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Latvijas Lauksaimniecības universitāte
Ekonomikas un sabiedrības attīstības fakultāte
Ekonomikas un reģionālās attīstības institūts

*MBA, MProf* **Natālijas Kostrikovas**

**promocijas darbs**

# OPPORTUNITIES FOR BLOCKCHAIN TECHNOLOGY ADOPTION IN THE ECONOMY OF LATVIA IN THE CONTEXT OF BALTIC STATES REGION

# *BLOKĶĒDES TEHNOLOĢIJU IEVIEŠANAS IESPĒJAS LATVIJAS TAUTSAIMNIECĪBĀ BALTIJAS VALSTU REĢIONA KONTEKSTĀ*

zinātniskā doktora grāda zinātnes doktors (*Ph.D.*) ekonomikā un uzņēmējdarbībā iegūšanai

*Promocijas darbs ir izstrādāts Ekonomikas un uzņēmējdarbības nozares Reģionālās ekonomikas apakšnozarē*

Promocijas darba vadītāja — *prof., Dr.habil.oec.* **Baiba Rivža**

Promocijas darba autore — *MBA, MProf* **Natālija Kostrikova**

Jelgava 2021

# ANNOTATION

**The author of the thesis:** MBA, MProf Natalija Kostrikova.

**The title of the thesis:** Opportunities for blockchain technology adoption in the economy of Latvia in the context of Baltic States region.

**The hypothesis of the thesis**: It is possible to facilitate digitalisation of the economy of Latvia through blockchain technology adoption.

**The aim of the thesis**: to develop recommendations for facilitating blockchain technology adoption in the economy of Latvia based on investigation of global blockchain technology adoption factors and scenarios with a focus on Baltic States region analysis.
**To achieve the aim, the following tasks are set**:

1. to outline a framework for blockchain technology adoption assessment through the lenses of innovation theories, technology adoption models and the concept of knowledge economy;
2. to analyse blockchain related policies, public opinions and regulatory developments in the European Union and Baltic States;
3. to analyse blockchain technology adoption trends worldwide and in the Baltic States;
4. to develop and analyse scenarios for blockchain technology adoption in the economy of Latvia.

To achieve the aim of the thesis, the research is structured in four chapters with sub–sections.

The **first chapter** outlines the theoretical research of blockchain technology, knowledge economy, innovation theories and aspects of innovation diffusion process and underlying innovation adoption factors. As a result, innovation adoption and technology acceptance models are summarized.

The **second chapter** studies blockchain related policies and regulatory developments – blockchain technology innovation planning documents and relevant regulatory enactments of the European Union and Latvia.

In the **third chapter**, blockchain technology innovation and adoption worldwide and in Baltic States is analysed in various areas of applications and geographical tendencies and success factors are investigated.

In the **fourth chapter**, blockchain technology adoption factors and scenarios are determined based on international experience and international expert survey involving 82 respondents from 30 countries; blockchain adoption factors and scenarios in the economy of Latvia are assessed through AHP analysis based on expert opinions of seven renowned national experts; and recommendations for facilitating blockchain technology adoption in Latvia are developed.

As a result of the thesis, a blockchain technology adoption assessment matrix and recommendations for facilitating blockchain technology adoption in the economy of Latvia have been developed with the aim of strengthening the global competitiveness of the economy of Latvia.

At the end of the thesis the main conclusions, research results and recommendations for facilitating blockchain technology adoption in the economy of Latvia are formulated.

The volume of the thesis for acquiring the degree of Doctor of Philosophy in Economics and Business (Ph.D.) is 184 pages. The work contains 15 tables, 50 figures, 12 appendices, 323 information sources.

# ANOTĀCIJA

**Promocijas darba autors:** MBA, MProf Natālija Kostrikova.

**Promocijas darba nosaukums:** Blokķēdes tehnoloģiju ieviešanas iespējas Latvijas tautsaimniecībā Baltijas valstu reģiona kontekstā.

**Promocijas darba hipotēze**: ir iespējams veicināt Latvijas tautsaimniecības digitalizāciju, ieviešot blokķēdes tehnoloģijas.

**Promocijas darba mērķis**: izstrādāt ieteikumus blokķēdes tehnoloģiju ieviešanas veicināšanai Latvijas tautsaimniecībā, balstoties uz globālo blokķēdes tehnoloģiju ieviešanu ietekmējošo faktoru un scenāriju izpēti, liekot uzsvaru uz Baltijas valstu reģiona analīzi. **Mērķa sasniegšanai ir izvirzīti šādi uzdevumi**:

1. raksturot blokķēdes tehnoloģiju ieviešanas novērtēšanas pamatus, skatoties caur inovāciju teoriju, tehnoloģiju ieviešanas modeļu un zināšanu ekonomikas koncepciju prizmu;
2. izanalizēt valdības īstenoto politiku, sabiedrības viedokli un tiesiskā regulējuma attīstību Eiropas Savienībā un Baltijas valstīs saistībā ar blokķēdes tehnoloģijām;
3. izanalizēt blokķēdes tehnoloģiju ieviešanas tendences pasaulē un Baltijas valstīs;
4. izstrādāt un izanalizēt scenārijus blokķēdes tehnoloģijas ieviešanai Latvijas tautsaimniecībā.

Mērķa sasniegšanai pētījuma izklāsts ir strukturēts **4 nodaļās** ar apakšnodaļām.

**Pirmajā nodaļā** tiek pētītas teorētiskas nostādnes par blokķēdes tehnoloģijām, zināšanu ekonomiku, inovāciju teorijām, inovāciju izplatīšanas procesa aspektiem un inovāciju ieviešanas faktoriem. Apkopoti inovāciju izplatīšanas un tehnoloģiju pieņemšanas modeļi.

**Otrajā nodaļā** tiek pētīta ar blokķēdes tehnoloģijām saistītas politikas un normatīvo aktu attīstība, t.sk. blokķēdes tehnoloģiju inovācijas plānošanas dokumenti un attiecīgie Eiropas Savienības un Latvijas normatīvie akti.

**Trešajā nodaļā** tiek analizēti blokķēdes tehnoloģiju inovācijas process un ieviešana pasaulē un Baltijas valstīs dažādās pielietošanas jomās, kā arī tiek pētītas ģeogrāfiskās tendences un veiksmes faktori.

**Ceturtajā nodaļā** tiek noteikti un novērtēti blokķēdes tehnoloģiju ieviešanu veicinošie faktori un ieviešanas scenāriji, analizējot starptautisko pieredzi un aptaujājot 82 ekspertus no 30 valstīm; tiek novērtēti blokķēdes tehnoloģiju ieviešanu veicinošie faktori un ieviešanas scenāriji Latvijas tausaimniecībā, izmantojot analītisko hierarhijas procesa analīzi, balstoties uz septiņu blokķēžu ekspertu aptaujas rezultātiem; un tiek izstrādātas rekomendācijas blokķēdes tehnoloģiju ieviešanai Latvijā.

Darba rezultātā ir izstrādāta blokķēdes tehnoloģiju ieviešanas novērtēšanas matrica un piedāvāti ieteikumi blokķēdes tehnoloģiju ieviešanas sekmēšanai Latvijas tautsaimniecībā ar mērķi stiprināt Latvijas digitālo konkurētspēju.

Darba beigās ir noformulēti galvenie secinājumi, pētījuma rezultāti un ieteikumi blokķēdes tehnoloģiju ieviešanas sekmēšanai Latvijas ekonomikā.

Promocijas darba apjoms zinātniskā doktora grāda zinātnes doktors (*Ph.D.*) ekonomikā un uzņēmējdarbībā iegūšanai ir 184 lapas. Darbā ir 15 tabulas, 50 attēli, 12 pielikumi, izmantoti 323 informācijas avoti.

# АННОТАЦИЯ

**Автор диссертации:** MBA, MProf Наталия Кострикова.

**Название диссертации:** Возможности внедрения технологии блокчейн в экономике Латвии в контексте региона Балтии.

**Гипотеза диссертации**: Дигитализацию экономики Латвии возможно стимулировать через внедрение технологии блокчейн.

**Цель диссертации**: разработать рекомендации по содействию внедрению технологии Блокчейн в экономике Латвии на основе изучения глобальных факторов и сценариев внедрения технологии блокчейн с акцентом на анализ региона Балтийских стран. **Для достижения цели поставлены следующие задачи:**

1. оформить структуру оценки внедрения технологии блокчейн на основании теорий инноваций, моделей принятия технологий и коцепции экономики знаний;
2. проанализировать политику, общественное мнение и законодательные изменения в Европейском Союзе и странах Балтии, связанные с технологией Блокчейн;
3. проанализировать тенденции внкдрения технологии блокчейн в мире и в странах Балтии;
4. разработать и анализировать сценарии, способствующие внедрению технологии блокчейн в экономике Латвии.

Для достижения цели исследование содержит **4 главы** с подразделами.

**В первой главе** проводится теоретическое исследование технологии Блокчейн, экономики знаний, теорий инноваций и аспектов процесса распространения инноваций и основных факторов принятия инноваций. Обобщены модели внедрения инноваций и принятия технологий.

**Вторая глава** посвящена политике и нормативным изменениям, связанным с технологией Блокчейн – документам по планированию инновационных технологий Блокчейн и соответствующим нормативным актам Европейского Союза и Латвии.

**В третьей главе** анализируется инновационный процесс и аспекты внедрения технологии Блокчейн в мире и в странах Балтии в различных областях применения, а также исследуются географические тенденции и факторы успеха.

**В четвертой главе** определяются факторы и сценарии внедрения технологии Блокчейн, основываясь на международном опыте и опросе 82 экспертов из 30 стран; производится оценка факторов и сценариев внедрения технологии Блокчейн в экономике Латвии, основываясь на процессе аналитической иерархии по результату опроса семерых национальных экспертов; и разрабатываются рекомендации по содействию внедрению технологии блокчейн в Латвии.

В результате диссертации разработаны матрица оценки принятия технологии блокчейн и рекомендации по содействию внедрению технологии Блокчейн в экономике Латвии с целью повышения глобальной конкурентоспособности экономики Латвии.

В конце дипломной работы сформулированы основные выводы, результаты исследования и рекомендации, способствующие внедрению технологии Блокчейн в экономике Латвии.

Объем диссертации для получения научной степени доктора наук (Ph.D.) в экономике и предпринимательстве составляет 184 страниц. Работа содержит 15 таблиц, 50 рисунков, 12 приложений, 323 источников информации.

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# INFORMATION ON PUBLICATIONS AND SCIENTIFIC WORK/ *INFORMĀCIJA PAR PUBLIKĀCIJĀM UN ZINĀTNISKI PĒTNIECISKO DARBU*

Natalija Kostrikova, Master of Business Administration in Global Finance and Banking, Master in Finance, has developed a PhD thesis 'Opportunities for Blockchain Technology Adoption in the Economy of Latvia in the Context of Baltic States Region' within a period from 2016 until 2021 under scientific supervision of Dr habil.oec. Baiba Rivža of Economic and Regional Development Institute at Faculty of Economics and Social Development (ESAF) of Latvia University of Life Sciences and Technologies (LLU).

**Scientific publications on the topic of the PhD thesis**

The author has published five publications on the topic of the PhD thesis in the international scientific conference proceedings (three publications are indexed in ***Web of Science*** database, one publication is expected to be indexed in ***Web of Science*** database and one publication is expected to be indexed in ***Scopus*** database):

1. **Kostrikova, N.** (2021). Studying Adoption of Cryptocurrencies and Blockchain Technology in the Baltic States. **In:** *Economic Science for Rural Development*: proceedings of the international scientific conference, Jelgava: LLU. (To be indexed in ***Web of Science, EBSCOhost, AGRIS, CABI Full text, CAB Abstracts*** databases).
2. **Kostrikova, N.** (2021). Assessment of Blockchain Technology Adoption Factors and Scenarios within the Economy of Latvia. **In:** *Innovations in Smart Cities Applications, Vol. 4:* proceedings of the International Conference on Smart City Applications. Springer International Publishing, p. 714–729. ISSN 2367–3370. DOI: 10.1007/978–3–030–66840–2 (To be indexed in ***Scopus*** database).
3. **Kostrikova, N., Rivza, B.** (2019). Disruption Potential of the Distributed Ledger Technology within the Economy of Latvia. **In:** *Economic science for rural development*: proceedings of the international scientific conference, No. 52 Jelgava: LLU, p. 53–61. (Indexed in ***Web of Science, EBSCOhost, AGRIS, CABI Full text, CAB Abstracts*** databases).
4. **Kostrikova, N., Rivza, B**. (2017). Opportunities and Barriers for Application of Distributed Ledgers in the Context of EU Digital Single Market Strategy. **In:** *European Integration Studies: Research and Topicalities*: proceedings of the international scientific conference, No 11. Kaunas: KTU, p. 160–172. ISSN 1822–8402. DOI: 10.5755/j01.eis.0.11.18134 (Indexed in ***Web of Science, DOAJ, EconBib, ESCI***).
5. **Kostrikova, N., Rivza, B.** (2017). E–government And E–participation In Baltic States: Comparison of Estonia, Latvia, Lithuania. **In:** *Economic science for rural development*: proceedings of the international scientific conference, No. 45 Jelgava: LLU, p. 118–126. (Indexed in ***Web of Science, EBSCOhost, AGRIS, CABI Full text, CAB Abstracts*** databases).

**Presentations in international and national scientific conferences on the topic of the PhD thesis**

The author has presented research results on the topic of the PhD thesis in seven international scientific conferences, one international scientific seminar and one national scientific conference.

1. **Kostrikova N.** Studying Adoption of Cryptocurrencies and Blockchain Technology in the Baltic States. The 22nd International scientific conference *Economic Science for Rural Development*, Jelgava, Latvia, 13 May 2021.
2. **Kostrikova, N.** 'Blockchain Technology Adoption Factors and Trends in the Baltic States'. The virtual scientific seminar of Nordic Association of Agricultural Science (NJF) *Section of Economy, Education and Society*, online, 03 March 2021.
3. **Kostrikova, N.** Assessment of Blockchain Technology Adoption Factors and Scenarios within the Economy of Latvia. The 5th International Scientific Conference on *Smart City Applications*, Safranbolu, Turkey, 07–09 October 2020.
4. **Kostrikova, N.** Blokķēdes tehnoloģijas Latvijas ekonomikas izaugsmei. Scientific Conference *Latvijas ekonomiskās attīstības problēmas un risinājumi*, Riga, Latvia, 06 December 2019.
5. **Kostrikova, N.** Disruption Potential of the Distributed Ledger Technology within the Economy of Latvia. The 20th International Scientific Conference *Economic Science for Rural Development*, Jelgava, Latvia, 09–10 May 2019.
6. **Kostrikova, N**. Analysis of the 2018 crypto crash. The 4th International Scientific Video Conference *Trends in Regional Development in the EU Countries*. Jelgava, Latvia, 26 October 2018.
7. **Kostrikova, N.** Opportunities and Barriers for Application of Distributed Ledgers in the Context of EU Digital Dingle Market Strategy. 15th International Scientific Conference *The Future of European Union International Role: Political, Economic and Social Challenges*, Kaunas, Lithuania, 07 April 2017.
8. **Kostrikova, N**. E–government and E–participation In Baltic States: Comparison of Estonia, Latvia, Lithuania. The 28th International Scientific Conference *Economic Science for Rural Development*, Jelgava, Latvia, 27–28 April 2017.
9. **Kostrikova N**. Innovative Advertising Channel for Promotion of Food Products in Latvia. The 5th International Conference of Young Scientists *The Young Scientists for Advance of Agriculture*, Vilnius, Lithuania, 10–11 November 2016.

**Other publications on the topic of the PhD thesis**

The author has published two publications on the topic of the PhD thesis in popular online journals:

1. **Kostrikova N., Hāka Ž.** (2020). *Latvijai blokķēdes tehnoloģijas ieviešanā par pamatu iesaka ņemt citu valstu pieredzi* [online]: Delfi.lv. [retrieved 15 November 2020]. Access: https://www.delfi.lv/bizness/bankas_un_finanses/latvijai–blokkedes–tehnologijas–ieviesana–par–pamatu–iesaka–nemt–citu–valstu–pieredzi.d?id=52701915
2. **Kostrikova, N.** (2020). *Par plānotajām izmaiņām kases aparātos un blokķēdes tehnoloģiju ieviešanu* [online]: I–Finanses.lv. [retrieved 15 November 2020]. Access: https://ifinanses.lv/raksti/vadiba/finansu–vadiba/par–planotajam–izmainam–kases–aparatos–un–blokkezu–tehnologiju–ieviesanu/17643

**Information on academic, scientific and pedagogical work related to the topic of the PhD thesis**

The author has developed and delivered two courses for Master's and Bachelor's university programmes on the topic of the PhD thesis and participated in two national research programmes:

1. Lecturer at RISEBA University of Business, Arts and Technology for Bachelor's programme 'E–commerce' (3 ECTS course 'Introduction to Blockchain Technologies') – 2020.
2. Lecturer at RISEBA University of Business, Arts and Technology for Master's programme 'Big Data Analytics' (3 ECTS course 'Blockchain Technologies') –2019 and 2021.
3. Activity as a researcher and doctoral student in the project 'Latvian state and society challenges and their solutions in the international context (INTERFRAME–LV)' of the State Research Program 'Latvian Heritage and Future Challenges for National Sustainability' (2019 – until now).
4. Activity as a researcher and doctoral student In the State research program 5.2.1. 'National Economy Transformation, Smart Growth, Local Government and Legal Framework for Sustainable Development of the State and Society – New Approaches to Creating a Sustainable Knowledge Society' (EKOSOC–LV) (2015 – 2019).

**Other activities related to the topic of the PhD thesis:**

1. Presentation 'Distributed Ledger Technologies for Food Security' at the 2nd European–Latvian Economic Forum *Industrial revolution 4.0: Digital Economics, Data Protection & Compliance Best–Practice*, Riga, Latvia, 07–08 September 2018.
2. Contribution to the policy planning document 'Digitālās transformācijas pamatnostādnes 2021.–2027.gadam', which resulted in inclusion of blockchain technology in three policy priorities (out of suggested nine)

**Other activities in addition to the topic of the PhD thesis:**

1. ECPR/EURA PhD Summer School 2019 in Local Governance held at ZHAW School of Management and Law in Winterthur, Switzerland (6th to 12th July, 2019) – 6 ECTS.

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# ACRONYMS AND ABBREVIATIONS/ *AKRONĪMI UN ABREVIATŪRAS*

ACM – Association for Computing Machinery
AHP – Analytic Hierarchy process
AIFMD – Alternative Investment Fund Managers Directive
AML – Anti–Money Laundering
AMLD – Anti–Money Laundering Directive
API – application programming interface
ATM – Automatic Teller Machine
AVNT – Lithuanian Audit, Accounting, Property Valuation and Insolvency Management Authority
BVI – British Virgin Islands
CBDC – Central Bank Digital Currency
CFT – Combating the Financing of Terrorism
CRM – Customer relationship management
DESI – Digital Economy and Society Index
DG TAXUD – The Directorate General for Taxation and Customs Union
DLT – Distributed Ledger Technology
DOI – Diffusion of Innovations
DSM – Digital Single Market
EBA – European Banking Authority
EBSI – European blockchain Services Infrastructure
EC – European Commission
ECB – European Central Bank
EEA – European Economic Area
EFSA – Estonian Financial Regulator
EGDI – E–government–development index
EPI – E–Participation Index
EP – European Parliament
ERP – Enterprise resource planning
ESMA – European Securities and Markets Authority
EU – European Union
EUR – euro
FATF – Financial Action Task Force on Money Laundering
FCMC – Latvian Financial Capital Markets Commission
FIML – Latvian Financial Instruments Market Law
Fintech – Financial technology
GCI – Global Competitiveness Index
GDP – Gross Domestic Product
GNI – Gross National Product
GPT – General Purpose Technology
HCI – Human Capital Index
HDI – Human Development index
IBM – International Business Machines Corporation
ICO – Initial Coin Offering
ICO TC – Technical Committee of the International Organization for Standardization
ICT – Information and Communication Technology
ID – Identification Document

IEO – Initial Exchange Offering
INATBA – International Association for Trusted blockchain Applications
IoT – Internet of Things
IPR – Intellectual Property Rights
ISI – Information Society Index
ISO – International Organization for Standardization
IT – Information Technology
KEI – Knowledge Economy Index
KI – Knowledge Index
KMO – Kaiser–Meyer–Olkin
KSI – Keyless Signature Infrastructure
KYC – Know Your Customer
LIAA – Latvian Investment and Development Agency
MAS – Monetary Authority of Singapore
MiFID – Markets in Financial Instruments Directive
MLTFPA – Money Laundering and Terrorist Financing Prevention Act
NATO – North Atlantic Treaty Organization
NFC – near–field communication
NILLTFNL – Law on Prevention of Money Laundering and Terrorist Financing
OECD – Organization for Economic Co–operation and Development
PEOU – Perceived ease of use
PIMT – Process, Institutional, Market, Technology
PIT – Personal Income Tax
POS – Point of Sale
PU – Perceived usefulness
QR – Quick Response
RBI – Reserve Bank of India
RIA – Estonian State Information System Authority
RIK – Estonian Centre of Registers and Information Systems
RIS – Regional innovation systems
SIA – Latvian Limited Liability Company
SRS – Latvian State Revenue Service
SSI – Self Sovereign Identity
STO – Security Token Offering
TAM – Technology Acceptance Model
TCP/IP – Transmission Control Protocol/ Internet Protocol
TOE – Technology, Organization, Environment
TRIPS – Trade–Related Aspects of Intellectual Property Rights
UAE – United Arab Emirates
UK – United Kingdom
UN – United Nations
USD – United States dollar
USA – United States of America
VAT – Value Added Tax
XRP – Ripple

# INTRODUCTION/ *IEVADS*

**Scientific topicality**

Blockchain technology is a recent innovation in ICT, which can be considered as a technological innovation according to Schumpeter (1912). Schumpeter (1912) believed that innovation is an essential driver of competitiveness and economic dynamics. He also believed that innovation is the centre of economic change causing gales of creative destruction that develops the economy while the entrepreneur performs the function of the change creator (Schumpeter, 1942). Schumpeter (1912, 1939, 1942) argues that the diffusion and imitation processes have a more substantial impact on the economy than the invention phase. Therefore, from the economic perspective, it is important to study factors facilitating blockchain technology diffusion and imitation process. These factors can be afterwards strengthened through industrial, innovation and digitalisation policies, which have considerable effect on regional development. Wintjes and Hollanders (2020) note that application of technology at regional level is more important than basic research, and region's competitive position is determined by three factors:

- Accessibility to knowledge;
- Capacity to absorb knowledge;
- Capacity to diffuse knowledge and technology.

