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THE ROLE OF SUSTAINABLE VALUE CREATION GENERATED FROM THE ECONOMY OF THINGS (EOT) FOR START-UP DIGITAL COMPANIES SUCCESS

Master's Thesis

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CONTENTS

ABBREVIATIONS

AI - Artificial Intelligence

AIoT - Artificial Intelligence of Things

BAT - Basic Attention Token

B2B – Business to Business

CEO – Chief Executive Offices

CIoT - Cognitive Internet of Things

DAB - Digital Asset Broker

dApp – Decentralized Application

Defi – Decentralized Finances

DLT – Digital Ledger Technology

ECG - Electrocardiography

EoT - Economy of Things

FAANG - start-ups in Big Tech: Facebook, Amazon, Apple, Netflix, Google

FIoT - Future Internet of Things

GIGO – Garbage in Garbage out

GIF - Graphics Interchange Format

GPU - Graphics Processing Unit

GPS - Global Positioning System

HTML – Hyper Text Markup Language

HTTP - Hypertext Transfer Protocol

IIoT – Industrial Internet of Things

IoT – Internet of Things

IEEE - Institute of Electrical and Electronics Engineers

IT – Information Technology

JSON - JavaScript Object Notation

LoRa – Long Range

LoRaWAN - Long Range Wide-Area Network

LPWAN - Low-power wide-range network

M2M - Machine to Machine

NFT – Non-Fungible Token

PoS – Proof of Stake

PoW - proof of work

P2P – Peer to Peer

RFID - Radio Frequency Identification

SaaS - Software-as-a-Service

SSI – Self-Sovereign Identity

VLSI - Very Large-Scale Integration

Web – World Wide Web

Wi-Fi - Wireless Fidelity

WSN – Wireless Sensor Network

XML - Extensible Markup Language

XMPP - Extensible Messaging and Presence Protocol

5G – 5th generation technology standard for broadband cellular networks

INTRODUCTION

Scope of the Work:

The latest technologies which use the internet and are applied in various spheres of human routine are extremely relevant in the development of modern society. The majority of such technologies are well known to people and massively adopted. Yet, they did not appear out of thin air. Digital space, as people know it today, evolved throughout the years and the stage at which it remained for the past years is now commonly referred to as Web 2.0. However, currently, digital space is changing.

The emergence of Web 3.0, which brings the latest cutting-edge technologies into people's daily routines, is already happening. Those technologies enable mankind to take a significant step in the development of civilization as a whole and reconsider the approach to many, as it seemed before, unshakable values in the sphere of economy. One such area of the economy in a dynamically developing society is the Economy of Things (EoT).

The EoT phenomenon is formed as a result of the advancement of several IT technologies in a Web 3.0 environment. One of the key technologies, which compile the Economy of Things, is the Internet of Things. The Internet of Things, at its core, is a rather popular Web 2.0 predecessor of a Web 3.0 Economy of Things environment.

IoT is a network of networks in which smart devices, sensors, and their digital counterparts, referred to as “things” interact autonomously. IoT enables the provision of a variety of complex services by connecting, both physically and virtually, devices (things) into digital networks based on their compatibility and communicability. When devices interact within the IoT environment, they exchange information using databases, which, in the process of development of the digital space, started to acquire certain value.

Another technology that made the Economy of Things possible is blockchain. The application of this technology led to the decentralization of data exchange processes and allowed the monetization of data in the environment of “things”. It formed a concept of data exchange between devices with economic relations between them.

In addition to the Internet of Things and blockchain, there are other equally important technologies, which also participate in the development of the Economy of Things. Such technologies include artificial intelligence, cloud lakes, and self-sovereign digital identities. The synergy of such technologies is what is being interpreted as the Economy of Things.

The EoT phenomenon has a lot to unravel. Therefore, further in this work, will be deeply researched, including the technologies behind it, real-life examples, and an overview of its key features. For a clear understanding of the topic, the evolution of the digital space as a whole will be studied. Following, the first chapter of the work will be devoted to that purpose. It will also include a discussion of cutting-edge technologies, some of which were previously mentioned. A study of the EoT environment will be held in the second chapter. There, a concept of sustainable value generated by EoT will be researched and disclosed. A separate part of the chapter will focus on understanding and analyzing the success of a digital start-up. A thorough examination of those aspects will allow establishing whether the EoT environment generates a sustainable value and identify this value. Subsequent chapters of the research will provide a methodological analysis of this value in the context of the success of start-up digital companies. It will allow this work to establish the role of sustainable value creation for s success of start-up digital companies.

The novelty of the study

It should be taken into account that EoT is a concept in the literal sense of the term. Currently, there is no well-established definition of this phenomenon and even the term Economy of Things is not universally adopted. EoT is an extremely young environment, which is being formed at this very moment and might have various interpretations. Due to such immaturity, the topic is vastly under-researched yet. Therefore, to avoid confusion, the study will clarify certain points and establish the terminology needed to understand the meaning of both the EoT phenomenon itself and the environment that it forms. At this point, humanity is only starting to approach the practical applications of this phenomenon. The current stage of EoT development can be relatively compared with the emergence of the Internet as such, or with the advent of Bitcoin.

The study provides an understanding of the concept of EoT and examines the approach to the successful development of a start-up in an EoT environment based sustainable value it generates. The key success factors of digital start-ups in the EoT and the benefits associated with the environment will be analyzed during the research. Certain, further discussed, businesses already acclaimed EoT as a very fruitful environment. Therefore, the novelty that this study carries, among others, is an analysis of the assumption that a digital start-up with access to EoT technologies will be able to significantly increase business efficiency.

Research question

In this research, the environment of the Economy of Things is being analyzed. The study examines the role of sustainable value generated within it as a success factor for start-up businesses. It is assumed that this environment generates a sustainable value which could play a vital role when it comes to the operation of start-up businesses. The research will discover if it is true or not. Further work will be focused on defining the dependence of the role of such value in relation to start-up success, and will answer the research question; What is the role of sustainable value creation generated from the economy of things for start-up digital companies' success? To answer this question theoretical research, which includes a review of scientific literature and case studies, comparative examination of documents, and analysis of statistical reports is being conducted.

Research aim

The subject of this study is the EoT environment and the digital start-ups which operate within it. The research aim is to unveil the potential of the Economy of Things via means of theoretical research. Achieving this aim will grant a better understanding of a rather under-researched phenomenon of the EoT. It will also allow to initiate discussions regarding the EoT environment, and provide certain recommendations for further research and practical implications. Obtained research results are intended to presumably attract the attention of members of digital start-ups by offering them a more comprehensive understanding of the EoT environment. As well as, providing an overview of technologies that can help to improve key business performance indicators, and, as a result, lead to the success of the project as a whole.

A clear formulation of concepts and a consistent study of all of the above material will make it possible to clarify the role of sustainable value in the development of digital startups. At the same time, sustainable value, in turn, will also be identified and justified in the research process. Ultimately, it will allow answering the established research question.

The study will cover theoretical knowledge, serving as a backbone for a comprehensive understanding of the Economy of Things and other related concepts. It will also cover the methodological framework (methods and instruments) used in conducting the research as well as data analysis. The final part of the work will present the findings of the research. It will establish the role of sustainable value generated by EoT for start-up digital companies’ success, followed by conclusions, and recommendations for future research and discussion.

1. REVIEW OF THE WEB SPACE IN THE FOCUS OF EOT

Discussion about the role of sustainable value creation in the Economy of Things implies talking about an overall digital world, that exists on the web. The Internet became immensely advanced and gargantuan over the past 3 decades. looking at history, the advancements are colossal. Yet it is far from perfect, and evolving at this very moment.

Recently, this evolution of the Web, which is being disused, generated the concept of Web 3.0. Web 3.0 is a crucial concept required to understand the Economy of Things. Simply put, the Economy of Things is a branch of a wider environment which is Web 3.0. However, same as Web 3.0, the Economy of Things did not appear out of thin air. It evolved from the Internet of Things. Much like the Internet of Things is a derivative of Web 2.0, the Economy of Things is a derivative of Web 3.0, and this time it is powered by blockchain technology. Therefore, to fully understand and evaluate the role of sustainable value creation in the Economy of Things, it is necessary to examine the history of the web, key developments and technologies, their potential, and how it all brought humanity to the verge of the new era of the digital world.

1.1. Web 1.0

1.1.1. Semantic Web

World Wide Web or, as people now call it Web 1.0, was created by Tim Berners-Lee in 1989. (Kerner, n.d.). When talking about the Economy of Things. It is imperative to, first, unravel the evolution of the web. As noted in a Forbes Advisor article, "the internet has evolved immeasurably from those early days, and it now has more than 5 billion regular users, roughly 63% of the world's population." (Ashmore, 2022). Currently, steps in the evolution of the web are divided into three major stages. Web 1.0 - read-only, Web 2.0 – read-and-write, and Web 3.0 – read-write-own.

While Web 3.0 is a very recent term, “father” of the Internet Tim Bernes-Lee already coined a somewhat similar concept back in the 90s. It was called the semantic web. At the First International WWW Conference, which took place in 1994, he presented his concept for the Semantic Web. Berners-Lee believed that adding metadata about the information found on the Web which computers could read and "understand" and assigning "values" to relationship hyperlinks which computers could use to guide searches, were the two essential components of creating a truly useful repository of information. (Hosch, 2022).

The Semantic Web, a development of the World Wide Web, is a method of giving data meaning (semantics) so that computers may look up and "reason" in response to human searches. The concept of the Semantic Web is a rather opposing concept to Web 2.0, which Berners-Lee has harshly criticized. Consequently, the Semantic Web never got much support from the proponents of Web 2.0, back in the 90s, who did not perceive semantic and machine intelligence as an integral part of a digital environment. It appears that, in fact, it would be more accurate to refer to the Semantic Web as one of the developments of Web 3.0, which also includes additional enhancements to the "back-end" data infrastructure, particularly data tags, to facilitate data mining and natural language searches (Hosch, 2022).

A logical question may arise if Web 2.0 is the internet as users know it, what is Web 3.0, and how is it different? Essentially, Web 3.0 is an evolution or even a revolution of the internet which allows the Economy of Things to exist. The World Wide Web, commonly referred to as the web, serves as the basic building block of the internet by offering website and application services. There isn't a single, accepted definition of Web 3.0 because it is continually changing and being defined. However, it is evident that Web 3.0 will heavily emphasize decentralized applications and utilize blockchain-based technology. Artificial intelligence (AI) and machine learning will both be used in Web 3.0 to enable smarter, more adaptive applications (Kerner, n.d.). Naturally, the term Web 3.0 implies that there were at least two iterations of the Web before it. Therefore, to understand what is Web 3.0, first, it is necessary to analyze what Web 1.0 and Web 2.0 are.

1.1.2. World Wide Web

Originally, there was no Web 1.0. Instead, it was called the World Wide Web by its' creator Tim Berners-Lee. The very concept of Web 1.0 appeared only after the term Web 2.0 came to be. Therefore, everything that happened on the Internet before Web 2.0 was considered Web 1.0. Between 1991 and 2004, the Internet was a collection of static pages filled with various data. Simply, put, a user could just open a page and it showed some information. Web 1.0 users could read news or articles, listen to or download music, and videos, and so on.

Web 1.0 is also called read-only web. “The first version of the internet is sometimes called the “static web.” It was made of read-only webpages that, by and large, lacked much in the way of interactive features.” (Ashmore, 2022). There was no authorization, logins, or sign-ups. There was no editing by users as well as no user interaction with pages other than

reading or downloading. Most importantly, everything was created, stored, and published by site owners, and centralized. Therefore, users could only receive what owners were to give them. "Early internet was all about these webpages, which were connected into a system using hyperlinks. Think of a massive, digital encyclopedia, without the visuals, controls, forms, and interactivity associated with the modern internet. That's why it's known as the "read-only" web." (O'Neill, 2022). Essentially, it was a huge data warehouse interlinked between content owners and content consumers.

In summary, Web 1.0 included “static pages, HTML 3.2 elements such as frames and tables, HTML forms sent via email, content from the server's filesystem, rather than a relational database management system, GIF buttons and graphics” (O’Neill, 2022). It was a database, which can be compared to a large library where a person can go and have an opportunity to read only those books that are present in the library. No interaction - read-only. Although there have been exceptions, for example, Amazon has allowed users to write reviews and user guides for products since its appearance in 1995. (Version Museum, n.d.)

1.1.3. Databases and Big Data

As it was stated earlier, read-only Web 1.0 was a database. Data is something that is being brought up a lot in this work, and big data, as we currently know it, started to form at the Web 1.0 stage. Therefore, for further context, it is important to understand databases. The main function of many information systems is to distribute data from databases. A database is a grouping of linked material that has been arranged to allow retrieval of specific records in response to certain criteria. For example, various product catalogs are common instances of databases. Databases help an organization's management and operational tasks. Archival data that has been gathered over time and stored in data warehouses can be mined for information to help develop and promote new goods, provide better service to current consumers, or connect with new prospective customers. These data collections include everybody who has ever used a credit card to make a purchase, whether it was in person or online. (Ellison, 2022)

Data is extremely valuable when used properly. Consequently, as the internet evolved, a cumulative volume of data grew as well. Around the time, Web 2.0 appeared the term Big Data was coined by Roger Mougalas (Keith, 2017). Big data is a broad term that refers to the massive collecting and processing of numerical, or structured data, as well as textual data that is frequently obtained online. There are numerous advantages to making judgments based on the information provided by big data. Examples include prescribing

evidence-based treatments, conserving resources by reducing waste, and recommending new goods (like books or movies) per a user's preferences. Big data supports new business models. For instance, a business might crowdsource (get information from various unaffiliated persons) the prices of things using smartphones all over the world, which results in a more reasonable decision-making process. The processing of textual data enables automated sentiment analysis for marketing, competitive intelligence, new product creation, and other decision-making reasons. Textual data includes reviews and opinions expressed by people on social networks, blogs, and discussion forums (Ellison, 2022).

Big data had an immense impact on the web. Increasing data volume and new use cases affected the transformation of Web 1.0 into Web 2.0, which had a variety of unforeseeable novelties. Back in the 90s, the mainstream perception of the internet was some sort of a gimmick. Why bother using the web, to send a message, when there are pagers? It was unpresidential and only a few could grasp its' real potential. However, things changed at the beginning of the new millennium.

1.2. Web 2.0

The emergence of the concept of Web 2.0 is usually associated with Tim O'Reilly's article "What is Web 2.0?" from September 30, 2005 (O'Reilly, 2009). O'Reilly linked the emergence of a large number of websites, united by some general principles, with the general trend of the development of the internet community. He called this phenomenon Web 2.0 as opposed to the old Web 1.0. (O'Reilly, 2009) In his book, Terry Flew describes the transition from Web 1.0 to Web 3.0 as moving "from personal websites to blogs and blog site aggregation, from publishing to participation, from web content as the outcome of large up-front investment to an ongoing and interactive process" (Flew, 2014). Same as with Web 3.0, there is still no single and approved definition of Web 2.0. However, there are a few key takeaways that signify the beginning of Web 2.0. The main one is a transition from a read-only to a read-write concept. It means that instead of solely web professionals, average users started to generate content. Essentially, the age of Web 2.0 was signified by current IT giants gaining power (such as Google), the emergence of social networks, and creation of the targeted advertisement.

1.2.1. Social Networking

One of the main innovations, associated with Web 2.0 was the emergence of social networks. Social networking is the practice of maintaining contact with friends, family, co-workers, and consumers through web-based social media platforms. Social networking is the use of technology to establish and maintain interpersonal and professional connections. The most popular social networking websites are Facebook, Instagram, and Twitter. These websites enable interaction between people and businesses so that they can build relationships and exchange data, concepts, and messages. (Kenton, 2022) Social networks have allowed a generation of content not only for web professionals and site owners but also for ordinary network users. It meant one thing, collaboration. “Unlike traditional media, created by no more than ten people, social media sites contain content created by hundreds of millions of different people.” (Computer Hope, 2022).

People started to write posts and upload photos on Facebook, began to make millions of search queries on Google, and even watch videos on YouTube. As stated by Sean Captain, “The modern era of the internet starts to emerge in 2007 when YouTube and Facebook seem to come out of nowhere. YouTube was founded just three years earlier, but got a huge boost in 2006” (Captain, 2019). People now shared personal information with a large number of sites, register accounts, entered their card details, made purchases, and so on. Resource owners collected this information about people and used it to show the content based on user's interests. Resource owners needed users to be interested so that consumers stayed longer on their platforms. It allowed platform owners to earn more from their users.

Next, platforms realized, that they could not only collect this data but also sell it to advertising campaigns, such as Google ads. Because of this phenomenon Web, 2.0 can be called the era of targeted advertising and a lack of privacy. The central principle behind the success of the giants born in the Web 1.0 era, who have survived to lead the Web 2.0 era, appears to be that they have embraced the power of the web to harness collective intelligence (O'Reilly, 2009). Despite that, people were willing to share personal information to enjoy the advantages of social networks, online stores, and other benefits of Web 2.0. Such a case identifies the problems and shortcomings of Web 2.0 which led to the idea of improved Web 3.0.

1.2.2. Imperfections of the Web 2.0

Since Web 1.0, the client-server architecture has not changed. When s user accesses the server, the server issues a response and records the data that the user enters. Servers are owned by specific people or companies. Therefore, they may block or remove users' content because their content or opinion is not in line with the company's editorial policy. Thus, for example, a person's Instagram photos and all related memories can be wiped out due to the controversial decision of the company.

Another problem is sensitive data transferring. Sensitive data is being transferred and stored on companies' servers. Such kind of storage can be hacked, data transferred to third parties, or even deliberately used for the personal gain of the company which stores such data. Michael Portnov states that “In the world of Web 2.0, we are at the mercy of large companies such as Google, YouTube, and Facebook” (Portnov, 2021). These businesses provided people with "free" services and gained immense popularity. However, eventually, these businesses had to start making money and repaying venture backers after their user bases had sufficiently expanded. Instead of openly charging for their services, companies started to keep track of their users' browsing habits in order to gather insightful marketing data and roll out specialized advertising campaigns. Users now share bits of personal information with third parties in the Web 2.0 environment to obtain goods and services, while Web 2.0 databases frequently suffer hacks and data breaches (Portnov, 2021). Because of such flows, it became clear that Web 2.0 needed an upgrade.

1.3. Internet of Things (IoT)

After examining Web 2.0 as a general concept, it is necessary to narrow it down and focus on one specific branch of it. Namely, the Internet of Things (IoT). IoT refers to a digital environment where different “things” or devices can collaborate and transmit data. The key importance of this concept is the fact that the Internet of Things is a predecessor of the Economy of Things. Therefore, in this chapter, the concept of the Internet of Things (IoT) will be revealed as well as its features and its ground, which is data.

What exactly the Internet of Things is? The Internet of Things (IoT) is a conceptual paradigm that connects a multitude of devices with the properties of transmitting data over the Internet. It allows the interaction of digital systems with physical infrastructures. The

Author of the term Internet of Things is Kevin Ashton, who first mentioned it in 1999 (Ashton, 2009). According to Osseiran (2017) “The Internet of Things (IoT) refers to the connectivity of tens of billions of network-enabled devices having diverse requirements”. Simply put, the Internet of things is the internet as people know and use it, to connect and exchange information, but for “things” instead of people.

“Thing” within the concept of the Internet of Things, as well as in the Economy of Things, implies a physical object or a virtual one that can be identified and integrated into networks. Things are machines, sensors, and other devices that transmit and receive data via the internet. In the modern world, things are everywhere. For example, smart weights in the bathroom, or smart lights in the living room. A smart home in itself is, essentially, a thing, as well as smart cities. “It is a new paradigm that has changed the traditional way of living into a high-tech lifestyle. Smart cities, smart homes, pollution control, energy-saving, smart transportation, and smart industries are such transformations due to IoT" (Kumar, 2019) By applying the force of identification, collection, procession, and transmission of data, the Internet of Things makes the most efficient use of things to provide services for all types of applications while meeting security and privacy requirements.

The Internet of Things (IoT) is a well-known technology at this point. Technology that enables the autonomous connection between "things" as well as identification, and management of other things and information processing. It also allows the protection of the environment through various network access techniques as well as the connection between things and people. “Applying IoT to different industries is like covering the Earth with a digital skin.” (Gubbi, 2013, as cited by Lv, 2022). IoT can gather, process, and distribute collected data deployed in many locations, and has a wide range of applications, including environmental monitoring, agriculture, military, and healthcare. (Aman, 2020, as cited by Lv, 2022).

1.3.1. Data in the Internet of Things

The current reality is comprised of computing devices or systems in a variety of spheres. Such devices collect data. Some of them constantly work and perpetually collect and transmit data in the background. This data is then gets stored and transferred over the web. The most daily example of such a computing device or "thing" is a smartphone. A smartphone is the ultimate device when it comes to data collection. At the same time, it is an integral daily life element of any individual. Paradoxically, smartphones may know more

about their owner's routines and desires than the owner of the thing themself. Not only that, but a smartphone is also capable of storing and sharing this kind of data with other "things". Most of the time, the owner is notified and gives consent to do so, but sometimes it might not be the case.

The popularity of smartphones can be supported by the research from Statista. “The number of smartphone subscriptions worldwide today surpasses six billion and is forecast to further grow by several hundred million in the next few years.” (Statista Research Department, 2022). This is just a sole example of “things”. Yet, it indicates how widely “things” are integrated into today’s world.

However, not only smartphones are collecting and transmitting data. Just a mere adoption level of virtual and physical computing devices illustrates the level of IoT integration "IoT is big and getting bigger - there are already more connected things than people in the world" (Ranger, 2020). Such massive adoption and approachability to devices and technologies generate networks of "things" that are capable of autonomous data collection and transmission. A lot of such networks are well known, such as smart home devices. Some of them are less noticeable and popular. Combined, those networks chain into an environment of the Internet of Things.

It is fair to say that the global coverage and penetration of data collection technology in the modern world are no longer surprising. Operation and interaction of "things" are tied to the data which they collect. It is imperative for the modern world to function. Therefore, logically, it would seem that data as such, collected by these devices, must have substantial value. Nevertheless, this is not entirely true. Data by itself is useless. It is not enough to capture, transmit and accumulate data. It must be correctly processed (classified, verified, interpreted, and integrated), meaning that data has to be turned into information and brought to action. It implies that data requires context. "Data is useful only when it helps to determine the context, the state of the world in which the IoT application is executing. We could similarly say that context without smart actuation is useless. If we know what the situation is with a good level of accuracy, but we do not know what to do, then we will not deem any application useful or smart." (Aiello, 2022). Only when it is interpreted, does data, indeed, become tremendously valuable.

