Fakultät Agrarwirtschaft, Volkswirtschaft und Management FAVM

Preparatory Seminar Master Thesis

In the degree program International Management
leading to the Academic Degree of
Master of Business Administration (MBA)

SUSTAINABILITY ASPECTS IN BLOCKCHAIN TECHNOLOGY

BASED BUSINESS MODELS

Submitted by

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Submission Date

10.10.2022

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LIST OF ABBREVATIONS

1. BAAS   Blockchain as a Service
2. BBC   British Broadcasting Corporation
3. BIS   Business Information Systems
4. CAGR   Compound Annual Growth Rate
5. CO2   Carbon dioxide
6. dApps   Decentralized applications
7. DL   Distributed Ledger
8. ESG   Environment, social and governance
9. EU   European Commission
10. GEM   Grenoble Ecole de Management
11. IoT   Internet of Things
12. kWh   Kilowatt-hours (a measure of electrical energy)
13. LCA   Life Cycle Assessment
14. NA   Not Available
15. P2P   Peer to Peer
16. SCM   Supply Chain Management
17. tWh   Terawatt-hours (a measure of electrical energy)
18. UN SDG   United Nations Sustainability Development Goals
19. UNCTAD United Nations conference on trade and development
20. USD   United States Dollar
21. W   Watts
22. WFP   World Food Program

1. INTRODUCTION:

Initially, Blockchain technology was invented to create a cryptocurrency called "Bitcoin" introduced to the world in the year 2008. The concept was published in a white paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System" under the pseudonym as Satoshi Nakamoto. Bitcoin terminology is defined as "a purely peer-to-peer (P2P) version of electronic cash that would allow online payments to be sent directly from one party to another without going through a financial institution" (Nakamoto, 2008).

The ultimate goal of creating cryptocurrency was to reduce transaction costs, fraud and payment uncertainties which have been regular problems in digital transactions. At the same time to increase the trust and transparency between unknown parties and developing secure mode of payment transactions. It was proposed as an alternative currency or exchange liquidity medium to the prevalent model of existing and new e-commerce businesses that relies on financial institutions serving as trusted third parties to process their electronic payments. Along with the technological solution it also leads to a technical problem while creating a ledger consisting of payments history without the central node. The central node controls the information in the ledger. Double spending is one of the Bitcoin protocol's major security concerns. If a person spending the same Bitcoin more than once as a result it will harm the financial ecosystem. The solution to this problem is creating distributed ledger (DL) through an innovative and ingenious combination of blocks of data, cryptography and an algorithm for network nodes to access the ledger's transactions. "Being a digital asset without any intrinsic value and central controller or issuer, Bitcoin is regarded as groundbreaking in the evolution of fiat currencies" (23rd International Conference, BIS, June 8–10, 2020). The invention of Bitcoin laid the foundations of blockchain technology and enabled the development of other cryptocurrencies. As a result of innovations and transformation of blockchain technology we can observe a steep increase in invention of cryptocurrencies in the market. Hence, the blockchain implementations have impact on the environment such as energy consumption, data security and privacy and carbon accounting results in the ecology mortification.

Sustainability is one of the prominent parameters and topics not limiting its boundaries only for the carbon accounting. Today, each one of us are very much worried about the environment. Billion dollars of question to all of us is how to maintain the eco-balance and transfer to future generations without disturbing it. Unfortunately, most of us are not practicing to keep it safe. The technological inventions and enhancements should make our living conditions better rather than effecting it.

We should focus on the zero impact environmental technological innovations and to enhance the reduction impact programs on the environment. For example, the invention of diesel engine was marvelous in history and it has changed the dimensions of transportation. After a century of time, we have realized the environmental damage and now focusing on the net zero emission engines like machines consumes renewable energy. The same effect we are experiencing in the blockchain technology based business models or cryptocurrencies. The vast amount of energy consumption for digging the data from blocks in their databases using blockchain technology which releases the carbon emissions into environment is a major concern for the technological giants, environmental researchers and protection organizations. Blockchain technology implementations are very helpful in achieving the United Nations sustainability development goals (UN SDG'S). Furthermore, the elimination of intermediaries in the innovations of blockchain technology contributes to reducing transaction costs and the time required to strengthen bonding between the entities and environment.

In this paper, I have presented about the sustainability aspects using blockchain technology and structured them under five topics:

- Introduction: Brief explanation about the invention of block chain technology, sustainability and its importance.