Latvia falls into a group of countries 'Skilled industrial Eastern Europe', which is characterized by average accessibility to knowledge and low absorption and diffusion capability indicating 'employment', 'regional development', 'sustainable healthcare system' and 'education and training' as significant challenges (Wintjes and Hollanders, 2020). Moreover, the survey performed by Wintjes and Hollanders (2020) for the European Commission concludes that impact from research, technology and innovation on regional development is high, therefore studying modern technology adoption is a necessity in various contexts of regional development, digital transformation and economic development.

Blockchain is the technology of the medium–term future, which is gradually being implemented in many countries around the world, both in private and public projects, and is shaping the Internet of future – Web 3.0, which will implement blockchain–based protocols for decentralized data and decision–making. In summary, blockchain allows network users to make sure that they possess the same information, and this confidence is not based on trust, but on underlying technological components of blockchain. Although blockchain technology is broadly associated with cryptocurrencies like Bitcoin and decentralized application platforms like Ethereum, these are only few implementations of blockchain technology and a fractional part of its overall functionalities. Blockchain technology and cryptocurrencies have equivalent inter–relations as the Internet and email, with email being just one application facilitated through the Internet, the same is true for cryptocurrencies, being just one application facilitated through blockchain technology.

A Deloitte Global Blockchain survey (2019) concluded that 2019 was a turning point for blockchain development, evidenced by a radical change in the attitudes of business leaders who recognized that blockchain technology was real and could serve as a pragmatic solution to business problems in various industries and applications. Blockchain guarantees trust, assures immutability, transparency, and supports disintermediation in addition to providing extra security for transactions executed over the Internet. These are considerable advantages that cannot be ignored, whilst adoption barriers can be depreciated and reduced throughout the time, as more experience with

applications is gained and blockchain becomes a core technology, as it was the case with the Internet in 1990–s.

Corporations, academia, technology pioneers, public institutions and the media broadly agree on the fact that blockchain technology can create new decentralized trust systems for business transactions and public services around the world, laying the groundwork for unprecedented business models and the Internet of value. Recent years was a period of experimentation, revealing practical benefits and challenges of blockchain technology, making it more understandable and increasing the enthusiasm of organizations regarding potential blockchain adoption. It is expected introduction of blockchain technology in the form of large–scale projects in various business structures will happen in nearest future. Blockchain proof–of–concepts and prototypes are implemented in different areas: in financial transactions, healthcare, real estate transactions, retail trade, supply chains, logistics, insurance, public services, etc. However, despite its rising popularity, sector–specific and regulatory obstacles continue to affect blockchain adoption. Therefore, for studying and understanding blockchain adoption factors, it is important to analyse and prioritize various factors, which may influence technology adoption on a broader scale.

Current studies on blockchain adoption factors are limited to particular use cases, such as crypto–currencies, supply chain solutions and payments. Therefore, it is necessary to apply a more holistic approach in order to study blockchain technology adoption within a national economy. In order to investigate factors and assess potential directions for blockchain technology adoption in Latvia, it is necessary to analyse global and local technological trends, blockchain solutions and regulatory developments globally and regionally and investigate interconnections between blockchain up–take and preceding measures by highlighting the factors that drive blockchain technology adoption by stakeholders and subsequently foster development and adoption of blockchain solutions in various application areas.

**The basis for the PhD thesis**

Author's previous research has concluded that e–government development may facilitate national income growth in Latvia, and at the same time Latvia lags behind Lithuania and Estonia in terms of e–government and e–participation development (Kostrikova & Rivza, 2016), therefore it is a clear indication of necessity to pay bigger attention to digital transformation. In addition, author's previous research has concluded that economic sectors with the most value added in the economy of Latvia are subject to potential disruption from blockchain and distributed ledger technologies in the short, medium or long term (Kostrikova & Rivza, 2017). According to World Economic Forum (*The Global Competitiveness…,* 2019), Latvia's global competitiveness stands at the 41$^{st}$ place, in comparison to Lithuania's 39$^{th}$ and Estonia's 31$^{st}$ place. The same tendency is observed with blockchain technology. For example, blockchain technology solutions in crypto space in Latvia substantially lag behind Estonia and Lithuania – funds raised through initial coin offerings (ICOs) in Latvia are circa 11 times and 34 times less than in Lithuania and Estonia, accordingly. Latvia was also the last country among Baltic states to introduce guidelines on treatment of ICOs – in Latvia the guidelines were published in 2019, whilst in Estonia and Lithuania in 2016 and 2017, accordingly.

Although activities of crypto and virtual assets services providers fall under national AML/ CFT regulation, EU Directive 2015/849 on the prevention of the use of the financial system for the purposes of money laundering or terrorist financing and recommendations of The Financial Action Task Force on Money Laundering in all three Baltic countries, in Latvia there is no specialized crypto–activity regulation and/ or

authorisation/ licensing regimes up to date, contrary to neighbouring countries, where crypto licensing regimes were introduced in 2017 and 2019 in Estonia and Lithuania, accordingly. Blockchain ConsultUs (*Blockchain Regulations,* 2020) has ranked Latvia 81st by crypto–regulation development, in comparison to Lithuania's 4th and Estonia's 14th place. Moreover, Estonia has already introduced blockchain technology in several e–government services and Lithuanian Central Bank has created a specialized regulatory Sandbox for testing blockchain solutions in fintech area, whilst in Latvia there is no proof–of–concept developed in e–government or regulatory area up to date.

Whilst the Ministry of Economics of the Republic of Latvia has issued a report 'On examples of the use of blockchain technology, perspectives and further actions to promote the development of the field' in 2018 and conducted a blockchain hackathon in cooperation with State Revenue Service and blockchain developers in 2019, no proof–of–concept has yet been developed up to date. Also, at the end of 2017, the Financial and Capital Market Commission (hereafter, FCMC) created a new virtual information environment 'Innovation Sandbox', where it is possible to obtain information and news about innovations and their opportunities in the Latvian financial sector, find out important practical issues related to financial technologies, as well as directly address Experts of the Financial and Capital Market Commission (*Inovāciju smilškaste,* [n.y.]). However, it does not involve financial technology piloting space and is not blockchain specific contrary to the Sandbox of the Bank of Lithuania.

On the other hand, FCMC fintech survey conducted in 2020 has revealed only one financial services provider, which utilizes a distributed ledger technology (a foundational technology underlying blockchain). It may indicate an overall insufficient interest of local market players in Latvia to utilize blockchain technology in fintech area, however this point must be further investigated in order to understand actual reasons. Author's previous research (Kostrikova and Rivza, 2017) has found strong and significant correlations between the blockchain–based crypto market activity and digitisation of public services in the EU. Therefore, it is important to investigate factors underlying blockchain technology adoption in all potential areas of application, such as crypto space, fintech, e–government and other industries for determining potential opportunities for blockchain technology adoption in the economy of Latvia.

**The hypothesis of the thesis**: It is possible to facilitate digitalisation of the economy of Latvia through blockchain technology adoption.

**The aim of the thesis**: to develop recommendations for facilitating blockchain technology adoption in the economy of Latvia, based on investigation of global blockchain technology adoption factors and scenarios with a focus on Baltic States region analysis.

**The tasks of the thesis** are as follows:

1. to outline a framework for blockchain technology adoption assessment through the lenses of innovation theories, technology adoption models and the concept of knowledge economy;
2. to analyse blockchain related policies, public opinions and regulatory developments in the European Union and Baltic States;
3. to analyse blockchain technology adoption trends worldwide and in the Baltic States;
4. to develop and analyse scenarios for blockchain technology adoption in the economy of Latvia.

**The research object**: blockchain technology innovation and adoption experience worldwide.

**The research subject**: blockchain technology adoption factors and scenarios in the economy of Latvia.

To achieve the aim of the thesis, the following structure was created: introduction, four chapters of the research, conclusions and proposals, list of used literature sources.

In the **first chapter**, the theoretical research of blockchain technology, knowledge economy, innovation theories and aspects of innovation diffusion process and underlying innovation adoption factors are performed. Innovation adoption and technology acceptance models are summarized.

The **second chapter** studies blockchain related policies and regulatory developments – blockchain technology innovation planning documents and relevant regulatory enactments of the European Union and Latvia.

In the **third chapter**, blockchain technology innovation and adoption worldwide and in Baltic States is analysed in various areas of applications and geographical tendencies and success factors are investigated.

In the **fourth chapter**, blockchain technology adoption factors and scenarios are determined based on international experience and international expert survey involving 82 respondents from 30 countries; blockchain adoption factors and scenarios in the economy of Latvia are assessed through AHP analysis based on expert opinions of seven renowned national experts; and recommendations for facilitating blockchain technology adoption in Latvia are developed.

At the end of the thesis the main conclusions, research results and recommendations for facilitating blockchain technology adoption in the economy of Latvia are formulated.

**Theses to be defended**

1. Blockchain technology is a disruptive innovation, which demonstrates its ability to fundamentally transform business models within the knowledge economy, however it has not yet reached a mass adoption phase.
2. The regulatory enactments in Baltic States do not regulate blockchain technology activities beyond crypto–currencies and virtual assets.
3. The level and scenarios of blockchain technology adoption beyond crypto space differs among countries depending on the levels of economic and digital competitiveness and crypto activity.
4. Analysis of the innovation diffusion and technology adoption models, as well as research on global blockchain activity and adoption factors allows illustrating a framework for blockchain technology adoption in the national economy.
5. In Latvia, blockchain technology adoption is the lowest in the Baltic States region; it is possible to facilitate it by undertaking targeted support actions for strengthening significant blockchain adoption factors, using international experience.

**Research methodology**:

1. General scientific research methods:
   - monographic or descriptive method, the application of which helped to find a detailed idea of the researched problem in the theoretical view, based on an extensive review of scientific literature and research;
   - graphical method – the use of the graphical method helped to clearly and effectively reveal the relationships and dynamics of objects;
   - method of synthesis and analysis – separate elements of the research object were connected in a single system, studying their interconnections.
2. Statistical research methods:

- descriptive statistics, correlation analysis, factor analysis, cluster analysis to analyse global blockchain innovation and adoption tendencies, interconnections and blockchain solutions in various application areas and countries.
- comparison, grouping, clustering methods to define a blockchain adoption factor matrix from various innovation diffusion and technology acceptance models.

3. Sociological research methods:
   - the method of international expert survey was used to identify significant blockchain adoption factors and to validate the most prominent blockchain technology adoption scenarios worldwide.
4. Forecasting research method:
   - Analytical Hierarchy Process (AHP) method, used to assess blockchain technology adoption factors, scenarios in the economy of Latvia, calculating the coordinates of priority vectors, coherence ratio and average values.

**Economic significance of the research**

The study is relevant for entrepreneurs, public authorities and regulators in order to successfully determine and implement blockchain technology development policies, support measures and courses of action in accordance with market sentiment, socio–economic rationale and general tendencies in the European Union and worldwide, taking into account the interests and opportunities of different stakeholders, as well as development priorities within the context of innovation policies. As a result of the PhD thesis, a blockchain technology adoption assessment matrix and recommendations for facilitating blockchain technology adoption in the economy of Latvia have been developed with the aim of strengthening the global competitiveness of the economy of Latvia.

The results of the PhD thesis are practically applicable for facilitating blockchain technology adoption in the economy of Latvia as well as for identification of development areas requiring particular focus. The results of the research would be particularly useful for the Ministry of Economics in development of policies and actions to strengthen blockchain innovation systems in Latvia, for the Ministry of Environmental Protection and Regional Development in substantiating blockchain technology applications within the framework of identified priority directions of the national digital transformation policy and for the Ministry of Finance to evaluate and define the extent of Latvia' crypto–friendliness and regulation. The results of statistical data analysis on blockchain technology adoption indicators, comparison with other Baltic countries and the assessment of blockchain technology adoption factors by local and international blockchain experts from 30 countries can be used in the policy planning process or in combination with other research, analysing and substantiating the importance and necessity of blockchain technology support measures.

**Novelties of the research**

1. Theoretical and practical aspects of the blockchain technology tendencies worldwide and in the Baltic States have been analysed, pointing to possible development areas.
2. Factors influencing blockchain technology adoption have been investigated, grouped and structured based on theoretical and empirical research.
3. Scenarios for blockchain technology adoption in the national economy have been defined and empirically validated by international expert survey.

4. The impact of technological, organisational, market and institutional factors on blockchain technology adoption in the economy of Latvia has been evaluated.
5. By using AHP assessment matrix, recommendations for facilitating blockchain technology adoption in the economy of Latvia have been developed.

**Scientific significance of the research**

The conducted research is the first PhD level scientific research on the topic of blockchain technologies in Latvia and will complement not only Latvian, but also international research base with a unique scientific work on blockchain technology adoption factors in the context of economic development and definition of possible blockchain innovation and adoption directions in the national economy. Publications developed and published to test the results of the research complement international scientific databases, where available research mainly studies blockchain adoption factors on micro level and in specialized blockchain technology application areas.

Analysis of statistical data on the blockchain technology innovation, adoption and classification provides information on the current situation and can be used as a comparison with previous research by other scientists to assess changes in the sector, developments, solving predefined problems or express future forecasts. The obtained research results can be used in the academic process and other research in both the economic and social sciences.

The research methods used expand their fields of application and indicate their relevance in blockchain–related economic research, as well as facilitate the choice of methods in new industry–related research

**Data and other materials used**

The methodological basis of the research is the works of local and foreign scientists, European Union and Latvian policy guidelines and planning documents, materials and research developed by competent national and international authorities and think–tanks, such as European Parliament, European Commission, International Monetary Fund, Ministry of Economics of the Republic of Latvia, Deloitte, Gartner as well as author's research.

The author has obtained statistical data on blockchain technology activity from various public sources (*All crypto–currencies...*, 2020; *Stats and Facts*…, 2020) and used research data from the journals and articles available in Scopus, Web of Science, Emerald, EBSCO databases and information on blockchain solutions, tendencies and research from relevant internet sources.

Empirical information on blockchain adoption factors and scenarios was obtained from the survey of national and international blockchain experts.

Based on these studies and surveys, blockchain technology adoption assessment matrix and recommendations for facilitating blockchain technology adoption in the economy of Latvia have been developed.

**Research limitation**

The study was conducted in the period from September 2016 to November 2020. Data from 2013 to 2020 was used for statistical data analysis of global blockchain trends.

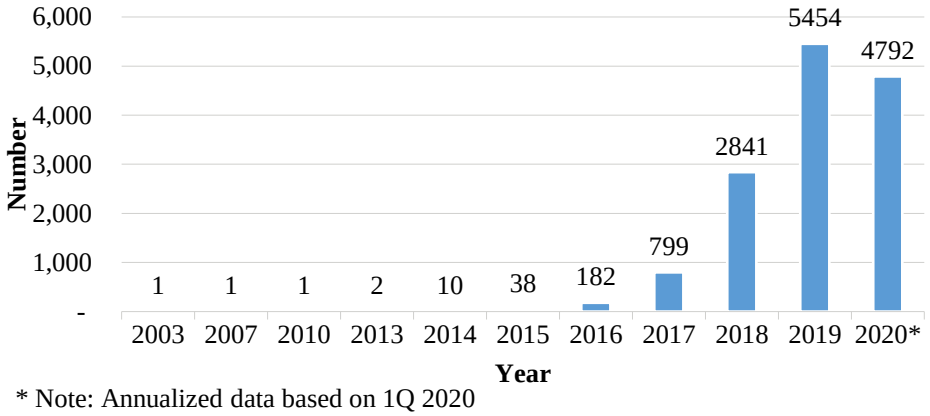
The author's PhD thesis has been developed within the State Research Program's 'Latvian Heritage and Future Challenges for National Sustainability' project 'Latvian State and Society Challenges and Their Solutions in the International Context (INTERFRAME–LV)'.

# 1. THEORETICAL AND HISTORICAL ASPECTS OF BLOCKCHAIN TECHNOLOGY/ *BLOKĶĒDES TEHNOLOĢIJAS TEORĒTISKIE UN VĒSTURISKIE ASPEKTI*

## 1.1. Blockchain technology definition, nature and history/ *Blokķēdes tehnoloģijas definīcija, būtība un vēsturiskā attīstība*

Since blockchain technology is a relatively new technological phenomenon, which received attention within the last decade only, it is important to define it and understand how it is connected to another increasingly popular technology called 'Distributed ledger technology' (DLT). Although two terms have been used by both practitioners and researchers interchangeably, it is important to understand and differentiate between them. DLT is a technology, which underlies blockchain technology. Any blockchain application uses distributed ledger for data storage, however not every distributed ledger implements blockchain technology for recording the history of transactions applying specific transaction confirmation and encryption techniques. Essentially a blockchain is a type of a distributed ledger. As blockchain term has gained higher attention in both academia and practical applications, the author will further analyse and use the term 'blockchain technology'.

Blockchain technology research has exponentially increased since 2015, driven by increasing number of initiatives aimed at experimentation, piloting and implementation of blockchain solutions in different sectors of economy.




* Note: Annualized data based on 1Q 2020

*Source: Author's construction based on data from Scopus database*

Fig. 1.1./ *1.1. att.* **Number of scientific articles containing 'blockchain' keyword in Scopus database, 2003–2020/** ***Zinātnisko publikāciju skaits Scopus datubāzē ar atslēgas vārdu 'blockchain', 2003–2020***

Blockchain technology and DLT can be used as innovative tools to transform any centralized system, eliminating the need for reliable intermediaries (such as banks, notaries, etc.), instead providing for verification and authorization of activities in the system, using efficient and high–security consensus mechanisms. At its core, this is the first database that makes it unnecessary to use a central service, distributes the database to all communication nodes, making them responsible for maintaining the system and checking information. Each node makes changes to the registry independently of other nodes, then they all vote for changes and, when consensus is reached, the registry is supplemented with new data. Each member of the network at the same time has its own identical copy of the registry, and the changes are added within a few minutes.

Table 1.1./ *1.1. tabula*

**Blockchain architectures and concepts/ *Blokķēdes arhitektūras un koncepcijas***

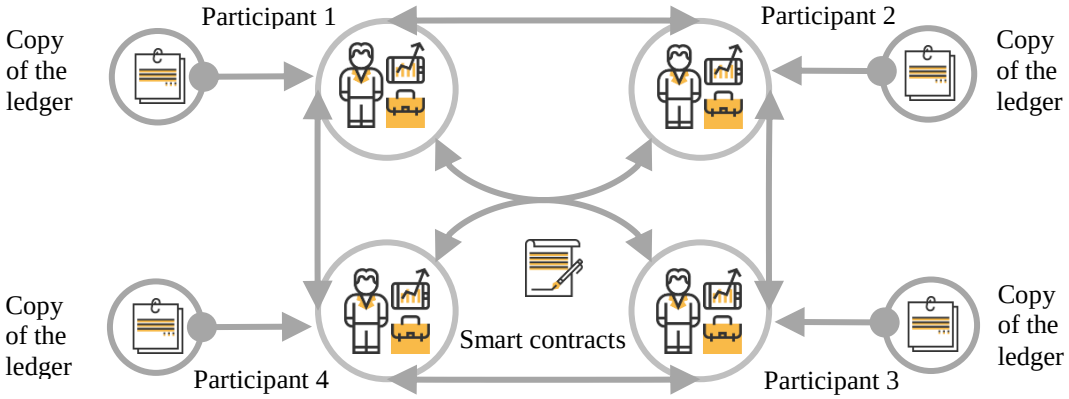
| **Operation** | **Centralized** | **Decentralized** | **Distributed** |
|---|---|---|---|
| Layout |  |  |  |
| Governance/ Business Model | Centrally Controlled | Community Controlled | Autonomous |
| Stability/ Resilience | Unstable | Bounded Stability | Stable |
| Scalability | Large Throughput/ Small Number of Nodes | Small Throughput/ Medium Number of Nodes | Infinite |
| Speed of Enterprise Development | Fast | Medium | Very Slow |
| Architecture Evolution/ Diversity | Permissioned/ Private | Hybrid | Permissionless/ Public |
| Tokenization | No | Possibly | Yes |
| Trust Control | High Traditional/ Low Algorithmic | Medium Traditional/ Medium Algorithmic | Low Traditional/ High Algorithmic |

*Source: Gartner, 2018*

In centralized systems, participants communicate with each other through a single central data server that stores all information. This approach provides easy data management, but makes the system dependent on one central element. Decentralized systems are more complex and allow communication between multiple servers (P2P or peer–to–peer communication). In distributed systems, there are no links between servers and all participants (or 'nodes') are independent entities that receive, store, generate and directly exchange data, as well as synchronise it in each electronic ledger within the network.