It brings back the concept of the Semantic Web by Tim Berners-Lee, which, to some extent, has been adopted. That is why networks and the environment of the Internet of Things

are precisely what makes data collected by "things" valuable. "Rarely IoT devices are useful in isolation, their utility comes from being part of a larger architecture that uses each one of them for a purpose. By ‘architecture’ here we mean the fundamental software and IoT elements and the intended relations and constraints governing their interactions” (Aiello, 2022).

To sum up, what has been stated so far, data is indeed playing a major role in the Internet of Things, but what truly gives this data value is the environment comprised of networks of various digital and physical things. Further, it would be reasonable to examine how the concept of the IoT is being integrated into the environment of daily life, making the usual attributes of human activity digital.

1.3.2. Internet of Things in a Daily Life

Today, IoT is about ubiquitous access to real-time data anywhere and anytime. For the exact purpose of discussing the Internet of Things in daily life, it is necessary to get a deeper understanding of the processes involved. In an article by Chui from McKinsey, IoT is identified as "sensors and actuators connected by networks to computing systems. These systems can monitor or manage the health and actions of connected objects and machines. Connected sensors can also monitor the natural world, people, and animals" (Chui, 2021).

From the hardware side, there are two major categories of hardware devices in IoT, actuators, and sensors. Those two hardware types comprise the Internet of Things. Sensors are objects that can detect or quantify a certain phenomenon and transmit the detected values to other parties (i.e., collect data and report states). IoT sensors include things like GPS and ECG machines. To meet the cost-effectiveness requirements of IoT solutions, the constituent sensor nodes often use small-scale embedded systems, expanding their adoption in a variety of fields. Sensor nodes frequently use 8-bit microcontrollers and have limited storage, which reduces their power requirements and enables them to operate for many years on batteries. When combined with the variety of networking protocols that are available to meet the existing infrastructure or the operational requirements it greatly encourages the deployment of IoT solutions in various areas (Elgazzar, 2022).

Actuators, like an AC thermostat and a valve, are physical objects that can modify physical surroundings (i.e., take actions) in response to a command or a suggestion. To be considered IoT devices, these gadgets must have an internet connection and the ability to communicate to send or receive data. (Elgazzar, 2022)

From a software side, any sensing device can be connected to the internet for data transmission using IoT applications, enabling sensing devices to be intelligently identified, tracked, positioned, and monitored. Additionally, the Internet of Things (IoT) includes a variety of Wireless Sensor Networks (WSNs), which, as a component of the IoT sensing layer, may accommodate people's actual needs for accurate data in various unique cases. (Sadowski, 2020, as cited by Elgazzar, 2022).

To illustrate the concept better, it might be reasonable to bring up an example. John needs to charge his electric vehicle. Because of IoT John doesn't need to search for a charging station. Instead, he can be directed there immediately thanks to connected sensors at charging stations that track whether or not stations are occupied. To sum up the concept, “There’s a fairly basic formula here: contextually aware devices streaming rich data via ubiquitous connectivity = The Internet of Things.” (Elavon, 2017).

The Internet of Things, without a doubt, is one of the main advancements of the Web 2.0 era. However, what is truly worth noting is how seamlessly IoT is integrated into humans' routines. Back in 1991, Mark Weiser stated that in the future technologies and devices will become so omnipresent, that people will stop noticing them. "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it." (Weiser 1991). His prediction indeed appeared to be true. Just as he said, 20 years later the world is full of technologies that got so deep into a daily routine, that people started to forget they are using them.

To illustrate how deeply mankind interacts with computing systems, another quote from an article by Aiello can be brought up. He discusses changes in the automotive industry which heavily relies on data and computing systems. "With up to 100 electronic control units and hundreds of millions of lines of code, the modern automotive industry has become more about software than mechanics and aerodynamics." (Aiello, 2022). While it might sound like ignorance, as a matter of fact, it is an indication that technologies reached a level of usability which allows disregarding their presence. The Internet of things is valuable as it saves energy and time. However, its value is also supported by numbers. “Tech analyst company IDC predicts that in total there will be 41.6 billion connected IoT devices by 2025” (Ranger, 2020). It can be said with confidence that the Internet of Things is here and will remain. It helps people to save time and effort. It streamlines business and daily operations, making it possible to complete activities quicker and more effectively than ever before.

1.3.3. Future of the Internet of Things

The versatility of IoT devices, and the improvement and integration of sensors for collecting data, allow the Internet of Things to improve and solve more complex tasks. The increased complexity also adds to the relevance and increases the demand for IoT-related products. It, consequently, attracts more businesses and start-ups due to opening opportunities. It is especially noticeable in the sphere of the Industrial Internet of Things (IIoT). According to the research done by McKinsey, in 2020 IoT economic value for the developed world accounted for 61% of the total value. (Chui, 2021)

However, attractive possibilities and the variety of IoT devices created for specific infrastructures, individual solutions, and developments for specialized tasks lead to a certain problem. The problem is associated with the lack of a single ecosystem for IoT, which limits compliance with certain standards. While IoT functions as an ecosystem of networks, it is lacking unified standards. This entails certain limitations and difficulties in assessing accuracy, cost, compatibility, and other indicators.

Another issue is the previously mentioned privacy. In the research regarding privacy in IoT Chanal concludes that User privacy issues continue to be an ongoing challenge for IoT, limiting its potential and preventing mainstream adoption. "To provide security and privacy to this data in IoT is a very challenging task, which is to be concerned at the highest priority for several current and future applications of IoT" (Chanal, 2020). IoT systems may reveal sensitive information about individuals. Therefore, people are primarily concerned about the possibility of private information leaking despite the potential promise of IoT to revolutionize interaction with surroundings.

Consumer goods (like smart TVs) and wearable gadgets (like smartwatches) capture a lot of previously difficult-to-gather data about individuals. IoT devices may also collect personal information about users (such as name, birth date, etc.), their biometric data (such as fingerprint, voice recognition, etc.), and their preferences (such as eating habits, preferred movie genres, etc.). This information is typically collected during the device's initial setup and done for the device to effectively carry out its task. Additionally, modern IoT systems frequently feature "sensor fusion," which is the collection of several data points from various smart objects. (Abdelmoneem, 2018 as cited by Elgazzar, 2022)

Despite the issue of privacy, ultimately, the collection is done to provide accurate and thorough information on the environment, including people, to aid in making better decisions.

Thanks to developments in artificial intelligence (AI) domain technologies, and other advancements, IoT has been given intelligence, which has facilitated its widespread adaptation and made it very valuable in a variety of application sectors. (Elgazzar, 2022)

To sum up, everything that has been stated so far, the Internet of Things is a very significant, possibly the most significant, step in the development of Web 2.0. IoT allows devices to communicate autonomously and significantly improves daily routine. Such interaction is achieved via data collected by devices and further interpreted to make it purposeful. At the current stage of development, IoT became so deeply integrated into daily life, that it is almost dissolved and turned out to be unnoticeable by a majority of people.

From the foregoing, the relevance and huge potential of the IoT for start-ups can be easily identified. Potential includes the generation and collection of data as well as the creation of the devices themselves. Moreover, as it was previously established data becomes truly valuable only when processed. Therefore, it also includes the development of effective specialized data processing software for IoT.

The Internet of Things is a truly great environment, which opens a tremendous number of opportunities. Yet, it still possesses problems. Problems include a lack of a unified ecosystem and privacy issues. Those shortcomings are essentially rooted in the concept of Web 2.0. That is where Web 3.0 offers improvements. Internet of Things in Web 3.0 becomes the Economy of Things which is not only freed from IoT's problems and restraints but also gains substantial advantages and potential. The particular reason for that circumstance is due to the implementation of blockchain technology, which will be further discussed in depth.

1.4. Web 3.0

Web 3.0 is taking its shape right now. Generally speaking, Web 3.0 is a new stage in the development of the internet. While Web 1.0 was read-only, Web 2.0 added the ability to collaborate and essentially was read-and-write. Dan Ashmore on Forbes Advisor, calls Web 3.0 a “read/write/own” upgrade to the internet. It's difficult to pin down a clear description of Web 3.0 because it continues to be primarily a collection of concepts. This Web 3.0 vision aims to create a more democratic online environment. It is based on the notion of ownership,

giving the general public control instead of the dominant big data businesses and other centralized authorities (Ashmore, 2022). This is what decentralization entails.

Decentralization enables peer-to-peer economic transactions between internet users, eliminating the need for middlemen and dispersing control away from central authorities. Focusing more on the privacy, transparency, and ownership of users. This is where cryptocurrency and blockchain technology comes into play. This decentralized paradigm is made possible by cryptocurrencies and the token economy, which enable data to be maintained on a distributed ledger beyond the purview of any controlling entity. (Ashmore, 2022).

All things considered, Web 3.0 can significantly affect current markets and even disrupt them. This way previously mentioned the Internet of Things is being reshaped into the Economy of Things. At the same time, the approach to data storage, collection, and transmission is transforming as well. In the following chapters, the innovations and technologies of Web 3.0 will be discussed. It will allow us to understand how the new internet will differ, where the Economy of Things is coming from, and what is its' main value.

1.4.1. Blockchain and decentralization

Web 3.0 will most likely use blockchain technologies and other decentralization tools like DAO (decentralized autonomous organization). Why most likely and not certainly? Because it is not yet clear whether it will be the current blockchain technology or something new will appear. Moreover, it is also unclear which blockchain or blockchains will serve as a ground for Web 3.0, and how they will interact with each other. At the moment, Web 3.0 is in its early stage of development, which makes it hard to predict anything.

Considering how deeply the internet affecting people's dilly life at this point, it is safe to say that Web 3.0 goes far beyond the internet itself and also penetrates the physical world. Web 3.0 is an attempt to change the financial system and the ways of interaction between people. An attempt to form new rules for companies and, even, to reshape the world. "The transition from Web 2.0 to Web 3.0 is seamless and invisible to users. But behind the interface, the structure connecting users to digital services will be noticeably different." (Shmitko, 2022). Web 2.0 author Tim O'Reilly even proposed defining Web 3.0 as "the interaction of the Internet with the physical world." (Shmitko, 2022)

A logical question may arise, what technology will generate such a shift? The answer is blockchain and its derivatives. First of all, it is necessary to understand blockchain. In his paper "Bitcoin: A Peer-to-Peer Electronic Cash System," Satoshi Nakamoto first made blockchain technology public (Nakomoto, n.d., as cited by Pierro, 2017). Although it was a ground-breaking paper, the author's real identity remains unknown. The technology itself first was described in 1991 by a group of scientists and was originally intended to timestamp digital documents to avoid backdating. The use case was a digital timestamp, like a notary (Rodeck, 2022). However, blackchin is a much more multifaceted technology.

Blockchain technology is the backbone of all cryptocurrencies. Moreover, it paved the way for applications like smart contracts, NFTs, and Defi. At its core, blockchain is a technique for storing data that makes it difficult or impossible for the system to be altered, hacked, or otherwise manipulated. A blockchain is a type of distributed ledger that allocates and copies transactions among the network of computers involved. Cryptocurrency transactions, NFT ownership, or Defi smart contracts can all be recorded on a blockchain.

Although this type of data can be stored in any traditional database, blockchain is special in that it is completely decentralized. It can be described as an Excel spreadsheet or a bank database, but instead of being kept in one place by a single administrator, a blockchain database is held on numerous identical copies on numerous machines dispersed throughout a network. The collective name for these distinct computers is nodes. The name "blockchain" is not accidental. The digital ledger is, most of the time, depicted as a "chain" made up of distinct data "blocks." A new "block" is made and attached to the "chain" each time new data is added to the network. To achieve this, all nodes must update their copies of the blockchain ledger to match one another (Rodeck, 2022).

Decentralization and how these new blocks are formed is the key reason why blockchain is seen as being extremely safe. Before a new block is added to the ledger, a majority of nodes must verify and affirm the legitimacy of the new data. They might entail verifying whether new transactions in a block are genuine, or that coins haven't been used more than once for a cryptocurrency. This is quite different from a standalone database or spreadsheet, where one individual can make changes without supervision. According to C. Neil Gray, a partner in the fintech practice areas at Duane Morris LLP “Once there is consensus, the block is added to the chain and the underlying transactions are recorded in the

distributed ledger. Blocks are securely linked together, forming a secure digital chain from the beginning of the ledger to the present." (Gray, n.d., as cited by Rodeck, 2022).

The application of Blockchain technology allows users to keep track of and share a common view of a system's status across a distributed network. This creates limitless opportunities for peer-to-peer value transfers, shared trusted registries serving as an absolute source of truth, and smart contract-based securely executed agreements. In general, Blockchain is seen as a tool for increasing transactional dependability, speed, and efficiency. Blockchain poses the power to disrupt established forms of organizational structure, governance, and company operations (Meunier, 2018). Thus, given its potential, a deeper understanding of the concept is required before discussing the role of value generated by the Economy of Things.

1.4.2. Blockchain Nodes and Miners

To understand the concept of EoT it will be reasonable to examine the major features of Web 3.0. First of all, Web 3.0 will not be running on centralized servers that are owned by specific people or companies. Instead, it will be a distributed database that will be stored on special nodes. Essentially, a node refers to a device that takes part in a blockchain network, typically a computer. It manages the software that powers the blockchain protocol, enabling it to assist in transaction validation and network security. Blockchain nodes exchange information with one another. The network is more decentralized the more nodes there are. (Daly, 2022). Anyone can become an owner of a node. Therefore, no single company will be able to single-handedly remove any kind of content, because thousands of users (nodes) will store a data copy.

Typically, cryptography is used to safeguard transactions, thus for nodes to complete a transaction, complex mathematical equations must be solved. Sarah Shtylman, fintech and blockchain counsel with Perkins Coie, explains that "As a reward for their efforts in validating changes to the shared data, nodes are typically rewarded with new amounts of the blockchain's native currency - e.g., new Bitcoin on the Bitcoin blockchain," (Shtylman, n.d., as cited by Rodeck, 2022).

To validate transactions, many blockchains use mining. In this sense, a miner is a specialized node that confirms collections of transactions in exchange for cryptocurrency incentives. Essentially, nodes and miners handle different aspects of the transaction process. Nodes first validate transactions in the process. On the other side, miners contend with one

another for the privilege of validating those transactions. However, how this is accomplished on various blockchains differs and is primarily dependent on the consensus mechanism of the blockchain. in the most popular approach, miners compete to be the first to solve an equation, it is called proof of work (PoW). In some other situations, miners are chosen at random for the same activity when a blockchain network uses a proof of stake (PoS) consensus process. The successful miner consolidates transactions into a block and confirms them. The block is then broadcast to the network for evaluation by the nodes. Each node verifies the validity of each element in the block before adding the verified block to its blockchain. (Oyinloye, 2022)

1.4.3. Distributed Ledger Technology (DLT)

The term Distributed Ledger Technology, also known as DLT was previously brought up. It is, in fact, one of the major terms, which makes it crucial for Web 3.0 and the Economy of things. In a nutshell, DLT is an advanced database. Generally, ledgers are basic accounting tools, which serve to establish who owns what and who owes what to whom. According to Worldbank "Distributed ledgers use independent computers (referred to as nodes) to record, share and synchronize transactions in their respective electronic ledgers (instead of keeping data centralized as in a traditional ledger)" (Worldbank, 2018). This way, DLT allows stakeholders to maintain their rights, instead of delegating them to third parties.

In the case of this research, the important part is that DLT creates a decentralized data registry system with immediate, transparent, and incorruptible transactions. Not only the ways of sending, receiving, and storing data are crucial aspects of the digital world (Frankefield, 2022). Most importantly, DLT brings vital applications to the Economy of Things, such as the previously mentioned, decentralization. It also allows the utilization Self-Sovereign identity, cryptocurrency, tokenization, and more.

“Distributed Ledger Technology (DLT) refers to the technological infrastructure and protocols that allows simultaneous access, validation, and record updating in an immutable manner across a network that's spread across multiple entities or locations” (Frankefield, 2022). By definition, DLT enables collaboration between individuals and groups in the development, upkeep, and administration of decentralized platforms and marketplaces.

Currently, Google owns its Gmail accounts as well as Facebook owns maintains and profits from its accounts. The user is simply allowed to use them on the terms of such corporations. However, if those platforms were decentralized, everyone with a stake in it, or an interest in it operating efficiently, would build, own, maintain, and profit from the

platform. Such an application would provide a neutral digital environment. “Distributed networks eliminate the need for a central authority to keep a check against manipulation.” (Frankefield, 2022). It enables the creation of such systems, organizations, and markets that are not just more equitable and inclusive but also more transparent and secure. Security is reached because there isn't a single point of attack while transparency is achieved because all stakeholders are participating in maintaining and validating it. It makes Web 3.0 significantly different from the old internet which is rather monopolized. This way Standard apps can turn into decentralized apps, dApps.

Instagram can be a good example. If Meta, a Web 2.0 company, the owner of Instagram, will decide to remove the user's account along with all the content for some reason, they will be able to do so since they have control over the server. It is worth noting that dApps offer the same variety of features as regular apps, including social networks, gaming, entertainment, productivity tools, and more. Many of them are meant to be tools that users can use to access decentralized financial services or Defi. (George, 2022). In this concept, Web 3.0 database copy will be distributed between a large number of nodes. If someone will attempt to single-handedly delete something, it will conflict with the rest of the nodes, and the blockchain will reject this deletion.

1.4.4. Smart Contracts

At this point, all major elements, such as decentralization, DLT, and nodes, which compile blockchain technology were covered. The last element of blockchain is the concept of the smart contract. Simply put, smart contracts are blockchain-based algorithms that are executed when certain criteria are met. They are often used to automate the implementation of an agreement so that all parties can be certain of the conclusion right away, without the need for an intermediary or additional delay.

Smart contracts can also automate a workflow in such a way that when circumstances are met, the following action is executed. Simple conditions, like "if/when...then", are typed into code and placed on a blockchain. That is how smart contracts operate. When predefined circumstances have been verified, a network of computers will carry out the actions. These can entail paying out money to the right people, registering a car, sending out notices, or writing a ticket. When the transaction is finished, the blockchain is then updated. As a result, the transaction cannot be modified, and only parties to whom permission has been granted can view the outcome (IBM, n.d.). Like any standard contract, smart contracts have the

ability to establish rules and have the system automatically enforce those rules. Smart contract interactions are irreversible by default and cannot be undone.

1.4.5. Cryptocurrency

Now that understanding of blockchain technology has been established, it will be reasonable to talk about the advancements this technology brings. One of the key differences between the Economy of Things and its predecessor, the Internet of Things, is something that can be seen from the name, the “economy” part. One of the reasons that make the Economy of Things an actual economy, is the addition of currency to automated processes.

It has been established that EoT is a branch of Web 3.0 in which almost everything is built around blockchain, including currency, which on the blockchain becomes cryptocurrency. As a matter of fact, when mentioning blockchain, people tend to associate it with digital currencies, such as Bitcoin. It is a reasonable way of thinking, considering that the primary cryptocurrency, Bitcoin, is what made blockchain popular in the first place.

For this research, there are a few reasons to focus on cryptocurrencies, or as they are often referred to "cryptos". Reason one is simply the fact that cryptos possess monetary value, which is important for any business-related research. It results in the second reason, which was mentioned earlier. Blockchain brought cryptocurrencies into the Web 3.0 environment. The added economic aspect is one of the reasons why the Internet of Things transformed into the Economy of Things. The majority of people know that there is a Bitcoin and a few other cryptos on the market. However, to understand the EoT environment better, it is necessary to cover the concept of cryptocurrency in more detail.

A cryptocurrency is a type of digital or virtual currency which use encryption to protect it from counterfeiting or duplicate spending. The foundation of many cryptocurrencies decentralized networks on a blockchain is a distributed ledger enforced by a dispersed network of computers. The fact that most of the time, cryptocurrencies are not issued by any central authority makes them potentially impervious to intervention from or manipulation by governments. Cryptocurrencies allow for safe online transactions without the need for middlemen (Frankefield, 2022).

The term "crypto" refers to the numerous cryptographic methods, such as hashing, public-private key pairings, and elliptical curve encryption, that protect these entries. It is possible to mine cryptocurrencies or buy them via exchanges. Each unit, or coin, of

cryptocurrency, is referred to as a currency token. Today's market accommodates thousands of cryptocurrencies. Every cryptocurrency claims to have a distinct purpose and specification. Ethereum's ether, for instance, positions itself as gas for the underlying smart contract platform. Banks utilize the XRP cryptocurrency from Ripple to make international transactions easier. Solana, Litecoin, Ethereum, Cardano, and EOS are a few other well-known coins. (Frankefield, 2022). The total market capitalization of all cryptocurrencies by December 2022 is over $855.43B (CoinMarketCap, 2022)

Currency tokens are tradable, which, obviously, implies that cryptocurrency is a part of the financial section. For Web 3.0 there is a new concept for finances as well, called Defi, decentralized finances. The term "decentralized finance" refers to a variety of blockchain-related services and apps that aim to expand the use of this technology and displace the current, centralized financial system. Compared to conventional systems, the absence of intermediaries and dispersed control over the system offer a number of benefits. As such, Defi does not have geographical limitations. In turn, this and the lack of intermediaries improves the speed of transaction. Plus, it is more transparent and safer due to the nature of blockchain. Finally, due flexibility of smart contracts it is programmable, meaning that allow superior automated solutions. (Smith, 2022)

It was established, that there are a huge variety of different tokens and cryptocurrencies. However, in the concept of the Economy of Things, the currency has to fit a few required criteria. First, it has to allow micro-transactions. In the EoT things need to be able to share microtransactions, as small as 0.01 cents. Second, the criteria are low fees. Simply put, high fees would make micro-transactions non-viable and consequently – impossible. Lastly, the third criterion is the availability of direct transfers, also known as peer-to-peer. This is imperative, as the whole concept of EoT implies things operating in the economy themselves, with no intermediaries. Moreover, most of the time intermediaries are the reason for high-transaction fees, and avoiding them makes micro-transactions possible.

Circling back to the example of John in chapter 1.3.2, for John, it simply means that his car starts to charge instantly, autonomously, and cheaper than before. All those discussed elements combined create the Economy of Things. Ultimately the Internet of Things evolves into the Economy of Things based on testified data, fair trade, and justifiable pricing (Davidsen, n.d.).