- Literature review and background: The evolution of blockchain technology and its different types of business models, core elements of sustainability and role of blockchain as an incentive tool for sustainability in business models.

- Research method: Presenting the research design & methodology.

- Results and Discussions: Describing the technological advancement in Blockchain, analysis using different technical sources to explain how Blockchain variations contributed to achieve UN SDG'S, unintended consequences and its need to improve the skill expertise for reducing environmental impact.

- Conclusion: Summarize the discussion, leading to solution perspective, limitation of the work scope and to include the future action scope.

2. LITERATURE REVIEW AND BACKGROUND:

2.1 Blockchain Technology:

In this decade, Researchers, scholars and investors are increased the attention to the use of Blockchain technology. "In fact, the research on scientific database shows that, there are more than 17,975 documents published on the blockchain according to the data on 2 January 2021, when considering only the subject area of "Business, Management and Accounting", the documents available totaled 2402. According to the definition given by the European Commission (EU), the blockchain has been recognized as a necessary tool to foster the development of equity and to make the digital economy secure and democratic in such a way as to have an impact on the way we think about our economic, social, and political institutions (EU 2020)" (Mercuri, Corte, & Ricci, 2021).

Blockchain is a series of data blocks also called as nodes consists of multiple immutable records managed by group of people or organizations that doesn't only own by any person, company or government authority. Individual data block is highly secure and linked to each other in a network of data blocks using a cryptographic chain. Therefore, the name "Blockchain" came into existence. Hence it transmits the information between parties in a fully automated and secure way. In the transaction process, it creates the block and verified by thousands of computing machines over the distributed network. After the verification the block is tagged to a chain and stored over the network labeled with record number and history. As a single record is stored in millions of instances it is impossible to modify the data. In addition to this immutable characteristic, it doesn't regulated by anyone. Thus Blockchain technology can take over the traditional business processes and models involves with charges.

Blockchain is based on three pillars mainly:

1. Decentralization: The data is stored inside a block and shared across the networks. Nobody owns the records and every one over the network can access the records.

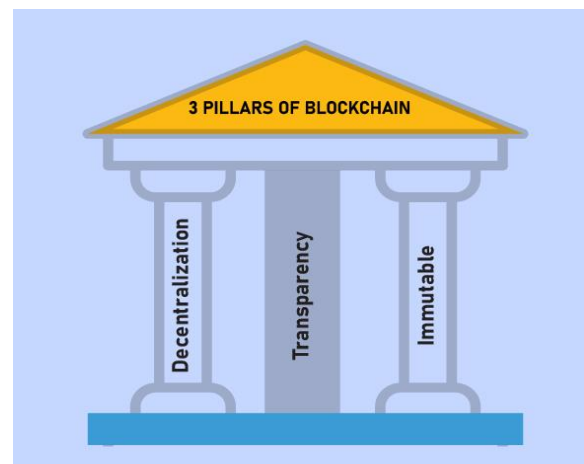2. Immutability: The data block is non-tamperable through cryptography, ensuring cyber security.

Figure 1: Pillars of Block chain technology

Image Source:https://www.appventurez.com/blog/blockchain-understanding-its-basics-and-how-it-works

3. Transparency: The data has been encrypted or hidden using complex cryptographic algorithm and represented by their public address. Considering the data security, the person's real identity is highly secure, but all the transactions are visible as it is performed by their public address.

2.2 Application, status and trends:

The evolution of Block chain technology and its applications across all the industries creating great opportunities and potential benefits. The spectrum of blockchain technology applications area is vast. According to custom market insight research studies, the current market share value for blockchain technology solutions and applications is approximately USD 4.8 Billion in 2021, and it is expected to reach over billion USD by 2030, at a CAGR of 68% between 2022 and 2030 (Global Blockchain Technology Market 2022 – 2030, 2022). Blockchain can be used in virtually any application. Currently, the prominent use cases for blockchain applications are in the areas of online payments, finance, international trade, and global value chains. In the demand side, the growth of blockchain market is mainly driven by factors such as increasing online transactions, digitization of currency, secure online payment gateways, the growing interest of the banking, financial services and insurance sector, and an increasing number of merchants accepting cryptocurrencies (Blockchain Technology Market Size Report, 2022).