Distributed Ledger Technology (DLT) is a recent decentralized innovation in the field of information and communication technology (ICT) that acts as self–sustainable ledger for documenting transactions self–protected against counterfeiting and hacker attacks. European Central Bank defines DLT as a record of information, or database, which is shared across the network (European Central Bank, 2016). Federal Reserve defines DLT as a combination of components, including peer–to–peer networking, distributed data storage and cryptography that, among other things can potentially change the way in which the storage, recordkeeping and transfer of a digital asset is done (Badev et al., 2016).

Distributed ledger is a ledger with stored in identical copies on devices of network's participants that are synchronized and automatically updated when new files is added to a ledger. In comparison to traditional transaction networks, distributed ledgers do not require trusted intermediaries for ownership certification and transaction clearing (see figure 1.2.).

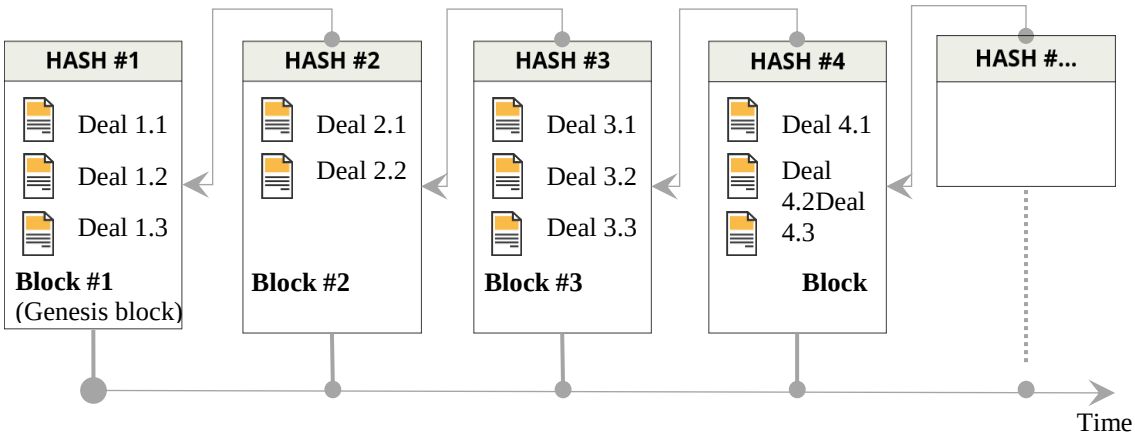



*Source: Author's construction*

Fig. 1.2./ *1.2. att.* **Distributed ledger network/** ***Izkliedētās virsgrāmatas tīkls***

In the past decade, DLT has revolutionised the ways to exchange and store data in digital environment. It is applicable in almost all industries and has significant advantages over standard data storage systems. However, DLT was not the first technological attempt to implement transactions through ICT. The core underlying concepts of such applications include establishment of trust, maintaining confidentiality and ensuring secure data exchange and storage. Previous technologies include such concepts as blind signatures (Chaum, 1982), b–money (Dai, 1998), hash–cash puzzles (Back, 2002), reusable proofs of work (Finney, 2004), all of them using encryption and consensus protocols, but none of them providing distributed data storage opportunity.

Blockchain is the most prominent example of DLT. Each transaction in a blockchain is stored within a block and each block is connected to the previous block with a cryptographic signature called 'hash', a mathematical function based on cryptographic algorithm. Hashing is essential for making blockchain immutable, ensuring that transactions are irreversible (see figure 1.3.).




*Source: Author's construction*

Fig. 1.3./ *1.3. att.* **The blockchain structure/** ***Blokķēdes struktūra***

Around the same time when Lehman Brothers went bankrupt in November 2008 an anonymous person or group of persons named Satoshi Nakamoto outlined a new concept called the Bitcoin protocol, which allowed people to make transactions and send money peer–to–peer without an intermediary in a secure and transparent way over the Internet. This was the first practical implementation of the revolutionary blockchain technology. In reality, blockchain allows sending peer–to–peer not only digital currency, but

potentially anything of value such as financial assets, intellectual property, energy, digital identity and even votes in an election securely and privately.

In blockchain, trust is not established by a third party, but rather through mass collaboration, cryptography and smart code and Bitcoin was just the beginning. Subsequently Ethereum pioneered a technology called smart contracts, which is basically a software that mimics the logic of a contract with guaranteed execution enforcement via the code instead of escrow agents, lawyers, courts and other intermediaries that add costs to transactions. Therefore, blockchain potential impact on the financial services industry is unprecedented, as every single financial asset basically is a contract – it is a piece of paper that entitles to something like a dividend payment, a coupon payment or a share in the company, etc.

The Linux Foundation has also launched an open source blockchain project called Hyperledger for the development of permissioned and hybrid blockchains deployable in enterprise level solutions, which now counts amongst its members thousands of technologists and hundreds of companies.

Boucher (2016) notes that blockchain may make some of the precautions necessary in people's daily lives faster, cheaper, more secure and more transparent. Therefore, blockchain technology has the ability to create a more prosperous world – journalists, musicians and filmmakers can get fairly compensated for the intellectual property that they create, land titling can considerably improve in the developing world where frauds with real estate ownership documents are common. The core blockchain features are summarised below.

Table 1.2./ *1.2. tabula*

**Core blockchain features/ *Blokķēdes būtiskās īpašības***

| Nr. | Blockchain feature | Description |
|---|---|---|
| 1. | Distributed Ledger | The ledger is shared across the network and contains an updated record of transaction history |
| 2. | Real Time Recording | Copies of the ledger get updated across all network nodes instantly |
| 3. | No Third Party Validation | All transactions are validated by independent data miners at all nodes & unknown identities of participants makes process free from biases |
| 4. | Immutable Transactions | Consensus requirement of all nodes on status of ledger at any time makes changes highly difficult as those would need to be done at all nodes |
| 5. | Decentralized Network | The database is maintained & governed in a decentralized manner by network participants without any central authority |

*Source: Thakkar, 2017*

Blockchain technology has the potential to open up new business opportunities, create more efficient solutions and could reduce the role of intermediaries in the future. Blockchain would make it possible to prevent any form of falsification of data, to change it retroactively and to sell the same asset twice to different buyers. With the blockchain, any transaction is encoded in a specific system, which is easy to check and analyse at any time.

Success of blockchain technology is based on the benefits it provides to potential users. The benefits of blockchain are broadly described in literature and research (Iansiti and Lakhani, 2017; Swan et al. 2019; Tapscott, 2018) and are also marketed within particular blockchain solutions. In the table 1.3. the author has compiled the most prominent blockchain benefits grouped under two pillars – 'cost–savings' and 'secure trust system', based on literature and information on particular blockchain solutions.

Table 1.3./ *1.3. tabula*

**Benefits of blockchain/ *Blokķēdes priekšrocības***

| Pillar | Blockchain benefit | Description |
|---|---|---|
| Cost–savings | Disintermediation | Removing the need for trusted intermediaries to verify transactions, and allow two parties to transact directly with each other |
| | Speed / Real Time Updates | Eliminating manual processing of paper documents & signatures via uploads to a single interface and real–time updates |
| Secure trust system | Irreversibility | All transactions are secured by cryptography, therefore are irreversible, reducing risk of double spending, abuse and manipulation |
| | Fraud Reduction | Unique tracking and authentic verification of each transaction and asset mitigates fraud and associated behaviour |
| | Accurate/ Traceable Information | Improving access to latest contracts, single sourced amendments, and pre–verified documents that are signed by all parties |
| | Privacy & Transparency | Increasing security of access, amendments, and exposure, through the use of key–permissioned access |

*Source: Author's construction*

Blockchain solutions can be used primarily in areas where there is a need for high security registers (land, business, license, education documents) or activity audit registers (document circulation, cash transactions, etc.). Blockchain excludes the possibility that any changes to the system will not be noticed, given that the possibility of unauthorized activity or destruction of the database is practically ruled out, as one or some nodes can be hacked, but it is practically impossible to hack all or most nodes. However, blockchain does not protect against erroneous or harmful actions of authorized users, it only helps to detect such actions, i.e. blockchain provides consistency rather than truthfulness.

Blockchain can be public or private/ permissioned. The difference between two is in access rights – whilst anyone can access a public blockchain, a special permission/ authorisation is required to access a private/ permissioned blockchain. The choice of a blockchain type depends on its potential application and business model. Taking into consideration the blockchain benefits described above there are various solution types, where such benefits may be maximized. In terms of business models, there are several types of business models facilitated through blockchain solutions:

- **Internal Business Models**. A pure crypto or token economy where all activity happens within one blockchain network. The blockchain network is not used to track or react to things happening outside of the network;
- **Mixed Business Models.** Mixed approaches combine activity happening outside the blockchain network with activity or tracking within it. Mixed business models are particularly relevant for blockchain technology integration into traditional business models.

The list of potential applications for the blockchain is extensive. The following areas could be highlighted where the greatest potential is already being developed and can be seen.

**Cryptocurrencies and virtual assets**

Cryptocurrencies and virtual assets is the most prominent blockchain technology use case up to date. A virtual asset is represented by a token. Tokens issued on a blockchain platform can be transferred directly between peers and executed using smart contracts without the risk of the token being double spent. Token Economy refers to the

system of incentives based on cryptocurrencies that reinforce and build desirable behaviours the in blockchain ecosystem (Hackernoon, 2019). Tokens can also facilitate micropayment transactions to sustain business models in a digital environment, for example, to ensure collection of royalties for digital content (Wright and De Filippi, 2015) or enhance other economical behaviours between blockchain network participants.

**Automated transactions via smart contracts**

Smart contracts were first introduced by Nick Szabo in 1996. Smart contracts are computer programs that automatically execute the terms of a contract, or contracts that are executed when user interfaces are combined with computer protocols (Crosby, et al., 2016; Nofer et al., 2017). The parties sign a smart contract using methods similar to the signing of sending funds in existing cryptocurrency networks. After signing by the parties, the contract takes effect. To ensure the automated fulfilment of contractual obligations, an environment of existence is required, which allows to fully automate the implementation of contract clauses. This means that smart contracts can only exist inside an environment that has unhindered access for executable code to the objects of a smart contract. All conditions of the contract should have a mathematical description and a clear logic of execution. In this regard, the first smart contracts have the task of formalizing the simplest relationships, consisting of a small number of conditions. Smart contracts, for example, can monitor the fulfilment of long–term loan conditions.

Having unhindered access to the objects of the contract, the smart contract monitors the achievement or violation of points according to the specified conditions and makes independent decisions based on the programmed conditions. Thus, the basic principle of a smart contract is the complete automation and reliability of the execution of contractual relationships between people. A smart contract can update the data on the blockchain in accordance with the originally set rules – for example, transfer digital assets from one participant to another. According to the British magazine The Economist (2017), smart contracts have the prospect of becoming the most important application of blockchain technology. As soon as the new technology gains momentum, smart contracts will make a real digital revolution, which will be comparable to the invention of HTML, which radically changed the Internet, and subsequently the entire world economy.

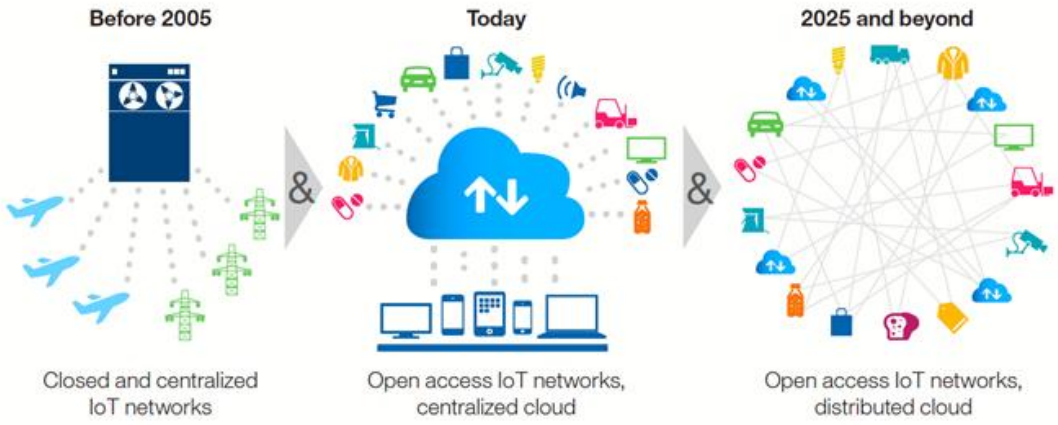
**Financial technologies (fintech)**

Financial markets have developed significantly in the past decades, driven by technology and globalization (Genberg, 2017). Blockchain projects are active in fintech area, building a new network of trust for financial transactions without intermediaries. The evolution of financial intermediation is going to be one of the most important and consequential stories in the coming years for law, finance, and society (Lin, 2016). Fintech blockchain solutions can be applied to an array of front–office and back–office processes in the financial services industry: internal banking processes (faster, cheaper, safer and more transparent transactions), insurance (smart contracts, indemnification and management, settlement, fraud reduction), payments (cross–currency payments); securities trading and investing (automatic financial services, post–transaction processing); lending and crowd financing (optimization of document processing and information exchange between several participants, smart contracts between donors and recipients of financial resources). According to Deloitte (2016b), blockchain and distributed ledger technologies can facilitate KYC/ AML compliance procedures for financial services providers, providing for a faster and more accurate KYC/ AML process and reducing administrative costs of financial institutions related to KYC/AML compliance by up to 90 per cent.

**Internet of Things**

Decentralization of computing is an inevitable trend in the development of the Internet of Things (IoT). On the other hand, blockchain is also based on the principle of decentralization, so it fits very organically into the architecture of the Internet of Things. The combination of both technologies can provide efficient consumer–device and device–device collaboration, such as smart booking (renting / using houses / apartments, renting cars / bicycles); smart devices (TV, music equipment, refrigerators, washing machines); related vehicles (accumulation of all vehicle characteristics and events, problem diagnosis, contacts with service providers).

According to IBM Institute for Business Value (2015), the world of information technology is moving from closed isolated models of device interaction to cloud centralized models that work on the principle of trust and authentication, and then to fully distributed models that work on the principle of complete lack of trust, where each transaction must be individually verified by a community of distributed nodes (see figure 1.4.).




*Source: IBM Institute for Business Value, 2015*

Fig. 1.4./ *1.4. att*. **Transformation of Internet of Things models/ Lietu Interneta modeļu transformācija**

In fact, this is the blockchain model, which would enable IoT devices to communicate and transact in real time.

**Supply chains and logistics**

Blockchain in logistics improves the reliability and transparency of the supply chain (DHL, 2018). It helps to avoid discrepancies in documentation: for example, if the carrier and the consignee interpret the delivery time differently. With the blockchain, this can be avoided, since all participants in the supply chain have access to the same version of all shipping documents. In addition, the entire data exchange is written in blocks, it is impossible to delete or change this information, therefore, if there is a disagreement, it is much easier to find the root of the problem. Therefore, blockchain enhances supply chain management and traceability, including traceability of the delivery route of the goods. It is often identified that supply chains are opaque to consumers, with it becoming increasingly difficult to identify where products originated and where they travelled. Blockchain can also solve such problems as trade of counterfeit goods, ensure that delivered goods meet quality standards, track the source of contamination of food, etc.

**Digital identity**

Digital identity solutions are designed to identify and confirm access rights aimed at ensuring identification tools in digital environment. A self–sovereign identity approach based on decentralized identifiers ensures that the final users are in control of their personal data (European Commission, 2019b), as each user's personal information is not stored in any centralized network and can be shared on a need–to–know basis. A digital identity can be used for signing digital documents, verifying certificates and attestations (for example, marriage, birth, educational documents), registering transactions with personal assets, certifying asset ownership, protecting copyrights, etc. Digital identity management solutions can also be integrated with fingerprint scanners and other biometric personal devices, allowing achieving the highest possible level of integrity and interoperability within digital infrastructure.

**Health care and medicine**

Blockchain in healthcare, medicine and pharmaceuticals can be used to manage electronic medical records, drug supply chains, to combat counterfeit drugs, control the distribution of donor organs, conduct clinical and biomedical research, remotely monitor patients, improve insurance and billing procedures, analyse medical data and ensure secure exchange of information between stakeholders, ensuring privacy of patients. Potential blockchain solutions include registration of personal health data databases, health care provider databases, consents to operations, etc. Support of the European Commission (*Blockchain to Enable…, 2020*) for projects in this area demonstrate their suitability for problem solution, as on one hand a secure and efficient exchange of data is ensured and on the other hand each end user is the owner and manager of personal data.

**Voting**

The European Commission (2019a) notes that blockchain technology can be applied in electronic voting. If today the votes are recorded, counted, controlled and managed centrally, then blockchain technology would ensure immutability of each vote in a decentralized network, which cannot be changed by any individual party as each party to the system would see if someone tried to change or delete the vote. It can be applied in elections, referendums and polls, creating unprecedented level of transparency and accuracy of voting results and at the same time bringing fulfilment of civic obligations closer to the citizen (by creating a 'bottom–up civil society').

**Public administration**

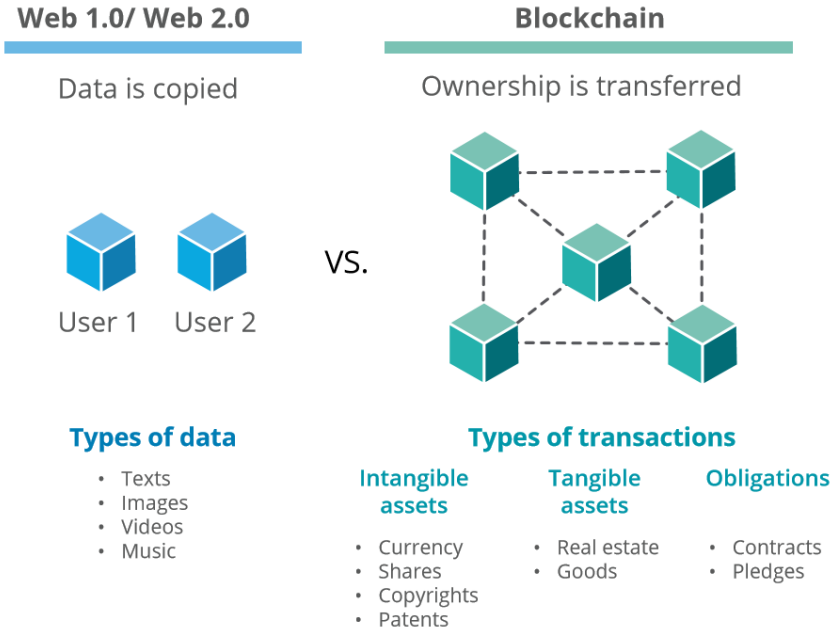
Public administration bodies are often fragmented, which makes it difficult to exchange information between institutions and departments. Blockchain can substantially decrease bureaucracy and ensure transparency of public administration functions. The European Commission (2019a) notes that blockchain technology can improve functions and services of public administration, such as processing citizens' records, maintenance of public registers, facilitation of economic transactions, regulatory monitoring and control, fight against tax evasion and allocation of public budget resources. Potential blockchain solutions may create new IT architectures for interaction between state units, ensure securely accessible record keeping in public registries, resulting in transparent and quick interaction between public administration bodies and the society.

**Cybersecurity**

Deloitte (2017a) suggests that the use of blockchain technology in the context of cybersecurity makes it possible to prevent fraudulent activities by using consensus

algorithms, as well as to detect data manipulation thanks to blockchain properties such as data persistence, transparency, auditability, data encryption and system resilience (including blockchains not being exposed to single point failures). In addition, blockchain can support management and control mechanisms through multi–party authentication. If several parties have command authority and they must reach a consensus before taking certain measures, then the system will be better protected from errors. Such tactics may have certain advantages for example, for military and defense, especially in the field of space forces. Blockchain can contribute to the development of this unit by adding multi–factor authentication to satellite communications systems. Typically, such systems are unsafe and previously became objects of exploitation or were vulnerable to the actions of hackers.