1.4.6. Tokenisation and Non-Fungible Tokens

Talking about cryptocurrency, tokens have been mentioned already. People tend to perceive tokens as digital coins of some cryptocurrency. This perception is not wrong, such tokens are referred to as currency tokens and possess specific monetary value, and are a denomination of a cryptocurrency. However, the concept of the token goes far beyond that.

Essentially, tokenization is the process of exchanging sensitive data for non-sensitive ones. Such data is what is called "tokens" which can be used in a database or internal system without bringing it into scope. The original sensitive data is then safely stored outside of the organization's internal systems. A token is a piece of data that stands in for another, more valuable piece of information. Tokens have virtually no value on their own they are only useful because they represent something valuable, such as a credit card primary account number or personal ID number. Unlike encrypted data, tokenized data is undecipherable and irreversible. As a result, a breach of a tokenized environment will not compromise the original sensitive data. A good analogy is a poker chip. Instead of filling a table with cash (which can be easily lost or stolen), players use chips as placeholders. However, the chips can’t be used as money, even if they’re stolen. They must first be exchanged for their representative value. (Phillips, 2022).

In Web 3.0, most likely, all data on the network, including users’ content, photos, videos, pictures, and so on, will be tokenized. This way, any sensitive data will become protected. Such data is replaced with tokens, which then can be traced to the original data via the tokenization system. What adds to the protection is the previously mentioned fact that without the tokenization system in place, tokens become useless because they cannot be reverted. It is important to point out that virtually anything can be tokenized. For instance, "In 2018, Elevated Returns, a New York-based asset management firm, completed its first tokenization real estate deal. The offering was made on St. Regis Resort in Aspen, Colorado, worth $18 million on the Ethereum blockchain." (Taylor, n.d.) Tokenization in the sphere of real estate implies the practice of dividing ownership of an asset using tokens. It helps to 'liquidate' the illiquid real estate assets.

Another example given by Taylor is the tokenization of artwork. Artists can create a limited number of replicas of the art piece, such as prints of their painting. Next, those prints may be tokenized by assigning ownership of the prints to a certain company. The business

can then allow customers to exchange their tokens for a single copy. (Taylor, n.d.) However, there is an even more thrilling concept in tokenization.

Previously discussed tokens were fungible. Meaning that, just like a dollar bill, it has value. Yet, a single dollar bill is identical to another one. Fungible tokens, including cryptocurrencies, are indistinguishable from one another. However, there are also non-fungible tokens, commonly known as NFTs. While NFTs are usually encoded with the same fundamental software as fungible tokens, they possess distinctive identification codes and metadata that differentiate them from one another. NFTs have a variety of potential applications. For instance, they are the perfect means of virtual proof of ownership for digital assets, like art or photography, or physical ones such as previously mentioned real estate. NFTs, which are based on blockchains, can also be used for identity management or to cut out middlemen and link artists with audiences. (Sharma, 2022). On top of that, NFT can be sold at a certain price in cryptocurrency, which also opens an opportunity for collectibles. Overall, NFTs can eliminate middlemen, seal ownership, streamline transactions, and open up new markets.

This way, in Web 3.0 any photo taken can be unique and have proven ownership as an NFT. This approach will also make it easier for content creators to monetize content. Circling back to Instagram, each of the user's photos can be NFT, but it does not mean that people need to sell them. Such tokenization simply confirms that a person is a creator and an owner of a specific image. This picture is an original and can be verified through the blockchain. No one is capable of stealing or removing such an asset and even if it was copied, the original is easily identifiable.

A logical question may arise, if Instagram in Web 3.0 cannot simply remove content, then what should be done with a cluster of spam, pornography, and other types of obscene content? Moderation and bans are still required, but the tools will require upgrades and democratization. Web 3.0 assumes that all organizations, companies, service providers, and applications will become DAOs - decentralized autonomous organizations. DAO does not have a CEO or board of directors. Instead, it has users who have the right to vote and share a common in the best interest of the organization (Reiff, 2022). It is the DAO that will determine via voting the tariff scale and editorial policy, the number of rewards and punishments.

1.4.7. Self-Sovereign Identity (SSI)

The next feature of Web 3.0 is upgraded user identity. The concept is called Self-Sovereign Identity, or SSI. It is a vital concept not only for Web 3.0 but also for the Economy of Things. Therefore, requires a thorough explanation. In the article done at Bosch, SSI is explained as "digital identities that are managed in a decentralized manner. This technology allows users to self-manage their digital identities without depending on third-party providers to store and centrally manage the data." (Bosch, n.d.).

Firstly, Web 3.0 allows one to surf the web, download files and purchase them, without leaving a trace of the user's real identity. Most likely, there will be special services in which users will be required to verify their identity and create their digital identity certificate. Further, when interacting with different dApps, those will identify that a real person stands behind the identity and that it is, indeed, his identity. Thus, the actions will be transparent and accessible to everyone, and the history will be tracked. At the same time, it will be impossible to trace the real person due to encryption.

Secondly, Web 3.0 identity will be cross-platform, meaning there will not be a need to register every time. Users will be able to use their identity everywhere. Also, due to SSI and tokenization, any digital items can become cross-platform. Here it is reasonable to consider an example of blockchain videogames. Firstly, it has already been mentioned that Web 3.0 processes do not operate on a single server, but on a decentralized database. Therefore, everything that person has earned or collected in the game cannot be taken away. On top of that, all those tokens will be tied to the user's SSI. Simply put, if a player finds or purchases a sword in a game, it can be transferred to another game, or sold on a marketplace. Boreham describes this scenario as follows, "SSI can unlock new gaming experiences alongside non-fungible tokens (NFTs). NFTs are fantastic for capturing uniqueness and scarcity, whereas SSI is perfect for storing, updating, and proving characteristics. Imagine gaming where your progress/skins/items can be ported across to another game." (Boreham, 2022).

Describing the advantage provided by SSI, one cannot but say about the metaverse. This is a very broad topic, which goes beyond the scope of this research, but it still needs to be briefly mentioned. Metaverse is the term that describes the digital world usually accessed via means of virtual reality. In fact, the Metaverse is an upgrade of social networks from Web 2.0. The user will have an identity with the properties described earlier, a virtual crypto wallet, and all the digital content tied to it. The real identity, however, will be hidden thanks

to encryption. All this will function on a decentralized database and be managed through DAOs. On top of that, by utilizing technology such as AR and VR (augmented reality and virtual reality), the metaverse can take the current social media experience to another level. "SSI will enable this in the metaverse by allowing users to control their information, in line with its core decentralization and digital ownership features." (Boreham, 2022)

Finally, how will SSI affect the interaction between things? A Self-Sovereign Identity is a digital identity that is owned and controlled, unlike a Facebook account, which can be used, but not owned. SSI makes it possible not only for people but for things as well. SSI "is the concept of individuals or organizations having sole ownership of their digital and analog identities, and control over how their data is shared and used" (Metadium, 2019). With their SSIs, machines, vehicles, and sensors will be able to own their identities and have complete choice over how their data is shared and used. It is a crucial layer of flexibility and security that enables them to only expose the information required for any given interaction or transaction, independent of any third parties.

The described concept can be illustrated via another example of John. On the decentralized charging network, digital representations of John, his automobile, and the charging station are all present via SSI. The digital car validates and authenticates itself and pays the digital charging station when the real John is in his real car and approaches a real charging station. While for John it seems that nothing has happened, the whole process took place in the digital world immediately. Such processes can move considerably more quickly and smoothly in the digital world than in the physical one. Things can instantaneously establish their credibility, enabling them to interact and operate immediately with complete autonomy.

1.4.8. Real Life Scenario

Considering all previously discussed technologies, the future of the internet indeed seems very bright. To universally adapt all advantages of EoT and blockchain internet has to transform into Web 3.0. However, the transition to Web 3.0 is going to be a long and complicated process. It is necessary to revise the entire internet stack and move from generally accepted protocols like "HTTP" to some new, decentralized ones. It will also require changing the existing company project management schemes to DAOs. All of this is a massive shift, not only for the entire economy but for overall life on the planet. In addition,

ordinary users also will require time to switch to dApps, to adopt and understand various aspects of Web 3.0, such as all elements of blockchain, and many more.

Despite the complications, the age of Web 3.0 is beginning already. There's a company called Brave and the Brave browser blocks the tracking of users' data. The user gets to retain privacy and owns his digital data. It opens an opportunity to choose whether or not to be a subject of ads, which is unpresidential in Web 2.0 browsers. On top of that, a user gets paid for watching ads directly from the advertiser (Brave, n.d.). It means that personal data transforms into people's assets.

Web 3.0 already impacts not only users but content owners as well. There's another company, Audius. It is supported by quite a few well-known musicians. Much like how Brave is a new alternative for browsing, Audius is an alternative to music streaming. These artists can post their songs on the platform and listeners can buy Audius tokens and with these tokens, they can access the music (Audius, n.d.). What changed here is that creators now have a direct pipeline of audience engagement. This concept cuts the intermediaries, such as labels, and streamlines creators' revenue.

Lastly, there is a business-related product, called Avalanche. It offers instant finality, which is essentially instant settlement. (Avalanche, n.d.) Now payment happens at the point of transaction, at the point of sale. In comparison, an international Swift transaction takes about 5 days and for any restaurant business, it takes 30 days to finally access the customer's money, not to mention fees (Swift, n.d.). Instant settlement is unlocking trapped capital. Trapped capital is essentially money in transit, waiting for counterparties to validate a transaction. Among other things, Web 3 unlocks trapped capital, which increases the velocity of money and boosts the economy.

1.5. Summary

To sum up, everything that has been stated so far, World Wide Web has gone through an amazing journey. From read-only databases to advanced decentralized networks, where things can function in the economy, completely autonomously. The Word Wide Web was created by Tim Berners-Lee in 1989. Web 1.0 was a collection of static pages (read-only). Web 2.0 was marked by the appearance of social networks and gave humanity a tremendous number of advantages, such as collaboration, content creation ability to search virtually

anything, and many more. One of the novelties which Web 2.0 brought was the Internet of Things (IoT), which is an autonomous collaboration of smart devices via the web. However, it brought some disadvantages as well, lack of privacy and an avalanche of targeted ads. At the same time, it made apparent the fact that one of the most valuable assets in a digital world is data. Yet, only properly handled and interpreted data is truly valuable. Consequently, some evident flaws of Web 2.0 appeared, and at this point, the emergence of Web 3.0 began.

Web 3.0 is a logical step in the evolution of the internet. It utilizes new technological advancements, improves many spheres of the economy, and allows the existence of the Economy of Things (EoT). The ground on which the Web 3.0 concept is standing is blockchain technology. Blockchain is known for its decentralization, security via encryption, traceability of data, speed of transaction, and overall technological superiority. It is achieved via a few underlying technologies. Distributed ledger technology (DLT), which is an advanced database. It allows decentralized, immediate record, validation, and access to data which remains secure due to the use of nodes. Nodes, at the same time, are usually individual computers that take part in the blockchain network and exchange information with one another. Essentially, everyone can become an owner of a node. Blockchain also utilizes smart contracts which can establish and atomically enforce rules.

The technology of blockchain became popular due to cryptocurrencies, such as Bitcoin. Cryptocurrency is a token that possesses monetary value and can be mined (generated) or purchased, as well as used as means of transaction via blockchain. Cryptocurrency is imperative when discussing EoT, as currency is what transforms the Internet of Things into the Economy of Things. Not all tokens are currencies, however. Essentially any sensitive data can be transformed into non-sensitive data via tokenization. A token is a piece of data that stands for more valuable data, like a poker chip, instead of real cash. It is predicted that the majority of data will be tokenized in Web 3.0.

Typical tokens are fungible, just like one dollar bill is identical to another dollar bill. However, there are non-fungible tokens – NFTs. NFT has distinctive metadata encoded, which is what allows one to differentiate one NFT from others. In Web 3.0 NFTs can solidify ownership of certain content, like an Instagram picture. This way the original creator of the photo will always be tracible and people will have more control over their digital assets.

One of the most important features of the Economy of Things, which blockchain brings, is Self-Sovereign Identity (SSI). SSI is a digital passport that can be assigned to

people or things. It allows immediate identification and due to encryption remains secure. All those advancements of Web 3.0 let the Economy of Things exist and significantly improve people's life by giving them freedom and security boosting the economy and opening new business opportunities.

Adoption of Web 3.0 is not a simple process, but it already started as Web 3.0 startups are present and successful. By searching for a music band user will receive Brave browser tokens. Then via the Avalanche platform, those tokens can be instantly swapped. Finally, swapped tokens can be used to purchase a music album on Audius. All that while boosting an economy. Full adoption of Web 3.0 will certainly take a significant amount of time and it is impossible to say how much. However, the adoption of Web 3.0 is now becoming a need for almost all enterprises, and it will only become more so as time goes on. It will probably be well worth waiting because of the benefits it provides in terms of greater openness, verifiability, availability, and confidence.

Today, neglecting Web 3.0 is equivalent to the Internet's tardy adoption 25 years ago (Boder, 2021). It can be said that migration has started as Web 3.0 technologies already improving products of standard Web 2.0. As for the Economy of Things, it is, in fact, here. While EoT is not an established term yet, and people still tend to call this environment IoT, it actually fits the description of EoT. The modern Internet of Things actively utilizes artificial intelligence, various blockchains, SSI, and cryptocurrencies. Therefore, it can be said that while Web 3.0 is not fully adopted yet, a certain form of Economy of Things is already existing. It functions, opens new business opportunities, improves, and caries sustainable value. The economy of things, sustainable value creation, and its role in start-up businesses will be examined in the next chapter.

2. THE ECONOMY OF THINGS: OVERVIEW

2.1. Terminology

First and foremost, when talking about the Economy of Things, it is important to restate that EoT is not an established term. As a matter of fact, even the Internet of Things is not a kind of conventual term that can be found in a dictionary. The idea proposed by Kevin Ashton was to supply computers with larger volumes of useful data which could be obtained via the use of RFID tags and sensors. (Gabbai, 2015) After that people from the IT world started to use the term IoT to describe a digital environment in which machines collect data and exchange it with one another. A full description of the IoT concept was given in chapter 1.3.

As time passed, and the internet started to evolve into Web 3.0, the concept of IoT started to gain more features and advancements. When IoT functionality surpassed the definition by Ashton, some people started to call it differently to differentiate various stages of IoT development. Among the names are, Economy of Things (EoT), Artificial Intelligence of Things (AIoT), Cognitive Internet of Things (CIoT) M2M (Machine to Machine) and Future Internet of Things (FIoT) (Lele, 2022). However, essentially, all of those terms refer to a similar concept. Namely, an advanced version of the Internet of Things based on blockchain features. It usually includes microtransactions via cryptocurrency, artificial intelligence, advanced methods of data collection and storage, and smarter "things" within the environment.

Yet, many people still call this phenomenon the Internet of Things. This clarification is crucial for understanding, as terminology might get utterly confusing when talking about EoT. In this research further discussed phenomenon will be referred to as the Economy of Things (EoT). Drawing the line, essentially IoT is a branch of the Web 2.0 environment, while EoT is its evolved counterpart in Web 3.0.

2.2. Understanding the Economy of Things

To understand the concept of EoT fully, it is necessary to talk about the technological side of this phenomenon. In its ground, EoT is a network of networks. As has been mentioned, there is no precise definition for this term. Mainly, people understand those concepts as an economized compilation of advanced smart devices, like smart fridges, smart

weights, smart cars, and smart homes. However, there are a few more elaborate definitions, which can be given while describing the concept.

The first one is that EoT is a compilation of sensors, physical objects, digital products, and services, which are untied into one global network with analytical and intellectual abilities, and an internal economy. Second definition claim that EoT is simply a compilation of key technologies which allow the paradigm of EoT to exist. "Imagine a world of connected devices that do not just upload data to the cloud, but actually generate value and exchange that value with people and other things/machines. This is what Bosch refers to as an EoT – an Economy of Things… the road to a trustworthy digital "Economy of Everything" (Scharmann, n.d.).

Mentioning key technologies, it would be reasonable to talk about them in detail. The technology of blockchain and all its derivatives were already covered in chapter 1.4. Other technologies include sensors, which are the eyes and ears of EoT, which allow the collection of data (Halim, 2022). Wireless connection protocols grant the ability to transfer collected data (Rackley, 2007). Power supply technologies, such as batteries, allow sensors to function. Cloud technologies, store collected data and, most immortally process them. Machine learning helps to classify and interpret data, for instance, to generate analytical forecasts. (Halim, 2022) Also, security and privacy are crucial for EoT. Those technologies are the once based on blockchain. Moreover, the economical aspect of EoT is also handled via the application of cryptocurrency (El-Hage, 2018).

It has been mentioned before, that EoT is not a new environment, but an evolution of the IoT environment. Tracking the process of this evolution, IoT emerged when people started to use RFID tags to identify things in an internet network. Then it became possible to connect sensors and devices to the internet and to send and visualize data. Overall, it became possible to set up a chain of data collection and data interpretation based on its actuation. The "things" included in this process are not necessarily physical devices. It can be a digital application or a social network (Serpantos, 2018). However, in line with the development of artificial intelligence (AI), neural networks, and blockchain technology, the Internet of Things is gradually transforming into the Economy of Things. AI allows cognitive or intellectual collaboration between things and fully autonomous operation (with no human interaction). (Tzafestas, 2018) At the same time blockchain allows decentralization and

economization of this collaboration. However, while autonomous and economized, EoT can adjust to human needs understand them, and generate economic value.

2.2.1. Blockchain in the Economy of Things

EoT is not a new industry, but instead an evolved Internet of Things. One of the key technologies which endorsed this evolution is blockchain. This statement provokes a question, what exactly blockchain adds to the environment of EoT? Blockchain is a topic that is currently being brought up quite often, even in this research a substantial part was dedicated to it. However, the major topic of conversation a few years ago was the Internet of Things (Wojciechowicz, 2018). IoT quickly overtook other technologies as the most popular of its time. Now, blockchain is catching up to it in terms of popularity. (Calabrese, 2021) The IoT market is currently worth over $621.6 billion (Vailshery, 2022), whilst the blockchain market (not to mistake with the cryptocurrency market) is just getting started at $5.85 billion (Statista Research Department, 2022).

The Economy of Things combines advancements of both the most potent technologies. As stated by Agarwal, “Aftrex Market Research in 2018 discovered that the total Blockchain and IoT market could grow to $254.31 billion in 2026” (Aftrex Market Research, as cited by Agarwal, 2022) The symbiosis of IoT with Blockchain creates the framework for an Economy of Things, offers a wide range of innovative, ground-breaking use cases, and creates unfathomable new market prospects (Davidsen, n.d.). To understand EoT, it is necessary to examine how these IoT and blockchain technologies can be combined to produce effective solutions for a variety of business problems.

2.2.2. Data Collection and Scaling

IoT essentially makes effective use of the internet's potential to connect people, locations, and tech-enabled objects. Additionally, it aids in automating procedures and systems. On the other hand, blockchain is a decentralized technology that uses tiny blocks to store data. A single piece of information is split up into several blocks and stored in a chain. Resulting in improved security and privacy, while adding a layer to the economy due to accessibility to cryptocurrencies.

The benefits of such a combination are numerous. For once, since the IoT is a centralized system, scaling can be an issue. All succeeding systems' data gathering, connectivity, and authentication are handled by the central system. Organizations are required

to spend sufficient resources to handle this. EoT, on the other hand, will function on decentralized technology which can easily handle multiple service requests. This makes the system more efficient and reduces the chance of developing a bottleneck. The distributed network automatically adds extra blocks to the chip when scaling up because it is decentralized, providing significant benefits in terms of scalability (Moudoud, 2022) Aside from that, the request's authentication is handled by multiple distributed systems.

2.2.3. Security

In contrast to a distributed system, if the central system is breached, it compromises the security of the entire network. EoT solves the issue of security through blockchain. Blockchain technology was designed particularly to increase users' security and privacy. It is transparent, and any data changes are tracked and documented. Furthermore, users don't have to worry about the central system being compromised because the data on the blockchain is distributed. EoT can also help in reducing or, at least, identifying inefficient processes. (Davidsen, n.d.) EoT allows a record of data regarding the state of a process automatically and then saves this data on a blockchain. Overall, the implication of blockchain makes EoT not only far more secure and scalable but also adds to further improvements in autonomous collaboration between "things".

2.2.4. Automation

Smart contracts, discussed in chapter 1.4.4, are another useful advancement. Those can help organization automate their contracts in a secure, unbiased, and efficient manner. With EoT businesses can record, analyze and enforce the terms of a contract automatically. This reduces human effort as well as the possibility of data tampering and further automates processes. A permissioned blockchain ledger can create a tamper-evident record in business networks when data like location, temperature, or other properties needs to be shared. (Schmitt, 2019) This opens up new opportunities for business process automation among partners without the need to build a centralized IT infrastructure, while all people and “things” can access the same information.

2.2.5. Economy

As the name itself implies, the Economy of Things also possesses a distinctive feature in comparison to the Internet of Things. The environment has an internal economy. Through the application of blockchain and cryptocurrency, EoT can generate tokens via internal

operations. As previously discussed in chapter 1.4.8, Web 3.0 startups that reward users with tokens can serve as an example. The specific difference in EoT is that the ones who are being rewarded are not people, but machines or devices (Mercan, 2021). This way machines can exchange tokens for services with one another. It is achieved via specific interpretation and application of useful data that machines collected.

Data is what allows EoT to function. The simplest example would be a miner. It is a device that generates cryptocurrency by solving a mathematical equation, it was deeper discussed in chapter 1.4.2. Consequently, a miner can then send crypto-tokens it obtained, to charge a smart car, which autonomously drives to a charging station and pays for electricity. Now the charging station gets those tokens and so on. Such processes function fully autonomously, with no human interaction involved.

Furthermore, any type of economically relevant data is autonomously tradable in the Economy of Things. As a matter of fact, digital coins are just a specific type of transferable asset (Davidsen, n.d.). However, not only EoT has its own economy, but it also helps develop a new shared economy with decentralized applications. Decentralized applications within the ecosystem can help to increase revenue by seamless sharing of services and goods, thus, boosting an overall global economy.

While the Internet of Things refers to things becoming contextually aware and linked, the Economy of Things is the ability of these gadgets to autonomously monetize and exchange the data they collect. Therefore, when new valuable data is drawn from the Internet of Things, the Economy of Things is generated. It indicates that the physical world is being liquefied by the transformation of physical assets into digital assets that can engage in brand-new disruptive digital markets. “If IoT is digitizing the physical world, then the Economy of Things represents the liquefaction of the physical world. (IBM Institute for Business Value, n.d.).

