in the manufacture of I-joists, where it forms the web or support between two flanges of solid wood. The world capacity for OSB rose from less than 2 million m³ (1996) to approximately 44 million m³ in 2017 (Wood Based Panels International 2019). According to EN 300 (2006), four quality types of OSB are manufactured. OSB/3 represents the majority of European OSB production, accounting for approximately 85%, followed by OSB/2 with 10%, and OSB/4 with 5% [3]. The properties of these OSB types are different and should meet the standard requirements. There are many parameters that affect the panel properties, such as raw material species, strands dimensions and quality, panel structure, resin type and receipt, pressure schedule, etc. The OSB properties are directly related to the natural strength properties of the wood raw material used, which is not homogeneous. OSB production in different regions is presented in Figure 1 [3].

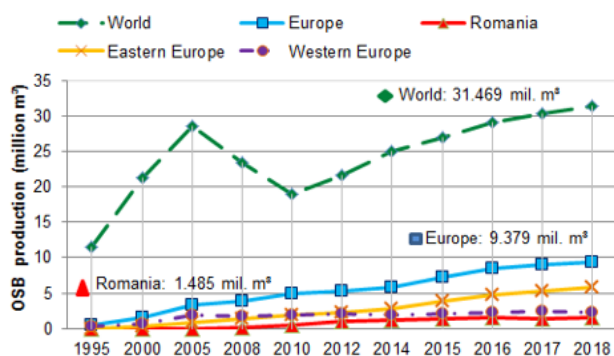


Figure 1. OSB production in different regions [3].

OSB is a widely used in building industry as sheathing and subflooring applications. OSB is intended for dry use applications and can swell substantially if the panels are exposed

to moisture during construction or in service. OSB can replace plyvwood in most applications. OSB is an important structural panel in the world of industrial wood products in terms of growth and performance. OSB was actually evolved from the waferboard, manufactured from square wafers.

Four grades of OSB are defined in EN 300 in terms of their mechanical performance and relative resistance to moisture. These are:

OSB/1 – General purpose boards and boards for interior fitments (including furniture) for use in dry conditions.

OSB/2 – Load-bearing boards for use in dry conditions.

OSB/3 – Load-bearing boards for use in humid conditions

OSB/4 – Heavy-duty load-bearing boards for use in humid conditions.

OSB production compared to plywood, particleboard, and MDF in UNECE region is presented in Figure 2 [4].

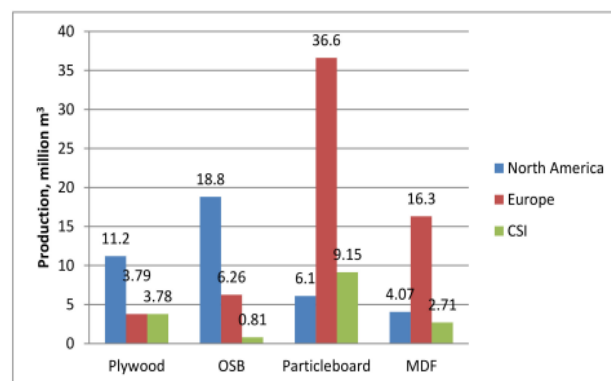


Figure 2. OSB production compared to plywood, particleboard, and MDF in UNECE region [4].

Mineral wool is the most common thermal insulation material used in light weight composites, and it is often placed between steel studs. Mineral wool is commonly utilised on the structure's external walls and slab elements, but it is also employed within inner partitions and floors. It offers additional fire resistance to LSF elements since it is an incombustible material [5].

In this study, it was aimed to understand physical and mechanical properties of OSBs, which were used as a multi-purpose carrier material in the wood panel industry, especially in the construction industry, were used in the production of OSB in different proportions, by using rock wool in different proportions.

2. Materials and methods

2.1. Materials

Maritime pine (*Pinus maritima*) wood was used as raw material in the production of test plates. The strands of 0.6-0.7 mm thickness, 10-30 mm width and 100-120 mm length were obtained from round woods by mechanically chipping. The obtained chips were dried in dryer tubes with a humidity of 3% between 3-3.5 minutes. For the mat forming process, the chipboard was prepared in the 50x50 mm prepared laying vessel/trough. As an adhesive, 60% of 1.28 kg/m³ urea formaldehyde (UF) E2 glue was used, 9% of the total dry fiber weight. As a hardener, 1.1 kg/m³ (NH₄)₂SO₄ ammonium sulfate of 20% was used in the glue at the rates of core layer: 3%, surface layer: 1%. In the hot pressing process, the mats were hot pressed at 185-190 °C and 2.5 N/mm² pressure for 5 minutes with a final thickness of 18 mm. The test methods are given in Table 1.

Table 1. Test methods used in the experiments.

Tests	Specimen size (mm)	Standard no	The requirement
Internal bond strength	50x50	TS EN 319	$\geq 0,30 \text{ N/mm}^2$
Bending strength	50x410	TS EN 310	$\geq 10 \text{ N/mm}^2$
Bending modulus	50x410	TS EN 310	$\geq 1400 \text{ N/mm}^2$
Thickness swelling	50x50	TS EN 317	20%
Free formaldehyde	2,5x2,5	TS EN 120	$\leq 8,0 - \leq 12$

The resulting OSB specimens with rockwool are presented in Figure 4.



Figure 4. OSB strands

2.2. Methods

Physical and mechanical properties of the OSB panels were determined according to European Norms (EN). One day thickness swelling (TS) test were performed on the ten specimens with dimensions of 50 mm x 50 mm according to the EN 317 standard (1993). The bending strength (MOR) and bending modulus (MOE) of the 10 OSB specimens with dimensions of 50 mm x 410 mm, (the average of 5 // and 5 ⊥ to the OSB surface) were tested according to the EN 310 standard (1993). The internal bond (IB) strength was determined on the ten specimens with dimensions of 50 mm x 50 mm according to the EN 319 (1993). The Free-formaldehyde emission of the specimens was determined according to the EN 120 standard.



Figure 3. Hot pressing of OSB mat.

3. Results and discussion

The average density of the test specimens produced with 18 mm thickness using maritime pine (*Pinus maritima*) wood was determined as 0.590 g/cm³. The mean and standard deviation values of the mechanical and physical properties of the test boards obtained by using different proportions of rock wool in the middle layer in OSB/2 production are shown in Table 2.

Bending strength and bending modulus of the OSB specimens decreased with increasing rockwool content. The bending strength of the OSB specimens with 10 wt% rockwool content was found to be the same with the control OSB while the OSBs with 20% and 30% rockwool. As compared to the control OSB, The internal bond strength decreased with increasing content of the rockwool. This result showed that the bond performance between the wood strands and rockwool was negatively affected by the rockwool content. The thickness swelling of the OSB specimens decreased when the rockwool content increased to 20 wt%, while further increment in the rockwool content increased the thickness swelling. Formaldehyde emission of the specimens considerably increased with increasing content of the rockwool (Table 2).

Table 2. Physical and mechanical properties of the OSB specimens

Test method	Control OSB	Core layer with 10% rockwool	Core layer with 20% rockwool	Core layer with 30% rockwool
Bending strength (N/mm ²)	12.93 (± 0.52)	12.97 (± 1.53)	11.46 (± 0.64)	10.78 (± 1,20)
Bending modulus (N/mm ²)	2403 (± 224.05)	2193 (±152)	1997 (± 197)	1755 (± 178)
Internal bond strength (N/mm ²)	0.35 (± 0.02)	0.32 (± 0.06)	0.28 (± 0.04)	0.22 (± 0.01)
Thickness swell (%) 24 h	15.12 (± 2.09)	13.92 (± 1.08)	14.48 (± 1.73)	21.41 (± 1.23)
Free formaldehyde emission (mg/100 g specimen)	13.25	12.18	9.04	9.59

4. Conclusions

The results of the present study showed that the thickness swelling and free-formaldehyde emission of the OSB specimens decreased with increasing rockwool content. The bending modulus of the specimens considerably decreased with increasing rockwool content while the 10 wt% addition of the rockwool content did not decrease the bending strength. Based on the test results, it was concluded that 10 wt% of rockwool can be used in the production of OSB without decreasing physical and mechanical properties.