In the figure 1.5. Deloitte (2017c) illustrates the transformative nature of blockchain technology by transition from data copying to ownership transfers.




*Source: Deloitte, 2017c*

Fig. 1.5./ *1.5. att.* **Moving toward the Internet of Value/** ***Virzība uz vērtību Internetu***

European Parliament notes that DLT's potential to accelerate, decentralise, automate and standardise data driven processes at lower cost has the potential to alter fundamentally the way in which assets are transferred and records are kept, with implications for both the private and the public sector (European Parliament, 2016). Maupin (2017) notes that for the first time in history, DLT and blockchain make it possible for people all over the world to transact securely on a peer–to–peer basis without trusted intermediaries transforming the way the world economy works.

Researchers (Swan, 2015, Nguyen, 2016, Underwood, 2016), public institutions (Federal Reserve, 2016; European Parliament 2016; European Central Bank, 2016) and think–tanks (European Union Agency for Network and Information Security, 2016; Oliver Wyman, 2016; Deloitte, 2016a) conclude that DLT can bring numerous benefits, however certain criticism exists majorly outlining a security concern about a possibility of a 51% attack (Lee and Low, 2014), slowness of the data adding process to the ledger (Deloitte, 2016a), size problem if scaled to mainstream use (Swan, 2015) and wasted energy resources on mining (Swan, 2015).

Many global companies are exploring possibilities of blockchain technology, because it can bring confidence by providing a system with no central control, resulting in new frameworks for conducting business relationships and potential cost savings on intermediation. This means that the system cannot be shut down or changed by any single party. It enables the users of the network to know that they can safely use the network without the rules changing, ensuring secure data, information and value exchange, which is crucial for knowledge economy.

Decentralized finance solutions in crypto space are one of the most popular blockchain applications up to date. It is no wonder because intermediation being a core issue addressed by blockchain technology is also at a core of financial transactions. The evolution of financial intermediation is going to be one of the most important and consequential stories in the coming years for law, finance, and society (Lin, 2015).

There is a positive global trend towards higher levels of e–government development as countries in all regions are increasingly embracing innovation and utilizing ICTs to deliver services and engage people in decision–making processes (United Nations, 2016). The rapid diffusion of ICTs gives rise to new business models and revolutionizes industries, bearing great promise for a future wave of innovations that could drive longer–term growth (Schwab and Sala–i–Martin, 2015).

For studying adoption of any new technology within a certain micro or macro environment and specifically blockchain adoption trends within global economic environment it is important to understand the role of different stakeholders in each possible development direction. Whilst certain blockchain solutions may purely rely on developers and end users (for example, crypto–economy solutions), other blockchain application areas may need to involve much broader stakeholder network in order to ensure its development and adoption. Overall, there are nine categories of stakeholders within the blockchain ecosystem (*Introduction to Blockchain…*, 2020), including:

- industry pioneers,
- venture capitalists,
- banks and financial services providers,
- developers,
- academia,
- leaders,
- governments and regulators,
- end users,
- NGOs.

For the purpose of further analysis, each stakeholder category is defined and described below.

Industry pioneers are companies operating in non–crypto industries, which develop and launch innovative products autonomously or in consortiums with other stakeholders. Industry pioneers can be seen as a driving force for blockchain innovation and adoption beyond crypto space.

Venture capitalists typically provide capital to start–up companies with high growth potential, which is essential for commercialization of any innovation, including blockchain. Venture capital funding is particularly important for blockchain applications beyond crypto space, as pure crypto applications have much more opportunities to attract funding through coin or exchange offerings.

Banks and financial services providers are naturally important stakeholders in blockchain ecosystem, whether they implement and adopt blockchain solutions or not. Clearly, decentralized finance applications, including crypto–currencies and virtual assets, are the most prominent blockchain use case up to date, which creates competitive

pressure for traditional financial service industry. From another perspective, traditional banks and financial services providers act as a bridge between exchange flows of crypto and fiat currencies, therefore it is important that they understand crypto business models in order to establish efficient compliance mechanisms.

Developers are both technology companies and individuals directly engaged in blockchain innovation and development activities either through contribution to open source blockchain communities or through engaging in tailor made development of blockchain solutions for specific client needs.

Representatives of academia naturally research various aspects of blockchain technology and engage in collaborative and awareness–raising activities. As with any innovation, it is certainly important to look at it not only from practical implementation angle but also from the perspective of broader economic and political theories, since blockchain technology covers broad range of application areas.

Opinion leaders certainly have influence on any innovation diffusion – supportive opinions can accelerate adoption, whilst negative opinions can hinder it. Therefore, trusted leaders may have substantial influence on how not only other leaders, but also general society responds to new technological developments, which is important for blockchain technology adoption.

Role of governments and regulators in blockchain ecosystem covers two primary angles – regulatory response to blockchain use cases in various application areas and blockchain solution implementation in public administration functions and public services.

End users are important for viability of any commercial or public product or service. In this regard, some of the above–mentioned stakeholders can themselves be a part of the end user group or their customers directly benefitting from blockchain solutions. Feedback from potential end users is essential in the process of blockchain adoption.

NGOs and particularly blockchain associations are important stakeholders in a blockchain eco–system, which may provide an efficient communication and collaboration platform for various stakeholders, involved in blockchain innovation and adoption process.

### 1.2. The nature and the role of knowledge economy for blockchain technology innovation and adoption/ *Zināšanu ekonomikas būtība un nozīme blokķēdes tehnoloģijas inovācijās un to ieviešanā*

Since blockchain technology has potential to considerably affect various processes relating to business management, public administration and digital interactions among various stakeholders, it is important to investigate this technology from the perspective of knowledge economy, specifically its reliance on the resource of knowledge and its capabilities to facilitate further development of knowledge economy and digital transformation.

Knowledge, information and technology are gaining more and more importance in contemporary economic systems shaping not only the way how parties interact with each other within and between those systems, but also creating new business models and economic theories. Many researchers noted a shift from the economy based on materials toward the economy based on knowledge.

Knowledge economy was first mentioned by Machlup (1962) in his book ‘The Production and Distribution of Knowledge in the United States’. In literature knowledge economy is closely associated with such terms as ‘knowledge worker’ and 'knowledge management' (Drucker, 1969), 'post–industrial society' (Bell, 1973), 'high mass

knowledge creation society' and 'information society' (Masuda, 1980), 'prosumer production' and the 'Third Wave' (Toffler, 1980) 'digital economy' (Tapscott, 1997), 'new economy' (Kelly, 1999), 'network society' (Castells, 2000), 'era of man–made brainpower industries' (Thurow, 2000), 'post–capitalist society' (Drucker, 1992), 'knowledge economy' (Drucker, 1992), 'knowledge capitalism' (Burton–Jones, 1999).

Toffler's (1980) technological wave theory is closely related to knowledge economy and refers to three technological waves of the development of humanity: agrarian, industrial and post–industrial. 'The third wave', the post–industrial, contemporary wave, described by Toffler, is characterised by mass implementation of new informatics and communication technologies which create unlimited possibilities of communication among people and transfer of information. 'The third wave' represents post–industrial economy in which a significant role is played by information and what a man can do with it using his intellect. The changes to which Toffler directs the attention result among others from technological revolution connected with relatively newly created ICTs, formation of global economy and closer connection of contemporary economy to science and its achievements.

Masuda's 'high mass knowledge creation society' is built on three pillars: computerization, voluntary community and self–actualization (Masuda, 1980). Masuda's computerization theory involves four stages: big science based computerization, management based computerization, society based computerization and individual based computerization. According to this theory, the humanity would now be reaching the maturity of the last stage of computerization, where 'each person is the subject that carries out computerization' and 'the ready availability of information and knowledge causes creativity to flourish among the people'.

Economic theory since Keynes has not offered theories to explain the economic effects of knowledge (Bell & Kristol, 1981). Drucker made this point as follows: 'How knowledge behaves as an economic resource we do not yet fully understand. We have not had enough experience to formulate a theory and to test it. We can only say so far that we need such a theory. We need an economic theory that puts knowledge into the centre of the wealth–producing process. Such a theory alone can explain the present economy. It alone can explain economic growth. It alone can explain how the Japanese economy works and, above all, why it works' (Drucker, 1992).

Knowledge–based theory argues that the performance of the firm relies on firm–specific capabilities for knowledge creation coupled with the management of relationships for external knowledge–transfer (Grant, 1996; Kogut and Zander, 1993; Spender, 1996).

Until the mid–1970s, knowledge economy research was mainly describing developments in the United States. From the late 1970s to the early 1990s many studies on the subject were published outside the United States as ICTs came to be widely applied in other rich and developed countries (Poirier, 1990).

As Drucker forecasted in 1969 the impact of cheap, reliable, fast and universally available information will easily be as great as was the impact of electricity. Drucker (1992) also argued that information and knowledge have overtaken traditional capital, natural resources and labour in their roles as basic means of production. The basic economic resource is no longer capital, nor natural resources (the economist's 'land'), nor 'labour'. It is and will be knowledge.

According to Bell (1973), the crucial point about a post–industrial society is that knowledge, information became the strategic, and transforming resources of the society, just as capital and labour have been the strategic and transforming resources of industrial society.

Luke (1983) noted that ‘an entirely new social formation tied to the production, interpretation and distribution of information has emerged from within American industrial capitalism since the mid–1950s’.

Romer (1990) claimed that economic growth is driven by technological change that arises from intentional investment decisions made by profit–maximizing agents, whilst technological change provides the incentive for continued capital accumulation, and together, capital accumulation and technological change account for much of the increase in output per hour worked.

In 1992 Drucker continued that the central wealth–creating activities will be neither the allocation of capital to productive uses, nor 'labour' – the two poles of nineteenth – and twentieth century economic theory; value is now created by productivity and innovation, both applications of knowledge to work.

In 1996 Stevens noted that high–technology share of manufacturing production and exports has more than doubled in the past decade in countries, which are members of Organization for Economic Cooperation and Development (OECD). There are many definitions for the knowledge based economy or the new economy. The Organization for Economic Cooperation and Development (1996) defines it as the economy, which ‘is directly based on the production, distribution and use of knowledge and information’. In 1996 OECD called for public policy formation in support of the ‘knowledge–based economy’ implying that innovation will play a key role in determining country’s levels of development and competitiveness.

Thurow suggests that knowledge is the ability to learn to adapt to new situations and change (Thurow, 1996). Kuklinski notes that knowledge is a stimulus to the social and economic development (Kuklinski, 2000), whilst Kozminski’s knowledge management concept sees knowledge as the main source of competitive advantage for modern enterprises (Kozminski, 2005).

Allee (1997) defines knowledge as ‘experience or information that can be communicated or shared’ whilst Argyris (1993) claims that knowledge is ‘a capacity for effective action’. Korzinov and Savin (2018) represent knowledge as a growing network, where agents learn what economic needs they need to satisfy and what technological combinations exist to fulfill those goals, applying their R&D effort accordingly. Johannessen and Olsen (2010) conclude that knowledge has emerged as the strategically most important resource for companies.

Davenport and Prusak (1998) define knowledge as ‘a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information’. Probst defines knowledge management as ‘a set of activities encompassing: knowledge identification, acquisition, development, distribution, preservation and use undertaken by organisations in order to achieve knowledge goals’ (Probst, 1998).

Consequently, economic transformation results in economic competitiveness being less dependent on material resources and more dependent on intangible resources. According to Leadbeater (1999) these days most people in most advanced economies produce nothing that can be weighed; communications, software, advertising, financial services. They trade, write, design, talk, spin and create: rarely do they make anything.

Castells (2000) emphasized that society and its economic relations are no longer primarily based on physical materials. ‘Over the last 40 years we have been witnessing pervasive changes on a global scale, brought about by new technologies, especially ICTs, including the converging set of technologies in micro–electronics, computing (software, hardware and recently, content), telecommunications/ broadcasting, and opto–electronics’ (Castells, 2000).

Castells (2000) believed that the new economy emerged in the 1990s from the United States, and started from information technology, finance, and biotechnology, but Bell (1973) suggested it had happened even earlier, in the 1960s. For Castells (2000), 'technological revolution, centred around information technologies, began to reshape, at accelerated pace, the material basis of society'. According to Chen and Dahlman (2006) it is critical for countries to make the transition to become a knowledge economy since the world economy has become more competitive as well as interdependent with the spread of modern and efficient ICTs.

A knowledge–based economy is one in which all sectors are knowledge–intensive, are responsive to new ideas and technological change, are innovative and employ highly skilled personnel engaged in on–going learning (Smith 2000).

The Organisation for Economic Cooperation and Development (2001) estimated that even before the 21st century, knowledge–based industries, such as high technology goods, high and medium high technology manufacturing and knowledge–intensive services accounted for more than half of major OECD economies' GDP. The term 'knowledge–based' or 'learning economy' describes economies in which the production, distribution and use of knowledge are the main drivers of growth, wealth creation and employment across all sectors of the economy (Organisation for Economic Cooperation and Development, 2001).

Kenway claims that 'the knowledge economy is a contemporary and dominant manifestation of capitalism; it is driven by the production, distribution and consumption of knowledge' (Kenway et al., 2006). The OECD defines nations emerging as knowledge–based economies as 'those where knowledge is the main source of wealth, growth and employment, with a strong reliance on information technologies' (cited in Debowski, 2006).

Despite the general optimism about the new knowledge economy, there was no common agreement among economists, sociologists and futurologists as to how the new economy actually operates in creating wealth and in supporting economic sustainability. For Hawken the key question was 'to understand the changing ratio between mass (i.e. physical resources) and information in goods and services (Hawken, 1983), in other words, the achievement of 'mind over mass' (Gilder, 1989).

The relationship between information and knowledge rests on the difference between 'knowing how' rather than 'knowing that' (Polanyi, 1967). Whereas information can be exchanged, knowledge cannot. Knowledge is also practice–specific. That is, it is something that is contextualised by reference to specific social practices. However, it also pertains to much broader contexts, be they historical, social or institutional.

Within the knowledge economy, knowledge becomes the source of capital, and the new technology becomes the means whereby information and collaboration are organised and accessed (Williams, 2010). The emphasis shifts to processes, knowledge and continuous improvement in increasing effectiveness and enhancing flexible work practices. The entire process demands the creation of new business environments; a work environment that focuses on collaborative processes using shared resources; process models that encompass knowledge mixing and sharing; and the ICT scaffolding that can service these new processes.

Knowledge plays a central role in the development of blockchain technologies, since it requires a specialized knowledge and knowledge sharing due to its distributed technological design, therefore blockchain technologies can only develop in the knowledge economy context, where knowledge sharing is possible globally.

Some authors such as May and Henwood have been sceptical about the notion of a knowledge economy. According to May (2002) the celebration of the information society,

the celebration of the new age, is predicated on the novelty of today. However, this ‘new age’ is neither unprecedented nor necessarily as novel as often presumed (May, 2002). Henwood denies the very existence of a new economy because in his opinion the new economy is only another version of the old economy, which operates in the same rules as before (Henwood, 2004).

Heeks has concerns about how far ICTs can really contribute to economic development. Discussing the ICTs for development trend Heeks (2005) argued that: we are often blinded from this reality by the blizzard of e–development pilots, prototypes, plans and possibilities where 'would' and 'could' replace 'does' and 'has'. This point is also observed within the paradigm of current blockchain technology development trends, when discussions about potential blockchain applications substantially supersedes actual prototypes and working solutions. However, there is already one well–proven area of blockchain technology application such as crypto–currencies and virtual assets, which proves its technological capabilities and suitability within globalized economic environment.

Rodrigues (2002) argues that all societies are knowledge–based – what is new is that ICT are changing the way in which knowledge is accumulated. More and more knowledge is being built into equipment, products and services. Knowledge is increasingly becoming the raw material of work.

Verschuren and Hartog are critical about the trend related to seeking knowledge in modern economy and activities associated with knowledge management calling this process as ‘looking for knowledge in order to look for knowledge’ (Verschuren and Hartog, 2005).

Braverman (1974) emphasises how management had a monopoly over knowledge in the industrial economy, and used it in order to control each step of the labour process and its execution. The organisation and management of work in the industrial age economy was based upon principles founded by Taylor and exploited by Ford. Taylor claimed that control over the labour processes had to pass to management. This was achieved by controlling and dictating each step of the labour process, which ultimately became disassociated from the skills of the worker. Taylorism, as the management process became known, was regarded by Matsushita (1988) as the main drawback in the ability to implement the knowledge economy claiming that only the intellects of all employees can permit a company to live with the requirements of its new environment instead of keeping executives on the one side and workers on the other side as suggested by Taylor.

In the age of globalization and the Internet, it is important to collect, disseminate and promote general knowledge and user education based on the knowledge of others. This concept is intensively used in collaborative efforts of blockchain developers within open–source projects for public blockchains.

A ‘decentralized or distributed knowledge’, can be defined as ‘the potential knowledge of a group, or the joint knowledge they could obtain if they had unlimited means of communication’ (Agotnes and Wang, 2017). Distributed knowledge aggregates the knowledge of each community agent and can be used by a community to solve certain problems. This concept, as such, dates back to Aristotle’s ‘wisdom of the crowd’ concept.

Technology is at the core of knowledge economy, however, economic transformation cannot be driven by technology alone and requires other elements for it to succeed. According to Powell and Snellman (2004), the three essential ingredients of a successful knowledge economy are technology, skills and a highly educated labour force.

Florida (2002) claims that what he refers to as the ‘creative class’, perhaps better conceptualised as a status group, is an important driver of economic growth. According

to Follath and Sprol (2007), this class '. . . is a diverse and colourful group, exemplified by the ability to create ideas that can flow into companies – that will in turn attract return hungry investors with plenty of start–up capital'. They claim that it is divisible into three groups: 'rational innovators', including engineers, scientists and computer experts; a 'creative middle', such as businessmen, advertising people and designers; and then the 'artists', including musicians, actors and painters. The so–called class is held together less by relations to the means of production or income similarities than by the sharing of a common culture.

Williams (2010) notes that since firms increasingly rely on ICT to develop and deliver products and services, they must become more effective through collecting, sharing, disseminating and enhancing corporate knowledge that leads to better products and services, and customer–centric business processes. Rodrigues (2002) claims that in the knowledge based economy the learning, labour and innovation systems will be linked much more intimately.

Innovation at the national level has been identified as driven by networks of public–private sector organisations whose activities and interactions initiate, import, modify, and diffuse new technologies and practices (Organisation for Economic Cooperation and Development, 2001). From the perspective of regions, these networks can be identified as an innovation system or 'innovation milieu', where the flexibility of the space stimulates innovation cycles that benefit the region (Capello, 1999) and advocate the importance of the formation of tacit knowledge (Maillat, 1991; Kogut et al., 1993; Camagni, 1999), therefore close interaction and cooperation is required needed to facilitate collective learning and innovation.

Regional innovation systems (RIS) concept underlines the increasing role of the direct involvement of authorities to stimulate innovation and competition on regional level (Storper, 1995, Landabaso, 1997; de La Mothe & Paquet, 1998; Cooke, 2001). A strong, regionalized innovation system is one that has systemic links between sources of knowledge creation (universities and research organizations), intermediaries (governments and private innovation services) and companies (Cooke, 1995).

Acs (2002) argues that the 'new' growth theory is based on the notion of technological knowledge as a competing, partially foreclosed product, as opposed to the neoclassical view of knowledge as a purely public good. Acs (2002) distinguishes between 'knowledge' and 'technology'. Knowledge is a non–competing product because it can be used by one stakeholder without restricting its use to others. In many cases, technology can be partially ruled out, as it is possible to prevent its use by others through legitimate methods such as patents and trade secrets. Consequently, Acs (2002) concludes that proximity and location matter in accessing knowledge spillovers and notes the importance of innovative regional clusters that fuel economic growth.

Daugeliene and Krisciunas (2006) identified four expressions of knowledge–based economy: human resources, ICT, entrepreneurship and innovation policy.

Romer (1990) identified that technological change arises in large part because of intentional actions taken by people who respond to market incentives whereby new knowledge is translated into goods with practical value.

The new technology, together with a growing complexity within an integrated system, does enhance the increasing use of information that can be transformed into knowledge. This expansion in knowledge intensity within the socio–economic system, according to Porter (1990), is accompanied by the importance of rapid learning. He argues that competitiveness involves enhancing the capacity to learn, including learning to learn. Where neo–classicists treated learning as involving the flow of information into the memory banks of the individual, Hayek (1948) was the one who insisted that information

was always perceived through the cognitive framework. This constituted a break from the empiricist conceptions of knowledge. Hayek also placed considerable emphasis on tacit knowledge.

Nonaka and Tekuchi (1995) maintain that thinking of knowledge as tacit provides the basis for a new way of thinking about innovation, which now becomes an individual process of what they call 'personal and organisational self–renewal'. Viewing innovation as the means whereby the world is recreated according to an ideal or vision, they claim that this involves recreating the entire organisational framework of companies, as well as the employees. Since learning changes a range of attributes including preferences, goals, capacities, skills and values, the individual is in a constant process of self–reformulation. Hence, we have the notion of 'lifelong learning'. More importantly, perhaps, this undermines the orthodox approaches to welfare economics that views the individual as given and constant. It is this process of reconstituted development that is the groundbreaking feature of the knowledge economy.