It is worth pointing out that EoT does not only refer to smart gadgets which can communicate or a smart home, it is far more than that. Namely, a world in which networks of interconnected "things" communicate with one another, search for what they require, and engage in autonomous trade in brand-new online markets, consequently turning data into value. EoT can generate value by trading energy for money, exchanging currencies, authentication, and many more. Most importantly, such processes are autonomous, secure, and require no intermediaries.

2.3. Future of the Economy of Things

2.3.1. Theoretical Example

To illustrate the future of EoT, it is needed to return to the example of John, who got home from work, approximately, in the year 2030. His smartwatch communicates his arrival time to his smart home assistant and then places an order at a local food takeaway. The payment is seamless and automatic. The home has made a payment for the food it ordered. Such a concept is currently being tested by Uber, which is trying to autonomously deliver food to people's houses with robots (McFarland, 2022). When the food was prepared, the restaurant streamed money directly to the delivery drone via micro-transactions for each second the drone was on its journey, delivering John's food. Similar drones are used by Amazon and starting deliveries this year. (Tarasov, 2022)

The autonomous car is already aware that John needs to get home. It arrives at the office by itself at the right time. It could be a Tesla, as already "Tesla's 'full self-driving beta is now available to everyone in North America" (Porter, 2022). The city is, presumably, also smart. The definition of a smart city by IBM is a city that makes the best use of all accessible interconnected information to better comprehend, control, and manage its operations while making the best use of limited resources (Dirks, n.d.). Such a city knows the locations of all vehicles in it. Not only does it ensure a safe drive, but warns the car of an incident 5 kilometers ahead.

The car takes a safer and faster road. Despite the traffic, it knows the exact arrival time, avoiding any delays. When the car delivers John home, it can earn money by continuing to serve as an autonomous taxi. For instance, according to The Guardian, the state of California already allowed smart taxis to operate in San Francisco (The Guardian, 2022). With the addition of micropayments, a taxi can credit passengers for each meter they traveled, and use earned tokens to recharge its battery.

At the same time, the drone delivers takeaway food orders right at the door. A drone goes to the charging station to charge its battery. In the Economy of Things, the drone will be able to transmit a tiny amount of payment for each second it receives this electricity. It might be as little as be as 1 cent, a micropayment.

Micropayments can be made in real-time in exchange for a service. Such micropayments are seamlessly enabled because of blockchain. Stringing many

micropayments together one after another allows for a payment stream. It is a time-saving, cheaper, and autonomous machine-to-machine (M2M) transaction (El-Hage, 2018). If each micropayment was being used to access a small amount of electricity for the drone, then the payment stream allows the drone to access electricity continuously so it can charge itself repeatedly with no human interaction. This way the Economy of Things enables decentralized autonomous cooperation between things.

2.3.2. Technological Advancements of the EoT

After the foregoing example of the Economy of Things, it would be reasonable to explain how would those processes go, if there were no Economy of Things. In this case, just to charge the car, John would have to undergo a procedure very similar to a typical gas filling, but more complex. He would've searched for a charger, but he could not use any charger just like people do with gas-powered cars. Instead, he had to ensure that it is compatible with his car. Only then he can plug in his car and manually pay for the electricity via card or cash.

IoT allows John to automatically pinpoint compatible charging stations. At the same time, EoT adds more on top of that. It improves all related processes via the implementation of AI, neural networks, SSIs, and decentralization. AI and neural networks allow exchanging and understanding of data between things, which creates intelligent, a semantic collaboration between things. All things have their Self-Sovereign Identities, which make the authentication process completely seamless. Finally, blockchain allows autonomous payments via cryptocurrency microtransactions, while Decentralization ensures the safety of such processes and the scalability of similar projects.

2.3.3. Expectations for the Development of the EoT

While it might sound too futuristic, some such projects already exist. Those reduce the reliance on middlemen and function autonomously. An individual can offer a good or service and transacts directly with a customer. This is a peer-to-peer economy. The economy of Things is a s also a peer-to-peer economy, but involves machines, or things. The potential of IoT combined with Blockchain technologies ultimately points to a world where data will be valuable and traded using machine-to-machine transaction models. As a result, data trading becomes of utmost relevance for both organizations and consumers, considering the financial value that data contains (Davidsen, n.d.).

While the described picture of a world requires a significantly more advanced ecosystem for things, it is achievable due to all Web 3.0 advancements. Even though such kind of world might never become a reality, separate improvements which were proposed will certainly become a daily routine eventually. The Economy of Things is a very new, developing industry, which is not fully fledged yet. However, because of all improvements regarding data collection, automation, decentralization, and economization, EoT is already present in the current world. Considering new business opportunities EoT creates, as well as rapid IT developments, it stands to reason that the Economy of Things will become more advanced and adopted as time goes by.

2.4. Sustainable Value Generated by the Economy of Things

2.4.1. The Concept of Value

In order to understand what is sustainable value generated by the Economy of Things, it is first necessary to discuss the concept of value itself. According to an article by Goswami, the term "value" has two meanings, which are not mutually exclusive. In ethics, the term "value" refers to orientations, standards, and goals that direct and motivate people's behavior (Goswami, 2012).

Value in economics refers to the exchange, use, and capitalization value of products and is, essentially, associated with money. Economic value is calculated based on demand, utility, and relative rarity. Value also refers to a company's ability to generate income and is known as shareholder value. Contemporary industrial business value creation is a complicated, multifaceted topic with new aspects constantly appearing (Goswami, 2012). According to Cambridge Dictionary, “the value of an asset calculated according to its ability to produce income in the future” (Cambridge Dictionary, n.d.)

Talking about business and start-ups, it is reasonable to focus on economic value. However, economic value is a broader term than monetary value or cost. Josh Kaufman explains economic value as follows. Every time a customer purchases a business, they are declaring that they value what the company has to offer more than an alternative that their money can purchase. Finding out what potential clients appreciate more than the purchasing power of their money is one of the main priorities when creating an offer. (Kaufman, 2010).

In other words, economic value is what a business has to offer and what allows a business to be viable.

2.4.2. Values of the Contemporary IT Business Industry

Currently, the world is at the point where "data will have value and be traded through machine-to-machine transaction models" (Davidsen, n.d.). Web 3.0 makes the world tradable. As it was mentioned before, it brings value in different forms and this value is sustainable. Meaning that the value grows without interferences. Now, it is necessary to focus on the value generated by this environment in more detail.

The way EoT allows to monetize the data has been established already, an electric vehicle can autonomously find the charging port, drive to it, and get changed. The payment is handled automatically via blockchain microtransactions from a digital wallet. The convince of service that the user gets is impossible to overlook. However, not only the consumers understand the such value, but also businesses. The monetary merit that data used in such structures holds, has great potential and can be utilized by a lot of existing businesses including new start-up digital companies. It is also worth noting an industrial application of the technology. It allows machines to operate autonomously on an industrial scale and create automated B2B relations.

The Economy of Things is a derivative of Web 3.0. According to Petras National Centre, the acceptance of EoT and the exploitation of its economic potential reflect a process that occurs at the interconnection of advancements in three key areas: social, technical, and economic. This is due to the fact that the EoT offers much more than just goods and services. The visible component of the environment is represented by "things," but what the EoT actually entails and how it functions go much beyond smart devices. It is an interconnection of digital and physical objects, such as sensors, data repositories, external parties, business models, actuators, and so forth. Petras National Centre's specialists refer to these linked groups as EoT constellations (Petras National Centre, 2022).

What EoT offers in fact, is data that is properly gathered and processed due to such constellations. Such data can be utilized to offer various products within the EoT environment. Therefore, it is critical to understand the process of data generation in EoT to fully understand its significance.

2.4.3. Significance of Data

Throughout the research, a lot of attention was paid to data. Indeed, data analysis and interpretation are vital for EoT. In May 2017, The Economist magazine wrote that "The world's most valuable resource is no longer oil, but data" (The Economist, 2017). It appears to be true, not oil, nor real estate, but data indeed. Data collection is crucial, but as mentioned in chapter 1.3.2, it is truly valuable when properly analyzed and interpreted. It allows the identification of some patterns, solves classification issues, and generates predictive analytics. It can be said with certainty that properly collected data is the ground of the EoT.

There is a saying among data scientists, "garbage in, garbage out", commonly referred to as GIGO, implying that poorly collected, imprecise or useless data (garbage in) leads to incompetent, unusable results with no value (garbage out) (Daintith, 2008). Therefore, the main goal of data is to provide context and solve some product-specific task or problem.

Data is now an essential resource for the worldwide economy. The Internet of Things paradigm offers great potential because things can obtain, process, and transport data, resulting in the creation of digital assets. Consequently, in the Economy of Things, these digital assets are gaining further value, being automatically exchanged for some other digital assets, such as blockchain-based currencies. (Davidsen, n.d.). However, data was present since the early days of the internet, Web 1.0 was essentially a data library. Therefore, it will be reasonable to ask the question, why data became so valuable only recently? To answer that, it is necessary to understand, which technological advancements allowed the emergence of the EoT industry. The Economy of Things is a consequent development of the Internet of Things. This development encountered quite a few obstacles due to the technological restraints of its time. EoT heavily relies on data. Thus, mainly those restraints were related to data collection, transition, and interpretation.

2.4.4. Evolution of Data

Data collection

"At the beginning of any economic process is the resource. It is the ingredient subjected to trade. Resources typically range from goods, such as oil, coal, or gold. In the imminent future, digital data will also become a resource." (Davidsen, n.d.) At the end of the 20th century sensors required for data collection were rare and expensive, and there was no variety of widely accessible motherboards. Overall, there were no hardware systems that

could make EoT a reality. However, as the industry progressed, a tremendous variety of low-power sensors appeared, which initiated a push for the development of smart things, leading to the establishment of the Internet of Things. Because nodes can be produced at incredibly low costs thanks to VLSI technology and Moore's law, EoT rapidly develops. Now for "things" to function, chips of a few square millimeters are sufficient for processing, and networking. (Serpantos, 2018)

In today's world, due to EoT's processing protocols, expensive and precise sensors are essentially not needed. Effectively, all social networks and online services can now function as EoT data collection sensors. It is rather important because "there is a growing market for personal data that are gathered from social networks and related cloud platforms. The increasing presence of smart devices and their tremendous production of data will provide new dimensions of economically meaningful resources" (Davidsen, n.d.)

Data storage

Data that was collected or generated must be properly stored. A structured collection of data is called a database. Databases can be used by businesses in a variety of ways. The organization of customer and client information might be aided by a database. Data on product inventory may be present in a database. Sales, costs, and other financial data can be tracked in a database. (Pilon, 2013). Throughout the development of the web, volumes of data became tremendously large. The cumulative volume of data is referred to as big data. "IoT connections already generated 13.6 zettabytes of data in 2019 alone and by 2025, more than 150 zettabytes of big data will need analysis." (Djuraskovic, 2022). Massive volumes of data are currently being produced by a variety of IoT devices, including machine sensors and smart devices.

Currently, general data storage is handled by various cloud service providers. Cloud service providers offer on-demand infrastructure and technologies to support a variety of use cases, such as web and mobile applications, website hosting, e-commerce, media and gaming, managed services, and many more. In addition, some public cloud service providers also offer Software-as-a-Service (SaaS), which are mainly apps aimed at an end user. (Zhang, 2022)

Machine-generated data is typically unstructured or semi-structured. Due to their intrinsic schema-oriented storage methods, traditional data warehouse systems are unable to handle such data. Consequently, the importance of data lakes is rising. A data lake is a flat,

non-hierarchical, centrally managed repository that holds unstructured, semi-structured, and structured data from many different sources. This repository can process any type of data, regardless of its size, and store it in its original format. It can be stored until a user decides to use the data for analysis, analytics, or other use cases, data lakes are designed to store and manage the data. (Zhang, 2022)

Data transition

Talking about the processes of transferring data, initially, a wireless cellular connection was very expensive, while the technology itself was quite slow and inefficient. The concept of which multitude of sensors transferring data with one another across substantial distances was quite challenging. It started to change in 1997 when a committee of industry leaders established a new standard, which was approved by the Institute of Electrical and Electronics Engineers. This standard was called IEEE 802.11, commonly known as Wi-Fi. It had improved spared and coverage, which allowed things to access the internet and transfer data through the web. (Editors of Encyclopedia Britannica, 2022). Therefore, soon after that, the concept of the Internet of Things appeared.

However, there still were issues, such as battery drainage. It was inefficient to use chips that had constant Wi-Fi connection (Lee, 2020). In today's world, there is an efficient, long-range technology called LoRa (Long Range) and LoRaWAN (Long Range Wide-Area Network), which allows transferring data through tens of kilometers, and requires substantially less power than its predecessors (Satrom, 2022). This technology is also known as LPWAN, Low-power wide-range network. Through such wireless networks, data is now being transferred to a cloud service. A digital asset might be kept in a blockchain or a data hub. As the final step, the data may undergo post-processing by dApps running on top of the blockchain (Davidsen, n.d.).

Unified standards

Previously discussed technological advancements solved critical restraints for the EoT concept. However, there was another issue. Namely, the lack of a unified network. Things have different manufacturers, and different software and collect data in different formats, which makes it challenging to combine them into one network. To solve that issue, data is stored in such a way that it can be accessed by things in commonly known formats such as JSON and XML. Moreover, there are such data transition protocols, like XMPP that allow

things to exchange data directly with one another in common formats, like the previously mentioned XML (Serpantos, 2018).

Sometimes, physical things in a network can be problematic. That is why there are digital twins of such things. Those are digital models, representing physical things. The simplest example of a digital twin is an XML code, which formally describes a thing. Such processes are achieved via utilizing semantic web technology. (Qian, 2022)

Data Processing

The final issue here is how to process huge clusters of data. Data processing is what gives it actual value. It essentially implies a process of filtering out poor, inaccurate data via various algorithms. Contemporary data processing implies machine learning and the use of artificial intelligence. Until recent times it had to be done through centralized networks and massive servers with huge computing power. That is an expensive process that slows down a scaling process and compromises security. Now it is being solved via decentralized blockchain technology. It allows handling data as small blocks in a decentralized manner, which significantly improves the processes. Blockchain technology paired with machine learning provides great advancements.

Another advancement here is that some data analytics can be done directly on things. There are external GPU processors which can connect to a thing, such as Intel Movidius and Nvidia Jetson. (Feng, 2022) Such an approach is called Edge Computing and allows the decluttering of networks via local data processing (Hassan, 2018).

2.4.5. The Value of Data

Over time sensors and other hardware components became more accessible. It allowed for the collection of large clusters of various data. Data is being sent via contemporary long-range wireless technologies. This data is then stored and transmitted via commonly used formats. Things can be either fully digital or have digital duplicates, which allows them to communicate with one another directly and autonomously. Most importantly, data can be properly and efficiently processed through machine learning on blockchain and Edge Computing. Consequently, such advancements allow IoT to evolve into EoT and create a distributed economized network of intellectual things.

In the context of EoT data became so valuable, because technological advancements allow things to collect contextual data or related information. Things can provide precise

assumptions during data analysis, which is being achieved through Semantic Web, AI, and neural networks. Contemporary wireless technologies, such as LoRa and 5G, allows EoT to operate autonomously and interact in real life. The autonomous operation is also supported via blockchain smart contracts. Blockchain also allows decentralized, secure operation and simplifies scaling of the environment. Finally, cryptocurrency and tokens economize EoT by providing means for things to initiate autonomous transactions.

The concept of EoT makes data tradeable, this way certain "things", sell such data to other "things". In the Economy of Things machines automatically produce an index, and trade valuable data. Blockchain is a coexisting paradigm that supports the concept by, for instance, the application of smart contracts to execute transactions. At the same time, smart contracts are frequently associated with digital currencies, such as Bitcoins and Ether, that function similarly to real money (Davidsen, n.d.). That is precisely why data became "new oil". As it was stated, data on its own is useless. However, contemporary technologies allowed to make sense of data and withdraw value from it.

2.4.6. Value Created by the EoT and Its' Sustainability

Finally, what is the value that the EoT environment generates, and why is it sustainable? It is important to clearly distinguish the value for businesses, which is generated in the EoT, and values that are formed in an overall Web 3.0 environment. It is fair to say that the activity of any business is not limited strictly to economic aspects. Business activity also affects the social and ethical aspects of human interactions, where certain values are generated as well. However, even if only referring to the economic values of companies, it can be noted that the Web 3.0 spectrum is much wider than the one in the EoT environment, where only machine interactions take place.

Based on the foregoing, the term value creation implies 'ways of using resources for the production of new goods, services and making the business viable by obtaining surplus value'. In this case, it becomes apparent that the environment of the Economy of Things indeed generates value. In the EoT environment, value is created based on the use of IT resources. This can be represented as the interaction of sets (constellations) of devices connected to each other via a network, using blockchain technology. EoT's technological resources, such as physical and virtual things, blockchain technology and its derivatives, artificial intelligence, cloud storage, and wireless communication protocols, are means of value generation.

The value which is being generated is data stored and exchanged between things. EoT is autonomous machine interaction and the only language machines understand is data or information. Data also has monetary value (cost) and is being processed and accumulated by devices for a mutually beneficial exchange with one another. This is essentially how the EoT functions. What is important to point out, is the fact that transaction between things (exchange of tokens) is, fundamentally, the same data transferring process. Such processes do not have any physical representation in the material world. Therefore, it remains within the economy of the EoT environment, unless a user (human) will withdraw tokens by exchanging them for a fiat currency (government issued currency, for instance, US dollars or Euros).

Finally, it can be said with certainty, that data, generated by the EoT, is indeed a sustainable value. The reasoning behind it is a fact that data volumes increase in size autonomously. Furthermore, their worth, both monetary and overall grow organically as well. Lastly, the sustainability of data is ensured by the fact that in the absence or damage of data, or data transmission channels, the overall EoT concept ceases to function.

As it was mentioned, in the beginning, any economy stands as a tradable resource. Currently, data becomes more significant than, real estate, coal, and gold. Davidson assumes that the evolution of EoT will inevitably lead to an increased number of data marketplaces. These will develop into platforms for data exchange and monetization, as well as the foundation for fresh business models (Davidsen, n.d.). EoT makes data its main resource.

The value of such a resource can range from information to passive enrichment. Generally speaking, the Economy of Things can stimulate a significant step in the development of civilization as a whole, not only on an economic level but on a societal as well. Still, this environment is a rather new and relatively unexplored sphere. It stands to reason, that EoT will change its form in the future, as it develops. Thus, it certainly will require future studies and further research. There is no question about whether or not the Economy of Things can generate sustainable value. Instead, the question is, what would be the role of this value for new, young companies? Further, research will address this question and will contribute to the overall scientific knowledge of the topic and ways to better understand the phenomenon.

2.5. Start-up Digital Companies in the EoT Environment

Aspects of the IT industry, such as blockchain, data, and the Economy of Things itself were covered. The most reasonable chapter to conclude the discussion of the EoT concept, its sustainable value, and the role of this value for start-ups, would be the discussion of EoT start-ups themselves. What exactly is an EoT start-up? To answer that, first, it is necessary to establish an understanding of the concept of a start-up which is often used in this research.

At its core, the concept of start-up implies a company in an early development stage in a certain industry. Digital startup refers to an IT-related field of operation. Primarily, start-ups are business that is funded by those who desires to provide a good or service that there is a presumable market for. Start-ups are businesses that are usually concentrated on one certain good or service. (Grant, 2022) However, sometimes, larger companies are standing behind such young businesses. For the purpose of this research, young branches of established companies that are operating in a new industry will be considered when talking about start-ups as well. The reason is, some businesses are becoming tremendously successful, yet still willing to explore some new industries. For such purposes, large companies can create an entirely new department. For example, Bosch, a very well-established company, dedicated a separate department for development in the EoT industry (Bosch, n.d.). Therefore, any company which is testing new industries will be considered in this research.

However, the primary focus will be on young businesses which are starting from scratch. Regardless of the background, the main goal of a start-up is to identify a viable business model and a product or service which possesses value for consumers, and, therefore, can be profitable (Grant, 2022). Finally, it is also worth pointing out that "start-ups come with high risk as a failure but they can also be very unique places to work with great benefits, a focus on innovation, and great opportunities to learn" (Bortolini, 2018). This is why this industry is worthy of deep analysis, especially in the context of the EoT environment.

Considering the definition of a start-up in this research is identified, now it is necessary to clarify, what is an Economy of Things start-up. EoT start-up implies a business model which relies on an autonomous interaction of “things” that is being (or expected to be) economized. EoT start-up relies on some, or all, of previously discussed technologies in order to be viable. Such start-ups are also heavily dependent on data collection, storage, processing, and transition. It is important to clarify, considering the nature of the term Economy of Things, that not all start-ups identify themselves as EoT startups. Some of them are referred

to as IoT start-ups or Web 3.0 start-ups. In some cases, there is no defined separation from the general IT world at all. However, it does not mean that such businesses are not operating in the Economy of Things.

As a matter of fact, EoT is such a novel industry, that there are few to no start-ups which are functioning entirely within this environment. Therefore, it is important to identify the criteria which make a business an EoT start-up. In simple terms, EoT start-up economizes people's daily routine by utilizing generated data. It means that some generic activity people do creates value for those people and businesses. It can be browsing the internet, driving a car, or even walking. In theory, EoT business functions with no human involved, while machines do all activities which are being monetized. However, at the current stage of development, this concept is not fully present. It means that a human should be the starting point of a chain, which then activates the Economy of Things.

The chain function as follows, a person gets digital tokens for some sort of activity, such as walking, and those tokens are then stored in a digital wallet. Tokens can be accessed by a car to charge itself or a phone to renew an internet plan. Then one “thing” exchanges token with another “thing” and the economic cycle starts. It worth pointing out, that in such processes many businesses are usually being involved, as there is no such company that has an internal Economy of Things.

2.5.1. Practical Cases of EoT Start-ups

Now it is reasonable to talk about some real-life scenarios in which EoT is being utilized. Smartphones, which plenty of people are using, are things. Furthermore, all smart devices, such as smartwatches or health monitors are things as well. The most popular industry in which EoT is developing is the smart home. One of the examples could be a Smart Drop, presented by Evian in 2012 (Pasori, 2012). The concept is very simple, the drop is a magnet that can stick, for instance, on a fridge. The drop could connect to Wi-Fi and order water for the user, either by schedule or by the user's request. When functioning through schedule it is supposed to operate fully autonomously. Unfortunately, the project never came to life and was canceled. This project, though, still remains within the scope of the Internet of Things, and only with a stretch can be called the Economy of Things product.