- SCM applications broadly classified into two directions. First, is to improve efficiency and operations capacity by reducing the bureaucratic works, transportation obstacles and transaction costs. Secondly aiming to guarantee the authenticity, provenance, and freshness of materials or products bought by consumers. (Pirus, B. Nestle Tests Public Blockchains For Dairy Supply Chain. Forbes. 2019, 2019).

- Certifications: The greatest characteristic of Blockchain technology is that it can serve as a decentralized, permanently immutable storage layer for any type of information. Therefore, this technology is suitable for cloud storing and certifying all kinds of sensitive records. (Makridakis & Christodoulou, 2019).

- Internet of things (IoT): The application of IoT with Blockchain is a cutting edge technology leads to smart contracts, homes and vehicles. In addition, this extensive application have opened wide doors and created wonders in the field of medicine (Gartner, 2015).

- Disruptive Applications: This allows and promises to change the transactions among the group of people with high trust, security and transparency the way organizations are operating.

2.3 Types of Blockchain based business models:

A business model consists of a planning document setting out a business future objectives and strategies for achieving them. The company earn profit by selling a product or service. The entities or organizations have unique way of doing business in the market. However, there is a centralized model, composed of the owners or the shareholders, the organization, the customers, and the employees. A blockchain business model inheritances three main characteristics of blockchain technology. They are decentralization, P2P (peer-to-peer) transactions, within a trusted and reliable network.
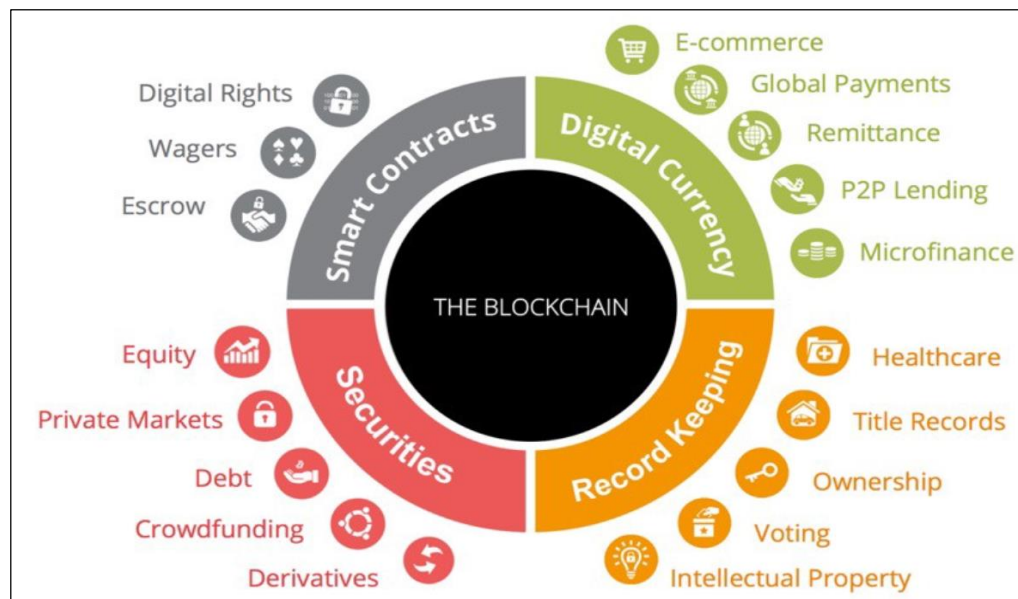

Figure 2: Block Chain technology application in business models

Image Source: Use cases of Blockchain Tech Application in Business Domains, Max Semenchuk, 2017

DL's can be classified according to the permissions and control access.

(1) Permissionless: Anyone can joins the network and act as node to validate the process (such as Bitcoin).

(2) Permissioned: Controls by the authority or a consortium (such as Hyperledger Fabric).