The organization of knowledge within a certain space is what is called a 'knowledge hub' where knowledge intensive organisations in private and public secotrs are located, such as universities and research institutes (Turpin et al., 2002).

Senge (1999) describes learning organisation as an organisation, where 'people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free and where people are continually learning how to learn together'.

Learning is the process whereby knowledge becomes known (Williams, 2010). This involves far more than the sequential accumulation of codifiable knowledge. As a feature of human experience, learning reconstitutes the individual (Hodgson, 1999). That is, learning involves far more than encountering information, and focuses on the reconstitution of individual capacities. This now is viewed as a continuous process. Consequently, unbeknown to the individual, she holds a vast repository of knowledge that is constantly dynamic, but which, simultaneously, must be capable of being shared with others. Shared knowledge and shared meaning assume a central importance for any economy. It is in this sense that knowledge is conceived of as an economic good. The argument shifts towards the intensification of knowledge, and to an emphasis on knowledge–intensive industries, and knowledge based organisations. Learning plays a central role, and the development of organisational structures that accommodate learning is paramount. Investment in knowledge generation and knowledge management is also important. This leads to an enhanced interest among policy makers in the role of institutional frameworks set by product market regulation, in science–industry links and in rethinking the basis for organisational innovation and management quality. Evidence indicates that high knowledge investment economies tend to pull away from the rest.

Within the knowledge economy, the process of work and the associated practices change. The emphasis in industrial age economy on information hoarding, command and control thinking, and departmental competition that escalates costs and subtracts value from goods and services yields to new ways of working. According to Williams (2010) within the competition for markets, profits and growth, organisations must be committed to information sharing, flexible processes, continuous improvement and new work styles. Thus, collaboration, knowledge sharing and organising around customer–centred processes will be evident.

Knowledge creation and sharing nowadays are closely connected with intellectual property rights (IPRs). The original motive of IPRs arose in the 17th century from Locke's suggestion that only through rewarding intellectual labour would human beings try to improve the world (cited by Moore, 1997). By withholding the use of intellectual

properties for a temporary period, IPRs create, a short–term monopoly over certain uses of a work and thereby, a limited scarcity in relation to the properties. The limited time of protection of IPRs was to ensure that on the one hand, those who could use knowledge objects most efficiently could secure an appropriate reward for such usage, on the other hand, by ensuring the transfer of knowledge to the most efficient users, the public good was maximized along with the totality of social welfare.

The IPRs regime makes ideas artificially scarce so that they can be given a price as material goods. Publishers and manufacturers prevent knowledge objects from unlicensed copy in order to reinforce the scarcity and maximize revenues from monopoly rights. TRIPS artificially protects the scarcity and maximizes returns by a constructed monopoly (May, 2000). However, intellectual properties are non–rivalry capitals. Goods are called 'non–rival' if their consumption by one person does not diminish its availability for use by any other person (Romer, 1990). In other words, an intellectual property can produce infinite copies. The real trick is here, with a marginal cost of reproduction almost as low as non–existent, an intellectual property, such as a software package or an information service, can be sold for as long as, and at as high a price as the IPRs jurisdictions can extend and permit.

In reality, the right of the direct creator of intellectual property is seldom highlighted in IPRs. The TRIPS agreement favours the right of knowledge of owners over the right of knowledge of creators (May, 2000). In employment contracts, the ownership of the employers is well established so that 'first to convey to the employer any rights the employee or independent contractor may have in specific copyrights, patents, trade secrets or trademarks' (Little & Trepanie, 1997), meaning that the ownership and control relations pertaining to society's productive assets and key resources, a major component of Marx's and Engel's (1954) relations of production, remain in the hands of the capitalist.

The talk on IPRs was initiated in the Uruguay Round by multinational corporations in the pharmaceutical and IT industries which claimed huge losses due to inadequate protection of their property overseas (Jawara & Kwa, 2003). The emergence of IPRs is firstly in the interest of specific groups in society: those who possess such resources can utilize it to accumulate more resources and the dominant discourse of IPRs is defined by the dominant actors. Maskus (2000) argued that the globalization of intellectual property really only benefited the US, the world's biggest net IPR exporter, and to a lesser extent the EU. It is the US and the EU that have the world's dominant software, pharmaceutical, chemical and entertainment industries and the world's most important trademarks. When TRIPS was negotiated, only 1% of 3.5 million patents belonged to the developing nations who were in the position of being importers of intellectual goods and services (Nguyen, 2010).

Although many blockchain solutions develop as open–source, some developers obtain IPRs through patents, which also proves that blockchain technology is knowledge intensive, unprecedented and may become a foundational technology for future technological developments and a new era of Internet, where value will be exchanged online instead of information.

Depending on the research object the level of knowledge economy can be assessed by individual statistical metrics. Daugeliene (2006) divides knowledge economy assessment models in two groups:

- comprehensive (when the common situation of knowledge economy is evaluated on the basic ground), and
- sectoral (when assessment of knowledge expression is issue oriented).

Indices compiled by international organizations can also be a good indicator for assessment of overall knowledge economy development in different countries.

The Information Society Index (ISI) was developed in the mid–1990s by International Data Corporation as the world's first measure of the ability of 53 nations to participate in the information revolution. The index and sub–indexes establish a standard by which all nations are measured according to their ability to access and absorb information and information technology with 15 variables arranged in four infrastructures to calculate and rank nations in one overall index and four sub–indexes (*The Information Society…,* [n.y.]):

- Computer Index
- Telecom Infrastructure Pillar
- Access, usage and utilization of Internet
- Social factors.

The Global Competitiveness Index (GCI) compiled by the The World Economic Forum measures national competitiveness – defined as the set of institutions, policies and factors that determine the level of productivity, which in turn sets the level of prosperity that the economy can achieve. These indicators are grouped into 12 pillars:

- Institutions
- Infrastructure,
- ICT adoption,
- Macroeconomic stability,
- Health,
- Skills,
- Product market,
- Labour market,
- Financial system,
- Market size,
- Business dynamism,
- Innovation capability.

The United Nations uses two key indicators in its E–government surveys.

E–government–development index (EGDI) is used to measure the readiness and capacity of national administrations to use ICT to deliver public services consisting of:

- Telecommunication Infrastructure component;
- Online Service component, and
- Human Capital component.

E–Participation Index (EPI) measures e–participation according to a three–level model of participation that includes:

- e–information – provision of information on the Internet;
- e–consultation – organizing public consultations online; and
- e–decision–making – involving citizens directly in decision processes.

The European Commission uses four key indicators in its E–government benchmark studies:

- User Centricity benchmark assesses the availability and usability of public e–services and examines awareness and barriers to use.
- Transparent Government benchmark evaluates the transparency of government authorities' operations and service delivery procedures and the accessibility of personal data to users.
- Cross Border Mobility benchmark measures the availability and usability of cross border services.
- Key Enablers benchmark assesses the availability of key enablers such as Single Sign On and eID functionalities.

EU Digital economy and society index (DESI) is a composite index that summarises relevant indicators on Europe's digital performance and tracks the progress of EU Member States in digital competitiveness (*The Digital Economy…*, [n.y.]). DESI components:

- Connectivity – Fixed Broadband, Mobile Broadband, Broadband speed and Affordability;
- Human Capital – Basic Skills and Usage, Advanced skills and Development;
- Use of Internet – Content, Communication and Online Transactions;
- Integration of Digital Technology – Business digitisation and e–commerce;
- Digital Public Services – e–government.

The Knowledge Index (KI) is an economic indicator prepared by the World Bank Institute to measure a country s ability to generate, adopt and diffuse knowledge. Methodologically, the KI is the simple average of the normalized performance scores of a country or region on the key variables in three Knowledge Economy pillars:

- Education and human resources
- Innovation system
- ICT.

Knowledge Economy Index (KEI) is an aggregate index prepared by the World Bank Institute representing a country's or region's overall preparedness to compete in the Knowledge Economy. The KEI is based on a simple average of four sub–indexes, which represent the four pillars of the knowledge economy:

- Economic Incentive and Institutional Regime
- Innovation and Technological Adoption
- Education and Training
- ICT Infrastructure.

In author's view activity in cryptocurrency markets and initial coin offerings, (ICOs) or token sales as a new way to raise funds by 'virtual' organizations are indicators for DLT diffusion level and knowledge economy development on a global scale, since the use of cryptocurrencies and investments in ICOs require a certain level of knowledge. In this context there are two main components to be monitored:

- Exchange and transaction activity with cryptocurrencies
- Amount of investments in ICOs.

The Human Capital Index (HCI) database provides data at the country level for each of the components of the HCI as well as for the overall index, disaggregated by gender. The index measures the amount of human capital that a child born today can expect to attain by age 18, given the risks of poor health and poor education that prevail in the country where she lives. It is designed to highlight how improvements in current health and education outcomes shape the productivity.

The Human Development index (HDI) was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone. The HDI can also be used to question national policy choices, asking how two countries with the same level of GNI per capita can end up with different human development outcomes. These contrasts can stimulate debate about government policy priorities. The HDI is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions.

### 1.3. Blockchain technology assessment within the concept of innovation/ *Blokķēdes tehnoloģijas izvērtējums inovācijas koncepcijas ietvaros*

Taking into account that blockchain technology is a new technological phenomenon it can be classified as innovation, therefore it is important to look at it from the innovation theory perspective.

In economic theory and practice, the term 'innovation' was introduced by the economic scientist Joseph Schumpeter. In his book 'Theory of Economic Development' (1912), he first identified innovation as a 'new combination', which means a different quality of production being achieved not discreetly by small improvements to old equipment or existing organizational charts, but through the introduction of new means of production and systems within the organization.

Schumpeter (1912, 1939, 1943) described development as historical process of structural changes, substantially driven by innovation. He divides the innovation process into four dimensions: invention, innovation, diffusion and imitation. Then he states that **dynamic entrepreneur**, who draws upon the discoveries of scientists and inventors, create completely new opportunities for investment, growth and employment.

To explain the mechanism of entrepreneurial cycles, Schumpeter uses the concept of 'innovation', defining it as a new function of production and proposes differentiation by five major types of innovation:

- production of a new product or product with qualitatively new properties (product innovation);
- the introduction of a new means of production, based on a new scientific discovery or a new one approach to commercial use of products (technological or process innovation);
- development of a new market, no matter has this market existed before or not (marketing innovation);
- attracting new sources of raw materials, whether or not they existed before (raw innovation);
- introduction of new organizational forms (organizational innovation).

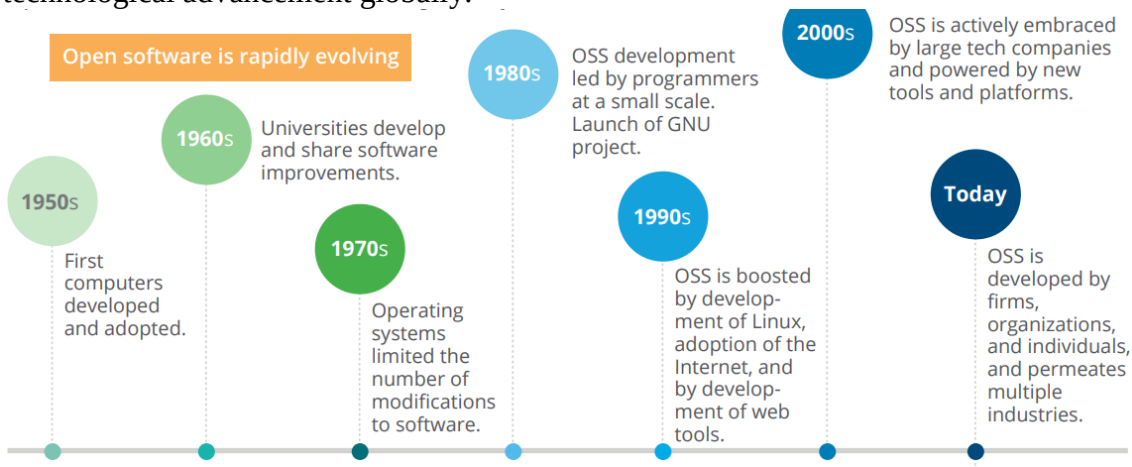
According to Schumpeter, economic development is always gradual and uneven in nature and constantly experiencing difficulties in its path. Therefore, the state of market equilibrium is only a theoretical construction, since competition is a constant 'process of creative destruction', in which new and qualitatively better technologies and the products produced by them supersede outdated technologies and goods. The history of capitalism is a history of creative destruction, according to Schumpeter.

Schumpeter is convinced that economic growth and development itself can only be explained by the successful activities of the innovators. These new inventions multiply productive forces and make economic progress possible. The innovative potential of enterprises is the internal potential of social development. Neither demand–side improvements, nor supply–side shifts, nor cyclical, financial, or tax–related government regulation can trigger an economic boom. Only innovations from entrepreneurs can make real profits, only they become the sources of a new economic boom, which creates a new wave of innovation. In this regard, blockchain technology can certainly be regarded as technological or process innovation according to Schumpeter's classification, which also boosts subsequent product innovations.

In Schumpeter's theory, the possibility and activity of the entrepreneurs, drawing upon the discoveries of scientists and inventors, create completely new opportunities for investment, growth and employment. With blockchain technology, entrepreneurs and public authorities are currently drawing upon various blockchain open–source solutions

developed and tested by communities of innovative technology developers, instead of scientists, however the first implementation of blockchain technology in Bitcoin relied on such scientific concepts as Nick Szabo's concept of smart contracts (1997), Adam Beck's cryptographic 'HashCash' technology (1997) and Hal Finney's reusable proof of work concept (2004). By now, there are 66 thousand different blockchain repositories on Github (*Blockchain Repository Results*, 2020), the world's leading open–source software development platform, clearly displaying its popularity among technology developers.

Figure 1.6. demonstrates the evolution of open–source software facilitates collaborative approach to development of technologies and significantly contributes to technological advancement globally.




*Source: Deloitte, 2017c*

Fig. 1.6./ *1.6. att.* **Evolution of open source software/** ***Atvērtā pirmkoda programmatūras attīstība***

Research can be defined as the conversion of money to knowledge, whereas innovation is the conversion of knowledge to money (Roos, 2016). Galanakis (2006) also concludes that the successful diffusion of the new product or process is required in order for it to be characterised as an innovation. The macroeconomic effects of any basic innovation are hardly noticeable in the first few years (and often even longer). What matters in terms of economic growth, investment and employment, is not the discovery of basic innovation, but rather the diffusion of basic innovation, which is the period when imitators begin to realize the profitable potential of the new product or process and start to invest heavily in that technology (Freeman, 1987).

Porter describes innovation as (1990) a new way of doing things that is commercialised. Galanakis (2006) defines innovation as the creation of new products, processes, knowledge or services by using new or existing scientific or technological knowledge, which provide a degree of novelty either to the developer, the industrial sector, the nation or the world and succeed in the marketplace. Lundvall (1992), Porter (1990), Freeman and Soete (1997) and Stoneman (1995) found that innovation is a major contributor to growth in economic welfare over time.

The term innovation has been used in the literature to describe both the process that uses new knowledge, technologies and processes to generate new products as well as the new or improved products themselves (Porter, 1990). Systems of innovation theory developed in the 1980s and the 1990s relates the policy of innovation players to the ability of firms to innovate which in turn affects the wealth of a nation (Sundbo, 1998; Edquist, 1997). The theory also tries to identify the social and economic effects of the process that creates innovation and the actors that affect this process across a nation. The literature of national systems of innovation focuses on the flow of knowledge at a personal, regional

or national level. This knowledge flow includes institutional interaction between the actors of the system such as, firms, universities, research institutes, governments and their staff; political support from governments in areas such as, legislation, finance and infrastructure development; market characteristics, for example, size and sophistication and, enterprise activities, such as, investment in new technology, in–house research and NPDD processes (Edquist, 1997; Organization for Economic Cooperation and Development, 1997, 1999; Lundvall, 1992; Nelson, 1993).

A region oriented on the implementation of innovations will always be a 'learning' region. According to Florida (1995), who created the term of a ‘learning’ region, a region of this type gets similar to a ‘learning enterprise’, that is introduces improvements, new solutions, upgrades its organisation structure. As some experts think, in 'learning' regions knowledge is generated in a society thanks to mutual cooperation. It is practical knowledge and always connected with current requirements. Scientific and research units and specialists representing various sciences take part in the process of knowledge generation. Competitive regions can only be the regions in which authorities and entrepreneurs can properly interpret the requirements of economy and use their knowledge in order to develop and modernise economy.

Johannessen and Olsen (2010) believe that individualized immediate feedback, a new organizational logic, and new cooperation structures are the mechanisms that initiate, sustain, and reinforce social–change processes, and that enhance innovation and the value–creation process within the global knowledge economy.

The concept of digital economy has emerged in 1990s. Tapscott (1997) extensively described the digital economy phenomenon in his book ‘The Digital Economy: Promise and Peril in the Age of Networked Intelligence’, focusing on the Internet’s transformational aspects for business models. Nowadays, blockchain technology has the similar transformational effects on economic and business models based on distributed ledger technology, cryptography and smart contracts, all being digital computer technologies. The Organisation for Economic Cooperation and Development (2019a) identifies blockchain technology as a digital enabler for sustainable infrastructure.

Mesenbourg (2001) identified three main components of the ‘Digital Economy’:

- e–business infrastructure (hardware, software, telecoms, networks, human capital, etc.),
- e–business (how business is conducted, any process that an organization conducts over computer–mediated networks),
- e–commerce (transfer of goods and services).

With the development of digital economy, the competition is becoming more global as transactions facilitated through Internet have become widespread and can connect different part of the worlds in seconds.

Digital economy mostly deals with the ordering and fulfilment of transactions by using computing technologies. This could include algorithms and systems; therefore, a blockchain technology naturally fits this framework. For example, a part of the digital economy would be buying groceries, clothes, and other things online. However, in a knowledge–based economy, knowledge or know–how is the commodity. Most often, knowledge–based economy are also digital already but it is not a requirement. Example would be medical tourism (where the best care is available at a certain city), or where a city’s labourers are more sought after because of their expertise compared to other labourers this could range from blue–collared work like carpentry to farming to machine operation to white collar office work or creative arts.

In reviewing human history from the agrarian age to the so–called postmodern age, historians have recorded at least three major changes in the world’s means of production:

the invention of the steam engine, the invention of electricity, and most recently, developments in ICTs such as telephone, mobile telephony and Internet (Nguyen, 2010). All of these new inventions can be characterized as 'general purpose technologies' (GPT). Lipsey et al. (2005) define GPT as a single generic technology, recognisable as such over its whole lifetime, which initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many spillover effects. GPT were introduced as one of the forces to explain economic growth and its cyclicality (Bresnahan and Trajtenberg, 1995; Bresnahan and Yin, 2010; Syverson, 2013).

Keane (2017) argues that General Purpose Technologies have three important characteristics that set them apart from other innovations, their ability to improve, widely penetrate markets and generate innovations, suggesting that blockchain technology is indeed a General Purpose Technology. Blockchain technology is viewed as a general–purpose technology by numerous researchers due to its disruptive nature and possible transformative applications for transaction implementation and data exchange in both private and public sectors (Yli–Huumo et al., 2016; Janssen et al., 2017). Davidson et al. (2018) also describes blockchain technology as an institutional technology due to its interaction with regulatory frameworks and introduction of new ways of governance and economic coordination. Iansiti and Lakhani (2017) sees blockchain as a foundational technology as it can potentially create new foundations for economic and social systems.

Golding (2000) divided technologies into two types: 'Technology One' makes existing social actions and processes occur more speedily, more efficiently, or more conveniently, for example in management processes or in communication. 'Technology Two' impacts comprise new forms of activity, which were previously impracticable, or even inconceivable. In the author's view however, Golding's classification is not much different from Marx's distinction between 'a new use for well–known use–values' and 'discovery of new use–values' (Marx, 1969).

May (2002) claims that ICTs are mistakenly seen as a Technology Two because ICTs 'lack of a manifest revolutionary effect requires the identification of a truly transformative information age to be constantly presented as a forthcoming development, as it frequently is'. Whether that might be true for certain ICTs, in author's view, blockchain has the capacity to enable new forms of activity which never existed before, such as micro transactions, safe exchange of sensitive information and new ways of interaction between individuals, institutions and businesses. In this sense, a distributed nature of blockchain technology is truly a revolutionary concept to ensure transparency, security and immutability. Thus, blockchain technology can be seen as a 'Technology Two' as defined by Peter Golding.

Blockchain technology is closely connected with e–commerce, as it facilitates transactions through Internet. E–commerce is traditionally classified according to the agents that interact, involving governments, consumers and business which are often categorised as acronyms: business–to business (B2B), business–to–government (B2G), or business–to–consumer (B2C) (Thatcher, Foster & Zhu 2006).