There is, however, an example that can illustrate the potential of EoT better. This example is the Platon system. This system charges logistic companies when their truck passes through a paid road. It is achieved via the installation of a GPS sensor which sends location

data to calculate a payment amount. Payment is fully automatic, which means trucks don't need to stop at certain points. (Platon, n.d.) It not only declutters traffic but also ensures faster delivery of goods. Combined with autonomous driving and digital wallet which can be charged via automatic micro transactions it can fully eliminate humans from the chain and let “things” do the job. It serves as a great example of EoT's potential. While disused two projects rely on some of the previously discussed EoT technologies, those cannot be called groundbreaking products.

2.5.2. Brave Browser

Brave browser is one of the Web 3.0 businesses that can be called an EoT start-up, as it serves as starting point for the Economy of Things. Being a part of the Web 3.0 concept, blockchain allows a new approach to many normalized processes. For example, web browsing and advertisement. It was mentioned that Web 2.0 can be called an age of targeted ads. In Web 2.0 ads became usual for internet users. However, most of the time, there is little to no value for the user. Logically, many people are trying to avoid them by installing some ad blockers, which often is still not enough. What is even more bothering, is unconsented data collection and centralized storage of it.

Earlier it was mentioned how Web 3.0 start-ups already affect the world from an economic and moral standpoint. Now, bearing in mind all discussed features of EoT, it will be reasonable to return to one of the examples and talk about it in deeper detail. Previously discussed Brave browser indeed seems to have the potential to disrupt current big players. It is mostly due to features that are now possible because of blockchain technology. Therefore, it will serve as a good example of how this technology is being utilized in practice.

Brave functions on the Ethereum blockchain and provides its own Basic Attention Tokens (BAT). However, before discussing the capabilities of BAT and how it generates tokens while a user is simply browsing the internet, it is necessary to cover the basics. Brave was founded by a rather noticeable persona from the IT world, Brendan Eich who essentially created JavaScript and was a co-founder of Mozilla Firefox, which stand alongside Google Chrome, Opera, Safari, and Microsoft Edge. (Tyson, 2022). Brave describes its browser as "speed & privacy-oriented" and a "blockchain digital ads platform" (Brave, n.d.). This platform adjusts to the needs of advertisers, users, and content generators. Currently Brave has 36 million active monthly users and more than 1 million verified content owners (Brave, 2021).

The Speed & privacy-oriented part of Brave provides internal ad blockers and privacy protection. Brave also claims that it is 3 times faster than the rest of browsers, which is mainly because it blocks requests to other unnecessary advertisement domains. (Brave, 2020) At the same time, blockchain digital ads platform implies that every link of the advertisement chain gains an income. Namely, content owner, advertiser, and user. One of the key differences here is that ads are voluntary for users. Another is that users' data is not stored on a centralized server, and ads are distributed based on the user's attention to a certain product.

Those features are achieved by utilizing Basic Attention Tokens (BAT). Its primary purpose is to provide improved digital advertisement solutions. Web 2.0 traditional advertisement is based on a collection of users' data. Then this data is offered for sale. As a matter of fact, Facebook and Google are actively utilizing this method. For example, a person viewed some product online, and then after a while, they see an advertisement for this product. It means, a Facebook pixel was installed on that website, and that is how it works. Moreover, devices can not only track online activity but even listen to users. It is, in fact, a serious privacy violation, and that is why the US senate has imposed sanctions on Facebook (Shepardson. 2019).

BAT developers offer a different concept, which is user-oriented. Brave track the activity of users in real time but does not store data on a centralized server. It adds to privacy, while current big players own and store users' data on a private server, Brave uses decentralized blockchain technology. Thus, if the Facebook server can be hacked and data can be stolen, with Brave it will be impossible. Such technology also allows the system to understand if a specific ad is interesting for a user based on the amount of time the user spent observing it. Simply put, the Basic Attention Token encourages advertisers to pay only for the direct attention of users.

To get into a bit more technical details, Brave allows a content owner to sell a place for an ad on their platforms, such as a video blog, or website. Then advertisers can purchase the place and create an agreement based on users' interest in certain content. All transactions are handled via BAT tokens. To summarize, Brave allows the provision of tailored-to-user ads which maximizes the profits of the advertiser. Moreover, it improves user engagement, ad profitability, privacy, and browsing speed. Essentially, users see what they are interested in and earn tokens, while advertisers show their product to the right audience. The advertiser pays the content owner in tokens, and then part of those tokens goes to the consumer of the

content. This way Brave generates tokens that can be further used within EoT or converted to fiat money. This way it either boosts the Economy of Things by allowing 'things' to access tokens, or the global economy by injecting fiat money into a turnover.

Talking further about economics, BAT has a worth of 22 cents per coin and has a total market value of $335.000.000 (CoinMarketCap, 2022). It means that some sufficient funds were inserted into Brave's economics. Considering that Brave's tokes are non-inflationary, there is a limited supply, which means tokens will get more value when the supply will drain. Considering the number of active users and content owners and overall approval of Brave's advertisement approach, it is likely the that token will grow in value (Rathod, 2022). Overall, Brave seems to be a very strong player. It indeed seems possible that it will disrupt current browsers due to its superior features. This example illustrates just one early case of an EoT start-up. A similar scenario is happening in other industries and the relative acceptance of Brave browser further proves the ongoing development of the Economy of Things.

However, it is important to note, that despite all the innovations, the Brave browser is just one of the elements of the EoT. To represent a fully-functioning system in the Economy of Things environment, Brave browser needs to be connected to other services and "things". Perhaps, in the future, it will be possible to purchase an internet plan for a smartphone, on which Brave is installed, via blockchain microtransactions. Payment will be done via tokens which the browser paid for watching advertisements. In addition to BAT tokens, users might be able to earn other tokens, for example, for watching a video (Bastyon n.d.) or for participating in a browser-based videogame, such as Axie Infinity (Axie Infinity, n.d.). All those different tokens will be stored in a digital wallet and an accumulated amount can be used by the user to expand his personal EoT environment by purchasing, say, a smartwatch. This device will also be able to exchange data with other 'things', and in return receive income in a form of certain tokens.

This way, a user will form an individual EoT environment, which, in turn, will interact with similar networks of other users. However, at the current stage of development, due to weak interaction between various projects and the lack of a single technological platform, it is yet too early to discuss EoT through the prism of a mature environment.

2.5.3. EoT Labs, Peaq, and Charge

The company which attempts to truly utilize the concept of the Economy of Things is a start-up with a self-explanatory name, EoT Labs. "EoT Labs develops, incubates, and

supports open-source projects with a focus on the Web 3.0 Machine Economy." (EoT Labs, n.d.) The business's main objective is to transform the Web 2.0-based Internet of Things into the Web 3.0-based Economy of Things, releasing the full potential of vehicles, robots, and devices for societal advancement. The company is founded by three people, Till Wendler, Leonard Dorlöchter, and Max Thake (EoT Labs, n.d.). EoT labs partners with many established businesses such as Audi and serves as a business incubator and parent company for two subsidiary start-ups, Peaq and Charge.

Peaq is a project which provides a platform that allows building dApps for various “things”, such as vehicles, robots, and other devices on a blockchain network. (Peaq, n.d.) The vision of Peaq is to democratize the age of automation. Founders claim that in the Web 2.0 concept, the value that is being generated from automation is obtained by a few big companies. Peaq takes the idea of automation and puts it into the context of Web 3.0. This way any private person or business can participate by adding their “things” to the network and earn rewards (Peaq, n.d.). In an interview with Hilton Supra, vice chairman of Ztudium Group, Leonard Dorlöchter, co-founder of Peaq speculates, that in the future, people can even gain income from autonomous value creation with no personal interaction with the network (Citesabc, 2022).

In 2020 Peak became a fully-fledged self-sustainable project. Founders choose EoT as their main industry of focus and started providing their products and services for EoT businesses. Dorlöchter says that Peaq blends the Internet of Things and blockchain technology, achieving the Economy of Things. During the interview, Dorlöchter describes Peaq's as an ecosystem, which makes revenue as a whole. This revenue is then fairly distributed and split between all the stakeholders according to their contributions (Citesabc, 2022). Such networks are different from traditional companies in the sense that assets are generated by joint efforts. Then, those assets are transparently distributed between partaking companies, based on businesses' contributions.

Leonard Dorlöchter, further mentions that one of their goals is to give blockchain-related space a better reputation. While this space attracted a lot of wrong people and generated a lot of scam projects, "the technology is neutral and the technology is wonderful. One can do a lot of wonderful things with technology, we just have to use it for the right things. We need to look at all the great projects that are out there, and differentiate between

those who are just there to make quick money, and those who are in for a long term to really build sustainable new ways of doing things" (Citesabc, 2022).

Another EoT Labs startup, which is built on Peaq's platform is a peer-to-peer electric vehicle charging, focused on Europe. (Charge, n.d.). Currently, there is a big charging infrastructure in Europe. There a lot of operators provide charging platforms. In such a case, a user has to individually sign up for all those platforms to access the service. Therefore, Dorlöchter says, "when someone drives through Germany, to charge a car, they need to have 10 to 15 different accounts in order to charge, authenticate and pay for the service because the industry is fragmented" (Citesabc, 2022). Those are independent, centralized platforms. Each of those has its own database, user base, and charging station. Furthermore, there are a lot of in-house charging stations. In fact, "in Germany more than 50% of charging processes take place at the owner's home" (Volk, 2020). However in-house charging stations are not accessible publicly because there's no digital way on making them a part of the charging network. Moreover, to pay for charging at such a station, would require integration of traditional payment providers, which are costly for an individual charger owner.

Charge is aiming to put all those stations on a blockchain network, both public and private ones, and enable peer-to-peer transactions (Charge, n.d.). As it was established, blockchain allows for cutting out the middleman and allows users to have a single identity for authentication. This allows charging at any station and direct settlement without going through central platforms. Charge startup is handled with a partnership with certain automotive companies and is being launched as a DAO (Charge, n.d.). Dorlöchter claims that it cannot be launched by a central big player. It needs to function in a neutral way. Then, big central players can join and use this neutral backbone on facilitating charging infrastructure. (Citesabc, 2022).

Dorlöchter says that the main issue with Web 3.0 and EoT is business model adoption, "the technical development allows all aspects of EoT to exist. Switch from the traditional centralized business model to an open decentralized network is, however, a challenge" (Citesabc, 2022). Consequently, EoT Labs recently announced its inclusion into the Gaia-X movement (Citesabc, 2022). It is a consortium that is led by Bosch and funded by the European Union (Bosch, 2022). There Bosch united a lot of Web 3 and EoT start-ups, having 360 total participants. The goal of the project is to combine expertise in the fields of

mobility and establish standards around a decentralized data transfer infrastructure for mobility in Europe. (Gaia-X, n.d.)

EoT Labs and its subsidiary projects are start-ups that are now a part of that movement. Such a consortium will allow advancements like, previously discussed, decentralized charging stations or decentralized car-sharing platforms within the established standards (Bosch, 2022). Dorlöchter says that "Gaia-X allows businesses to work together in the European framework and not have silos in their efforts. It is an important development for the industry, as before, multiple startups were trying to establish their decentralized networks, which created fragmentation again" (Citesabc, 2022). Gaia-X is creating a neutral data infrastructure in Europe where companies can collaborate and obtain funding. Currently, the goal of Gaia-X is to set up the standards and to create a decentralized infrastructure in Europe used for mobility and then go beyond that. (Citesabc, 2022).

2.5.4. Big Players

One of the big companies which pay a lot of attention to the Economy of Things is previously mentioned, Bosch. Bosch has a research department, dedicated to examining and developing the EoT industry. The department is led by Nik Scharmann and is simply named “Economy of Things”. The strategic advance engineering project team is investigating ways to create a digital ecosystem that will be financially successful over the long term, and allow networked devices to engage in secure, reliable transactions with one another, for both individuals and businesses (Bosch, n.d). Furthermore, Bosch has a Gaia-X project, as well as a few others which are aimed to make the Economy of Things a reality. Bosch Research is pursuing the goal of creating decentralized, open, and transparent digital ecosystems that are economically successful while also meeting security and data protection standards. The democratized web, Web 3.0, or the crypto movement are terms used to describe this concept. Therefore, businesses like Bosch do not strive for platform supremacy but rather aim to develop competitive EoT solutions. (Bosch, n.d)

Another example is Vodafone, which recently announced the launch of Economy of Things in partnership with Master Card. The new platform that will allow people and businesses to enter the world of EoT is called Digital Asset Broker (DAB). The system is secure, which is achieved via utilizing blockchain technology, all machines and devices connected to Vodafone DAB are automatically verified for trustworthiness before being let to exchange and trade data and money over secure and encrypted connections. The system is

done in partnership with Master Card and is compatible with existing digital wallets. Another partner in this project is Energy Web, which is a nonprofit organization focused on green energy. (Vodafone, 2022).

Essentially Vodafone DAB allows drivers to get updates regarding the compatibility of the nearest charging station and authorize their vehicle to recharge automatically. It also solves the issue of isolated devices by allowing them to effortlessly communicate and exchange data through blockchain technology. As stated by Johan Wibergh, Vodafone's Chief Technology Officer: "we are building in-house new, scaled platforms for our customers across Europe and Africa. This, our latest platform will drive the new Economy of Things where everyday objects and devices can negotiate, buy and sell services on our behalf." (Wibergh as cited by Vodafone, 2022).

Finally, IBM is also actively researching the topic of EoT. An article from Forbes written by Veena Pureswaran from IBM clearly states Economy of Things is growing and that businesses need to prepare for it. Not only that, but the article also states that EoT carries tremendous economic opportunities for growth and advancement (Pureswaran, 2015). The article was written in September 2015, which implies that IBM is indeed aware of the EoT developments and started to examine the industry at least 7 years ago. Pureswaran also refers to research done by IBM's Institute for Business Value and Oxford Economics when claiming that EoT is not just about asset utilization, but instead about an entirely new business model (Pureswaran, 2015).

While IBM did not announce any technologies adding to the Economy of Things, it can be seen that they are indeed researching the industry and are well aware of this potential. When in line with start-ups such as Brave and EoT Labs, business giants such as Bosch, Vodafone and IBM are also invested in a certain environment, it can be said with certainty that it will grow and develop. This can be said with confidence regarding the Economy of Things. While the environment is not yet fully established, it is already possible to see its potential and the benefits it brings to both businesses and individuals. Therefore, it can be assumed, that an all-around expansion of the EoT is just a matter of time.

2.6. Summary

To summarize everything that has been stated so far, the foregoing chapter provides a deep analysis of the EoT concept, the sustainable value generated by the environment in a form of data, and EoT start-ups. The Economy of Things is a very recent term, which is not fully established yet. This concept is essentially an evolution of the Internet of Things. The Economy of Things implies economized interaction between smart things or devices in a form of data exchange. Economization entails that things can trade some form of data for different data in a form of currency tokens that possess monetary value. Essentially it is a network of networks where things operate in the digital world via data exchange, while the results of such operations are reflected in the physical world. The Economy of Things indeed has great potential for business and individuals and rapidly developing.

There are groundbreaking technologies that serve as a ground for this phenomenon. One of the key technologies which allow EoT to exist is blockchain. The Economy of Things is a combination of the Internet of Things and blockchain. Blockchain significantly improves scaling and security. It also allows automation via smart contracts and SSIs. However, most importantly, blockchain adds an economic layer that transforms the Internet of Things into the Economy of Things. It is achieved via the specific use of data in a form of digital currency tokens. Therefore, contextually aware things can engage in autonomous trade.

Presumably, in the future, due to the development of the EoT, things will replace people in a majority of routine tasks, such as driving or charging a car, delivering food, reporting roadblocks, etc. Those things will function in autonomous networks and generate monetary value, which the user can either withdraw or let circulate within the Economy of Things. In theory, EoT is a phenomenon in which things operate within a digital world in chains of networks autonomously, and exchange data for tokens that possess monetary value. However, in practice, the current stage of EoT development implies human interaction as a starting point of a chain.

All operations in EoT are tied to data. Every type of machine interaction is possible due to data collection, exchange, and processing. Even the monetary aspect of EoT falls under the concept of data exchange. Therefore, it can be concluded that data, which is being generated in the EoT environment is, in fact, its most valuable resource. The reason for data gaining such tremendous value in the modern world is due to technological advancements. This way, improved sensors increased the volumes and quality of collected data. At the same

time, new wireless connection protocols allowed for the efficient transfer of collected data volumes. Also, unfired standards of data storage, such as XML and JSON appeared. Finally, such technologies as artificial intelligence, semantics, and neural networks made it possible to properly process data.

Those advancements revealed the true value of data and made the Economy of Things possible. EoT, in turn, also generates data. In an environment where only machine interaction takes place everything is tied to data. Not only it has monetary value, but first and foremost, data allows EoT to exist. Therefore, the key value generated by the Economy of Things is data. Moreover, this value is sustainable, as it grows organically in size and worth.

EoT is a very young industry, which does not have many businesses that are operating entirely within the environment. There are, however, some examples of both start-ups and established businesses that are closely related to the EoT. One example is the Brave browser, which exchanges tokens for viewed advertisements and improves users' privacy. Yet, Brave can only be called an entry link of EoT. For it to be fully integrated into EoT it requires deeper interaction between the browser and other external “things”. It is complicated to achieve in the current stage of development, but few companies are closer than others.

As such, there is a start-up called EoT Labs, which dedicates its operation to boosting the development of the Economy of Things. EoT Labs has two startup projects. The first one is Peaq, which is aimed at providing a decentralized network for other businesses to join EoT. The second project, Charge, is built on the Peaq network and focuses on providing autonomous charging for electric vehicles in Europe.

Big players are also devoting resources to exploring the EoT environment. Bosh dedicated a research department to study the Economy of Things and established the Gaia-X project to standardize decentralized data transfer infrastructure for mobility in Europe. There are also IBM and Vodafone. While IBM actively researching the environment as well, Vodafone already announced the launch of the EoT project in a form of autonomous electric car chargers. EoT indeed attracts a lot of attention from various angles. It generates sustainable value and promises great opportunities for business and life improvements for individuals. Currently, EoT is not yet fully adopted, but it is reasonable to predict a wide spread of this environment in the future.

3. RESEARCH METHODOLOGY

In the following chapter, the methodology of the research will be discussed. Furthermore, this chapter will describe the research instrumentation and process-related problems. The phenomenon which is being researched in the study is the Economy of Things environment. It was previously established that the concept of the Economy of Things indeed possesses great potential and substantial business opportunities. However, it is also clear that the environment is rather immature and under-researched. Therefore, one of the objectives of this research is to deeper examine the phenomenon. The study examines the concept of the Economy of Things and answers the research question 'what is the role of sustainable value generated by the Economy of Things for the success of start-up digital companies?'.

In order to achieve that, substantial theoretical research was conducted. It established the process of the development of the EoT, key technologies which allow the environment to exist, and the value which EoT generates (data). It has also been proven that this value is sustainable and that the EoT environment has great potential. This research allows predictions of potential challenges and growth opportunities for start-ups in the context of sustainable value creation by the EoT environment. The following chapter will propose hypotheses and disclose the purpose of the research, design of the study, methods of data collection, types of gathered data, approach to data interpretation, and expected findings.

3.1. Research Purpose

Previously discussed sustainable value created by EoT is data, which is being generated due to the combination of several technologies, such as blockchain, the Internet of Things, and artificial intelligence, under the overarching EoT environment. Therefore, this research establishes the relationship between the use of data and the success of start-ups through a theoretical study of the phenomenon. Such findings allow drawing conclusions regarding the role of EoT's sustainable value (data).

Findings will grant digital start-up owners, who are potential or current participants in the emerging EoT concept, the information, and guidance required to make effective decisions based on the use of the value generated in the innovative EoT environment. In turn, it will allow start-ups to optimize their development processes in terms of innovation, productivity, profitability, and competitiveness, to a certain extent. Under certain conditions,

such optimization can provide some advantages in comparison to digital giants such as Google and Facebook, which are also actively researching and implementing technologies inherent in the Economy of Things.

The research proposes several hypotheses based on previously examined materials.

- Hypothesis 0 presumes that the role of sustainable value generated by the EoT (data) is defining factor for the success of start-up digital companies.
- Hypothesis 1 assumes that sustainable value generated by the EoT (data) positively affects the attractiveness of the industry for businesses, which affects the development of the Economy of Things environment.
- Hypothesis 2 supposes that data in the EoT is the equivalent of money in a global economy.

3.2. Design of the Study

This research aims to develop knowledge, theories, and predictions. Therefore, can be considered a theoretical study. The research does not focus on developing any new technics, products, or procedures, instead, proposing a theory that evaluates the role of value and success of start-ups. Those factors will be evaluated based on theoretical arguments, and collected data. At its core, the research explores the main aspects of an under-researched concept (Economy of Things), which also allows the categorization of the study as exploratory.

The methodology may be understood "as the logic of the use of the research method, i.e., indicating on what precisely the choice of some method is based" (Kardelis, 2002). The previously described design of the study was chosen due to the nature of the researched phenomenon. This research takes into account the fact that the EoT phenomenon is extremely young. It is being formed at this very moment and, as a result, cannot have a substantial number of studies over a sufficiently long time period or accumulated volumes of statistical data. However, since the EoT is a synergistic structure that has incorporated such innovative technologies as IoT, blockchain, AI, and cloud computing, previous research in these technological areas regarding the use of data can be applicable.

Such research can be used because data (sustainable value in the context of work), is also an integral part of the operational processes of all listed above technologies.

Consequently, the study bases the judgment of the role of data generated by EoT for the successful implementation of digital start-ups on theoretical findings and collected data from related technological industries.

Conducted exploration of the Economy of Things allows concluding that the environment does not have a substantial background for the research due to its youth. It was also established that EoT is a synergy of several technologies. Those technologies include the Internet of Things (things, sensors), blockchain (decentralization, economization), machine learning/artificial intelligence (data processing), and wireless IT technologies (data collection and storage). Furthermore, it is worth pointing out, that similar to a global economy, there are no companies that go through a whole economic cycle. Meaning that for EoT to function, it requires several businesses with different technological backgrounds to provide their "things". Those things consequently will function in a network, and such networks compile the Economy of Things, as mentioned in chapter 2.7.