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Social media behaviours of Gen Z women in the context of social Customer Relationship Management

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Abstract: Building relationships with Generation Z on social media is becoming a challenge for present-day enterprises. Generation Z has a huge purchasing power, and will be the largest customer base by 2030. The aim of the paper is to identify social media behaviours of Gen Z females in the context of social CRM. The study of social media behaviours of Generation Z is part of wider research conducted by the authors among students in Poland and Great Britain in 2020/2021. The study used survey as the method and CATI as the surveying technique. For data analysis, measures of descriptive statistics were used. In both the countries, women most often used Facebook, YouTube and Instagram. Out of the benefits of using social media accounts, the following ones were rated highest by female Gen Zers in Poland: swift communication, opportunity to find and follow friends, sharing information with friends and opportunity to acquire information about products/services of a given company, whereas in the case of females in Great Britain, the following benefits were rated highest: swift communication, following the Internet trends and sharing information with friends. The majority of the surveyed women in Great Britain and in Poland often or almost always search for social media accounts of a specific company before using its service / purchasing its product. Polish women would preferably communicate with a company via Messenger, chat with a consultant and fan page, whereas British women would do so via e-mail, Messenger and chat with a consultant. The results of the research conducted in Poland and Great Britain in 2020/2021 did not show clearly whether female Gen Zers could be described as loyal customers. The respondents in Great Britain defended a company's reputation on social media more often than the respondents in Poland.

Keywords: CUSTOMER RELATIONSHIP MANAGEMENT, SOCIAL CUSTOMER RELATIONSHIP MANAGEMENT, ENTERPRISE, SOCIAL MEDIA, WOMEN, GENERATION Z, MARKETING STRATEGY

1. Introduction

Gen Zers, who have a huge purchasing power, are a very important partner of the market game for modern enterprises, as they account for around 40% of consumers in the United States, Europe and BRICS countries, and around 10% of consumers in the remaining countries. Enterprises that do not want to lose their market shares must learn about Gen Zers and make them part of their business strategy by building long-lasting relations with them [1].

Gen Zers differ significantly from the representatives of other generations, i.e. Baby boomers, Generation X and Millennials (Gen Y), as they have different characteristics and expectations. Generational differences are often presented in the literature and the media in an unsubstantiated way [2]. As a result, without clear information about generations, managers do not understand generational differences and, consequently, do not manage them properly [3]. Identification of the characteristics of a given generation is highly significant in building enterprise-customer relationships. At the time of competition at the click of a mouse, the ability to build relations with customers is perceived as a very important source of the competitive advantage of enterprises [4, 5, 6, 7].

An important factor in building enterprise-customer relationships is the customer's gender, which determines communication. The existing research shows an impact of gender on various marketing analyses, e.g. research into persuasion [8], research into segmentation [9], information processing [10], gender role stereotypes [11], advertisement effectiveness [12] and purchasing decisions [13, 14]. Each generation has distinct characteristics, and it should be divided into subgroups of clearly distinct female and male types [13].

The dynamic development of the Internet and social media facilitates entrepreneurs' communication with potential and existing customers, which – if effectively designed and executed – may contribute to the maintenance of long-lasting relations with customers and, ultimately, the strengthening of the enterprise's competitive position on the market. Hence, entrepreneurs increasingly use the concept of Customer Relationship Management (CRM), which is a critical success factor impacting the business results of enterprises [15, 16, 17, 18, 19]. A condition for an effective use of CRM is sound knowledge about customers, based on which a manager will know where to find them on social media and what benefits and ways of communication they expect.

Such information will enable enterprises to respond to customer expectations, which is the first step towards building long-term relations with them.

The aim of the paper is to identify the behaviours of female Gen Zers on social media in the context of CRM. For that purpose, the authors examined what portals the surveyed females used most frequently, how they assessed the benefits of having a social media account, whether they searched for information about a product/service on social media before purchasing it, and whether they considered themselves loyal customers.

2. Literature review

There is no clear definition of CRM in the research literature, which is due to the fact that this concept can be looked at from different perspectives – CRM can be treated as a process, strategy, philosophy, capacity (potential) of an organisation or technology [20]. Solima presented the concept of CRM captured from different perspectives: (1) as a process, (2) as a strategy, (3) as a philosophy, (4) as an ability, (5) as a technology [21]. Often, the concept of CRM is defined in terms of a few perspectives simultaneously. According to Bose CRM is “an integration of technologies and business processes used to satisfy the needs of a customer during any given interaction. More specifically, CRM involves acquisition, analysis and use of knowledge about customers to sell more goods or services and to do it more efficiently” [22, p. 89]. According to Parvatiyar and Sheth CRM “is a comprehensive strategy and process of acquiring, retaining, and partnering with selective customers to create superior value for the company and the customer. It involves the integration of marketing, sales, customer service, and the supply-chain functions of the organization to achieve greater efficiencies and effectiveness in delivering customer value” [23, p. 5]. The essence of CRM was aptly defined by Greenberg “CRM is a philosophy and a business strategy supported by a system and a technology designed to improve human interactions in a business environment” [24, p. 30].

It helps to understand the behaviours of customers through an intense communication with them [25]. CRM helps firm to predict the future behavior of customers and to scope the implementing of policies from a future perspective and also helps firms to streamline the existing setup of the organizations by guiding some fundamental changes that are required for competitive advantages [26]. The authors of the study take the position that CRM does not exclude any of the above-listed perspectives, but it combines them. CRM is a strategy, a philosophy and a process of acquiring, analysing and

using customer knowledge to boost sales, and at the same time an organisation's capacity to implement this strategy, philosophy, and process in a conducive organisational culture and using appropriate technologies. The main aim of CRM is to build and maintain long-lasting relations with customers based on trust and loyalty, which lead to product and service sale that remains at a high level or/and shows an increasing trend, which results in the achievement of competitive advantage and increase in the organisation's market value. CRM stands for the ability of an organization to [25, p. 16]: „1. find customers; 2. get to know them; 3. keep in communication with them; 4. ensure that they get what they want from the organization – not just in the product but in every aspect of the organization's dealings with them; 5. check that they receive what they were promised – subject, of course, to it being profitable; 6. ensure that the customer is retained – even if the customer is unprofitable today, the goal is long-term profitability”.

The development of social media contributed to the evolution of the concept of CRM and emergence of the concept of social CRM. According to Thompson, social CRM is combination of social media and the concept of CRM [27]. Greenberg stresses that social CRM is an extension of CRM, not its substitute, and defines social CRM as an extended CRM – “Social CRM is a philosophy & a business strategy, supported by a technology platform, business rules, workflow, processes & social characteristics, designed to engage the customer in a collaborative conversation in order to provide mutually beneficial value in a trusted & transparent business environment. It's the company's programmatic response to the customer's control of the conversation” [28].

The basic difference between CRM and social CRM is that CRM assumes one-way communication between the customer and the enterprise, which is usually initiated by the enterprise. This type of communication is insufficient to build relations, as it marginalises the significance of customer expectations. The concept of social CRM, in contrast, offers two-way communication.

Social media is the environment where entrepreneurs should look for Generation Z customers in order to establish contact and build relations with them. Scholars stress that when studying a generation, one should take into account its heterogeneity, which necessitates examination of specific segments in each generation [29, 30, 31]. The object of the study presented in this paper is the behaviour of females – students – on social media. Knowledge about where female Gen Z customers can be most often found on social media, what benefits they expect in their relations with enterprises and what ways of communication would be best-suited to them will allow entrepreneurs to propose a personalised, and thus effective communication, which is the basis of social CRM.

In keeping with the views of Kavounis [32], Francis and Hoefel [33], Bassiouni and Hackley [34], Kamenidou et al. [35], Priporas et al. [36], Hampton and Keys [37], the authors assumed for the purpose of the research that the term Generation Z means a generation of people born in the years 1995-2009 (2010 is the first year of birth of Generation Alpha [38]).

Based on the existing research results, one can characterise Gen Zers as: responsible, loyal, cautious, compassionate, open, determined [39], realistic, creative, hyper-connected, open to sharing with other people via mobile devices and social media their good and bad experiences resulting from the customer-company relationship, and preferring contact via technology to face-to-face interaction [40]. Generation Z is the most diverse generation of all [41], which makes it open to ethnic diversity [42].

Gender, a key variable in segmentation and marketing research, determines differences in the behaviours of males and females during online shopping, communication and relationship management on the Internet. In particular, it is believed that females are relation-oriented, while males are agentic; females show preferences for maintaining family ties, connecting with friends and engaging in social activities, while males are more focused on task-oriented activities [43]. Research shows that females and males

show different approaches and preferences when using various information systems [44]. Research concentrated around identifying gender differences in overall effectiveness of marketing strategies revealed distinctly different convictions, attitudes and behavioural intentions [12]. Males and females differ in how they perform various activities on the Internet connected with communicating with others, watching photos and films, following people or events, posting or sharing information, playing online games, and reading and sharing with others promotional information [45]. For instance, males and females become loyal in their behaviours for different reasons [46].