There are 4 types of blockchain:

- Public Blockchain
- Private Blockchain
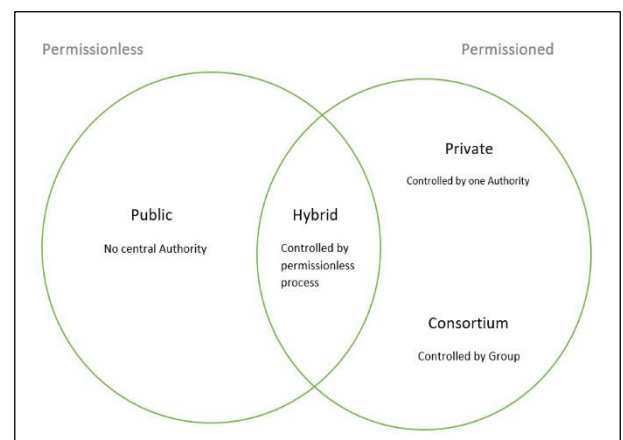- Hybrid Blockchain
- Consortium Blockchain

Figure 3: Types of Block chain technology

Image Source: https://www.geeksforgeeks.org/types-of-blockchain/

Major types of Blockchain Business models:

1. Token Economy: A business model uses the utility token as a way to perform different activities and provides an incentive to end users.
2. Blockchain as a Service (BAAS): Defining an ecosystem for other entities to thrive and utilize blockchain technology.
3. Development Platforms: It will provide blockchain technology stack to other organizations.
4. Blockchain based Software Products: Companies develop the blockchain based solutions and products to sell and earn profits.
5. Network fee charge: It's a business model designed where the network fee is charged from the customers for using the blockchain technology.
6. Blockchain Professional Services: Offering Services such as dApps development, Consulting, auditing etc.,
7. P2P Blockchain business model: This business model utilizes blockchain where peers are able to execute direct tasks. (101Blockchains, 2021)

3. RESEARCH METHOD:

The very first step to prepare the study is defining the kind of research resources serving the goals of the paper. These research resources need to satisfy evaluation criteria to be trustworthy. There are five criteria that are set to evaluate and decide to choose a research source for this paper:

- Accuracy: The information is reliable, error-free, based on proven facts and verified sources.
- Authority: the authorities have the qualifications to speak on the chosen topic.
- Objectivity: The information presents the facts and is not biased.
- Currency: The used information should be in the latest edition and is not outdated for the study.
- Coverage: The information meets the intended purposes of the study and provides coverage.

By following the evaluation criteria of research resources, the information of the paper is reliable and up-to-date, satisfies the purpose of the paper and presents the depth in specialist knowledge. Following the goals of the paper, the needed information includes theories about sustainability aspects in blockchain, the studies about how blockchain technology could thrive to achieve the UN SDG's with practical examples supporting. In this paper, all the theories and main results are collected from scientific resources including specialized books and their authorities are professors, experts and employees studying or relating to the sustainability and blockchain technology implementation.

4. RESULTS AND DISCUSSIONS:

4.1 Technological innovations

The unique value chain characteristics of Blockchain technology such as developing trust, transparency and tamper-resistant feature, disintermediation and substantial improvements put it always in the top list of technologies. Blockchain is not only limited itself in the area of financial ecosystem such as usage of cryptocurrencies but its evolution and enhancement into other application fields is unstoppable due to its decentralization characteristic.

Blockchain technology based business models and innovations were seen as a scientific weapon enabling the fulfillment of sustainability goals in the broader perspective such as by enhancing and creating transparency & traceability in supply chains, incentivizing the circular economies, enabling geospatial platforms, boosting the various carbon reduction programs, reducing information asymmetry in resource management, facilitating access to finance, and improving natural or predefined disaster preparedness and management (PricewaterhouseCoopers, 2018).

4.2 Sustainability aspects in blockchain technology usage:

According to the latest McKinsey survey, more than 50 percent of company executives consider sustainability as the management of environmental, social, and governance issues. It is very or extremely important in a wide range of applications, including new-product development, reputation building, and overall corporate strategy (McKinsey survey, 2021).

Figure 4: The triangle of sustainability
Image Source: *Triangle* of *sustainability* for Life Cycle Assessments | *TÜV Rheinland*