Previously established factors allow evaluation of the role of sustainable value in a form of data based on technologies that compose EoT. For the purpose of this research collection of empirical data and research findings regarding the success and failure of start-ups that work with data in, previously mentioned, essential for EoT technologies, is conducted. Consequently, collected data is examined. Those businesses are being researched to identify the role of data in their operation and evaluated in terms of success. Next, the dependency between the success of such start-ups and the role of data being derived. Individual evaluation of the role of data in each technological industry, which together let EoT exist, allows to draw out the cumulative role of data for the success of start-ups in EoT. While collected information is valid for a narrower technological phenomenon, the final evaluation applies to an overarching economic phenomenon of the Economy of Things.

3.3. Data Analysis

The study is conducted based on secondary data such as web sources, statistical databases, and academic literature. To achieve well-defined and clear results research using a mixed method of data collection. In the study, both qualitative and quantitative methods are used. The scope of data collection narrows down to start-ups that are focused on data in their operations and function in technological industries which, when combined, create the

Economy of Things. The collected data is descriptive by nature, as it aims on identifying characteristics, patterns, and correlations.

One of the methods of data collection used in this research is the quantitative collection of secondary data. Quantitative research is the process of objectively gathering and analyzing numerical data in order to define, predict, or regulate factors of interest. Quantitative research aims to explore causal correlations between variables, make predictions, and generalize results to wider populations. For this study, quantitative research was applied in a form of secondary data collection. Quantitative data were collected in a form of statistical numbers. Collected data is being used to measure several parameters which allow evaluating the role of data in the success of start-ups from a certain technological industry.

Qualitative collection of secondary data is also used for the purpose of this research. Such data were collected through different academic researches and various articles. It allowed to deeper examine the EoT phenomenon, and to obtain initial data. Qualitative research is used to gather a deep understanding of the EoT environment, its key technologies, and its potential. Furthermore, secondary qualitative data is analyzed to examine the development trends in the context of value for start-ups within previously mentioned technological industries. Qualitative research allows for establishing the importance of data for EoT start-ups and reveals the expectations of future industry development as well as supports statistical findings with opinions.

Overall, collected data allows the research to study the cause-and-effect relationships between the use of data (sustainable value) and start-up success. It allowed to further illustrate the importance of the phenomenon of the EoT. "The capacity of smart devices has followed Moore's law, doubling every two years" (Hu, 2021). Therefore, the findings developed in this research would be beneficial for different groups of people and organizations both in a practical and theoretical sense. The analysis allows to explore and evaluate the role of sustainable value that can be created in the EoT environment. Regardless of the outcome of the research, it creates a potential basis for discussions regarding the topics covered in this study and provides a new look and better understanding of the EoT phenomenon and the role of sustainable value for start-up success.

3.4. Feasibility of the Study

This feasibility of the study can be proven by the fact EoT affects society as a whole and triggers a new development stage. “It will undoubtedly affect all sectors of the economy such as automotive, construction, energy or manufacturing, wherein communication is a prerequisite to reach the fourth industrial revolution.” (Osseiran, 2017). This new reality already brings unique sustainable value and this research delivers the theoretical knowledge of the topic to readers. The study creates a theoretical basis for the concept of EoT and may serve as a framework for future start-up development. It also assesses the role of the sustainable value created within EoT for the success of the business.

Further described approach and methods of data collation allow to evaluate the role, which is expected to be either major, neutral or minor. A more detailed description of the role will be given in the following chapters of the study. The research is relevant in the context of new industries (EoT) which are developing currently as well as in the context of start-up development. Theoretical knowledge is being provided for the listed above spheres of study. Moreover, further, the study will propose recommendations for ongoing studies of the phenomenon, which is expected to be useful in the context of future research.

However, research will also have practical value. It can be applied to the evaluation of the potential of a start-up and the contribution that EoT can generate. The research will give conclusions, propositions, and suggestions. Those can be useful in practice as a means to develop a real-life project and consequently improve its flaws. The practical value of this research can be further extracted for governmental and corotational use. EoT is a concept that can be applied within governmental systems as well. Consequently, making the operation of governmental institutions more automated and transparent. For corporate use, this research possesses value as a comprehensive study of the phenomenon which holds substantial business potential. Overall, benefits can include not only the successful development of a business but as a consequence, potential improvements in quality of life and the development of new income streams.

3.5. Summary

In summary, the research carries a theoretical and exploratory nature due to the specifics of the examined phenomenon. The methodology of the study describes the

importance of the researched topic and proposes several hypotheses based on forgoing materials. Research is examining the role of sustainable value, in a form of data, generated by the EoT in the context of start-ups' success.

As it turned out, due to a deep examination of the topic, the Economy of Things does not have substantial ground to evaluate the role of data for start-ups because of the immaturity of the industry. However, data is being generated in the Economy of Things through a synergy of technologies, much like the environment itself. Therefore, the role of data in each of those technologies is being examined individually through the prism of start-up businesses that are applying those technologies. It is done to find a common denominator and evaluate the role of data for start-up success in EoT as a whole.

To achieve that secondary data, in a form of web sources, statistical databases, and academic literature is collected. It is being analyzed via both quantitative and qualitative methods. The quantitative method will be used in order to collect statistical data to establish relations between data (sustainable value) and the success of certain businesses. The qualitative analysis relies on academic literature and opinions in order to understand the value of data and deepen the examination of the EoT concept.

Research can be considered feasible, as it was proven that the development of the Economy of Things carries great importance. It provides bespoke benefits and excessive business opportunities. The study gives a deep examination of the industry which can serve as beneficial information for businesses and researchers. Moreover, it evaluates the role of data for EoT start-ups which can provide a competitive advantage when designing a business model. Furthermore, it can deliver an understanding of EoT features to an individual, which can improve their lives and even generate additional income streams.

Expected findings are anticipated to prove or disprove previously established hypotheses as well as allow to answer the research question. The results can show different indicators regarding the level of importance of sustainable value. It is expected to confirm that EoT indeed has great potential for business and start-up development. However, it is not clear what would be the role of the sustainable value generated by the EoT environment in the context of digital start-ups’ success. Regardless of the outcome, research achieves its aim and objectives and provides value in form of a deep study of the environment of the Economy of Things as well as ground for further research and discussions.

4. RESEARCH ANALYTICS

As it was previously established, due to the youth of the EoT concept, at the moment, it is not possible to study and evaluate digital startups' effectiveness and success over a long period of time. Due to its immaturity, the EoT environment does not have digital start-ups that have been operating within it for long enough yet. However, having carefully studied the EoT environment and the formation of sustainable value in it (the theoretical part of the work was devoted to this), It is possible to make certain logical conclusions.

First, since the EoT incorporates several technologies of the modern IT industry, many digital start-ups have been mastering these areas for a substantial time and indirectly contributed to the development of the EoT environment. Second, businesses have realized the sustainable value of data and have been utilizing it for quite a long time, examples can be the success of Facebook or Google. An example of data monetization could be a popular business model of cryptocurrency mining. Consequently, universal platforms for the EOT environment, such as the previously discussed Peaq, are currently being developed. Such platforms will allow connecting all interested parties to EoT through them. This way many structures and users will be able to create new revenue and business models within EoT, in turn, developing the environment. Therefore, it is possible to analyze the activities of start-ups that are making the EoT possible.

These digital startups explore and develop certain technologies, which, in synergy, compile the Economy of Things. Evaluation of such start-ups in terms of relations between data and success can be categorized via the following technological industries:

1. Creation of smarter things: sensors, devices, and related digital technologies with low power consumption. This technological industry is essentially the Internet of Things, which is now becoming a part of the Economy of Things. Advancements in this industry provide the necessary means for modern data collection requirements.
2. Development of internet wireless communication network protocols, which allow connecting sensors to other “things” and cloud storage for efficient data transfer. Such technologies were previously discussed in chapter 2.5.4, and include technologies like LoRa.

3. Advancements of blockchain technologies. It allows for security, decentralization, smart contracts, microtransactions, automation, and many more advantages. The technology itself is actively progressing and improving and essentially serves as a ground for projects in the Web 3.0 environment.
4. Improvements in the field of cloud computing platforms increase the possibilities of data storage. Such platforms let both businesses and consumers access the infrastructure they need, and scale, while their data is being stored on remote servers. It is fundamental technology not only for EoT but for the overall IT world.
5. Further improvements in machine learning and analytics, namely, artificial intelligence (AI), semantics, and neural networks will allow machines to better-interpreted data and process it in a more efficient way. Additionally, it makes smart things more viable for personal use.

Combining advanced analytics and access to the rich and vast volumes of data stored, which are being properly sorted, allows companies to access the true value of data. The development of these related technologies contributes to the progressive development of the EoT. At the same time data generated by the EoT fuels these technologies. In the following chapter, the dependency between the use of data and business success will be drawn out. It is being achieved via examining start-up digital companies in all previously mentioned technological industries. The examination is be done via secondary data analysis in a form of a mixed research method. Further in the chapter, qualitative and quantitative findings will be revealed, described, and analyzed.

4.1. Analysis of Start-ups' Reliance on Data

To analyze the reliance of start-ups from previously discussed technological industries, qualitative data was collected throughout the research in a form of various scientific articles and other web resources as well as qualitative data in a form of numbers representing the discussed aspect. Based on forgoing research it can be stated that data indeed serves a key role in the Economy of Things. However, it is necessary to establish the reliance of digital start-ups from each of the listed technological industries on data to discuss its role in the success of businesses.

Cloud storage and computing

According to statistics given by Djuraskovic "there were 79 zettabytes of data generated worldwide in 2021 and by 2022, the big data market will grow to $274.3 billion" (Djuraskovic, 2022). It is safe to say that almost all leading IT companies show interest in tools for collecting, processing, managing, and analyzing big data. Naturally, it is due to two factors. First, they are directly facing this phenomenon in their daily operations. Second, big data opens up tremendous opportunities to develop new market segments and attract additional customers.

Digital startups, in turn, are also aware of the value and opportunities given by big volumes of data. To use such data, start-ups, among other things, rely on cloud infrastructures. Cloud service providers imply businesses that offer databases and infrastructure for other businesses that allow them to build, deploy, and scale their software applications and databases. (Zhang, 2022) Cloud service providers include start-ups such as Databricks, Matillion, and Varada. (Cbinsight, n.d.) Naturally, businesses in this industry primarily rely on data, which they are processing and sort. Furthermore, that is why cloud service is an imperative technological industry for the Economy of Things.

Internet of Things

Sensors and things are a vital part of EoT, as those “things” are the main participants of such an economy. The ecosystem of contextually aware sensors and smart things is essentially a definition of the Internet of Things. In an article written by Osseiran, IoT is described as an ecosystem of networks that consists of devices interlinked with one another (Osseiran, 2017). For businesses in the IoT, reliance on data is imperative, according to chapter 1.3.1. those “things” operate via perpetually collecting and transmitting data in the background. The major functionality of various devices and sensors is the capability to autonomous operations with data (Elgazzar, 2022). The expected worth of the IoT market by 2030 is $621.6 billion, in comparison to $251.6 billion in 2022, which illustrates significant industry growth (Vailshery, 2022).

Overall, the development of smart devices and sensors is boosted by a sole need to collect data in more efficient ways. (Serpantos, 2018). However, the goal of any IoT business, or start-up, is not to collect data, but to properly process it (Aiello, 2022). In this case, it can be useful for business purposes and allows the IoT business model to function. Data processing is what lets IoT grow (Ranger, 2022).

All IoT businesses heavily rely on data analytics. “The greatest potential for IoT analytics lies in the Industrial Internet of Things (IIoT). Organizations are able to deploy sensors in everything from manufacturing equipment, to pipelines, to weather stations, and delivery trucks – for the purposes of collecting and analyzing data.” (Simmons, 2022). Therefore, it is undeniable that data is essential for IoT businesses to function. In turn, it implies that this technological aspect of the Economy of Things transfers the reliance on data to the EoT environment.

Wireless connection networks

The technological industry of wireless communication networks and protocols has been proven to be undeniably important for the Economy of Things in chapter 2.5.1. In this case, the only goal of a business in this industry is to improve the quality of data transfer. It implies improvements in quality, security, range, and usability, which are achieved via constant improvement and the creation of new transmitting protocols. (Satrom, 2022). Davidsen further states that advancements in wireless communication networks now allow the storage of data in blockchain and cloud services and undergo further data processing. (Davidsen, n.d.).

As an example, there is Helium blockchain, which launched a start-up called People's Network. It is "the world's largest, and fastest growing LoRaWAN network" (Helium, n.d.). It is claimed to be used by hundreds of companies and provides superior data transition solutions. "Thousands of existing solutions, sensors, devices, and gateways can be easily configured to run LongFi - a powerful blend of LoRaWAN and blockchain technologies" (Helium, n.d.) These findings further prove that the sole function of such businesses is based on data.

Blockchain

Foregoing research already established the immense importance of blockchain technology not only for the Economy of Things but for a Web 3.0 environment as a whole. In essence, blockchain is a technology that allows decentralized data processing. The technology is rather broad. Thus, it might seem that the goals of start-ups working with blockchain are not tied to certain use of data. This is not entirely true, as while use cases of blockchain technology are multiple, all of them are still implying data processing to a certain extent.

It can be well illustrated by an interview for Citesabc (2022) between Hilton Supra and Leonard Dorlöchter. Dorlöchter is a co-founder of 2 blockchain startups Peaq and Charge. Those start-ups possess different goals, but all those goals are achieved via various utilization of data. Peaq aims to provide a network for dApps via blockchain, which implies the processing of data, that those dApps generate. Charge, however, is very different in nature, as it is focused on autonomous car charging. Yet, it still implies data exchange between the car and the charging station. (Citesabc, 2022) At its core, the term ‘autonomous’ already means communication between devices via data exchange.

Furthermore, blockchain allows monetization of the data. It is done via transforming data into digital currency tokens, which are also a certain form of data, as discovered in chapter 2.4.6. The application of data is numerous, but if talking about currency tokens, digital wallets can serve as a good example. Examples of such wallets include Coinbase Wallet, SafePal, Crypto.com Defi Wallet, and Exodus. Digital wallets operate on blockchain and simply store personal data in a form of tokens. (Powell, 2022). Therefore, it can be said that despite the wide nature of blockchain technology, all blockchain start-ups are tied to data-related operations. Moreover, while cloud storage businesses store and process data and wireless connection networks transfer it, blockchain and IoT businesses not only make use of data but also generate it in the nature of new tokens or other forms.

Machine learning

Much like previously listed technologies, machine learning implies working with data. "Machine Learning models are built on a massive amount of data. As a result, they often become highly sophisticated and sometimes even opaque in order to capture the complex nonlinearity in real-world data" (Lu, 2021). Any artificial intelligence or neural network relies on consuming data to get more advanced. AI in deep learning and data adaptation, leads to the implementation of increasingly complex tasks, as stated in chapter 1.3.3. Advancements in this technology allow to "make sense" of data. According to research by Forbes, "a combination of AI and Big Data technologies can automate almost 80% of all physical work, 70% of data processing, and 64% of data collection tasks." (Brown, 2021).

Even at its core, the term machine learning implies working with data, as from the foregoing research it has been established, that the only language, asset, or value, a machine can understand is data. Consequently, artificial intelligence and neural networks imply

making machines more intelligent by giving them access to more and more data. At the same time semantics allows machines to understand the context of data.

Much like blockchain start-ups, machine learning businesses are also generating new data. "The global AI market is currently worth $136.6 billion and is expected to grow by at least 120% year-over-year" (Howarth, 2022). AI consumes data not only to make sense of it but also to generate more. Here, there is a wide variety of data that can be created, from bespoke imagery to detailed statistical forecasts. Therefore, start-ups which focus on machine learning technology are as reliant on data, as other discussed businesses.

Results:

Foregoing qualitative findings can be interpreted as the following statement. Indeed, start-ups that operate in previously listed technological industries must rely on data in order to function. However, the use of data does not generate profit for such businesses directly. Instead, it lets them operate, which then allows them to generate certain profits by providing goods or services.

The development of previously discussed technological industries contributes to the development of the EoT environment. At the same time, data generated by the EoT also fuels these technologies. Because all those industries combine the Economy of Things, it also implies that EoT start-ups, which operate in those technological industries have to equally rely on data. Therefore, data (sustainable value) generated by the Economy of Things is an imperative factor in business operations. The value generated by the Economy of Things simply creates the environment itself, which, in turn, provides an ecosystem in which start-ups can be created.

4.2. Analysis of Start-up Success Criteria

Previously analyzed data allowed to establish that discussed business indeed have to heavily rely on data to operate. Further analysis will rely on statistical findings, scientific articles, and academic opinions which will draw out the key factors of success of disused start-ups. Combined, analyzed data will provide findings to examine the dependency between the success of start-ups and their reliance on data.

To discuss factors of digital start-ups' success, it is necessary to define the scope of researched businesses. An article from Forbs by Rebecca Baldridge elaborates on the concept of start-up, claiming that "you may be most familiar with start-ups in Big Tech - think Facebook, Amazon, Apple, Netflix, Google, collectively known as FAANG" (Baldridge, 2022). That implies that the scope of the term start-up covers a very wide range of businesses from small companies to corporations. To narrow down the concept, Baldridge proposes other criteria for a start-up. The criteria are speed and growth, meaning that start-up companies aim to build on ideas as fast as possible. (Baldridge, 2022).

Further, it is worth mentioning the key factors for start-up success described by Baldridge. The author claims that, for a start-up to succeed, many factors must align. Proposed factors include the size of the market, the reasoning behind the innovative idea, the founders' expertise, and the quality of the team. (Baldridge, 2022). While those factors are certainly applicable, in the context of digital start-ups other, technological, factors might outweigh them. It is especially true when talking about the data-related industry, where the majority of operations are handled by machines.

Also worth noting is that statistical findings authored by UC Berkeley and Stanford researchers report, show that 90% of start-up businesses fail. (UC Berkeley and Stanford as cited Baldridge, 2022). This factor is indeed applicable to any start-up business, regardless of their specialization. Therefore, it has to be taken into consideration, when discussing factors that define success as such.

Most researchers tend to associate the success or failure of a digital start-up with some most obvious and, one might say, traditional criteria. However, for start-up digital companies which operate within EoT-related technological industries, more specific factors must be taken into consideration. It might be reasonable to restate those industries which compile the EoT environment. Those are cloud storage and computing, the Internet of Things, wireless connection networks, blockchain, and machine learning. Focusing on start-ups from those technological industries, several statistical findings were discovered.

Daniel Ruby provides some statistical insights. "Start-ups around blockchain, E-commerce, Artificial intelligence, and Fintech are growing rapidly as of 2022" (Ruby, 2022), indicating the importance of appropriate timing and a fruitful environment for businesses in discussed industries to succeed.

Moreover, the artificial intelligence industry showed rapid growth. "Between 2016 and 2020, funding for AI start-ups increased by 327 percent" (Ruby, 2022). Seeing that investors are indeed interested in funding such start-ups and that this affects their growth, one can conclude that funding is another key factor in digital start-up success. In fact, "the second largest reason why start-ups fail (29% of cases) is due to running out of funding", which further proves the previous point. (CBInsights as cited by Steward, 2020)

Finally, Ruby illustrates the issue of a competitive environment. Even though, the environment provides the necessary means for success, "fierce competition is one of the most common challenges faced by start-ups today" (Ruby, 2022). It illustrates that competitive advantage is yet another success/failure factor, as 19% of start-ups fail due to being beaten by competition (CBInsights as cited by Steward, 2020).

Mentioning factors of failure, Harvard Business Review reveals 60% of failure statistics are due to issues within a business's team. (Mol, 2019). Thus, the team factor is also crucial for any start-up. Forgoing data illustrates that even though a lot of companies attempting to succeed in previously mentioned technological fields, few of them succeed.

Based on data that was previously analyzed in the research, it appears to be difficult to identify an explicit dependence between the success of a start-up on the generated value (data) in the EoT environment. The following data was further collected in order to clarify if any dependence is present.

While discussed digital start-ups seem to require unique success criteria, "statistics from the Office of Advocacy show that new business failure rates are very similar across industries" (SBA, as cited by Kotashev, 2022). Which makes it possible to assume that the success factors of start-ups in general are more universal than it seems.

Interestingly enough, Kotashev mentions a somewhat contradicting finding by The Statistic Brain Research Institute, which shows that the highest failure rate is, in fact, in the IT industry. (Statistic Brain Research Institute, as cited by Kotashev, 2022). Kotashev explains that it is due to the attractiveness of the environment and the low entry barrier (Kotashev, 2022).

From the foregoing, it can be concluded that, much like any other start-up business, EoT-related start-ups tend to have universal success and failure factors. The key difference which was identified is the environment. The environment has a lot of technological benefits

which were deeply discussed in the foregoing work, as well as low barriers to entry. While it might serve as a key success factor, when utilizing advantages properly, it might also be otherwise, due to the same factors which transfer onto opponents, making the competition rather fierce.

Taking some specific examples from discussed technological industries, blockchain undeniably has tremendous potential, which can be seen from the previous examination of the phenomenon. However, the reality is that blockchain-related start-ups are affected by tremendous volatility which is natural for this technology. (Kotashev, 2022). It leads to an issue of an immature environment and further proofs the importance of an environment as a success factor. Nick Chubb mentions 300Cubits as an example of a blockchain start-up, which failed in part due to those factors, despite having access to all the benefits technology was giving. (Chubb, 2019). Another issue that affects blockchain businesses is the unfamiliarity of potential stakeholders/investors with the technology. Adding further to the issue of an immature environment and proves the importance of funding success factor.

Another technological industry that can be further examined is machine learning/artificial intelligence. This technology has been proven to possess great potential. However, much like many previously discussed technologies, it is also very young. According to Kotashev, it is hard to find economically viable applications for it at the current stage of development (Kotashev, 2022). This illustrates a few success factors, the previously mentioned factor of environment and the factor of viability behind the innovative idea. Moreover, Kotashev claims that AI start-ups "resemble a fundamental science research team" which adds importance to the factor of a team. An example of a start-up that failed due to such factors is Roadstar and MapR (Kotashev, 2022). The second one was considered an industry giant, which actively utilized the value of data, yet it failed due to poor business strategy (Gillin, 2019).

Finally, covering the IoT technological industry has an issue related to Moore's Law. It states that every two years number of transistors will double. Today it is often applied to devices in general. In IoT, new, improved "things" appear so rapidly, that often start-ups are unable to keep up. QBotix can be a good example. They had a product, a solar panel that was attached and regulated by robots. It was innovative and raised substantial funding. However, while they were developing the technology, the competitors' product improved and QBotix failed in the competition. (Failory, n.d.) This example shows how aggressive the competition

is in discussed technological industries and further proves the importance of comparative advantage as a success factor.