Like in the case of other psychological phenomena, gender and age are among variables impacting purchasing decisions, which allow for identification of individual differences. Females are more susceptible to the impact of the environment; they search for more information and dedicate to it more time in the decision making process [47]. An enterprise seeking to build relations with customers on social media needs to know not only where to search for customers, but also what benefits are expected by social media account users and what forms of enterprise-customer communication are most desirable. Therefore, we formally pose the following research questions:

- RQ1. What social networking sites do female Gen Zers use most often?
- RQ2. What benefits do female Gen Zers expect when using social media portals?
- RQ3. What way of enterprise-customer communication would be the most suitable according to female Gen Zers?
- RQ4. Do female Gen Zers assess themselves as loyal customers?
- RQ5. Do female Gen Zers defend an enterprise's reputation on social media?

3. Research methodology

The research into the attitudes of Gen Zers towards brands on social media is part of broader research conducted by the authors among students in Poland and Great Britain in the fourth quarter of 2020 and the first quarter of 2021. In both the cases, which included qualitative and quantitative aspects, the method of indirect measurement in the form of survey research, the technique of a survey, and the research tool of a survey questionnaire were used. The catalogue of the variables used in the research was proposed based on critical analysis of the literature [48, 49]. There is no agreement in the literature regarding the year of birth of representatives of Generation Z. The most often cited date is the year 1995, which the authors of the paper adopted as the cut-off year in their study.

The authors also assumed that the independent variable is the tested group of respondents, not the entire population of generation Z. The difficulty in unequivocally indicating the age range of generation Z makes it problematic to treat this variable as an independent variable. The authors found that using Gen Z as a heuristic is useful because generational profiling now exists as description in popular media and popular culture.

Before commencing the main research, the authors conducted a pilot study in 2018, which allowed them to identify and eliminate errors in the survey questionnaire before proceeding to the main research. A total of 157 students participated in the research conducted in Poland, and responses of 151 students (126 females and 25 males) were qualified for the analysis. A total of 150 students participated in the research conducted in Great Britain, and responses of 150 people (80 females and 70 males) were qualified for further research. The research was conducted using the CAWI technique. In Poland, an online survey questionnaire was made available on the Webankieta.pl platform, while data collection in Great Britain was commissioned to an external institution specialising in conducting surveys. The sampling for both studies was non-probabilistic. Using non-probabilistic selection, the authors also applied statistical inference, treating it only as an opportunity

to identify relationships in the studied groups, which descriptive statistics does not allow. It is also important to stress the high degree of feminisation of the group of the Polish students qualified for the research, which impacted the gender structure of the respondents.

Based on the research results, the authors calculated the number and frequency of the respondents' responses to the individual questions on the survey. The authors are aware that the applied sampling technique does not allow the researcher to estimate the error appearing when generalizing the regularities observed in the sample to the entire population. All the analyses were conducted using software Statistica v.13.

The authors are aware that survey research has limitations such as providing merely superficial understanding of the phenomena being studied or inaccurate answers given by respondents. Criticism of the presented research results may be that the research was conducted on a small group of participants. Small samples may be methodologically questionable (e.g., generalisation is difficult), but they can be useful in inference if proper statistical tests are used [50].

4. Results

All the surveyed Gen Zers in Poland and Great Britain reported using social networking portals. Figures 1 and 2 present responses (in %) to multiple choice questions about which social networking portals were used by the respondents (by gender) in 2020/2021.

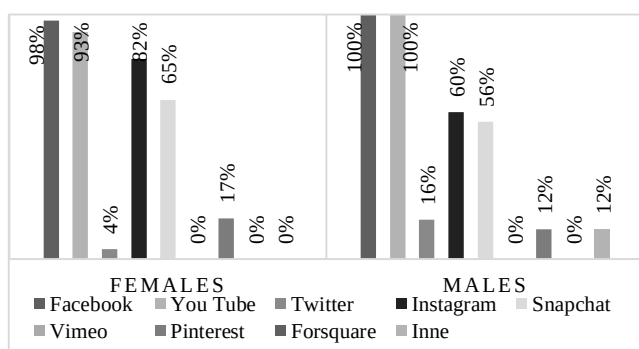


Fig. 1. Use of social networking portals by respondents (by gender) in Poland in 2020/2021.

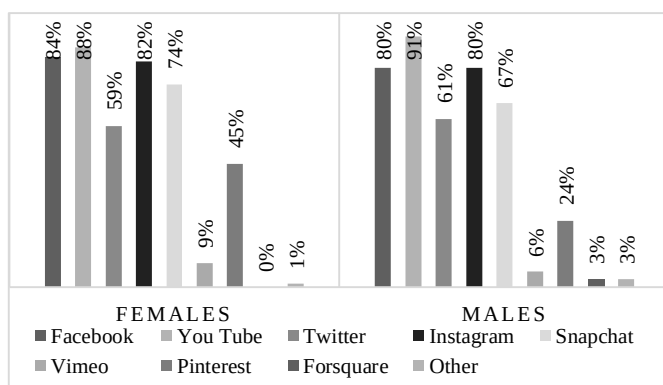


Fig. 2. Use of social networking portals by respondents (by gender) in Great Britain in 2020/2021.

The collected data showed the most popular social networking portals in the examined groups of female respondents in 2020/2021. In both the countries, the surveyed females most often indicated Facebook, YouTube and Instagram, but the popularity of these three portals differed between the analysed countries. Huge differences between the female respondents in Poland and those in Great Britain were also observed in the use of Twitter (55 percentage points) and Pinterest (28 percentage points). The women in Poland did not specify any portal in the category "other", whereas those in Great Britain indicated TikTok (1 woman).

The next stage of the research was finding out which benefits of the use of social media accounts by female Gen Zers were significant in both the analysed countries. The respondents were presented with a catalogue of benefits (along with the possibility of indicating benefits other than those mentioned in the question) and asked to rate each of them on a scale of 1 to 5, where 1 signified the least significant benefit, and 5 – the most significant one (Tables 1 and 2).

Table 1: Assessment of the benefits of the use of social media accounts by female respondents in Poland in 2020/2021.

Benefits of using social networking sites	Evaluation of the benefits (responses in %)				
	1	2	3	4	5
possibility of finding and following friends	0.79	0.79	3.18	33.33	61.91
fast communication	0	1.59	1.59	19.04	77.78
most important information at one place	0	6.36	15.87	50.79	26.98
following trends on the Internet (e.g. interesting video, music)	2.38	5.56	15.08	44.44	32.54
sharing information with friends	0	3.18	8.73	24.6	63.49
possibility of acquiring information about products/services of a particular company	0	3.97	7.94	50.79	37.30
possibility of expressing one's opinions about products/services of a particular company	0.79	13.49	11.11	46.83	27.78
possibility of creating and implementing changes in products/services and the functioning of a company	3.97	20.64	41.27	24.60	9.52
access to numerous web services using one account on a social networking site	0.79	7.14	19.84	38.10	34.13
opportunity to have access to additional materials (in the case of artists' official profiles, TV channels)	0	3.96	15.08	43.65	37.31
finding new friends	3.97	15.08	17.46	35.71	27.78
possibility of self-promotion, being seen	9.52	11.90	18.25	40.49	19.84

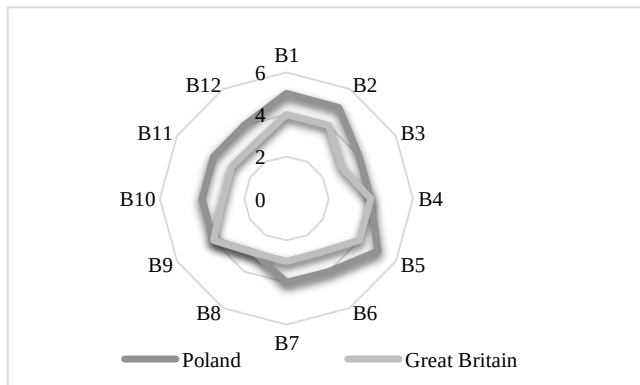
Out of the benefits of using social media accounts, the following ones were rated highest by the female respondents in Poland: swift communication, opportunity to find and follow friends, sharing information with friends and opportunity to acquire information about products/services of a given company. Opportunity to create and make changes to products/services and the functioning of the company was indicated as the least important benefit.

Table 2: Assessment of the benefits of the use of social media accounts by female respondents in Great Britain in 2020/2021.