Blockchain technology implementations in the fast moving tech world is joggling the global financial ecosystem and adversely alarming the environmental concerns risk stifling innovations. National Governments driven regulatory boards or actions forcing the companies to concern the energy impact due to blockchain technology usage is an another important reason to focus on the sustainability. Block chain developers and researchers are considering the crucial factors like Environment, social and governance (ESG) issues in their efforts to innovate. "For example, one of the largest crypto currencies by market capitalization plans to change its model to, in part, massively reduce energy consumption, indicating the urgency with which developers are factoring in their environmental impact" (PwC, Embracing sustainable innovation, 2021).
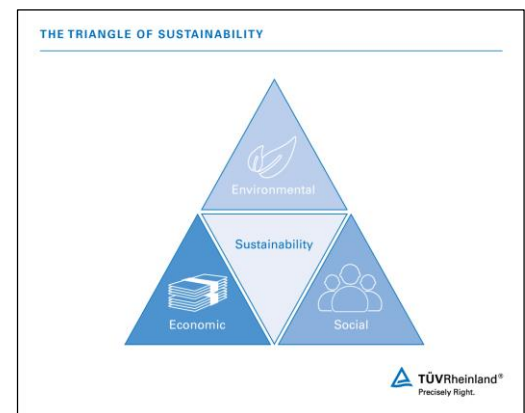
Corporate companies are doing great efforts bringing the sustainability dashboards, frameworks, assessment tools using blockchain to calculate and present their product carbon footprint, life cycle assessments (LCA) and sustainability goals on their company corporate social responsibility and environmental portals to grab the customer attention.

4.3 UN Sustainability development goals using Blockchain:

Blockchain technology could thrive to achieve the United Nations Sustainable Development Goals. On 25th of September, 2015, the 193 member states of UN unanimously adopted 17 sustainable development goals (SDG's). The 17 goals were designed considering 169 targets with a vision of linking to other areas into a unitary vision.

Table 1: Examples of practical applications of blockchain technology achieving for the UN SDG's

Sustainable Development Goals	Blockchain application
Goal 1: No poverty	Digital identity against poverty. "Proof of ownership of capital, combined with a self-sovereign identity, can be used to obtain loans" (Rijmenam, 2018)
Goal 2: Zero hunger	Food voucher transfers with blockchain. "The UN World Food Program "Building blocks" pilot project is using blockchain at refugee camps in Jordan to distribute food" (UN World Food Programme Building Blocks, 2017)
Goal 3: Good health and well-being	"Modern information sharing mechanism for biomedical and health care applications" (Kuo, T.-T., Kim, H.-E., and Ohno-Machado, L., 2017)
Goal 4: Quality education	"Global higher education credit platform" (Turkanović et al. M., 2018). Receive and share official credentials securely and efficiently" (Blockcerts, 2020)
Goal 5: Gender equality	Helps for Women empowerment (UN-Women, 2018). "Blockchain use in UN Women's cash-for-work program in Jordan" (Thylin, 2019)
Goal 6: Water and sanitation for all	"Transparent and reliable water trading system in Australia" (Arup, 2018). "To improve the solid waste management in small municipalities" (França, Neto, Gonçalves, & Almeida, 2020)

Goal 7: Affordable and clean energy	Design solutions for energy efficiency improvement
Goal 8: Decent Work and Economic Growth	Access to interest-free loans using blockchain
Goal 9: Industry, innovation and infrastructure	Blockchain-based cash register. "Opening the architecture of commercial and banking infrastructures" (Chong, Lim, Hua, Zheng, and Tan, 2019)
Goal 10: Reduced inequalities	Improve schools' Internet connectivity around the world
Goal 11: Sustainable cities and communities	Blockchain makes cities inclusive, safe, resilient and sustainable. "Blockchain technology for smart devices to provide a secure communication platform in a smart city" (Biswas and Muthukkumarasamy, 2016)
Goal 12: Responsible consumption and production	Blockchain-based seafood traceability and quality control
Goal 13: Climate action	Low carbon tea project in Kenya (GLI-TEA)
Goal 14: Below water	"Rewards for protecting biodiversity in Australia" (Commonwealth Bank of Australia (CBA), 2019)
Goal 15: Life on land	"Incentive wildlife conservation in Namibia" (Oberhauser, 2019; Wildlife Credits, 2020)
Goal 16: Peace, justice and strong institutions	Transparency in transactions and immutability of asset registration
Goal 17: Partnerships for the goals	Platform to coordinate and trace international aid. Partnering universities, trade and industry association and innovation clusters in the Danish design industry (Industriens Fond, 2019)

Source: UNCTAD, based on contributions from the Governments of Cuba, Thailand, the United Kingdom and from WFP, available at https://unctad.org/meeting/commission-science-and-technology-development-twenty-fourth-session.

4.4 Potential environmental threats

The existing literature reviews of empirical research on blockchain innovations hardly mention the sustainable development (Grover et al. 2018; Hawlitschek et al., 2018; Notheisen et al., 2017; Risius and Spohrer, 2017) with small number of exceptions (Nir Kshetri, 2018).