Yet, regardless of the statistics and failures, it is apparent that modern start-ups gravitate towards the Internet and digital technologies. Findings highlighted by Artem Minaev show that "60% of entrepreneurs agree that AI is currently the most promising innovation technology. Not only that, but they also agree that it will be the most promising technology over the next 10 years. The areas of this technology with the most potential are autonomous transportation and big data." (Minaev, 2022). Findings are based on Silicon Valley Bank research, which shows that AI, an element of machine learning, and autonomous transportation, an element of IoT, are two of the most promising technologies among start-ups (Silicon Valley Bank as cited by Minaev, 2022).

One of the reasons for such attractiveness is a sustainable value that is being generated in a form of data. Vladimir Dobrynin in his article for RBK states that by analyzing the technological market of the past 3 to 5 years, it can be seen that data has become the main value and the most desired resource for most companies. Facebook turned into Meta and shifted its focus on the metaverse for a reason. For Meta, virtual worlds are a new portal to data, which will allow analyzing not only behavior and interests but also the biometric parameters of users. Another example is Tesla. With their autopilot technology, the company can collect gigabytes of data about the behavior of drivers and the operation of the car. (Dobrynin, 2022). All that is achievable because of discussed sustainable value in a form of data.

Therefore, it is obvious that data is indeed a very valuable resource. However, data itself does not seem to affect the success of start-ups directly, instead, proper application of data can boost previously identified success factors. Analyzed data can improve products or services by revealing patterns and trends, this can significantly increase competitive advantage. Data can showcase the most profitable areas of business, which addresses the factors of financing or funding. Finally, data can help to measure the short-term and long-term success of a business, which can improve an overall business model. (Jain, 2022)

Results:

Findings regarding the success criteria of start-ups in technological industries of cloud services, wireless connection networks, blockchain, Internet of Things, and machine learning showed that, in most cases, digital start-ups have the same success factors as all start-ups in general. Those factors include the reasoning behind the viability of an innovative idea,

business strategy, founders' expertise, funding, competitive advantage, and quality of a team. For this study, one of the most important identified factors is the environment. Namely, the size of a market that the environment provides, the level of competition, the maturity of an environment, and the benefits and advancements it offers. It is crucial when discussing the Economy of Things and the technology industries which compile it, as this environment has some specific benefits and issues which are mostly related to data.

The analysis also showed that the technological sphere is the most attritive one for start-ups. Specifically, industries such as machine learning, blockchain, and the Internet of Things. One of the reasons, among others, is data generation. It was identified that data is perceived as an extremely valuable resource by companies. However, while it is valuable, it does not affect the success of digital start-ups directly. Instead, properly processed data can boost other success factors which may lead to a triumph of a start-up digital company.

4.3. Research Findings

Currently, there is a variety of materials and data regarding the success and failure of start-ups. However, despite the abundance of such information, the failure rate of young businesses remains at 90%. Yet the number of start-ups keeps growing and the information technology industry appears to be the most attritive. Within this industry, a new extremely promising concept, the Economy of Things, is being formed right now. It has absorbed all the relevant Web 3.0 digital technologies and was proven to be capable of generating sustainable value in a form of data. While the individual success factors of start-ups have been extensively explored, it appears that the dependence of the success of start-ups on the EoT's sustainable value remains vastly under-researched yet.

Based on the topic of the work, the study examines the role of sustainable value generated directly in the EoT environment for the successful development of a start-up. At the same time, the analysis of statistical data shows that financial strategy, human competence, and a combination of socio-economic conditions certainly play a vital role in the success of any start-up. However, those factors do not fall under the concept of EoT, based on its definition. Analyzed data did not identify data (sustainable value) as a single key success factor for start-ups. The study showed that there are several universal factors of success, such as investment, sales growth, return on capital, turnover, employment, or income, which are universally applicable to any start-up business.

However, those factors are not evaluated in this work, since they are not directly generated by the EoT. Discovered factors are not included in the formulation of the question of the topic which is being studied and, therefore, cannot be applied when evaluating the role of generated value for start-ups. Nevertheless, research makes it clear that many of those success factors are, in fact, dependent on the data created by the EoT environment. The correct application of data can serve as an amplifier for other success factors that were identified. It means data can be an indirect cause of the success of digital start-ups in a discussed environment.

The study also discovered the importance of the environment in which digital start-ups are operating. It can serve as both a success and failure factor. In the case of the examined phenomenon of the EoT, data is what allows start-ups to operate within the environment. Essentially, data grants start-ups the ability to operate in the EoT. Research findings allow concluding that, when defining success, the role data, a sustainable value of the Economy of Things, is neutral. Data is crucial in the sense that it allows the EoT concept to function, which in turn provides a very fruitful environment for digital start-ups. Yet, regardless of the significance of the generated value of the EoT, it affects the success of a start-up only indirectly. Data is a resource and just like any other resource, such as money, can be beneficial only when properly utilized. No resource, even the most valuable, can solely define the success of a business. Success is achieved via a combination of factors of equal importance and data can strengthen those factors, when used properly.

5. CONCLUSIONS AND RECOMMENDATIONS

The foregoing conducted research examined the phenomenon of the Economy of Things and its sustainable value. It thoroughly studied the environment as well as the process of its emergence including its historical background. Then, the study evaluated and proved that the Economy of Things indeed generates a sustainable value in a form of data. In turn, it allowed assessing the role of sustainable value in the success of start-up digital companies. To achieve that, secondary data was collected in qualitative and quantitative forms.

Subsequently, data were analyzed in order to establish the dependence between data generated by the EoT and the success of young businesses. Analysis revealed certain findings which allowed to draw out specific conclusions. In the final chapter of the research, those conclusions will be revealed and discussed. The chapter will also answer the research question and test hypotheses. Furthermore, it will also offer potential implementation of the research, propose recommendations for further study, suggested discussion topics and hypotheses, and give recommendations for practical application of studied material.

5.1. Research Conclusions

The primary goal of the research is to answer a research question. Therefore, it would be reasonable to restate the research question of this study. The question sounds as follows: What is the role of a sustainable value generated by the Economy of Things for the success of start-up digital companies? Therefore, to answer this question, it was necessary to establish the dependence between the value and the success of start-ups. To achieve that, a thorough examination of the studied phenomenon, the Economy of Things was conducted. This examination included tracking the historical development of the IT industry, a detailed overview of key technologies involved in the Economy of Things, and a discussion of some businesses which operate in the environment.

Understanding the phenomenon allowed to evaluate if the EoT really generates a sustainable value, and establish its form. The study showed that the Economy of Things indeed generates value, which is data. This value was proven to be sustainable as it grows organically. Moreover, it was discovered, that data generation is crucial for the EoT as it allows the environment to function.

The mentioned study allowed to conduct a data analysis needed to discover the dependence between data and start-up success. For that purpose, secondary data was collected in a form of statistics, analytical articles, and academic researches. Due to the immaturity of the EoT environment and consequent lack of data, the study separated EoT into key technological industries, cloud services, the Internet of Things, blockchain, wireless network connections, and machine learning. It was done in order to examine if businesses within those industries indeed rely on data. The examination has proven that they do, which in turn, allowed to establish key factors that impact the success of digital start-ups in observed industries. Considering that those technological industries compile the Economy of Things it became possible to transfer the results of the findings onto the EoT environment.

Research shows, that digital start-ups rely on the same, general, success factors as all other start-ups. Those factors include the reasoning behind the viability of an innovative idea, business strategy, founders' expertise, funding, competitive advantage, and quality of a team. Data (sustainable value), however, is not a success factor on its own. Instead, data is a key asset on which the EoT environment functions, it is what allows start-ups to operate within the environment and access the benefits it provides. In the EoT one start-up can be successful and the other not. The reason is a business organization. The role of EoT value for both businesses is the same. However, it does not identify success for any of the two, rather just provides means of operation.

Study reveals that data is a resource, rather than a success factor. Much like any other resource, only when well utilized, data can affect success. Examined nature of data allows concluding that certain processed data in the Economy of Things is equivalent to money in a global economy. Much like monetary resources, data can give businesses the means to function and an advantage on the way to success, but it does not guarantee it. It is proven by statistics, that even though EoT start-ups have access to sustainable value (data), few of them succeed.

Findings allow concluding that, there is no direct dependency between the sustainable value generated by the EoT and the success of a start-up. There is, however, an indirect dependency. When used correctly, the resource, in a form of data, can amplify other success factors and eventually might lead to a business triumph. Thus, while it is not possible to achieve success in the EoT environment without data, much like there is little chance to grow any business with no finances, access to a valuable resource still does not guarantee success.

The success of a start-up is defined by a wide variety of factors, and none of them is prevailing. Businesses should not overvalue the role of data, as for it to be useful, many other factors must align. Therefore, the sustainable value generated by the Economy of Things, data, has a neutral role in the success of start-up digital companies.

Test of hypotheses

Foregoing conclusions allow the test of proposed hypotheses and check, whether those are true or not. Hypothesis 0 presumes that the role of sustainable value generated by the EoT (data) is defining factor for the success of start-up digital companies. It appeared to be untrue, it was revealed that data does not have any direct dependency on a start-up's success. Nevertheless, it does have an indirect effect, via the possibility of amplification of other success factors. This effect, however, can be achieved only when data resource is utilized in the right matter.

Hypothesis 1 assumes that sustainable value generated by the EoT (data) positively affects the attractiveness of the industry for businesses which affects the development of the Economy of Things environment. This hypothesis is true, as indeed data is what allows the machine economy to function. It brings great possibilities for development and, as it was mentioned, is a valuable resource. Therefore, the sustainable value that EoT generates indeed makes the environment attractive for new businesses.

Finally, hypothesis 2 supposes that data in EoT is equivalent to money in a global economy. This hypothesis is only partially true, only certain types of EoT data can be equivalent to money in a global economy. Other kinds of data can be equivalent to commodities or products.

5.2. Limitations of the Study

It is necessary to mention limitations that are relevant to this research. The major limitation is the novelty of the discussed phenomenon. The Economy of Things is a very young environment, which did not accumulate a substantial amount of statistical data yet. Moreover, the term EoT is not an established one yet. This factor makes the amount of accessible data regarding the Economy of Things very scarce and limits findings regarding the role of the sustainable value generated by the environment.

Furthermore, researching an immature environment also limits the number of applied research methods. As such, it appeared to be problematic to collect primary data, as there are no subjects from a business industry who could have been accessed for a qualitative interview. Moreover, quantitative primary data is not accessible either, as a general totality of people is simply unaware of the EoT phenomenon.

Another limitation is an evaluation of a start-up's success in general. As explained by Daniel Keogh, "As young firms, startups lack long time-trends of metrics used to evaluate older businesses; the question of how to identify and measure startup success is an argument in the economic literature" (Laitinen, 2019, as cited by Keogh, 2021).

5.3. Recommendations

Recommendations for further research

The Economy of Things is, undeniably, a very important step in the development of information technologies. One can say it is a crucial step, which, combined with the emerging age of Web 3.0 can transform the approach to many, as it seemed before, unshakable values in the sphere of economy. This research was aimed at a deep study of the EoT phenomenon and delivering theoretical knowledge of its aspects. However, since the environment is immature, the phenomenon remains under-researched. Therefore, certain recommendations for further research will be provided.

Due to a relative scarcity of resources required to study the Economy of Things, it would be reasonable to advise conducting another deep research of this topic after a certain period of time. Not only it will provide time for more data to emerge, but it also will allow the industry to advance. Technologies involved in the EoT evolve rapidly and within the scope of several years, the environment might look drastically different.

The Economy of Things is not been fully adopted yet and its full potential is far from being discovered. Thus, it will be reasonable to examine some hypothetical consequences of global EoT adoption, which is expected to happen in the near future. When examining such consequences, it is necessary to address both positive and negative aspects. Even though the technologies are neutral in their nature, the consequences of the implementation will still lay in hands of certain people, start-ups, and corporations. Consequently, the adoption of EoT can serve both a greater good and have some negative impact in the wrong hands. However,

it stands to reason that implementation will include a mix of both. Yet, to predict anything with certainty, further research is required.

Talking about the potential of the Economy of Things implies the advancement of the machines and improvement of the digital world. Currently, those worlds still function separately. However, they already started to collide. Adoption of the Economy of Things might further boost an irreversible collision of digital space and physical one. This phenomenon has a lot of aspects that can be unpacked. Therefore, it is recommended to research it as well.

Hypotheses for further study and discussion

Conducted research also allows for a proposal of certain hypotheses for future discussion and study. The first hypothesis that is being proposed, presumes that the Economy of Things and the sustainable value that it generates will allow future Web 3.0 start-ups to become superior and disrupt their Web 2.0 well-established counterparts.

The second hypothesis is slightly more ambiguous. It speculates that the expansion of the economy of machines will transform the current global economy by releasing humans from the current monetary system. Machines will handle redundant tasks instead of humans, and generate income in return. Such a shift can allow humanity to focus on global issues instead of caring about monetary means of existence. This is a rather ambiguous hypothesis, as has been mentioned. However, it might be an interesting topic to research and discuss.

Practical implications and recommendations

Finally, considering the nature of business-related research, it will be logical to offer some practical recommendations and implications. This research can serve as an outline to understand a new, emerging, EoT environment, which can be applied to certain early-stage start-ups. Another practical implication of this study is to serve as an addition to some current researches which are being held by a corporation such as Bosch and IBM. It might be useful since the study provides a comprehensive overview of the environment with practical examples and statistical findings.

As for practical recommendations, examined materials and conducted research allow to propose several pieces of advice. It was established, that the EoT environment is not saturated yet. However, small and large companies are showing some considerable interest in the environment. It lets to conclude that now, in 2022, it might be a good time to come into

the industry with some well-tailored offers. It might be possible to launch a bespoke product and create one of the "killer applications" which have not yet appeared in the Economy of Things.

However, it is crucial to understand that the EoT environment only offers new opportunities. It does not provide any defining success factors, as it was established. Therefore, it is recommended not to overvalue novelties of the environment and focus on general factors of start-up success that were listed earlier. At the end of the day, the Economy of Things is an environment that possesses great opportunities and implements cutting-edge technologies. Yet, it does not offer a shortcut to success. However, when properly aligning all necessary factors, one can achieve some ground-breaking results in this emerging environment.

REFERENCES

Agarwal, A. (2022) *"6 Benefits of Blockchain and IoT to Propel Market Growth"*, Readwrite. Retrieved from: https://readwrite.com/6-benefits-of-blockchain-and-iot-to-propel-market-growth/

Aiello, M. (2022), *"IoT architectures: from data to smart systems"*, Frontiers. Retrieved from: https://www.frontiersin.org/articles/10.3389/friot.2022.959268/full#B15

Ashton, K. (2009), "*That 'Internet of Things' Things*", RFID Journal. Retrieved from: http://www.itrco.jp/libraries/RFIDjournal-That%20Internet%20of%20Things%20Thing.pdf

Ashmore, D. (2022), *"A Brief History of Web 3.0"*, Forbes Advisor. Retrieved from: https://www.forbes.com/advisor/investing/cryptocurrency/what-is-web-3-0/

Audius, (n.d.). *"Freedom to Share and Listed"*, Audius. Retrieved from: https://audius.org

Avalanche, (n.d.) *"Welcome to Multiverse"*, Avalanche. Retrieved from: https://www.avax.network/

Axie Infinity (n.d.) *"Axie Infinity: Origins"*, Axie Infinity. Retrieved from: https://axieinfinity.com/

Baldridge, R. (2022) *"What Is a Startup?"*, Forbes Advisor. Retrieved from: https://www.forbes.com/advisor/business/what-is-a-startup/

Bastyon (n.d.) *"Stand up to censorship & gain financial independence",* Bastyon. Retrvied from: https://bastyon.com/about

Boder, R. (2021) *"Entrepreneurs Should Embrace Web 3.0"*, Entrepreneur. Retrieved from: https://www.entrepreneur.com/science-technology/entrepreneurs-should-embrace-web-30/394083

Boreham, J. (2022) *"Enabling True Digital Identity in the Metaverse"*, The Metaverse Insider. Retrieved from: https://metaverseinsider.tech/2022/09/06/enabling-true-digital-identity-in-the-metaverse/

Bortolini, R. F. (2018) *"Lean Startup: a comprehensive historical review"* Management Decision. Retrieved from: https://www.emerald.com/insight/content/doi/10.1108/MD-07-2017-0663/full/html

Bosch, (n.d.), *"Digital identity – enabling secure collaboration with blockchain technology"*, Bosch. Retrieved from: https://www.bosch.com/stories/self-sovereign-identities/

Bosch (2022) *"GAIA-X 4 moveID project develops basis for secure mobile data exchange"*, Bosch. Retrieved from: https://www.bosch-presse.de/pressportal/de/en/gaia-x-4-moveid-project-develops-basis-for-secure-mobile-data-exchange-245952.html

Brave, (n.d.), *"The best privacy online"*, Brave. Retrieved from: https://brave.com

Brave (2020) *"A Browser Built to Perform"*, Brave. Retrieved from: https://brave.com/compare/chrome/performance/

Brave (2021), *"Brave Passes 36 Million Monthly Active Users"*, Brave. Retrieved from: https://brave.com/36m-mau/

Brown, A. (2021) *"Utilizing AI And Big Data To Reduce Costs And Increase Profits In Departments Across An Organization"*, Forbes. Retrieved from: https://www.forbes.com/sites/anniebrown/2021/04/13/utilizing-ai-and-big-data-to-reduce-costs-and-increase-profits-in-departments-across-an-organization/?sh=364d7ccc6af7

Calabrese, N. (2021) *"The Growing Popularity of Blockchain Technology"*, Research G2. Retrieved from: https://research.g2.com/insights/growing-popularity-of-blockchain-technology

Cambridge Dictionary (n.d.) *"Economic Value"*, Cambridge Dictionary. Retrieved from: https://dictionary.cambridge.org/dictionary/english/economic-value

Captain, S. (2019) *"Watch Google, Facebook, and YouTube's rise to dominance in this hypnotic video"*, Fast Company. Retrieved from: https://www.fastcompany.com/90421999/watch-google-facebook-and-youtubes-rise-to-dominance-in-this-hypnotic-video

Cbinsights, n.d. *"Databricks's alternatives and competitors"*, Cbinsights. Retrieved from: https://www.cbinsights.com/company/databricks/alternatives-competitors

Chanal, P. (2020). "*Security and Privacy in IoT: A Survey*", Springer Link, Retrieved from: https://link.springer.com/article/10.1007/s11277-020-07649-9

Charge (n.d.) *"Borderless, Frictionless, Permissionless Electric Vehicle Charging"*, Charge. Retrieved from: https://www.charge.xyz

Chubb, N. (2019) *"Why did blockchain startup 300Cubits' TEU Tokens fail?"*, Thetius. Retrieved from: https://thetius.com/why-did-blockchain-startup-300cubits-teu-tokens-fail/

Chui, M. (2021) *"New research shows that the Internet of Things offers significant economic value potential, particularly in standardized production settings, but companies must achieve scale to capture it"*, McKinsey Digital. Retrieved from: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/iot-value-set-to-accelerate-through-2030-where-and-how-to-capture-it

Citesabc (2022) "*Leonard Dorlöchter, Co-founder of Peaq - The Economy of Things"* [Video Interview]. YouTube. Retrieved from: https://www.youtube.com/watch?v=MS0ydgee5KQ&list=LL&index=7&t=2s

CoinMarketCap (2022) *"Basic Attention Token"*, CoinMarketCap. Retrieved from: https://coinmarketcap.com/currencies/basic-attention-token/

CoinMarketCap (2022) *"Today's Cryptocurrency Prices by Market Cap"*, CoinMarketCap. Retrieved from: https://coinmarketcap.com

Computer Hope (2022), *"Social Network",* Computer Hope Retrieved from: https://www.computerhope.com/jargon/s/socinetw.htm

Daintith, J. (2008) *"A Dictionary of Computing"*, Oxford University Press

Daly, L. (2022), *"What Is a Blockchain Node?"*, The Money Fool. Retrieved from: https://www.fool.com/investing/stock-market/market-sectors/financials/blockchain-stocks/blockchain-node/

Davidsen, M. (n.d.) "*Empowering the Economy of Things".* Retrieved from: https://assets.ctfassets.net/fo0rvac1gv8v/5Ui5mhVJKgGqYqe6O2OESm/4c66ff073a6510a8b4fe68e16ef2e48d/weeve_whitepaper.pdf

Dirks, S. (n.d.) *"A vision of smarter cities"*, IBM Institute. Retrieved from: https://www.ibm.com/downloads/cas/2JYLM4ZA

Djuraskovic, O. (2022) "*Big Data Statistics 2022: How Much Data is in The World?"*, First Site Guide. Retrieved from: https://firstsiteguide.com/big-data-stats/

Dobrynin, V. (2022) *"How Startups Build Ecosystems in the Age of Platform Giants"*, RBK Trends. Retrieved from: https://trends.rbc.ru/trends/innovation/6290c0719a794736e4175276

Editors of Encyclopedia Britannica (2022) *"Wi-Fi Networking Technology"*, Britannica. Retrieved from: https://www.britannica.com/technology/Wi-Fi

Elavon (2017), *"Economy of Things*". Retrieved from: https://www.elavon.co.uk/content/dam/elavon/en_GB/documents/Economy-of-Things-white-paper-released-October-16.pdf

Elgazzar, K. (2022), *"Revisiting the internet of things: New trends, opportunities and grand challenges"*, Frontiers. Retrieved from: https://www.frontiersin.org/articles/10.3389/friot.2022.1073780/full#B7

El-Hage, S. (2018), *"Micropayments Between IoT Devices"*, Royal Institute of Technology. Retrieved from: https://www.diva-portal.org/smash/get/diva2:1272048/FULLTEXT01.pdf

Ellison, L. (2022) *"Database"*, Britannica. Retrieved from: https://www.britannica.com/technology/database

EoT Labs (n.d.) *"EoT Labs is building the next generation of the Internet of Things, the Economy of Things"*, EoT Labs. Retrieved from: https://www.eotlabs.io

Failory, (n.d.) *"Startup Cemetery"*, Failory. Retrieved from: https://www.failory.com/cemetery/qbotix

Feng, H. (2022) *"Benchmark Analysis of YOLO Performance on Edge Intelligence Devices"*, College of Electronics and Information Engineering. Retrieved from: https://www.mdpi.com/2410-387X/6/2/16

Flew, T. (2014) *"New Media, Fourth Edition"*, Oxford University.