Dyatlov et al. (2019) argues that the blockchain technology is a fundamental innovative technology within the modern global economy that offers new ways of recording transactions, events, certificates and access rights.

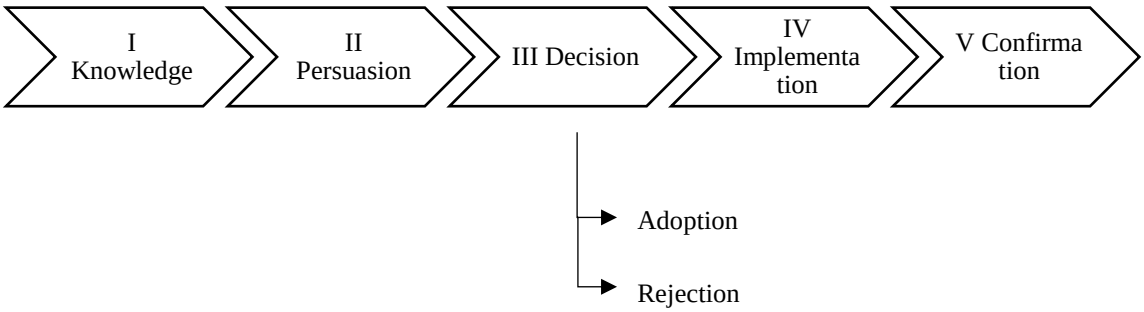
## 1.4. Analysis of innovation diffusion and technology adoption theories in the context of blockchain technology/ *Inovāciju izplatības un tehnoloģiju ieviešanas teoriju analīze blokķēdes tehnoloģijas kontekstā*

### 1.4.1. Diffusion of Innovations theory (DOI)/ *Inovāciju izplatības teorija*

The French sociologist Gabriel Tarde (1890) and German and Austrian anthropologists such as Friedrich Ratzel and Leo Frobenius first studied the concept of 'diffusion of innovation'. In 1962, Everett Rogers, a professor of rural sociology at Ohio State University, published a book 'Diffusion of Innovations'. In his book, Rogers synthesized studies from more than 508 studies on diffusion and created a theory of innovation among individuals and organizations. The origin of the theory of diffusion of innovation is diverse and has its sources among several sciences. Rogers (1962) identifies six main sources that influenced the research on the diffusion of innovations: anthropology, early sociology, rural sociology, education, industrial sociology and medical sociology.

Diffusion of innovations is a theory that seeks to explain: how, why, and at what speed new ideas and technologies spread across different cultures (Rogers, 2003). Rogers defines diffusion as 'the process by which innovation (for example, new ideas, processes or products) is transmitted over time through certain channels among members of social systems'.

Rogers (1995) described the process of innovation decision–making as 'an information–seeking and information–processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation, involving five steps as demonstrated by the figure 1.7.



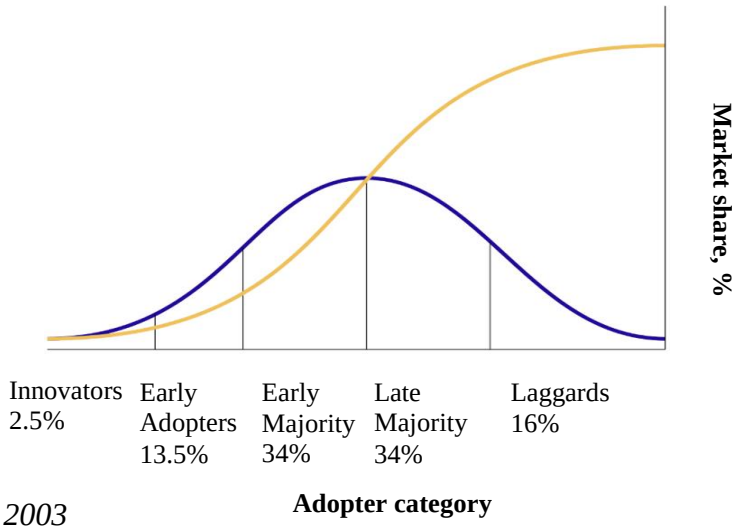

*Source: Rogers, 1995*

Fig. 1.7./ *1.7. att.* **Model of Five Stages in the Innovation–Decision Process/** ***Piecu posmu modelis inovāciju lēmumu pieņemšanas procesā***

According to Rogers (2003) two factors determine the type of innovative solution: whether the decision is made freely and carried out voluntarily and who made the decision. Based on these considerations, within the diffusion of innovations, three types of innovative solutions were identified (Rogers, 2003):

- Voluntary innovative solution – This decision is made by an individual who is somehow different from other people in the social system.
- Collective innovative solution – This decision is made collectively by all persons of the social system.
- Imperious innovative solution – This decision is not made by the social system, but by a group of people with influence or power.

Within his diffusion of innovations theory Rogers (2003) depicted an adoption curve of innovation diffusion process, which follows an S shape (see figure 1.8).



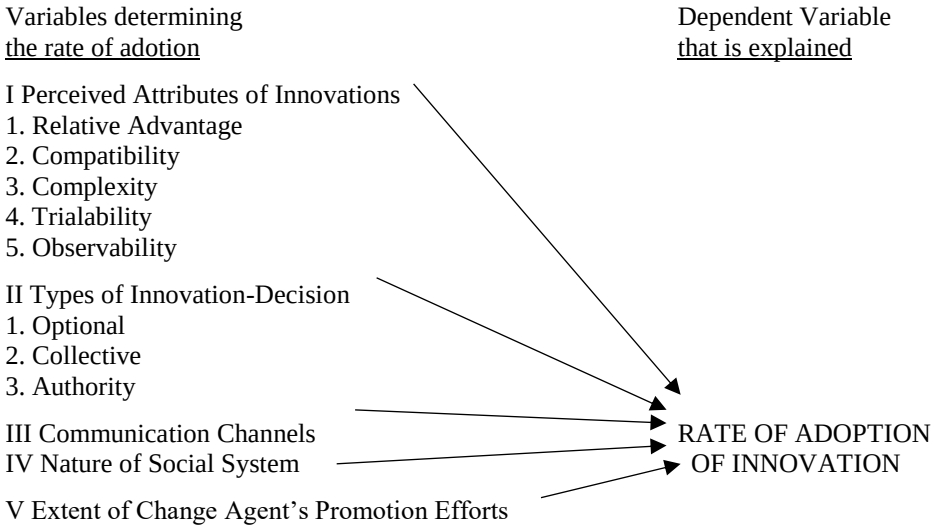

*Source: Rogers, 2003*

Fig. 1.8./ *1.8. att.* **Adoption process of innovation diffusion/** ***Inovāciju izplatīšanas pieņemšanas process***

Rogers (2003) has also identified five perceived attributes of innovations:

- Relative advantage – the degree to which an innovation is perceived as being better than the idea it supersedes.
- Compatibility – the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters.
- Complexity – the degree to which an innovation is perceived as relatively difficult to understand and use.
- Trialability – the degree to which an innovation may be experimented with on a limited basis.
- Observability – the degree to which results of an innovation are visible to others.

Based on the variables described above, Rogers (2003) has outlined a model of Diffusion of Innovations defining the rate of adoption of innovation as a dependent variable (see figure 1.9).




*Source: Rogers, 2003*

Fig 1.9./ *1.9. att.* **Model of Diffusion of Innovations/** ***Inovāciju izplatīšanas modelis***

Based on the works of Rogers (1962), Tornatksky and Klein (1982) and the PhD thesis of Moore (1989), Benbassat and Moore (1991) developed a tool for measuring an individual's perceptions of personal computer workstation adoption, making it adaptable to all innovations, even though it was particularly suited to information technology. The final tool consisted of 34 subjects with eight scales:

- relative advantage,
- compatibility,
- ease of use,
- demonstrability of results,
- visibility,
- trialability,
- voluntariness,
- image.

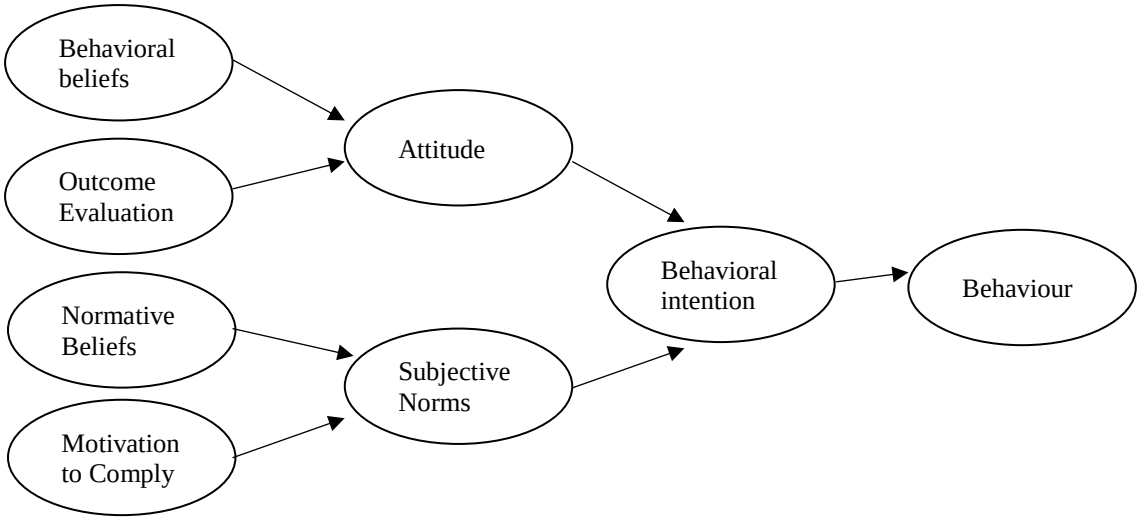
The first six characteristics are from Rogers (2003), and 'observability' is divided into 'demonstrability of results' and 'visibility'. 'Voluntariness' was defined as 'the degree to which innovation is perceived as voluntary or of free will'. The 'image' was defined as 'the degree to which use of an innovation is perceived to enhance one's status in one's social system.

It was revealed that the emergence of any advanced technologies, sociocultural and other innovations requires solving the issue of their social perception as a fact of their viability within the society and the trajectory of its development. In addition, Roger's diffusion of innovations theory has already been adapted to study the adoption of ICTs. Therefore, the theory of Diffusion of innovations (Rogers, 1962, 1995, 2003) is certainly applicable for the study of blockchain adoption. It is important to identify the location of blockchain technology solutions on an adoption curve of innovation diffusion process, in order to understand the extent of blockchain technology adoption and potential timeframe to mass adoption. For TCP/IP protocol, it took more than 30 years to go through various phases involving single use, localized use, substitution, and transformation (Iansiti and Lakhani, 2017).

### 1.4.2. Theories of Reasonable Action and Planned Behaviour/ *Saprātīgās rīcības un plānotās uzvedības teorija*

The most commonly cited and recognized behavioural predictor is Fishbein and Ajzen's (1975) Theory of Reasonable Action (TRA). The theory is based on the principle that people in their actions are based on ideas and acceptable information, and not on logical justification. The theory establishes that the behavioural intentions of the personality are usually the most adequate predictors of how a person will behave and, in turn, behavioural intentions can be predicted if there is knowledge about the attitudes and ideas that relate to them.

In particular, the behavioural intentions for the implementation of a certain kind of behaviour (for example, the choice of a particular specialty for training) represent the function of two factors: personal attitudes of the person regarding behaviour and the subjective norm associated with other people's ideas about how it should be done in such situations, which are in turn influenced by behavioural beliefs, outcome evaluation, normative beliefs and motivation to comply (see figure 1.10).




*Source: Ajzen and Fishbein, 1975*

Fig. 1.10./ *1.10. att.* **The theory of reasonable action/** ***Pārdomātās rīcības teorija***

Each of these factors is calculated according to the model of the value of expectations – which involves combining a number of characteristic representations of realized probability (or expectations) compiled in value terms (the realized value of the result for the individual (Ajzen & Fishbein, 2009). Thus, an individual's attitudes regarding behaviour combine behavioural representations (ideas about the consequences of actualizing behaviour), each of which is composed of personal assessments of possible consequences. Attitude is the sum of these kinds of compounds. Similarly, a subjective norm is created that is deduced from normative ideas (ideas that significant others can think about how to act in such situations), each of which is determined by the person's motivation to subordinate significant others. The result of this kind of elimination is the subjective norm.

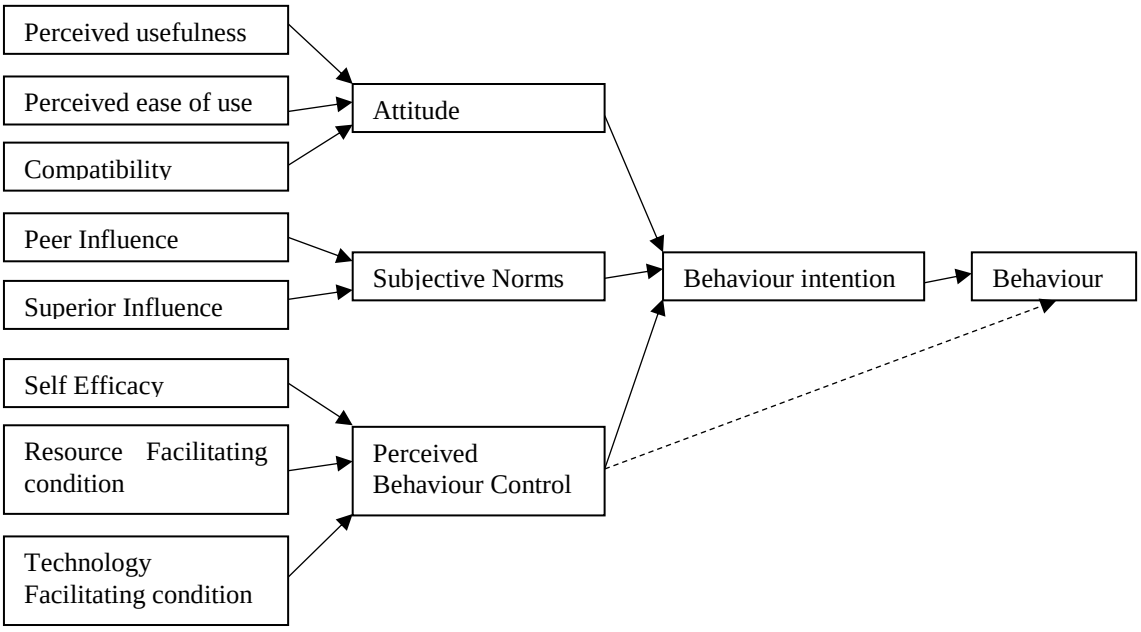
Connecting to the attitudes as the basis for predicting the expectations of the subject in relation to the result, its subjective significance or value, normative ideas and their significance or motivation for submission certainly expands the possibilities of more adequate forecasting, but does not exhaust all the problems. Firstly, the problem of matching expectations with what will happen in reality is not being solved, because the situational context can change significantly (Ajzen & Fishbein, 2009). Secondly, in assessing expectations, there is still an essential element of hypothetics. Thirdly, it is necessary to take into account both the dynamics of the personality itself and the situational context, which are very difficult to predict and can act as trends. Nevertheless, as a definite new step in the study of the problem of forecasting behaviour changes, this model is of interest.

The theory of planned behaviour is a theory that links beliefs with behaviour. The concept was proposed by Ajzen (1991) in order to increase the predictive ability of the theory of justified action by introducing a factor of perceived behavioural control. A theory of planned behaviour is a theory that explains human behaviour. It is used in studies of the relationships between beliefs, relationships, behavioural intentions, and behaviour in various fields, such as advertising, public relations, advertising campaigns, and healthcare (Ajzen, 1991). According to this theory, attitudes, subjective norms, and perceived behavioural control in combination form behavioural intentions and individual behaviour.

Regulatory belief – an individual's perception of socio–normative pressure or the beliefs of significant others regarding the fact that the individual should or should not implement such behaviour. A subjective norm is the individual's idea of a specific behaviour that is influenced by the judgment of significant others (for example, parents, spouse, friends, teachers). Controlling beliefs – the beliefs of the individual about the presence of factors that can contribute to or impede the implementation of behaviour. The concept of perceived behavioural control is conceptually related to the concept of self–efficacy. Perceived behavioural control – perceived by the individual ease or complexity of the implementation of a certain behaviour. It is assumed that perceived behavioural control is determined by the general set of available controlling beliefs. Behavioural intention is a factor that testifies to an individual's readiness to realize a specific behaviour (Ajzen, 1991).

Ajzen (1991) argues that human behaviour is determined by three factors: 'behavioural beliefs,' 'normative beliefs,' and 'controlling beliefs.' Given all relevant aspects, 'behavioural beliefs' create a favourable or unfavourable 'attitude toward behaviour', the result of 'normative beliefs' is a 'subjective norm', and 'controlling beliefs' give rise to 'perceived behavioural control'. In particular, it is assumed that 'perceived behavioural control' influences actual behaviour not only directly, but also indirectly through behavioural intention. As a rule, the more favourable the attitude to behaviour and the subjective norm and the greater the perceived behavioural control, the stronger the person's intention to implement a certain behaviour should be (Ajzen, 1991). Ultimately, given a sufficient degree of actual control over behaviour, it is assumed that when opportunities arise, people should realize their intentions.

As demonstrated by the figure 1.11., by incorporating the 'perceived behaviour control' factor, a theory of planned behaviour can explain the relationship between behavioural intentions and real behaviour.




*Source: Taylor and Todd, 1995*

Fig. 1.11.*/ 1.11. att.* **The decomposed theory of planned behaviour/ *Sadalītā pārdomātās rīcības teorija***

In addition, considering the 'social norm' as an important variable, the theory of planned behaviour and theory of reasonable action can explain social behaviour. The concept of social influence is determined by the social norm and normative belief, both

in the theory of reasonable action and in the theory of planned behaviour. The developed thoughts of individuals regarding subjective norms are an idea of whether friends, family and society expect them to realize the recommended behaviour (Ajzen, 1991). Social influence is measured by evaluating various social groups.

In studying blockchain technology adoption, behavioural intentions are certainly important and factors influencing those intentions such as subjective norms and attitudes must be considered, specifically any influence and opinions of various stakeholders involved in blockchain ecosystem.

### 1.4.3. Technology Acceptance Models/ *Tehnoloģiju pieņemšanas modeļi*

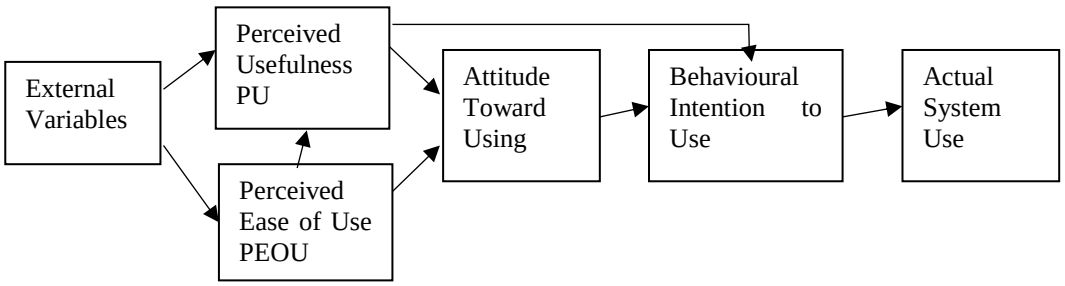
Technology acceptance model theory is one of the most influential extensions of Ajzen's and Fishbein's (1975) theory of reasonable action (TRA) in the literature to study user acceptance and use of technology. TAM replaces many measures of spatial position of TRA with two attributed – ease of use and usefulness. TRA and TAM, both of which have strong behavioural elements, supposing that when someone forms an intention to act, that they will be free to act without restriction. In the real world, there will be many restrictions, such as restrictions on the freedom to act (Bagozzi, Davis & Warshaw 1992).

The following variations of Technology Acceptance Model are extensively used to study technology adoption process:

- Technology Acceptance Model (TAM) (Davis, 1989),
- Technology Acceptance Model (TAM 2) (Davis & Venkatesh, 2000),
- Technology Acceptance Model (TAM 3) (Bala & Venkatesh, 2008).

Technology Adoption Model (TAM) is an information systems theory, a model of how users come to accept and use technology (Davis, 1989). As demonstrated by the figure 1.12., the model assumes that when users are presented with new technologies, a number of factors affecting their decision about how and when they will use, in particular:

- Perceived usefulness (PU) – 'the degree to which a person believes that using a particular system will help increase his or her job productivity'.
- Perceived ease of use (PEOU) – 'the extent to which a person believes that using a particular system will be free from effort'.