Recent trends in the research studies and publications, shows that how the topic of sustainability is highly important to sustain in the global competitive business and pledge to protect the environment. In the context of blockchain technology research, we refer sustainability is mostly in the relation to the ecological footprint of blockchain itself such as consumption of high energy which is required by the computing intensive processes for data digging (Becker et al., 2013; Delliere and Grange, 2018). Currently, the situations are changing rapidly as the blockchain innovations are bursting.

But, as per the available data shows that bitcoin was using as much energy consumption as Switzerland (BBC News, 2019), and due to the complicated validation and securing processes the consumption has been growing in the recent years. This energy consumption releases huge amount of CO_2 emissions that pose a threat to the environment. As per the latest research study, Bitcoin energy consumption generates about 22 megatons of CO_2 annually (Science Daily, 2020) in comparison it is equal to the amount of CO_2 annual emissions of the Kansas City in the United States. Because of the considerable variation in the consumption of energy for the work of Bitcoin is due to its number of transactions in the blockchain.

Table 2: Environmental impact of Bitcoin usage

Electricity consumption by bitcoin	Comparison	Year	Source
67.4 tWh	Annual energy consumption of Switzerland	2020	(Cambridge Bitcoin Electricity Consumption Center, kein Datum)
45.8 tWh	NA	2018	(The Carbon Footprint of Bitcoin, kein Datum)
22 tWh	Annual energy consumption Ireland	2015	(Energy Market Barometer Report by GEM, kein Datum)
Up to 215 kWh per transaction	Incandescent lightbulb of 25W burning for one year	2015	(Energy Market Barometer Report by GEM, kein Datum)
300 kWh per transaction reaching 900 kWh per transaction (by 2018)	More energy per transaction than all the world's banks put together	2018, 2019	(Bitcoin Growing Energy Problem BBC news article, kein Datum)

Source: UNCTAD available at https://unctad.org/system/files/official-document/dtlstict2021d3_en.pdf

5. CONCLUSION:

The research paper has structured with empirical research discussions that how does the blockchain technology can help and actually impact on sustainable development. The paper have limited scope concerning the environment problems using blockchain and its applications in achieving UN SDG's. Blockchain helped to achieve the environmental and natural resource challenges which are often coming from insecurity and the inability to verify the implementation of regulations by offering a secure and verifiable records. It helps governments to reinforce entitlements to use a natural resources, incentivize environmentally sustainable actions and substantiate claims of reduced environmental impact (Harnessing Blockchain for sustainable development: Prospects and challenges, UNCTD, 2021)

"Digital technologies like Blockchain are in fact seen as both enablers and obstacles to sustainability, equity and social inclusion" (Zheng and Walsham, 2008). The technological innovations like the telegraph, Aviation, Internet and telephone have made the world much better place by increasing the living standards of well-being, education and reduce the inequality, poverty. On the contrary, it created unintended consequences in long term like degrading the ecology having direct impact on sustainable development. But, we continuously struggle to make things good, better and the best. Similarly, Blockchain is in the phase of maturity. Hence, we can't predict all the unintended environmental threats at this budding and booming stage of any technology. Therefore, it's time to think about creating a global standard regulatory boards or action committee of environment to monitor and enhance the innovations in Blockchain technology with potential risks.

Every technology can provides us with opportunities of positive and negative. In fact, sometimes we observe high percentage of positive or negative results. We have to share our research knowledge and information to achieve success. Instead of restricting the talent of innovation in blockchain, need to think about bridging the gap between blockchain technology and sustainability. All the countries doing great research and developments in the Blockchain innovations & implementations should connect on one platform leads to globalization for effective problem discussion forums, designing sustainable solutions for long term in co-operation like space programs and work together for making the world better sustainable place to live.

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DECLARATION ON HONOR

I hereby declare on my word of honor:

1. The paper presented is my own work and was composed without any outside help.

2. Any direct quotations from the literature used as well as any ideas of other authors have been marked clearly in my paper.

I realize that if I give false evidence in this declaration, I could be prevented from taking further examinations according to article 15 section 3 SPO – AT Bachelor or article14 section 3 SPO – AT Master and might be de-registered from my degree program.

Nürtingen, 10th of October 2022

Place, Date   (Signature)