Benefits of using social networking sites	Evaluation of the benefits (responses in %)				
	1	2	3	4	5
possibility of finding and following friends	6.25	12.50	27.50	33.75	20.00
fast communication	3.75	7.50	11.25	32.50	45.00
most important information at one place	2.50	13.75	35.00	32.50	16.25
following trends on the Internet (e.g. interesting video, music)	6.25	13.75	23.75	40.00	16.25
sharing information with friends	2.50	10.00	21.25	41.25	25.00
possibility of acquiring information about products/services of a particular company	2.50	15.00	35.00	27.50	20.00
possibility of expressing one's opinions about products/services of a particular company	7.50	20.00	26.25	26.25	20.00
possibility of creating and implementing changes in products/services and the functioning of a company	8.75	30.00	25.00	18.75	17.50
access to numerous web services using one account on a social networking site	10.00	13.75	25.00	33.75	17.50
opportunity to have access to additional materials (in the case of artists' official profiles, TV channels)	5.00	15.00	36.25	30.00	13.75
finding new friends	18.75	12.50	27.50	26.25	15.00
possibility of self-promotion, being seen	15.00	18.75	28.75	20.00	17.50

In the case of the study carried out in Great Britain, the following benefits of using social media accounts were rated highest by the respondents: swift communication, following the Internet trends and sharing information with friends. Like in the case of the respondents in Poland, opportunity to create and make changes to products/services and the functioning of the company was indicated as the least important benefit.

In order to compare the responses assessing the benefits of using social media accounts by the surveyed females in Poland and Great Britain, median was used. By calculating the median value for each of the benefits (Figure 3), the middle value was found, i.e. one that splits the number of observations in half (with the same number of observations above and below it) in each study group.



B1 – possibility of finding and following friends; B2 – fast communication; B3 – most important information at one place; B4 – following trends on the Internet (e.g. interesting video, music); B5 – sharing information with friends; B6 – possibility of acquiring information about products/services of a particular company; B7 – possibility of expressing one's opinions about products/services of a particular company; B8 – possibility of creating and implementing changes in products/services and the functioning of a company; B9 – access to numerous web services using one account on a social networking site; B10 – opportunity to have access to additional materials (in the case of artists' official profiles, TV channels); B11 – finding new friends; B12 – possibility of self-promotion, being seen

Fig. 3. Medians of the scores of the benefits of using social media accounts as given by female respondents in Poland and Great Britain in 2020/2021.

Based on the comparison of the medians (Figure 3), it was concluded that the presented benefits were rated higher by the female respondents in Poland compared to those in Great Britain. In the case of the benefits designated as B4, B8 and B9, i.e. following the Internet trends, opportunity to create and make changes to products/services and the functioning of the company, and access to multiple Web services via one social media account, the medians of the scores were identical among the respondents in both the countries.

Other benefits of using a social media account as indicated by female respondents in Poland were as follows:

- possibility of shopping and fast sale of products; forming an opinion about a given product or company,
- finding a job,
- discovering new interests, possibility of personal development, having a specific style,
- gaining popularity, self-promotion,
- following the life of others, observing what is happening in the world,
- time for relaxation and enhancement of mood,
- learning about various events,
- connecting people into groups, possibility of discussing any subjects with other people, more openness to new friendships,
- encouraging others to help, e.g. to adopt a pet.

The respondents in Great Britain, in turn, indicated the following benefits:

- up to date source to look at what's going on the world and to see other peoples opinions,

- being able to connect with people in different timezones,
- keeping in contact with friends from other places,
- learn something new,
- creativity.

The next stage of the research was asking the respondents (through a question based on an ordinal scale) whether they searched for the social media accounts of a specific company before using its service or purchasing its product. Figure 4 presents the collected data (as quantities) in Poland and Great Britain in 2020/2021.

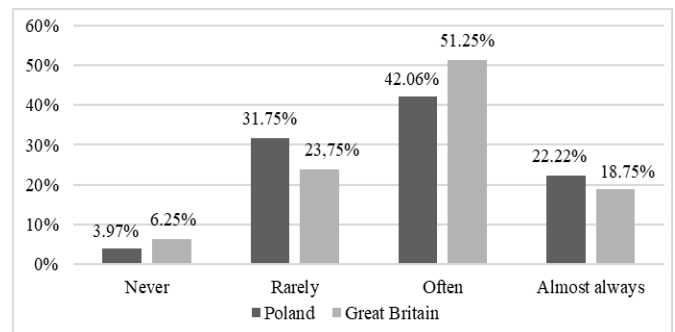


Fig. 4. The quantities of the responses (in %) to the question about searching for social media accounts of a specific company before purchasing its product/service as provided by female respondents in Poland and Great Britain in 2020/2021.

When comparing the percentages of the responses provided to the individual categories (Figure 4), there is a significant similarity in the responses concerning searching for social media accounts of a specific company before using its services/purchasing its product between the respondents in both the analysed countries. The majority of the surveyed women (70% in Great Britain and 64.28% in Poland) reported that they often or almost always searched for social media accounts of a specific company before using its service/purchasing its product.

The respondents were also asked to indicate the form of social media communication with an enterprise that was most suitable for them. Polish females would preferably communicate with a company via Messenger, chat with a consultant and fan page, whereas British females would do so via e-mail, Messenger and chat with a consultant. The forms of communication that Polish females would prefer the least were: SMS, open discussion on the forum, e-mail and live transmission. For British females, the least desirable forms of social media communication with an enterprise were: SMS, open discussion on the forum, live transmission and fan page.

The next stage of the research was gathering the opinions of the respondents in Poland and Great Britain regarding their loyalty towards a given company (brand). Table 3 presents the quantities of responses (in %) by the respondent's gender.

Table 3: Respondents' self-assessment as loyal customers (by gender) – findings of the research conducted in Poland and Great Britain in 2020/2021.

Select the statement that best describes you	Gender (responses in %)			
	Males		Females	
	GB	PL	GB	PL
I am a loyal customer, i.e. I become attached to a company.	41.43	52.00	45.00	40.48
I often experiment, I don't become attached to a company.	58.57	48.00	55.00	59.52
In total	100.00	100.00	100.00	100.00

The research conducted in Poland and Great Britain in 2020/2021 does not indicate clearly whether Gen Zers can be described as loyal customers. Over half of the surveyed females in Poland (60%) and Great Britain (55%) described themselves as customers who often experiment and do not attach themselves to a given company. Similar proportions of the responses were obtained among the surveyed males in both the countries.

Table 4 presents the quantities of responses (in %) by gender of a Gen Z respondent regarding the willingness to defend a company's reputation on social media.

Table 4: Respondents' willingness to defend a company's reputation on social media by gender – results of the research in Poland and Great Britain in 2020/2021.

Willingness to defend a company's reputation on social media	Gender (responses in %)			
	Males		Females	
	GB	PL	GB	PL
no, I don't defend a company in a discussion, because it doesn't have to respond to every attack	14.29	16.00	18.75	23.02
no, I don't defend a company in a discussion, because lapses in an offer and customer service should be publicised	1.43	28.00	6.25	8.73
no, I don't defend a company in a discussion, because a company has a person responsible for communication at a fanpage	15.71	12.00	15.00	31.75
yes, I defend a company in a discussion, if the accusations are unfounded and absurd (do not match the reality)	25.71	28.00	30.00	20.63
yes, I defend a company in a discussion, when the author of a critical statement hides himself/herself behind a fake name (it is clear that his/her personal data is untrue)	7.15	4.00	8.75	5.55
yes, I defend a company in a discussion, when a negative opinion is presented over and over again and becomes annoying for other	17.14	12.00	11.25	7.94
yes, I unconditionally defend a company (I like) in a discussion	18.57	0	10.00	2.38
In Total	100.00	100.00	100.00	100.00

The results of the research carried out in 2020/2021 (Table 4) indicate that the female respondents in Great Britain (60%) defended a company's reputation on social media more often than Gen Z female respondents in Poland (36.5%). The surveyed females in Poland usually explained their lack of defence of a company's reputation on social media by stating that a company employed a person responsible for fan page communication (32%) and that a company did not need to respond to every attack via social media (23%). When comparing the responses of females and males in both the analysed countries, it is clear that the surveyed Gen Z males are more willing to defend a company's reputation. The willingness to defend a company's reputation on social media was confirmed by 44% of the surveyed males in Poland and 68.5% of the surveyed males in Great Britain.

5. Conclusion

From the commercial point of view, a company's success in the Internet environment depends to a large extent on whether it knows the size, characteristics and requirements of the Internet user market, and in the case of Generation Z – social media users in particular. Hence, a better insight into Internet users and their behaviours in the online environment is of key importance to companies that want to successfully build competitive advantage.