*Source: Davis (1989)*

Fig. 1.12./ *1.12.att.* **Technology acceptance model/** ***Tehnoloģiju pieņemšanas modelis***

TAM has been continuously explored and extended by two major updates being TAM 2 (Davis & Venkatesh 2000) and TAM 3 (Bala & Venkatesh, 2008). Both models are visualized in Annex 1. TAM 2 introduced several constructs influencing PU – image, job relevance, output quality, result demonstrability and subjective norm. In addition, experience and voluntariness were added directly influencing intention to use. TAM 3 was proposed in the context of electronic commerce with the inclusion of trust effects and the perceived risk of using the system (Bala & Venkatesh, 2008). TAM 3 introduced several constructs influencing PEOU – computer self–efficacy, perceptions of external control, computer anxiety, computer playfulness, perceived enjoyment and objective

usability. Although these are important factors in analysing the adoption of information technology on user level, current research is focused on macro level, therefore the most relevant factors for analysing blockchain technology adoption in the national economy would be subjective norm, experience and voluntariness.

Bagozzi, Davis & Warshaw (1992) argue that since new technologies such as personal computers are complex and there is an element of uncertainty in the minds of decision–makers regarding their successful adoption, people form attitudes and intentions in relation to trying to learn to use new technologies before starting using it. Attitudes toward use and intentions to use may be poorly formed or lack of conviction, or else it can only happen after preliminary searches to learn how to use technology to evolve. Thus, actual use cannot be a direct or immediate consequence of such views and intentions (Bagozzi, Davis and Warshaw, 1992)

Earlier research on diffusion of innovation also suggested a prominent role for perceived ease of use. Klein & Tornatzky (1982) analysed adoption, finding that compatibility, relative advantage, and complexity were the most significant relationships with adoption in a wide range of innovations.

Collerette et al. (2003) suggest that TAM needs to be expanded to include variables, counting for change processes and this can be achieved by integration Rogers' (1995) DOI theory's constructs in TAM – relative advantage, trialability, complexity, compatibility and observability.

### 1.4.4. Framework for studying blockchain adoption/ *Blokķēdes tehnoloģiju ieviešanas pētījuma struktūra*

The TOE framework was proposed by Fleischer & Tornatzky (1990) and considers the impact of technology (technology accessibility and its characteristics), organizational (size, complexity of the managerial structure, communication process, and the availability of resources at the company) and external factors (industry characteristics, market structure, information infrastructure, government regulation). This concept is an effective approach to the study of factors influencing the adoption of innovation, as it offers directions for the classification of factors. Within this classification, the category of technological factors may include the perceived characteristics of innovation, as well as the relevance of the innovation to the company's objective. To assess external influence, the concept is combined with institutional theory, to assess the impact of the institutional environment of the organization, which has a significant impact on the structure and actions of the company. According to institutional theory, decisions of companies are made not only in accordance with the goal of achieving efficiency, but also under the pressure of the need to correlate their actions with the rules and regulations adopted in the industry. Three types of institutional influence are distinguished: forced, imitative, and normative pressure (Fleischer & Tornatzky, 1990). The dominant organizations (the parent company, state regulatory authorities and other organizations on which the company depends) exert pressure on the company, forcing the company to act in its own interests. Imitative pressure forces companies to adopt the practices and innovations of other organizations, regardless of their technological value, in order to comply with industry standards. This type of pressure over time leads to the fact that companies of the same industry become more similar to each other. Regulatory pressure suggests that all actions of the company must comply with the rules and regulations adopted by members of the social community of the industry.

Various theories are combined in research. An example is the integration of DOI theory and institutional theory within the framework of the TOE concept. In addition, a modified model of technology adoption and the theory of planned behaviour are often

combined when analysing the behaviour of both companies and employees of organizations. Elements of the theory of diffusion of innovation (characteristics of innovation and innovativeness) are also added to the model of technology adoption and the theory of planned behaviour (Fleischer & Tornatzky, 1990) In addition, it is important to note that the models under consideration are also supplemented by additional factors.

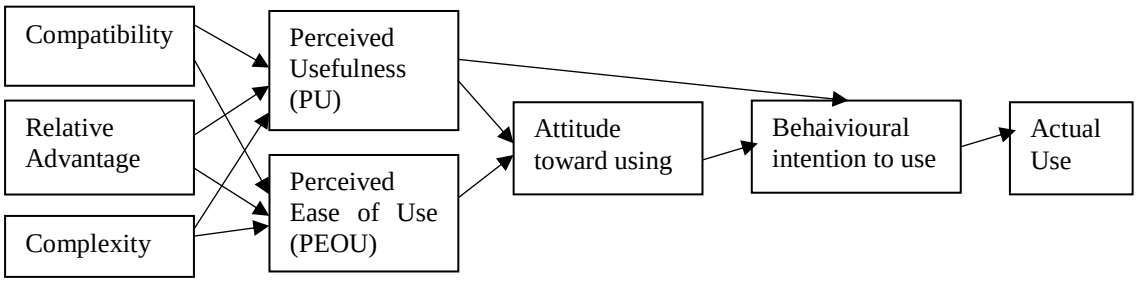
For example, the TOE concept can be supplemented by factors related to the personality of the company's leader, or models of a person's personality and blockchain features can be added to the technology adoption model. In this regard, to analyse the factors influencing the adoption of innovation, it is necessary to conduct a review of studies to determine the list of additional factors. Overall, it can be concluded that the TOE model is relevant in the context of blockchain adoption study, specifically on macro level.

For identifying frameworks and factors, relevant to blockchain technology adoption, the author has studied previous research in published in Web of Science and Scopus data bases. The author performed several searches in order to select relevant scientific articles, comprising of the following key word combinations:

- blockchain adoption
- blockchain, adoption, factors
- blockchain, factors
- blockchain, technology, organization, environment
- blockchain, diffusion, innovation
- blockchain, technology, acceptance, model

The resulting data set comprised of 39 publications, net of intersecting articles. The author has studied the selected articles in detail and has searched for blockchain adoption factor overview and justification within each article. Whilst most articles have been focused on specific blockchain applications, e.g. in supply chain (Wong et al., 2020; Karamchandani et al., 2020), payments, crypto–currencies or specifically Bitcoin, there were only three articles focused on a broader research of blockchain adoption factors, that can be applied both to adoption within organizations, institutions, eco–systems and consequently, economy in general.

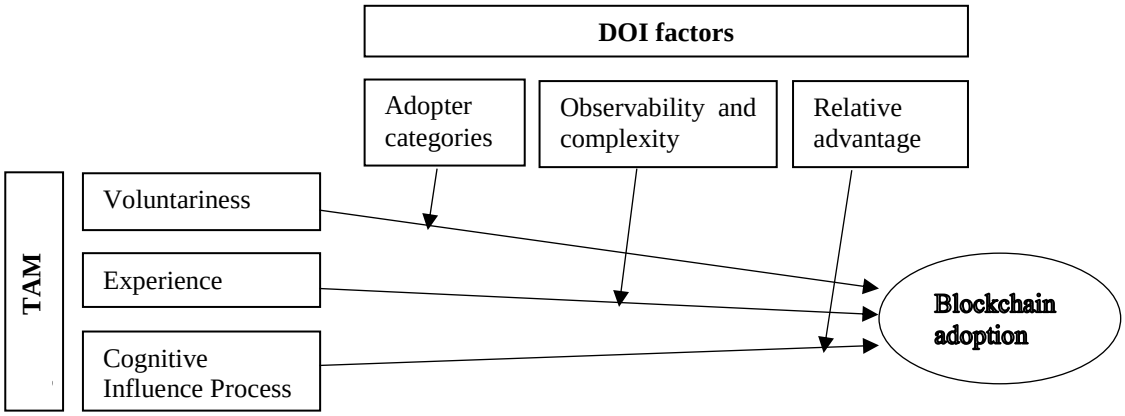
Li and Lou (2017) propose an integrated research model based on DOI and TAM models to investigate intentions to adopt blockchain technology. As demonstrated by the figure 1.13., the model uses two primary factors from TAM model (PU and PEOU) and three factors from DOI theory (relative advantage, compatibility and complexity).




*Source: Le and Lou, 2017*

Fig. 1.13./ *1.13. att.* **The integrated research model based on DOI and TAM models/** ***Integrēts pētījuma modelis, kura pamatā ir DOI un TAM modeļi***

Bhattacharyya and Smith (2018) suggested a combination of DOI theory and TAM2 model to study the factors that influence adoption of blockchain technology in manufacturing supply chains (see figure 1.14.).




*Source: Bhattacharyya and Smith, 2018*

Fig. 1.14./ *1.14. att.* **Conceptual model for blockchain technology adoption/** ***Blokķēdes tehnoloģiju pieņemšanas konceptuālais modelis***

Acton & Clohessy (2018, 2019) have studied blockchain technology adoption factors through the lens of TOE framework. Within their article published in 2018 the authors have grouped various significant factors under TOE framework through comprehensive literature review process applying the method of qualitative content analysis. In their subsequent article, published in 2019, the authors have conducted an empirical study – a survey of management representatives within blockchain savvy organizations on the group of selected factors within the Organizational angle. In addition, the authors have updated the selection of factors from their previous research. The selected factors with the most significance are summarized in table 1.4.

Table 1.4./ *1.4. tabula*

**Summary of significant blockchain technology adoption factors using TOE framework/** ***Būtisko blokķēdes tehnoloģiju ieviešanu veicinošo faktoru kopsavilkums, izmantojot TOE ietvaru***

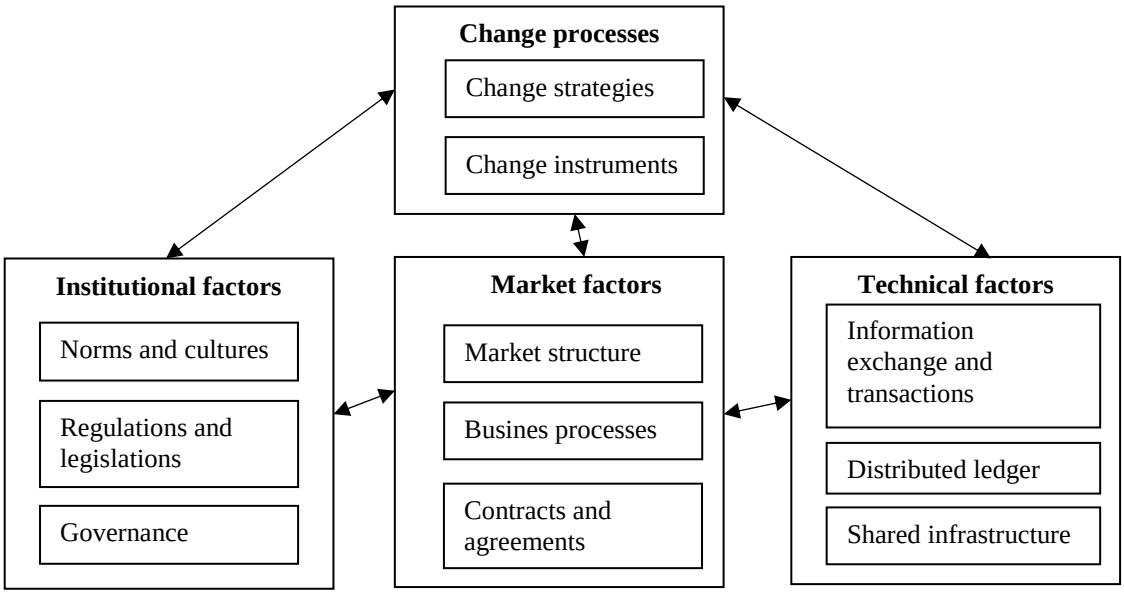
| **Technological factors** | **Nr** | **Organizational factors** | **Nr** | **Environmental factors** | **Nr** |
|---|---|---|---|---|---|
| Perceived benefits | 13 | Organizational readiness | 13 | Regulatory environment | 15 |
| Complexity | 12 | Top management support | 9 | Market dynamics | 11 |
| Compatibility | 8 | Organizational size | 9 | Industry pressure | 5 |
| Data security | 6 | Business model readiness | 7 | Government support | 5 |
| Smart contract coding | 6 | Technology readiness | 3 | Business use cases | 4 |
| Maturity | 5 | Innovativeness | 3 | Trading partner support | 3 |
| Relative advantage | 4 | Participation incentives | 3 | Critical user mass | 1 |
| Disintermediation | 4 | Blockchain knowledge | 1 | X | X |
| Permissions (public vs. private) | 3 | X | X | X | X |
| Architecture | 2 | X | X | X | X |

*Source: Acton & Clohessy, 2019*

According to Acton & Clohessy's (2018, 2019) framework the most frequently mentioned factors in studying blockchain adoption are 'Perceived benefits' and 'Complexity' from Technology factor group, 'Organizational readiness' from

Organizational factor group and ‘Regulatory environment’ and ‘Market dynamics’ from Environmental factor group.

Irani et al. (2020) have developed a PIMT framework based on Koppenjan and Groenwegen’s (2005) framework for the analysis of institutional re–design process and divided blockchain adoption factors into three dimensions: institutional, market and technical. The framework with the most significant factors is summarized in the figure 1.15.




*Source: Irani et al., 2020*

Fig 1.15./ *1.15. att.* **Integrated PIMT framework for blockchain technology adoption/** ***Integrēts PIMT ietvars blokķēdes tehnoloģiju ieviešanai***

According to Irani et al.’s (2020) framework the most frequently mentioned factors in studying blockchain adoption are ‘Norms and cultures’ and ‘Regulations and legislations’ from Institutional factor group and ‘Distributed ledger’ from Technical factor group. In addition to identified factor groups, the framework also underlines the importance of change processes within each factor group for facilitating blockchain adoption in long term.

A combination of factors from various models and theories can provide a good framework for studying technology adoption. Therefore, technology acceptance models are quite consistent with studying adoption of blockchain technology and may be complemented by elements from the DOI theory. A framework for studying blockchain technology adoption is further elaborated in Chapter 4.

## Summary of the Chapter 1/ *1. nodaļas kopsavilkums*

As a kind of decentralized transaction and data management technology, blockchain technologies provide trust, anonymity, security and data integrity without the need for any third–party controlling organization. Blockchain innovation process clearly relies on production and dissemination of knowledge as evidenced by its popularity in an open–source GitHub platform, where knowledge is shared among technology developers and may be further converted to practical technological solutions.

The primary features of blockchain technology include a distributed ledger, real time recording, no third party validation, immutable transactions secured by cryptography

and a decentralized network. The primary benefits of blockchain technology include disintermediation, speed/ real time updates, irreversibility, fraud reduction, accurate/ traceable information, privacy and transparency.

Based on the analysis of economic development described in the Chapter 1, it is reasonable to conclude that knowledge in the new economy is a dynamic resource, which involves constant interaction of other factors opposed to static material resources that prevailed in agrarian and industrial ages. Such factors include human capital, information, technology and learning process, a combination of which create solid grounds for innovation processes, including blockchain technology development and experimentation.

Blockchain applications can be seen as a 'Technology One' or 'Technology Two' depending on the purpose of application. 'Technology One' would correspond to blockchain applications that make existing transactions between parties more efficient (i.e. faster execution of transactions, getting rid of intermediaries, etc.), whilst 'Technology Two' would apply to innovative business models facilitated through innovative blockchain applications and enterprise level collaborations. However, from the literature review conducted in Chapter 1, it is clear that the use of blockchain technology is still in its infancy.

There is enough evidence to claim that blockchain is a General Purpose Technology. In addition, blockchain has the potential to become widely used and generate many spillover effects, just as the Internet did after its application expanded beyond local intranet networks.

Communities of technology developers who are associated with creation and improvement of blockchain applications can be defined as a creative class, which is a cornerstone of knowledge economy. Also, many public blockchain solutions are launched as open source projects, allowing everybody not only to use these applications, but also create new applications on top of existing ones, which enhances knowledge sharing and dissemination.

The combination of globalization, decentralization and digitization trends are driving the up–take of blockchain solutions, coupled with policy actions that adapt the blockchain innovation to regulatory framework and private and public investments necessary for proof–of–concept and pilot project development and subsequent integration with standard processes. On the opposite end, the lack of above–mentioned drivers coupled with simple non–acquaintance with blockchain functionalities hinders blockchain based project development and up–take.

Based on the knowledge economy concept, innovation and technology adoption theories and blockchain technology position within those concepts and theories, it can be concluded that a solid technological base, human capital, innovativeness and regulatory framework may be important factors for blockchain technology adoption.

Review of research on blockchain adoption factors showed that most research on blockchain technology is mainly focused on technological aspects. Most existing blockchain research has focused on the financial industry, which limits the application of results to other industries. Studying blockchain technology adoption on macroeconomic level requires a more holistic approach.

Taking into consideration the variety of blockchain technology application areas and interdisciplinary impact, a proper analysis of blockchain technology adoption must take into account the rationale and motivations of various stakeholders. Therefore, TOE framework is a relevant approach applicable to the study of blockchain technology adoption process on macro level, which may be complemented with specific factors from other theories, models and frameworks, leading to a decision to adopt the technology.

Specifically, a combination of constructs from TAM models and DOI theory may complement TOE framework for studying blockchain technology adoption.

Chapter 1 synthesized the main blockchain adoption factors reported in the literature and research. Although it was expected, discussions about blockchain adoption factors in modern literature are limited. In this regard, the adoption of blockchain technology can be based on examples of previous changes that have been influenced by technology, which used institutional, organizational, market and technological factors as the basis for the conceptualization of innovation and technology.

# 2. OVERVIEW OF POLICIES, GUIDELINES AND REGULATORY ENACTMENTS IN THE EUROPEAN UNION AND BALTIC STATES REFERRING TO BLOCKCHAIN TECHNOLOGY/ *UZ BLOKĶĒDES TEHNOLOĢIJU ATTIECINĀMĀS EIROPAS SAVIENĪBAS UN BALTIJAS VALSTU POLITIKAS, VADLĪNIJU UN TIESĪBU AKTU ANALĪZE*

## 2.1. Overview of EU innovation, digitalisation and blockchain policies, guidelines and support measures/ *Eiropas Savienības inovāciju, digitalizācijas un blokķēdes tehnoloģijas politikas, vadlīniju un atbalsta pasākumu raksturojums*

The previous section has outlined proof and evidence that blockchain technology is a General Purpose Technology, underpinning development of innovations in various industries and application areas with disruptive and transformational effects for businesses, governments, customers and economy in general. Thus, blockchain technology can both facilitate more efficient development of innovative solutions in targeted application areas and, more importantly, foster attainment of innovation policies' goals, specifically in the areas of e–government, e–commerce and smart specialization.

A schematic overview of legislative base, innovation and digitalisation strategies, guidelines and programs and blockchain specific initiatives on European, national and international level is summarized in Annex 2.

The legislative grounds for the European Union have been initially outlined by the **Treaty establishing the European Community** (1957), **Maastricht Treaty** (1992) and the **Treaty of the European Union** (2007), which replaced a Maastricht Treaty (*EU Treaties*, [n.y.]). EU treaties set out objectives of the European Union and the roles of EU institutions in policy planning and implementation. In 2009 the **Treaty of Lisbon** (2007) has entered into force, which amended both treaties, forming current constitutional ground for functioning of the European Union. The political strategy of the European Union is developed by European Parliament, European Commission, Council of the European Union and European Council. The President of the European Commission sets out priorities for a 5–year planning period in accordance with the duration of a political mandate, which serves as basis for strategy planning documents and activities. Current **Commission's priorities for 2019 – 2024** are (*The European Commission's…,* [n.y.]):

- A European Green Deal.
- A Europe fit for the digital age.
- An economy that works for people.
- A stronger Europe in the world.
- Promoting our European way of life.
- A new push for European democracy.

As of the date of the research, there are several policy planning documents and efforts on EU level that aim to support and contribute to the research and development of a blockchain technology and its applications.

In 2015 the **EU Digital Single Market Strategy** was introduced aimed at improving access to digital goods and services, forming an environment in which digital networks and services can thrive and increasing the level of digital skills that are necessary for a comprehensive digital society (*A Digital Single…*, 2015). It also includes a targeted **European Blockchain Strategy** under its framework (*European Blockchain Strategy*…, 2021). Current European Commission's priorities for 2019 – 2024 include a

priority titled ‘A Europe fit for the digital age’ (*The European Commission’s…* [n.y.]), which serves as basis for relevant strategy planning documents and funding measures:

- **Digital Europe program** with the budget of EUR 7.5 billion in 2021–2027 is aimed at increasing Europe’s digital competitiveness, including through Digital Innovation Hubs across the EU (*Europe Investing in…*[n.y.]*)*.
- **Horizon Europe** research and innovation program with the budget of EUR 100 billion in 2021 – 2027 is based on three pillars – (1) excellent science, (2) global challenges and European industrial competitiveness (including digital, industry and space) and (3) innovative Europe (*Horizon Europe Structure…*[n.y.]*)*.
- **Connecting Europe Facility** with a budget of EUR 3 billion in 2021–2027 includes support for digital services infrastructures (*Connecting Europe Facility…*[n.y.]*)*.

Digitalization is becoming an integral part of all areas of politics, including development policy and foreign policy. This emphasizes the correctness of previous decisions on the implementation of the EU Digital Single Market Strategy. The strategy implementation program is fully based on European values, policies and regulatory models to achieve (*A Digital Single…*, 2015):

- fair and open competition with predictable and stable market conditions for enterprises, investors and consumers;
- open and secure internet that provides a free flow of information;
- particular attention to data protection, privacy and cybersecurity, including Internet governance issues.