Frankefield, J. (2022), *"Cryptocurrency Explained with Pros and Cons for Investment*", Investopedia. Retrieved from: https://www.investopedia.com/terms/c/cryptocurrency.asp

Gabbai, A. (2015) *"Kevin Ashton Describes "the Internet of Things"*, Smithsonian Magazine. Retrieved from: https://www.smithsonianmag.com/innovation/kevin-ashton-describes-the-internet-of-things-180953749/

Gaia-X (n.d.) *"Members Directory"*, Gaia-X. Retrieved from: https://gaia-x.eu/membership/members-directory/

George, B. (2022) *"What Is a Dapp? Decentralized Apps Explained"*, Coindesk. Retrieved from: https://www.coindesk.com/learn/what-is-a-dapp-decentralized-apps-explained/

Gillin, P. (2019) *"Big-data bombshell: MapR may shut down as investor pulls out after 'extremely poor results'"*, Silicon Angel. Retrieved from: https://siliconangle.com/2019/05/30/mapr-may-shut-investor-pulls-following-extremely-poor-results/

Goswami, B. (2012) *"Understanding ethical values and economic value"*, Research Gate. Retrieved from: https://www.researchgate.net/publication/269744631_Understanding_ethical_values_and_economic_value

Grant, M. (2022) *"What a Startup Is and What's Involved in Getting One Off the Ground"*, Investopedia. Retrieved from: https://www.investopedia.com/terms/s/startup.asp

Gubbi, J. (N.D.) *"Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions"*, IEEE Press. Retrieved from: https://opensyllabus.org/result/title?id=1941325217859

Halim, D. (2022) *"Towards data sharing economy on Internet of Things: a semantic for telemetry data"*, Journal of Big Data. Retrieved from: https://journalofbigdata.springeropen.com/articles/10.1186/s40537-021-00549-0

Hassan, N. (2018) *"The Role of Edge Computing in Internet of Things"*, IEEE Communications Magazine. Retrieved from: https://ieeexplore.ieee.org/abstract/document/8450541/citations#citations

Helium (n.d) *"People-Powered Networks Start a Wireless Revolution"*, Helium. Retrieved from: https://www.helium.com

Hu, J. (2021). "*Recent Advances in Cybersecurity, IoT Security, and Blockchain Technologies*" MDPI (Multidisciplinary Digital Publishing Institute). Retrieved from: https://www.mdpi.com/journal/sensors/special_issues/cybersecurity_blockchain

Hosch, W. (2022) *"Semantic Web"*, Britannica. Retrieved from: https://www.britannica.com/topic/Semantic-Web

Howarth, J. (2022) *"57+ Amazing Artificial Intelligence Statistics (2022)"*, Exploding Topics. Retrieved from: https://explodingtopics.com/blog/ai-statistics

IBM Institute for Business Value, (n.d.). "*The Economy of Things*". Retrieved from: https://www.ibm.com/downloads/cas/AVRE308E

IBM (n.d.), *"What are smart contracts on blockchain?"*, IBM. Retrieved from: https://www.ibm.com/topics/smart-contracts

Jain, P. 2022 *"A Practical Guide to Increasing Startup Success Through Data Analytics"*, Entrepreneur. Retrieved from: https://www.entrepreneur.com/growing-a-business/how-data-analytics-can-help-your-startup-achieve-success/436929

Kaufman, J. (2010) *"The Personal MBA: Master the Art of Business"*, Penguin Publishing Group

Kardelis, K. (2002) *"Research methodology and methods"*, Šiauliai. Retrived from: https://www.scribd.com/doc/37948910/K-Kardelis-Mokslinių-tyrimų-metodologija-ir-metodai

Kenton, W. (2022) *"What Is Social Networking?"*, Investopedia. Retrieved from: https://www.investopedia.com/terms/s/social-networking.asp

Keogh, D. (2021) *"Survival of the funded: Econometric analysis of startup longevity and success"*, JEMI. Retrieved from: https://jemi.edu.pl/vol-17-issue-4-2021/survival-of-the-funded-econometric-analysis-of-startup-longevity-and-success

Kerner, S. (n.d.) *"Web 3.0 (Web3)"*, Tech Target. Retrieved from: https://www.techtarget.com/whatis/definition/Web-30

Kotashev, K. (2022) *"Startup Failure Rate: How Many Startups Fail and Why?"*, Failory. Retrieved from: https://www.failory.com/blog/startup-failure-rate

Kumar, S. (2019). "*Internet of Things is a revolutionary approach for future technology enhancement: a review*" Journal of big data. Retrieved from: https://journalofbigdata.springeropen.com/articles/10.1186/s40537-019-0268-2

Lee, I. (2020) *"Battery Draining Attack and Defense against Power Saving Wireless LAN Devices"*, Sungshin University. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7180966/pdf/sensors-20-02043.pdf

Lele, C. (2022), *"Internet of Things (IoT) A Quick Start Guide"*, BPB Publications

Lu, 2021 *"Human Reliance on Machine Learning Models When Performance Feedback is Limited: Heuristics and Risks"*, Purdue University. Retrieved from: https://mingyin.org/paper/CHI-21/reliance.pdf

Lv, Z (2022), *"Practical Application of Internet of Things in the Creation of Intelligent Services and Environments",* Frontiers. Retrieved from: https://www.frontiersin.org/articles/10.3389/friot.2022.912388/full#B26

McFarland, M. (2022) *"Uber to test delivering food with robots"*, CNN Business, Retrieved from: https://edition.cnn.com/2022/05/13/cars/uber-robot-delivery-la/index.html

Metadium (2019) *"Introduction to Self-Sovereign Identity".* Retrieved from: https://medium.com/metadium/introduction-to-self-sovereign-identity-and-its-10-guiding-principles-97c1ba603872

Meunier, S. (2018) *"Transforming Climate Finance and Green Investment with Blockchains"*, Science Direct. Retrieved from: https://www.sciencedirect.com/science/article/pii/B9780128144473000033

Mercan, S. (2021) *"Cryptocurrency Solutions to Enable Micro-payments in Consumer IoT"*, Florida International University. Retrieved from: https://arxiv.org/pdf/2102.02623.pdf

Mersh, M. (2019) *"What Is Web 3.0 & Why It Matters"*, Medium. Retrieved from: https://medium.com/fabric-ventures/what-is-web-3-0-why-it-matters-934eb07f3d2b

Moudoud, H. (2022) *"Towards a Scalable and Trustworthy Blockchain: IoT Use Case"*, University of Technology of Troyes. Retrieved from: https://arxiv.org/pdf/2201.11337.pdf

Nesa, N. (2018). *"Outlier Detection in Sensed Data Using Statistical Learning Models for IoT"*, IEEE Press. Retrieved from: https://opensyllabus.org/results-list/titles?size=50&findWorks=iot

Osseiran, A. (2017). "*Internet of Things*", Communication Standards Magazine, Retrieved from: https://ieeexplore.ieee.org/abstract/document/7992936

O'Neill, S. (2022) *"Web 1.0, Web 2.0, And Web 3.0?"*, LXA hub, Retrieved from: https://www.lxahub.com/stories/whats-the-difference-between-web-1.0-web-2.0-and-web-3.0

O'Reilly, T. (2009), *"What Is Web 2.0"*, O'Reilly. Retrieved from: https://www.oreilly.com/pub/a/web2/archive/what-is-web-20.html

O'Reilly, T. (2009), *"What Is Web 2.0"*, O'Reilly Media Inc.

Phillips, D. (2022) *"What is Tokenization?"*, Tekenex. Retrieved from: https://www.tokenex.com/blog/what-is-tokenization/

Oyinloye, T. (2022) *"Blockchain Nodes: What Are They and Why Are They Important in Decentralized Networks?"*, Dailycoin, Retrieved from: https://dailycoin.com/blockchain-nodes-what-are-they-and-why-are-they-important-in-decentralized-networks/

Pasori, C. (2012), *"The Evian Smart Drop"*, Complex. Retrieved from: https://www.complex.com/style/2012/06/the-evian-smart-drop

Peaq (n.d.) *"Powering the Economy of Things"*, Peaq. Retrieved from: https://www.peaq.network

Petras National Centre (2022) *"STaR-IoT: 1st International Workshop on Socio-technical Cybersecurity and Resilience in the Internet of Things"*, Petras National Centre. Retrieved from: https://petras-iot.org/update/star-iot/

Pierro, M. (2017), *"What Is the Blockchain?"*, Computing in Science & Engineering. Retrieved from: https://cse.sc.edu/~mgv/csce190f19/diPierro_mcs2017050092.pdf

Pilon, A. (2013) *"What is a Database?"*, Small Business Trends. Retrieved from: https://smallbiztrends.com/2013/06/what-is-a-database.html

Platon (n.d.) *"Responsibility to Clients, Partners and Government"*, Platon. Retrieved from: https://platon.ru/ru/

Porter, J. (2022) *"Tesla's 'Full Self-Driving' Beta is now available to everyone in North America"*, The Verge, Retrieved from: https://www.theverge.com/2022/11/24/23476570/teslas-full-self-driving-beta-release-north-america-safety-score

Portnov, M. (2021) *"The Problem with Web2.0 – Why Web3 Is Emerging"*, Magic Square. Retrieved from: https://magicsquare.io/blog/the-problem-with-web2/

Pureswaran, V. (2015) *"Get Ready For 'The Economy of Things'"*, Forbes. Retrieved from: https://www.forbes.com/sites/ibm/2015/09/08/get-ready-for-the-economy-of-things/?sh=59faa8642219

Qian, C. (2022) *"Digital Twin—Cyber Replica of Physical Things: Architecture, Applications and Future Research Directions"*, Towson University. Retrieved from: https://www.mdpi.com/1999-5903/14/2/64

Rackley, S. (2007), *"Wireless Networking Technology"*, Elsevier Ltd.

Ranger, S. (2020). "*What is the IoT? Everything you need to know about the Internet of Things right now*" ZDNet. Retrieved from: https://www.zdnet.com/article/what-is-the-internet-of-things-everything-you-need-to-know-about-the-iot-right-now/

Rathod, A. (2022) *"Technical Analysis: LINK, HIVE, DOT, BAT, FLUX and APT Price Prediction (Nov. W3)"*, CoinMarketCap. Retrieved from: https://coinmarketcap.com/alexandria/article/technical-analysis-link-hive-dot-bat-flux-and-apt-price-prediction-nov-w3

Reiff, N. (2022), *"Decentralized Autonomous Organization (DAO): Definition, Purpose, and Example",* Investopedia. Retrieved from: https://www.investopedia.com/tech/what-dao/

Rodeck, D. (2022) *"What is Blockchain?"*, Forbes Advisor, retrieved from: https://www.forbes.com/advisor/investing/cryptocurrency/what-is-blockchain/

Ruby, D. (2022) *"106+ Startup Statistics of 2022 (The Extensive List)"*, Demand Sage. Retrieved from: https://www.demandsage.com/startup-statistics/

Satrom, B. (2022) *"Demystifying LoRa and LoRaWAN Wireless Network Protocols"*, All About Circuits. Retrieved from: https://www.allaboutcircuits.com/technical-articles/demystifying-lora-network-and-lorawan-network-wireless-network-protocols/

Scharmann (n.d.) *"The road to a trustworthy digital "Economy of Everything""*, Bosch, Retrieved from: https://www.bosch.com/research/know-how/success-stories/economy-of-things-a-technology-and-business-evolution/

Schmitt, G. (2019) *"Smart Contracts and Internet of Things: A Qualitative Content Analysis using the Technology-Organization-Environment Analysis using the Technology-Organization-Environment Framework to Identify Key-Determinants Framework to*

Identify Key-Determinants", Elsevier B.V. Retrieved from: https://www.sciencedirect.com/science/article/pii/S1877050919316758

Serpantos, D. (2018), *"Internet-of-Things (IoT) Systems"*, Springer International Publishing. Retrieved from: https://etu.ru/assets/files/international/winter-school-iqmai4/01-03-internet-of-things-systemss-architectures-algorithms-methodologies.pdf

Sharma, R. (2022) *"Non-Fungible Token (NFT): What It Means and How It Works"*, Investopedia. Retrieved from: https://www.investopedia.com/non-fungible-tokens-nft-5115211#:~:text=Non%2Dfungible%20tokens%20can%20digitally,domain%20names%2C%20and%20event%20tickets

Shepardson, D. (2019) *"Facebook to pay record $5 billion U.S. fine over privacy; faces antitrust probe"*, Reuters. Retrieved from: https://www.reuters.com/article/us-facebook-ftc/facebook-to-pay-record-5-billion-u-s-fine-over-privacy-faces-antitrust-probe-idUSKCN1UJ1L9

Shmitko, Y. (2022), *"Web 3.0: The most common business technology trend"*, Ideasoft. Retrieved from: https://ideasoft.io/blog/why-is-web-3-0-the-most-common-business-trend/

Simmons, A. (2022) *"Internet of Things (IoT) Analytics: Understanding Data"*, Dgtl Infra. Retrieved from: https://dgtlinfra.com/internet-of-things-iot-analytics/

Smith, A. (2022) *"What Are the Advantages of Decentralized Finance?"*, Blockchain Council, Retrieved from: https://www.blockchain-council.org/info/what-are-the-advantages-of-decentralized-finance/

Statista Research Department (2022) *"Blockchain technology market size worldwide in 2021, with a forecast for 2030"*, Statista. Retrieved from: https://www.statista.com/statistics/1319369/global-blockchain-technology-market-size/

Statista Research Department (2022), *"Number of smartphone subscriptions worldwide from 2016 to 2021, with forecasts from 2022 to 2027"*, Statista. Retrieved from: https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

Steward, J. (2020) *"The Ultimate List of Startup Statistics for 2023"*, Findstack. Retrieved from: https://findstack.com/resources/startup-statistics/

Swift, (n.d.). *"How long do wire transfers take?"*, Swift. Retrieved from: https://www.swift.com/your-needs/banking/how-long-do-wire-transfers-take

Tarasov, K. (2022) *"A first look at Amazon's new delivery drone, slated to start deliveries this year"*, CNBC. Retrieved from: https://www.cnbc.com/2022/11/11/a-first-look-at-amazons-new-delivery-drone.html

Taylor, K. (n.d.) *"Use Cases of Tokenization"*, Hitech Nectar. Retrieved from: https://www.hitechnectar.com/blogs/use-cases-tokenization/

The Economist (2017) *"The world's most valuable resource is no longer oil, but data"*, The Economist. Retrieved from https://www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data

The Guardian, (2022) *"California allows driverless taxi service to operate in San Francisco"*, The Guardian. Retrieved from: https://www.theguardian.com/technology/2022/jun/03/california-driverless-taxi-cars-san-francisco

Tyson, M. (2022) *"Brendan Eich: Don't blame cookies and JavaScript"*, Infoworld, https://www.infoworld.com/article/3673292/brendan-eich-dont-blame-cookies-and-javascript.html

Tzafestas, S. (2018) *"Synergy of IoT and AI in Modern Society: The Robotics and Automation Case"*, National Technical University of Athens. Retrieved from: https://theblockchaintest.com/uploads/resources/JP%20-%20Synergy%20of%20IoT%20and%20AI%20in%20Modern%20Society-The%20%20Robotics%20and%20Automation%20Case%20-%202018%20-%20Sep.pdf

Vailshery, L. (2022) *"Internet of Things (IoT) total annual revenue worldwide from 2020 to 2030"*, Statista. Retrieved from: https://www.statista.com/statistics/1194709/iot-revenue-worldwide/

Version Museum, (n.d.), *"Amazon.com Design History"*, Version Museum. Retrieved from: https://www.versionmuseum.com/history-of/amazon-website

Vodafone (2022) *"Vodafone launches new Economy of Things platform – a world in which devices, vehicles and machines can buy and sell for us"*, Vodafone. Retrieved from: https://www.vodafone.com/news/technology/new-economy-of-things-platform

Volk, C. (2020) *"KfW Research: Private charging stations provide great potential for expansion of e-mobility in Germany"*, KFW Group. Retrieved from: https://www.kfw.de/About-KfW/Newsroom/Latest-News/Pressemitteilungen-Details_617088.html

Weiser, M. (1991), *"The Computer of the 21st century"*, Palo Alto Research Center. Retrieved from: https://dl.acm.org/doi/pdf/10.1145/329124.329126

Wojciechowicz, T. (2018) *"Why Blockchain and the Internet of Things (IoT) Belong Together"*, Symmetry Electronics. Retrieved from: https://www.symmetryelectronics.com/blog/why-blockchain-and-the-internet-of-things-belong-together-symmetry-blog/

Worldbank (2018) *"Blockchain & Distributed Ledger Technology (DLT)".* Retrieved from: https://www.worldbank.org/en/topic/financialsector/brief/blockchain-dlt

Zhang, M. (2022), *"Data Lake: A Single Source of Truth in the Cloud"*, Dgtl Infra. Retrieved from: https://dgtlinfra.com/data-lake-cloud-aws-azure/

Zhang, M. (2022) *"Top 10 Cloud Service Providers Globally in 2022"*, Dgtl Infra. Retrieved from: https://dgtlinfra.com/top-10-cloud-service-providers-2022/

SUMMARY

Amelin, 0. The Role of Sustainable Value Creation Generated From the Economy of Things (EoT) for Start-up Digital Companies Success / Electronic Business Management Master's Theisis. Supervisor dr. T. Mendelsonas. - Lithuania, Vilnius: Mykolas Romeris University, Department of Business and Economics, 2022.

The Economy of Things (EoT) is a very recent phenomenon, that is emerging as a result of the advancements of several IT technologies in a Web 3.0 environment. This phenomenon implies economized autonomous interaction of machines, sensors, and devices, that are referred to as "things", in a decentralized ecosystem of networks. The Economy of Things is an evolved counterpart of the Internet of Things combined with blockchain technology. Blockchain supplies EoT with decentralization, improved security, Self-Sovereign digital identities, and tokenization. Other technologies which are involved in EoT are machine learning, cloud computing, and advanced wireless network connection. EoT environment, is a rather under-researched, but a very promising topic.

The study provides an understanding of the concept of EoT through an examination of the technologies behind it, real-life examples, and an overview of its key features.

Certain companies already acclaimed EoT as a very perspective environment. It possesses substantial opportunities for businesses and individuals. This research aims to unveil the potential of the Economy of Things via means of theoretical research. The study examines the role of sustainable value generated within it as a success factor for start-up businesses. The research answers the following question. What is the role of sustainable value creation generated from the Economy of Things for start-up digital companies' success?

The study covers theoretical knowledge, serving as a backbone for a comprehensive understanding of the Economy of Things and other related concepts. It also covers the methodological framework used in conducting the research as well as data analysis. An extensive examination of those aspects defines the value generated by the EoT environment. Research identifies this value as data. This value is sustainable as it grows naturally. Subsequent analysis allows the examination of the success factors of a digital start-up.

Ultimately, the research unravels the dependency between data generated by the EoT and the success of start-up digital companies.

Research findings establish the role of sustainable value generated by EoT for start-up digital companies' success, followed by conclusions, and recommendations for future research and discussion.

Keywords: Economy of Things (EoT), Internet of Things (IoT), Start-up success factors, Sustainable value creation, Web 3.0, Blockchain, Big Data, Cryptocurrency, Machine Learning, dApp, Information Technologies, Digital start-up.

SANTRAUKA

Amelin, O. Iš daiktų ekonomikos (DE) sukurtos tvarios vertės kūrimo vaidmuo naujų skaitmeninių įmonių sėkmei / Elektroninio verslo vadybos magistro darbas. Vadovas dr. T. Mendelsonas. - Lietuva, Vilnius: Mykolo Romerio universitetas, Verslo ir ekonomikos katedra, 2022

Daiktų ekonomika (DE) yra visai neseniai atsiradęs reiškinys, atsirandantis dėl kelių IT technologijų pažangos Web 3.0 aplinkoje. Šis reiškinys reiškia ekonomišką autonominę mašinų, jutiklių ir įrenginių, vadinamų "daiktais", sąveiką decentralizuotoje tinklų ekosistemoje. Daiktų ekonomika yra tobulas daiktų interneto atitikmuo kartu su blockchain technologija. "Blockchain" teikia DE decentralizaciją, pagerintą saugą, savarankiškas skaitmenines tapatybes ir prieigos raktus. Kitos technologijos, susijusios su DE, yra mašininis mokymasis, debesų kompiuterija ir pažangus belaidžio tinklo ryšys. DE aplinka yra gana mažai ištirta, bet labai perspektyvi tema.

Tyrimas suteikia supratimą apie DE koncepciją, nagrinėjant jame esančias technologijas, realius pavyzdžius ir pagrindinių jos savybių apžvalgą.

Kai kurios įmonės jau pripažino EoT kaip labai perspektyvią aplinką. Ji suteikia didelių galimybių įmonėms ir asmenims. Šiuo tyrimu siekiama atskleisti daiktų ekonomikos potencialą pasitelkiant teorinius tyrimus. Tyrime nagrinėjamas joje kuriamos tvarios vertės, kaip sėkmingo verslo pradžios veiksnio, vaidmuo. Tyrimas atsako į šį klausimą. Koks yra tvarios vertės kūrimo, sukurtos naudojant Daiktų Ekonomiką, vaidmuo siekiant naujų skaitmeninių įmonių sėkmės?

Tyrimas apima teorines žinias, kurios yra visapusiško daiktų ekonomikos ir kitų susijusių sąvokų supratimo pagrindas. Ji taip pat apima metodologinę sistemą, naudojamą atliekant tyrimą, taip pat duomenų analizę. Išsamus šių aspektų nagrinėjimas apibrėžia DE aplinkos sukuriamą vertę. Tyrimai šią vertę nustato kaip duomenis. Ši vertė yra tvari, nes ji auga natūraliai. Vėlesnė analizė leidžia ištirti skaitmeninio startuolio sėkmės veiksnius. Galiausiai tyrimas atskleidžia priklausomybę tarp DE generuojamų duomenų ir pradedančių skaitmeninių įmonių sėkmės.

Tyrimų išvados nustato tvarios vertės, kurią sukuria DE, vaidmenį pradedančių skaitmeninių įmonių sėkmei, o po to pateikiamos išvados ir rekomendacijos būsimiems tyrimams ir diskusijoms.

Pagrindiniai žodžiai: daiktų ekonomika (DE), daiktų internetas (DI), verslo pradžios sėkmės veiksniai, tvarios vertės kūrimas, Web 3.0, blokų grandinė, dideli duomenys, kriptovaliuta, mašinų mokymasis, dApp, informacinės technologijos.