Understanding the impact of gender on online communication and management of enterprise-customer relationships on social media is vital, both theoretically and in practical terms. The findings of the present research may help scholars to explain the inconsistencies pointed out in previous studies, and offer practitioners a better understanding of the preferences of Generation Z females in the context of online communication. Research into gender differences in the use of social media, ways of communication, information sharing or developing loyalty towards a company as a result of online marketing communication activities should enrich the theoretical understanding of the specificity of the behaviours of social media users, and empirically highlight and point out the differences in behaviour that enterprises may use to design future marketing strategies.

The results of the research, although it was not conducted on a representative sample, can deepen the knowledge about social media behaviour of the representatives of Generation Z. The differing responses provided by Polish and British females indicate that when building relations with customers from different countries, enterprises should take different actions depending on the country. The first step in the process of social CRM is finding customers on social media. In the case of both the countries, an entrepreneur will most often find females on Facebook, YouTube and Instagram. Both the Polish and British women value swift communication most. However, when using social media accounts, the former also appreciate the possibility of finding and following friends, sharing information with them and the possibility of acquiring information about the products/services of a given company. British women, in turn, mainly use social media accounts to follow the Internet trends and share information with friends. An important piece of information for entrepreneurs is that the majority of the surveyed females in Great Britain and Poland often or almost always search for social media accounts of a given company before using its services/purchasing its product. When an entrepreneur knows where to search for female customers and that such customers also look for him/her on social media, in the next step he/she should seek to learn more about social media behaviours of his/her female customers. This knowledge will allow him/her to propose a tailored, and hence successful campaign. Polish women would preferably communicate with a company via Messenger, chat with a consultant and fan page, whereas British women would do so via e-mail, Messenger and chat with a consultant. The results do not show clearly whether Gen Z females can be described as loyal customers, but it should be noted that the respondents in Great Britain defend a company's reputation on social media more often than Gen Z respondents in Poland.

Analysis of the collected data enables a discussion on designing marketing strategies targeted at Gen Z females in the context of online communication. Knowledge about where Gen Z females can be most often found on social media, what benefits they expect in their relations with enterprises and what ways of communication would be best-suited to them will allow entrepreneurs to propose a personalised, and thus effective, communication, which is the basis of social CRM.

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A Shift in a Skill Set

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Abstract: The objective of the paper is to outline a future skill set in EU. To try to make a projection of structure of necessary skills on EU and member states level. Trends and challenges are embedded. Skills life span is collaborated as well. Perspectives of different sources are compared.

Keywords: SKILL SET, EU LABOUR FORCE TRENDS AND CHALLENGES

1. Introduction

We live in a world of major and rapid changes. These changes appear in each aspect of life. We've entered the Age of Acceleration — a time when change is happening faster and faster. As the workplace continues to move more rapidly, so does the market value of skills [1]. Half of the world's work force will have to be retrained by 2025. This is one of the conclusions of the Future of Jobs Report of World Economic Forum [2]. The reason is the double effect that the pandemic has caused - the health and financial crisis, as well as the accelerated digitalization on the workplace [3]. In highly dynamic and competitive labor markets, investing in people's skills and competences is key. However, which skills and for which jobs? This question is central to national, European and international debate. However, how to foretell future skill needs, especially if the impact of the fourth industrial revolution is not yet clear. 'The goal of forecasting is not to predict the future; but to tell you what you need to know to take meaningful action in the present' [4]. The purpose of this paper is to attempt to outline the shift in the skill set that will be in demand in next years.

2. Trends and challenges

The workforce trends are changes influenced by the prevailing circumstances that occur over time.

Macro perspective

According to Official Journal of the European Union nowadays, competence requirements have changed due to the following: more jobs are subject to automation; technologies playing a bigger role in all areas of work and life; and entrepreneurial, social and civic competences becoming more relevant in order to ensure resilience and ability to adapt to change [5].

According to Smit (et al.), influential trends and challenges are: the differential speeds to automation adoption across Europe's regional labor markets; the growing divergence between the most dynamic cities and shrinking regions across the continent; a decline in labor supply that could create a shortage of workers, particularly in growing sectors and regions; and major shifts in the types of skills and specific occupations that will thrive or be put at risk. To put it briefly, the main trends and challenges are: Pandemia, automation, migration, and shrinking labor supply. Because of these trends, geography of employment is shifting. [6].

Bakhshi et al. provide a comprehensive perspective of trends. Through a detailed analysis of 1,095 local labor markets across Europe, including 285 metropolitan areas, (Bakhshi et al.) it examines profound trends that have been playing out on the continent in recent years and will continue to do so in the future [7]. According to them the automation and technology development are not the only influencers. They determine the following key trends:

- A. Environmental sustainability - climate change consensus and structural changes resulting from emerging 'green economy sector' and 'green jobs';
- B. Urbanization - more than half of world population lives in cities - 70 % by 2050. Cities attract high-value, knowledge intensive industries, offer more varied employment and

consumption opportunities. Uncertainties include fiscal policy, infrastructure investments, and high public debt ratios.

- C. Increasing inequality - rise in income and wealth inequality, middle class squeeze. Disparities in education, healthcare, social services, consumption.
- D. Political uncertainty - Indices of geopolitical uncertainty have remained high. Mirrored by political and policy uncertainty capacity of institutions and policymakers to act credibly and consistently. Uncertainty negatively affects economic activity in government-influenced sectors, such as defense, finance, construction, engineering, and healthcare.
- E. Technological change - perennial fears about impact of automation on employment. Estimates of future automation influence range, from 47% employment at risk to only 9% (in US). Conversely, technology amplifies human performance in some occupations and gives rise to entirely new occupations and sectors.
- F. Globalization - global labor markets increasingly integrated. Benefits (e.g., advanced manufacturing, knowledge intensive services) and costs (e.g., employment and wage impacts, trade deficits, legacy manufacturing). Post-financial crisis headwinds (e.g., sluggish world trade growth, rising protectionism).
- G. Demographic change - pressures to control age-related entitlements vs. investments in education, R&D, infrastructure. Ripple effects through healthcare, finance, housing, education, recreation. Rising Millennial generation, with divergent consumption and work behaviors.

Organizational perspective

1. Fairness and equity will be the defining issues for organizations. Who has access to flexible work? In today's labor market, companies are paying 20% compensation premiums to hire new employees. Is it fair to pay new employees so much more than established employees? In 2022, executives will need to address how they are managing fairness and equity across the increasingly varied employee experience. In fact, this will be the number one priority for HR executives.
2. Pandemic rules— vaccine mandate or testing?
3. To compete in the war for knowledge worker talent, some companies will shorten the workweek rather than increase pay. Employers are offering significant compensation increases to attract and retain talent in today's market. When we also consider inflation, real wages have declined. Moreover, if inflation continues to rise, employers will find the compensation they offer will be worth less and less in terms of purchasing power for employees.
4. Employee turnover will continue to increase, as hybrid and remote work become the norm for knowledge workers. Employees expect flexibility within their job. Employers that do not offer flexibility will see increased turnover.
5. Managerial tasks will be automated away, creating space for managers to build relationships that are more human with their

employees. The manager-employee relationship has become more important than ever; for hybrid and remote employees, their managers are the primary connection through which they experience their employer.

6. The tools that we use to work remotely will become the tools that help measure and improve performance. When work becomes more geographically dispersed, managers have less insight into what work their employees are doing.
7. The complexity of managing a hybrid workforce will drive some employers to require a return to the office.
8. Wellness will become the newest metric that companies use to understand their employees. Executives have experimented with different metrics, such as employee satisfaction or engagement, to understand their employees. Organizations will add in new measures that assess their mental, physical, and financial health.
9. Sitting is the new smoking. The shift to working remotely has affected employees in various ways. More became increasingly sedentary (40%) and gained weight, likely due to the lost physical movement associated with commuting and walking around from meeting to meeting in the workplace.
10. Underestimation of hybrid mode of working. Employees who work remotely or on a hybrid schedule perform at equal levels compared to employees who work in the office. However, managers believe that people who work from the office are higher performing and more likely to be promoted than people who work from home. Woman are willing to work home office, thus a gender issue could pop up. [8].

3. Future skill set

According to Official Journal of the European Union, people need the right set of skills and competences to sustain current standards of living, support high rates of employment and foster social cohesion in the light of tomorrow's society and world of work. Supporting people across Europe in gaining the skills and competences needed for personal fulfilment, health, employability and social inclusion helps to strengthen Europe's resilience in a time of rapid and profound change. [5] Memorization of facts and procedures is key, but not enough for progress and success. Skills, such as problem solving, critical thinking, ability to cooperate, creativity, computational thinking, and self-regulation are more essential than ever before in our quickly changing society. They are the tools to make what has been learned work in real time, in order to generate new ideas, new theories, new products, and new knowledge. [5] To put it simple, those who are on the path of continuously upgrading themselves and the willingness to learn will win employability.

Along with upgrading oneself with new skills, there are other aspects, which are also equally important, which is developing a critical and analytical mindset. M. Sabharwal, put it in an ambiguous fashion. "The notion of lifetime employment has now shifted to a taxi-cab relationship where skills are a premium," Sabharwal was of the view that though the future is unknowable, today there is a massive opportunity to learn and along with that, inculcating soft skills becomes the critical differentiator. [9] Even though a lot has been said about technology advancement and technical expertise soft skills remain into spot. Skills like superior communication or ability to work in teams, which makes the critical difference. Ability to learn become essential. Having a growth mindset and a curious mind will ensure one's path towards learnability. In era of increasing automation, superior skills in sales and customer support could become a critical differentiator for employees in the near future. The willingness to learn new things will always emerge as the key differentiator in the hyper competitive world shaped by new technologies [9].

It is popular that lifelong learning is key for a successful career and to stay atop the ever-changing world. Nevertheless, in the last

few years, we have seen an explosion of new topics, science fields, technological advancements and it is short-lived.

When it comes to skills, we need to look much more at our personal attributes, build strong foundations and look for skills that can be universally applied. Talin [10] divides it into 2 different areas. The basis and foundations, which need to be there, do something in the future, and the job-specific skills and competencies to approach complex problems, and personal qualities to improve over time to adapt. (Fig. 1)

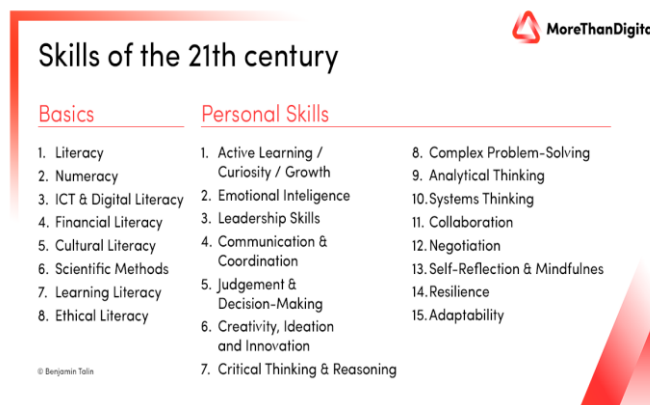


Fig. 1 23 skills of the future – What are the most important skills and competencies of the 21st century? – Source [10].

A research published by M. Dondi et al. [11] identified a set of 56 foundational skills that are wide applicable and showed that higher proficiency in them is already associated with a higher likelihood of employment, higher incomes, and job satisfaction. The researchers used academic research and McKinsey's experience in adult training to define foundational skills (Fig 2). The skill composed of four broad skill categories—cognitive, digital, interpersonal, and self-leadership—then identified 13 separate skill groups belonging to those categories.



Fig. 2 56 Foundation skills – Source [11]

The above-mentioned skills are not necessary connected to education.

4. Skills life span

"Lifespan of skills has dramatically shortened and learnability is the only way forward." [9] Javier spoke about the shrinking lifespan of a skill shifting from 26 years to 5 years. Meaning, for skills we learn today, five years will be the length of relevancy. [12]

Stephane Kasriel, CEO of Upwork and member of the World Economic Forum council, puts the half-life of a learned skill at about 5 years—meaning 5 years from now, the current skill set of your workforce will be worth about half as much as it is today [13].

Ten years from now, perhaps a quarter of existing knowledge will still be valuable. Many of today's jobs fit a 21st-century model, while training and skills are stuck in the 20th century. [1]

Depiction of longevity of a skill, divides skill durability into three categories:

1. Perishable skills : Half-life < 2.5 years – Specific technology skills that are updated frequently; organization-specific policies and tools and specialized processes all can be classified as perishable skills.
2. Semi-durable skills : 2.5 years < Half-life < 7.5 years – These tend to be those frameworks with base sets of knowledge from which field-specific technologies, processes and tools arise.
3. Durable skills : Half-life > 7.5 years – They constitute a base layer of mindsets and dispositions. They include skills like design thinking, project management practices, effective communication, leadership which are more foundational in nature.

As organizations and individuals get ready for a reset and start to think through a skills refresh, it's important to consider just how transferable a given set of skills really are.

5. Conclusion

Trends and challenges that affect the formation of skills for the public and employers are identified. Trends at the social and organizational level are considered.

Two sets of skills are depicted - basic and enriched. The enriched skill set consists of 56 skills that are not related to schooling and also cover attitudes. The extended set is suitable for common use.

The issue of the shortening of life skills is addressed. According to this criteria, they are divided into three categories.

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Possibilities for application of sediment microbial fuel cells as biosensors for monitoring of recurrent water pollution with copper

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Abstract: Sediment microbial fuel cells (SMFCs) are special microbial fuel cells in which the anode is placed in the anaerobic sediment and the cathode is immersed in the surface layer of water. Natural electroactive bacteria decompose organic compounds in sediment, producing electrons and protons. The electrons reach the cathode through an external electrical circuit, while the protons pass through the soil layer, which acts as a kind of membrane. Oxygen is in many cases the preferred electron acceptor due to its presence in the cathode region and its high potential. Heavy metal ions and other compounds can also be reduced on the cathode, which will increase the energy generated. Based on the above characteristics, SMFCs would be suitable for application as biosensors and would be suitable for monitoring recurrent water pollution with heavy metals. In the present study, the possibility of application of SMFCs as biosensors for recurrent water pollution with copper has been studied. A high correlation was found between the concentration of copper ions and the voltage generated by SMFC, as the coefficient of determination reached 0.9921.

Keywords: SEDIMENT MICROBIAL FEUL CELLS, BIOSENSORS, MONITORING, HEAVY METALS

1. Introduction

Heavy metal pollution can be both natural and anthropogenic. Heavy metals from anthropogenic activity are more mobile and bioavailable than natural ones and pose a greater risk to human health and the environment. The level of heavy metal pollution has increased significantly with rapid industrialization. Heavy metals released from various industrial activities are distributed in the environment, mainly through running surface waters. [11]

Industrial wastewater usually contains heavy metals such as chromium, copper, lead and others, which in high concentrations can cause health problems and pollution of natural ecosystems. There are various chemical, physical and biological technologies for treating such waters that effectively remove heavy metals. However, after treatment, the water must be examined to see if it meets the discharge standards. If emissions of heavy metals exceed permissible concentrations, this can lead to serious environmental problems and damage to the environment. It is crucial that the concentrations of heavy metals in wastewater are strictly controlled in real time before they are released into the environment. [6] Most control methods include periodic monitoring, which implies a limitation in monitoring, as the samples reflect the current water quality. No contamination may be detected at the time of sampling or it may be minimal, but may have a significant impact on aquatic ecosystems over a long period of time. This disadvantage is much more serious in running surface water, where conditions can change at any time. [9] This problem is solved with the use of appropriate biosensors, through which water quality can be monitored and environmental pollutants can be detected on site and in real time. [1] Traditional methods of analysis have high selectivity and sensitivity, but are also expensive, have complex sampling and sample preparation, and cannot provide real-time and on-site data. [4] In recent years, a number of biosensors have been developed, which integrated devices are combining biological materials and transducers, for quantitative and semi-quantitative monitoring of various analytes, such as heavy metals, BOD and others. [12]

To overcome the shortcoming, it is possible to use sensors based on sediment microbial fuel cells to monitor heavy metal contaminants occurring in wetlands. [2] The main advantages of the sensor include the reduction of heavy metals on the cathode leading to an increase in voltage. [8] Sediment adsorbs much of the heavy metal, protecting electroactive microorganisms from being inhibited by heavy metal ions, so the sensor can operate normally after shock contamination. The sensor uses natural electroactive bacteria living in the sediment, generating base voltage, therefore the inoculation process can be avoided. Based on the above advantages, the sensor would be suitable for monitoring recurrent heavy metal contamination in water. [3]

The main advantages of sediment microbial fuel cells are low cost, simple construction and long-term output power. In this way, the system is applicable as a biosensor for long-term in situ operation. [5] There are a number of data on the application of SMFC-based biosensors for real-time monitoring of environmental parameters such as temperature and dissolved oxygen. [7]

The purpose of this study is to investigate the possibilities for application of sedimentary microbial fuel cells, such as biosensors for monitoring recurrent water pollution with copper.

2. Materials and Methods

In order to establish the possibilities of operation of sediment microbial fuel cells, as a biosensor for monitoring water pollution with copper, one cell was constructed. The sediment microbial fuel cell is a plastic container with a volume of 1000 cm³. At the bottom of the vessel is a stainless steel electrode with an area of 25 cm². The electrode is covered with a layer of gravel 2 cm thick. The particle size is from 5 to 10 mm. and above the vessel is filled with substrate (soil) with a volume of 800 cm³. The cell was then filled with water and a second 25 cm² stainless steel electrode was placed in the surface layer of the water. On Figure 1 is shown a scheme of the laboratory model of the SMFC-biosensor 1.

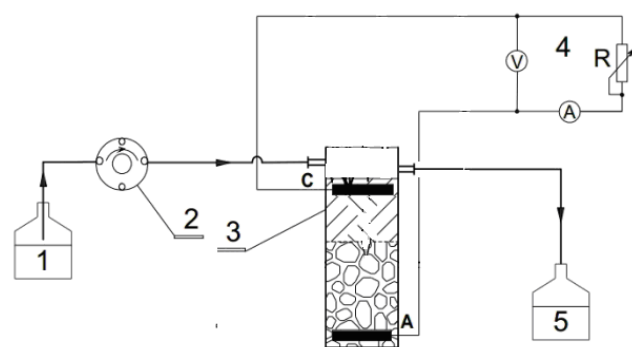


Fig. 1 Design of Sediment microbial fuel cell Biosensor 1

1 – Inflow, 2 – Peristaltic pump, 3 – Sediment microbial fuel cell, 4 – Digital multimeter, 5 – Outflow, A – Anode C – Cathode

After filling with substrate and maintaining a constant water level in the cell, the open circuit voltage was monitored for two weeks. After stabilization of the electrochemical parameters, polarization curves of the sedimentary microbial fuel cell were measured and compared.

After analysis of the polarization curves, a suitable resistance is connected to the sediment microbial fuel cell and synthetic copper solutions are successively fed to it. The solutions contain 25, 50, 100 and 200 mg/l of copper added via $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, respectively. After the addition of each solution, the change in voltage was recorded, after which a standard curve was plotted.

In order to more accurately measure the change in voltage at different copper concentrations, four sedimentary microbial fuel cells were connected in series (Figure 2) in the next experiment.

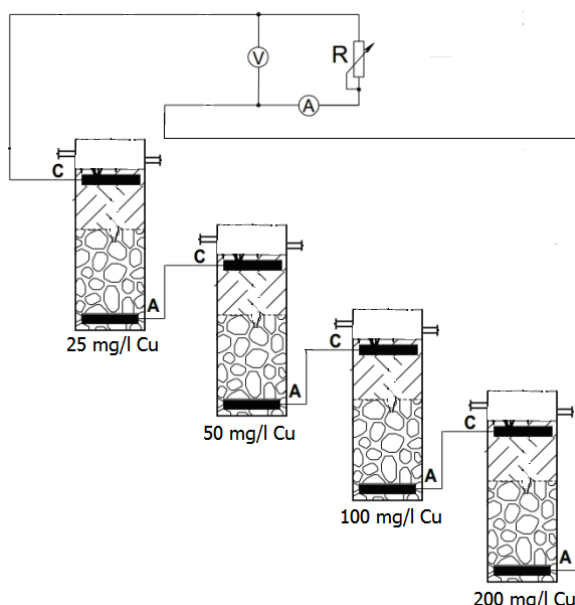


Fig. 2 Design of Sediment microbial fuel cell Biosensor 2

The sediment microbial fuel cell is a plastic container with a volume of 1000 cm^3 . At the bottom of the vessel is a stainless steel electrode with an area of 25 cm^2 . The electrode is covered with a layer of gravel 2 cm thick. The particle size is from 5 to 10 mm, and above the vessel is filled with substrate (soil) with a volume of 800 cm^3 . The cell was then filled with water and a second 25 cm^2 stainless steel electrode was placed in the surface layer of the water.

After filling with substrate and maintaining a constant level of water in the cells, they were connected in series and the voltage in the open circuit was monitored for two weeks. After stabilization of the electrochemical parameters, the polarization curves of the sequentially connected sedimentary microbial fuel cells were removed and compared.

After analysis of the polarization curves, a suitable resistance was applied to the sediment microbial fuel cells and a synthetic solution of copper of different concentrations was applied to each of them. The solutions contained 25, 50, 100 and 200 mg/l of copper added via $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$. After the addition of each solution, the change in voltage was recorded, after which a standard curve was plotted.

The electrical parameters of PSMFC was measured using portable digital multimeter UNI-T UT33C. A precise potentiometer with maximum value of $13,5 \text{ k}\Omega$ used for measuring of external resistance.

3. Results and Discussion

After filling with substrate and maintaining a constant water level in the sediment microbial fuel cell (Biosensor 1), the open circuit voltage was monitored for two weeks (Figure 3).

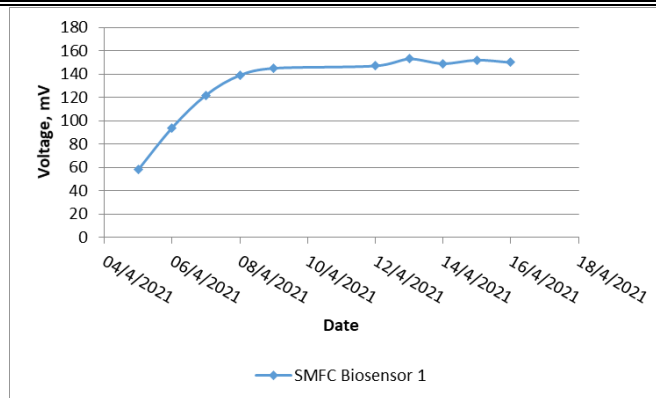


Fig. 3 Open circuit voltage of SMFC-Biosensor 1

Figure 3 shows that after several days of cell stabilization, after the fourth day the voltage reaches close to its maximum and by the eleventh day it is in the range of 142 - 156 mV. On the eleventh day, the polarization curves of the sediment microbial fuel cell were measured. Data from the study are presented in Figures 4 and 5.

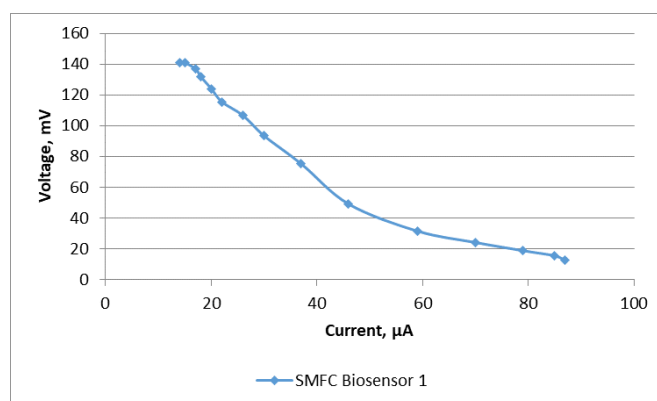


Fig. 4 Voltage dynamics (data from polarization curve) of Biosensor 1

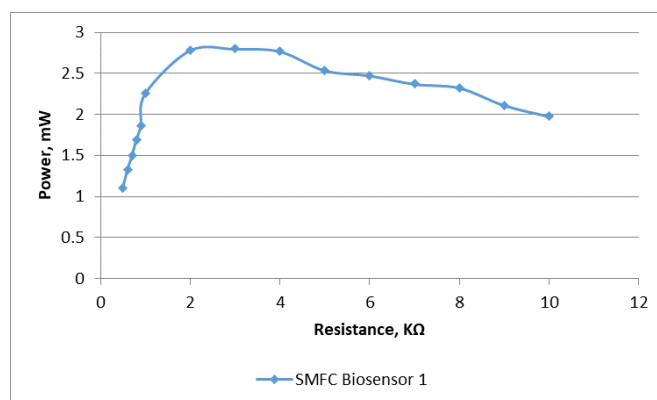


Fig. 5 Power dynamics (data from polarization curve) Biosensor 1

The graphs show that Biosensor 1 reached a maximum power of 2.79 mW with an applied resistance of $3 \text{ k}\Omega$. At this resistance, the cell has a voltage of 93.3 mV and a current of $2.8 \mu\text{A}$.

According to the measurement of the polarization curve, a resistance of $3 \text{ k}\Omega$ is connected to the biosensor and within a few hours the voltage stabilizes at 100 mV.

After stabilizing the voltage, we moved on to the next part of the experiment. Synthetic copper solutions with increasing concentration - 25, 50, 100, 200 mg / l were successively fed to Biosensor 1. When feeding the individual solutions, the change in voltage after its stabilization was taken into account. Based on the change in voltage at different copper concentrations, a standard curve is plotted. The graph is shown in Figure 6.

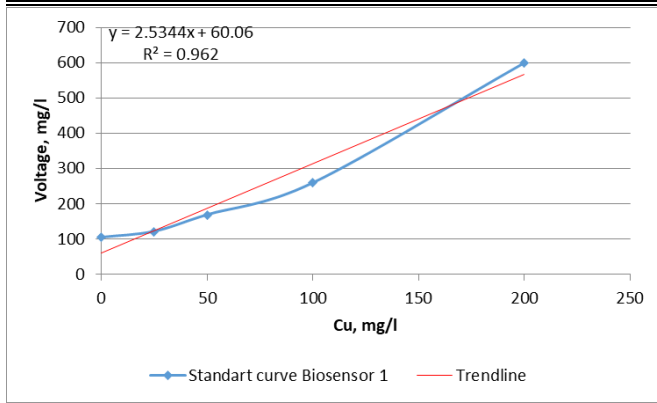


Fig. 6 Biosensor 1 standard curve

The graph shows a high coefficient of determination $R^2 = 0.962$. However, the calculations according to the obtained formula would give a significant error in the voltage range from 200 to 400 mV.

In order to better correlate between copper concentration and voltage, as well as more accurate measurement of voltage change, a biosensor was constructed of four sedimentary microbial fuel cells connected in series. In this way, factors such as residual concentrations of copper in the cell, dilution of incoming solutions will be eliminated, and it will help to more accurately read the change in voltage.

After filling with substrate and maintaining a constant level of water in the cells (Biosensor 2), the open circuit voltage was monitored for two weeks (Figure 7).

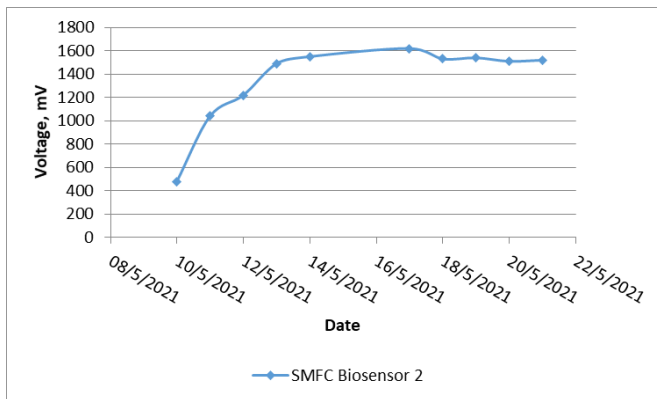


Fig. 7 Open circuit voltage of SMFC-Biosensor 2

Figure 7 shows that after a few days of stabilization of individual cells, after the fourth day the voltage reaches its maximum and by the eleventh day is in the range of 1500 - 1600 mV. On day 11, polarization curves of sequentially bound sedimentary microbial fuel cells were measured.

After stabilization of the electrochemical parameters, the polarization curve of Biosensor 2 was measured. Data from the study are presented in Figures 8 and 9.

The graphs show that Biosensor 2 reached a maximum power of 69.58 mW with an applied resistance of 2 K Ω . At this resistance, the cell has a voltage of 749 mV and a current of 92.9 μ A.

According to the measurement of the polarization curve, a resistance of 2 K Ω is connected to the biosensor and within a few hours the voltage stabilizes at 390 mV.

After stabilizing the voltage, we proceeded to the next part of the experiment. After stabilizing the voltage, proceed to the next part of the experiment. A synthetic solution of copper with different concentrations - 25, 50, 100, 200 mg / l - was fed to each cell of Biosensor 2 once. The voltage change after its stabilization was measured during the supply of the individual solutions. Based on

the change in voltage at different copper concentrations, a standard curve is plotted. The graph is presented in Figure 10.

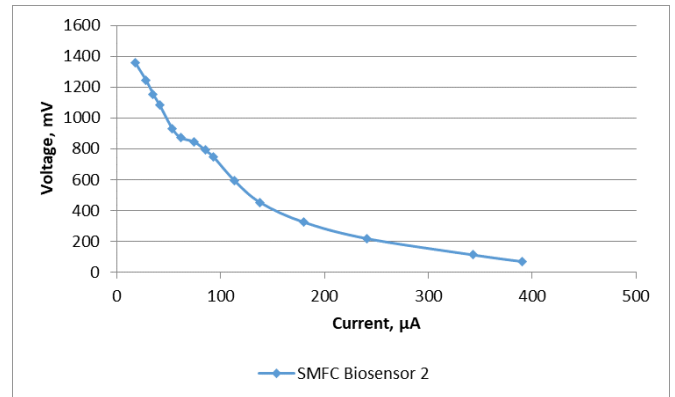


Fig. 8 Voltage dynamics (data from polarization curve) of Biosensor 2

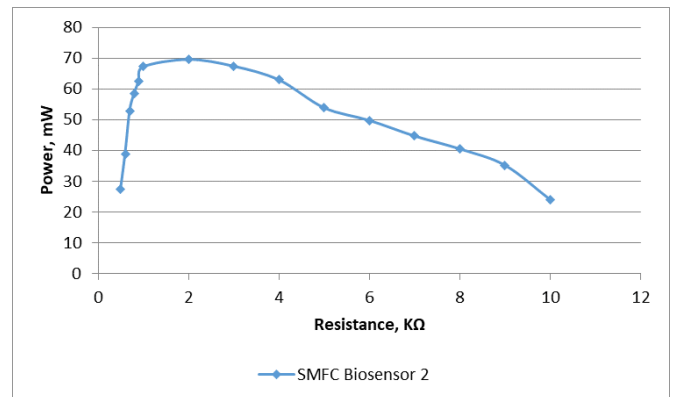


Fig. 9 Power dynamics (data from polarization curve) Biosensor 2

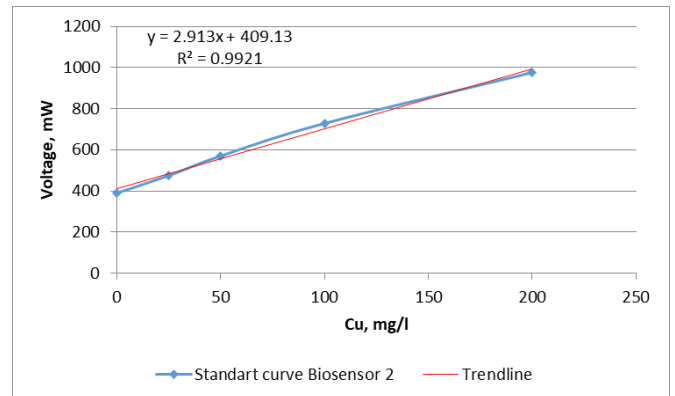


Fig. 10 Biosensor 1 standard curve

The graph shows a high coefficient of determination close to one - $R^2 = 0.9921$, with slight deviations of the graph from the standard curve in the studied interval. This proves the possibilities for the use of sediment microbial cells as biosensors for monitoring recurrent water pollution with copper.

4. Conclusion

In order to determine the possibilities for application of sediment microbial fuel cells as biosensors for monitoring of recurrent water pollution with copper, two variants of SMFC-biosensors were constructed. The influence of four concentrations of copper (25 mg / l, 50 mg / l, 100 mg / l, 200 mg / l) on the change of the electrochemical parameters of the cells was studied. The addition of copper in the cathode region increases the electrochemical parameters of the cell, because in addition to dissolved oxygen, copper cations are also used as the ultimate

acceptor of electrons. When using one SMGK, a correlation was found between the increase of the copper concentration in the cathode region and the change in the electrochemical parameters of the cell, reaching a coefficient of determination of $R^2 = 0.962$. In order to better detect the change in voltage, four sediment microbial fuel cells are connected in series electric circuit. In this case the coefficient of determination reaches $R^2 = 0.992$. Research has shown that sediment microbial fuel cells can be used as biosensors for recurrent copper contamination, but further research is needed on their design, inertia in changing electrochemical parameters and detection range.

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