Today, DSM is seen as the main asset of Europe, aimed at taking its rightful place in the international digital economy and society. Trade agreements and associations in Europe have great digital potential. They allow promoting and facilitating the trade in data, as well as goods and services – for example, the development of telecommunications and electronic commerce, and, ultimately, data flows. Such agreements are considered as important elements for ensuring cooperation in digital politics, in particular on cybersecurity issues in terms of the development of common standards, certification and labelling, which is important for enhancing the security of related facilities around the world. They are also a good tool for eliminating new forms of digital protectionism or other issues that restrict access to markets by removing unreasonable barriers that disrupt trade and investment flows.

The Digital Single Market project team, supported by the European Parliament and the Council of Europe, aims to ensure that the creation of a single digital market is completed as soon as possible. Achievement of stated goals of its activities consists of three strategic directions, such as (*A Digital Single…*, 2015):

Improving access to digital goods and services. The digital single market strategy should provide increased access for consumers and businesses to online goods and services in Europe, for example, by removing barriers to cross–border e–commerce and access to online content while enhancing consumer protection.

Formation of an environment in which digital networks and services can thrive. The single digital market includes creating an enabling environment for digital networks and services through the development of a high–speed, reliable telecommunications infrastructure and the creation of regulatory rules. Key challenges that need to be addressed include ensuring cybersecurity, data privacy, and the fairness and transparency of online platforms.

Digitalization as a driving force for growth. DSM aims to maximize the growth potential of the European digital economy. This should enable every European to take

full advantage of their advantages – in particular, by increasing the level of digital skills that are necessary for a comprehensive digital society.

In February 2016, the European Parliament's Committee on Economic and Monetary Affairs called for a proportionate approach to be taken to distributed ledgers until they become systemically relevant. It also proposed creating a distributed ledger task force under the leadership of the European Commission to provide the necessary technical and regulatory support at both EU and Member State level. In terms of existing law, the Committee stated that it believed key existing EU legislation would apply irrespective of technology, but recommended a review of EU payments legislation.

European Commission (*European Blockchain Strategy*…, 2021) sees that blockchain and distributed ledger technologies (DLT) have the potential to bring improvements to the European industry and citizens as they enable companies, from start–ups to large corporates, and administrations to provide decentralised, trusted, transparent and user–centric digital services leading to new and improved business models, benefiting society and stimulating sustainable economic growth. Overall, blockchain transforms the way in which internet and digital services are used globally.

The European Commission has a holistic approach to blockchain technologies and DLT, which aims at positioning Europe at the forefront of blockchain innovation and uptake and relies on the following main initiatives to enable globally inclusive governance, reinforce cooperation and investments in deploying blockchain/ DLT based applications, support international standard setting and facilitate dialogue between industry stakeholders and regulators, notably for a regulatory framework, that builds on the EU acquis – The European Blockchain Partnership, The International Association for Trusted Blockchain Applications (INATBA) and the European Blockchain Observatory and Forum (*Proposal for*…, 2020).

The **European Blockchain Partnership (EBP)**, created in April 2018, joins at a political level all EU Member States and members of the European Economic Area (Norway and Liechtenstein) to promote collaborations on establishment of a European Blockchain Services Infrastructure (*European Countries Join…,* 2018).

The International Association for Trusted Blockchain Applications (INATBA) brings together market participants and various stakeholders to discuss all–important working issues such as interoperability, governance, trust and legal frameworks to bring blockchain to the next level (*International Association for…*, [n.y]).

European Commission launched the **EU Blockchain Observatory and Forum**, which acts as a stakeholders engagement platform, an initiative to accelerate blockchain innovation and uptake, by featuring, knowledge sharing, community engagement, project mapping, working groups on use cases and the regulatory framework, production of thematic reports and delivery of training (*EU Blockchain…,* [n.y.].

European Blockchain Services Infrastructure (EBSI) is expected to provide EU–wide cross–border public services using blockchain technology (*What is EBSI*.., [n.y.]). One of the objectives of the initiative is to create a distributed node system across the EU, while continuing to identify new potential applications that focus on specific areas, such as automated compliance, verifiable credentials, self–sovereign identity, inter–institutional data exchange, etc.

The European Commission is also supporting and is engaged in work on international standardisation for DLT and blockchain, as interoperable blockchains are needed for global deployment. A **Technical Committee on ISO TC 307 Blockchain and Distributed Ledger Technologies** has formed several working groups for the development of international standards with the following standards being developed (*ISO/TC 307…*, 2020):

- ISO 22739 – Vocabulary
- ISO/CD TR 3242 – Use cases
- ISO/CD TR 23245.2 – Security risks, threats and vulnerabilities
- ISO/CD 23257.3 – Reference architectures
- ISO/WD TS 23258 – Taxonomy and Ontology
- ISO/AWI TS 23259 – Legally binding smart contracts
- ISO/CD TR 23576 – Security management of digital asset custodians
- ISO/WD TS 23635 – Guidelines for governance

The EU blockchain observatory and the European Union Forum regularly publish research on blockchain and distributed ledger technology. The studies also involve members of the European Commission and other interested parties. The scope of research covers the topics of using blockchain and distributed ledger technology during voting, for the supply of goods, trade finance, digital identity, for improving the quality of medicine, for booking seats in ports and cargo racks, for monitoring the quality of imported goods, etc. (*EUblockchainforum*, 2020).

EC Digital Innovation and Blockchain (Unit F.3) supports the scaling up of deep tech start–ups in European ecosystems and mobilising innovators to raise the level of market ready innovation, manages the Start–up Europe and Innovation Radar initiatives and improves access to finance for digitisation and the use of innovation procurement in the Digital Europe and Horizon Europe framework programs (*Digital Innovation…*, [n.y.]). The unit is driving policy action for blockchain–enabled innovation, including work on legal and regulatory aspects, and managing the European Blockchain Partnership, its deployment of Digital Services Infrastructures under the Connecting Europe Facility and running the European Blockchain Observatory and Forum (*Digital Innovation…*, [n.y.]).

For example, a new acceleration program 'Block.IS' is funded from the European Union's Horizon 2020 research and innovation programme and aims to create an open and cross–border innovation cross–sectoral innovation ecosystem that will directly promote the use of blockchain technologies in the food, logistics and financial sectors (*Block.IS Catalyzing…*, 2020). The program is open to the small and medium–sized enterprise sector, as well as start–ups in the information and communication technology sector. Support is provided at three levels, from the idea to the commercialization phase, offering customized business and technical support services.

**European Parliament** in its report on blockchain technology states that the decentralised, cross–boundary character of blockchain raises jurisdictional issues as it seems to diffuse institutional accountability and legal responsibility in an unprecedented manner, rendering the need for a harmonised regulatory approach at the transnational level more pertinent compared with a local or regional one (Boucher et al., 2017). If blockchain technology developed significantly, centralised structures of law might lose their ability to control the ledger, with control passing to their users or other parties in the system, or to shape the activities of disparate people or autonomous decentralised organisations, as no one (including the original creator) can control the ledger after it has been deployed.

Boucher et al. (2017) note that decentralized blockchain–based frameworks might be available to alteration by outer forces and, without adequate institutional assurance, the platforms could advance into oligarchies. Customer assurance will likewise be a key worry of regulators, as the authoritative provisions and review measures may not be obvious to consumers and, given their computerized character, not effectively movable to a potential difference in conditions. Besides, there are security worries of an administrative sort, as it could be possible to deduce a party's identity from transactions.

At last, blockchain may prompt inquiries concerning the choice of law and jurisdiction for the settling of dispute resolution.

Boucher et al. (2017) note that blockchain applications have the capacity to unprecedently transform the way how economy works, thus, there are many issues to be taken into account by policymakers, lawmakers and regulators, such as:

- **Accountability/ responsibility**: Control over the ledger is decentralized and distributed among the network of nodes, so how do you control or regulate the ledger, its users or other parties in the system? Who is accountable in a decentralised system? Whom (or what) do you regulate?
- **Who would regulate?** Given the cross–border nature of the technology, who would regulate? It is very likely that there would need to be agreed international regulatory principles and cooperation among regulators.
- **Definitions:** Various definitions under existing laws may need to be reassessed, e.g., in terms of the classification of assets (e.g., are virtual currencies just commodities?).
- **Smart contracts:** How would existing contract law need to change to take account of automated or 'smart' contracts? Would they be valid and enforceable? Moreover, is legislation sufficient, or would regulators need to regulate distributed ledgers via the technical code which defines the rules, rather than purely by legislation? Who would check that the operation of the technical code actually reflects the requirements of the legal code? If there is a problem with the code, how would this be identified and how would remedies be enforced and against whom? It is likely that smart contracts would still lead to disputes, and there will be limits on what smart contracts can do. Lawyers, regulators and the court systems would need to become familiar with smart contracts. Recordkeeping requirements and evidentiary rules would need to be adapted to enable access to underlying data by courts and other authorities.
- **Consumer protection:** Consumer protection will be a key concern of regulators. With such transformative technology, how do you ensure consumers understand what they are agreeing to, and their legal redress for failures?
- **Privacy and security:** The technology relies on an assumption that it is very secure because records would be almost impossible to decrypt. However, there were cases when crypto–currencies were stolen due to loopholes in the code. How to investigate cases when personal data are stolen or some material harm is done through hacker attacks or misuse of privileged data decryption rights? However, with the continued development of quantum computing, this may not always be the case. There are other security concerns, for example, that it could be possible to trace or deduce a party's identity from transactions or through access to a party that has permission to decrypt the data. In theory, at least, a ledger might also be 'captured' if someone were able to control the majority of participating computers.
- **Competition/ anti–trust:** If private distributed ledgers are created that are equivalent to consortia, there could be arguments of monopolistic or cartel activity. In addition, there could be a risk that algorithms are set up in a manner, which produces anti–competitive results that are secret or not readily detectible.
- **Decentralised organisations:** Various issues would need to be considered in terms of liability and accountability as existing legal systems are primarily designed to assign responsibilities and liabilities to persons (human or legal) rather than to a mechanism such as a distributed ledger that involves automated contracts. Lawmakers may need to consider how to adapt the existing law related to liability in the context of unincorporated associations to deal with the operation

of distributed ledgers, which may be particularly challenging to the extent that these are likely to operate across borders.

- **Reputational damage:** Although much of the original scepticism with distributed ledgers has gone away, until distributed ledger applications have been rigorously evaluated, organisations will need to be mindful of the risk of reputational damage resulting from distributed ledger applications that do not work or do not provide the benefits envisaged.
- **Compliance with data protection laws:** Most data protection regimes focus on the relationship between collector and end user or data subject as a key point in the compliance cycle. A clear challenge in DLT implementations is how these compliance requirements can be achieved by each participant, given that although each (or at least many) of them may end up holding personal data, in many instances only one of them will have the opportunity to directly interface with the data subject.
- **Compliance with cross–border data transfer requirements:** It will be important for any DLT implementation to consider the transnational data flows that will be generated, and to establish processes to enable compliance with all relevant cross border transfer requirements. Typically, data protection regimes seek to restrict the transfer of personal data to countries where the strength of data protection that will apply in that country is not 'adequate'.

### 2.2. Overview of innovation policies in Latvia/ *Latvijas inovāciju politikas raksturojums*

A schematic overview of legislative base, innovation and digitalisation strategies, guidelines and programs and blockchain specific initiatives on European, national and international level is summarized in Annex 2.

The National Innovation Concept was the first government document dedicated to the development of innovation in Latvia. It was accepted at the meeting of the Cabinet of Ministers on February 27, 2001 and was followed by the National Innovation Program for 2003–2006 – an innovative development policy document developed in accordance with the National Innovation Concept. The program was fully in line with the objectives of Latvia's long–term economic strategy. The program was approved on April 1, 2003 at the meeting of the Cabinet of Ministers.

At the highest decision–making level, the state policy in the field of innovation, science and technology development is determined by the Saeima and the Cabinet of Ministers.

In accordance with Cabinet Regulation No. 271 of 23 March 2010 (Protocol No. 15(3)) 'Regulations of the Ministry of Economics', the Ministry of Economics is the leading public administration institution in the field of economic policy, whose tasks and competence include the development of innovation development policy and its implementation.

The main state priorities, action directions and activity levels, measures aimed at industrial development, promotion of access to finance, innovation and exports, as well as improvement of the business environment, are included in the **National Industrial Policy Guidelines for 2014–2020** (*Nacionālās industriālās politikas…*, 2013). Within the framework of the Latvian National Industrial Policy, innovation and increase of innovation capacity is one of the main pillars to improve the competitiveness of Latvia's industrial sectors and increase productivity and export volumes. The guidelines set out

four equally important elements for the development of the Latvian innovation system (*Nacionālās industriālās politikas…*, 2013):

- knowledge capacity,
- innovation supply,
- innovation demand,
- transfer system.

At the same time, the goals and directions of innovation policy are also defined in the National development policy planning documents that are being prepared in line with the **Law on Development Planning System** (Attīstības plānošanas sistēmas…, 2009).


*Source: National Development Planning…, [n.y.]*

Fig 2.1./ *2.1. att.* **National Development planning of Latvia/ *Latvijas nacionālās attīstības plānošana***

To summarize, innovation policy in Latvia is included in the following planning documents:

- Sustainable Development Strategy of Latvia until 2030 (*Sustainable Development Strategy…*, 2010)
- National Development Plan of Latvia for 2014–2020 (*Latvijas Nacionālais attīstības…*, 2012)
- National Development Plan of Latvia for 2021–2027 (*Latvijas Nacionālais attīstības…*, 2020).
- Guidelines for Science, Technology Development and Innovation 2014–2020 (*Zinātnes un tehnoloģijas…*, 2013).
- Smart specialization strategy RIS3 (*Viedās specializācijas stratēģija*, 2016).
- National Digital Transformation Guidelines 2021–2027 (*Digitālās transformācijas pamatnostādnes…*, 2020)

Two out of seven priorities outlined in the **Sustainable Development Strategy of Latvia until 2030** (*Sustainable Development Strategy…*, 2010) include the innovation angle (see Annex 3):

- Innovative and eco–efficient economy, including mass–creative activity, innovation, and renewable and safe energy.
- Innovative government and public participation, including increase in the social capital value, e–government and public innovation.

In the **National Development Plan of Latvia for 2014–2020** innovation policy targets have been set to increase public spending on R&D to 1.5% of GDP by 2020 (*Latvijas Nacionālais attīstības…*, 2012). In order to achieve the goal, it is necessary to increase the efficiency of innovation policy by creating strong incentives for entrepreneurs to finance innovative activities.

To attract European Union funds for investment in research, development and innovation in the 2014–2020 programming period, the European Commission set an ex–ante conditionality for Member States: to define a smart specialization strategy that would ensure a more focused concentration of R&D and innovation spending in higher returns.

**National Development Plan of Latvia for 2021–2027** outlines a direction of 'Production, Innovation and Exports' with the objective to support growth and competitiveness of enterprises, based on the ability to create and sell demanded, knowledge–intensive products and services on the basis of science, integrating into increasingly higher value–added global chains, underlining that smart specialization, innovation, technological development and modernization, as well as targeted investment in human capital, are the basis for productivity growth (*Latvijas Nacionālais attīstības…*, 2020). It sets the following indicators to be achieved by 2027:

- 39th place in the rating of Knowledge and technology output component of Global Innovation Index (from 45th in 2019)
- 21st place in the rating of Market sophistication component of Global Innovation Index (from 40th in 2019)
- 30th place in the rating of Business sophistication component of Global Innovation Index (from 41st in 2019)
- Export Unit Value (SITC 5–8), 5–year moving average growth rate > 2% (from 1.8 in 2018, Eurostat)
- Exports of computer and information services out of total exports of services > 15% (from 9.2% in 2018, LB)

In order to ensure the ex–ante conditionality, the **Science, Technological Development and Innovation Guidelines 2014–2020** were approved in 2013. The guidelines set out the government's policy objectives, operating principles and priorities for the development of science, technology and innovation, as well as the **Smart Specialization Strategies (RIS3)**. The aim of RIS3 is to increase the innovation capacity, to create an innovation system that promotes and supports technological progress in the economy and ensures the transformation of the national economy in favour of the production of higher value–added products and services. The areas of specialization of Latvia identified in RIS3 are (*Viedās specializācijas stratēģija*, 2016):

- knowledge–intensive bio economy;
- biomedicine, medical technology, biopharmaceuticals and biotechnology;
- smart materials, technologies and engineering systems;
- smart energy;
- information and communication technologies.

National Digital Transformation Guidelines 2021–2027 aim to define a unified digital development policy for public administration, national economy and society, including five lines of action (*Digitālās transformācijas pamatnostādnes…*, 2020):

- Digital skills and education.
- Digital security and reliability.
- Availability of telecommunications and computing.
- Digital transformation of the national economy (incl. public administration).
- Innovation, ICT industry and ICT science.

Innovation support structures are constantly evolving. There are eight technology transfer contact points and four science and technology parks in Latvia (Latvian Technology Centre, Latvian Technology Park, Ventspils High Technology Park, Latgale Apparatus Technology Centre), which also offer business incubation services. In recent years, many incubators, centres, workspaces and initiatives have appeared aimed at promoting innovation, entrepreneurship and the creation of new companies in Latvia: incubator 'Turība Business HUB', RISEBA Creative Business Incubator, Riga Technical University Design Factory, Madona Business Incubator, etc.

The performance of innovation policy is described in the European Innovation Scoreboard published by the European Commission. In a report published in 2020, Latvia is ranked 23rd among the 28 European Union member states included in the group of 'moderate innovators' (*European Innovation Scoreboard*…, 2020). Since 2008, Latvia has shown one of the highest annual growth in innovation performance (more than 20%) among all European Union member states. Despite some progress, the Latvian national innovation system still has a number of shortcomings, the elimination of which is a challenge for innovation policy.

In accordance with the Law on Scientific Activity, the Ministry of Economics has been designated as the state institution responsible for the development and implementation of innovation policy. The innovation policy implemented by the Ministry of Economics is mainly related to business support in the field of innovation, as well as the implementation and monitoring of projects financed by the Structural Funds related to support for innovative activities. Innovation policy is closely related to the state science and technology development policy, the development and implementation of which is the responsibility of the Ministry of Education and Science.

Latvia Investment and Development Agency, which is one of the institutions under the supervision of the Ministry of Economics, plays an important role in the implementation of business support innovation programs.

JSC 'Development financial institution 'Altum' is a state development financial institution. The aim of Altum is to provide financing through state aid financial instruments in areas that the state has identified as important and supportable and where sufficient funding from credit institutions is not available.

There are two advisory bodies in Latvia: the Latvian Higher Education Council (AIP) and the Latvian Strategic Research and Innovation Council (LPISP). The AIP helps to develop a national strategy for higher education, to promote cooperation between higher education institutions and to monitor the quality of higher education. LPISP was established at the end of 2013. The LPISP is chaired by the Prime Minister and is responsible for advising the Cabinet of Ministers on important issues related to investment in research and technology and the evaluation of policy proposals. The Latvian Academy of Sciences, as well as the Latvian Council of Science, which aims to promote the development and implementation of science and technology development policy in Latvia in accordance with the goals and requirements of the European Union, also play an important role in shaping innovation policy.

Since 2004, Latvia, as a member of the European Union, has had access to financial support from the European Union Structural Funds, which is an important source of financing for innovation.

In the 2004–2006 programming period of the European Union Structural Funds, the Single Programming Document covered five priorities, incl. 'Promoting Entrepreneurship and Innovation' (Priority 2). Funding for the implementation of priority measures accounted for 25% of the total funding from the Structural Funds. The priority

was introduced by supporting five key areas, incl. support for the development of innovations and the development of applied science in state scientific institutions.

The implementation of the projects of the European Union funds in 2007–2013 programming period was completed in 2016. Within the framework of the projects, with the support of state and European Union funds, several measures were implemented to improve the Latvian innovation system, as well as to strengthen the innovative capacity of entrepreneurs. A total of 231 industrial research and new product and technology development projects were implemented in the centres of excellence. As a result of the operation of the Centres of Excellence, additional private co–financing for R&D activities in the amount of at least EUR 18.4 million was attracted and 445 R&D jobs were created. In 2016, the implementation of 187 projects for the total (European Union funds) financing of EUR 169.1 million was completed in the state support program 'High value–added investments' co–financed by the European Union Structural Funds. In 2015, the implementation of 112 projects of the program 'Introduction of new products and technologies into production' was completed with a total funding of EUR 34.9 million. At the same time, in 2015, the implementation of 22 supported projects was completed with funding of EUR 0.23 million, which were supported by the European Union Structural Funds co–financed activity 'New product and technology development program for micro, small and medium–sized enterprises'.

Nearly EUR 200 million European Union Structural Funding is available in the 2014–2020 programming period to support companies' efforts to invest in R&D and innovative projects, which could attract at least an additional EUR 80–100 million in private sector investment in R&D activities. Several programs are available to support innovation at the Latvian Investment and Development Agency (LIAA) ('Innovation Motivation Program', 'Support for Commercialization of Research Results', etc.).

As of the date of the research, there is no targeted blockchain policy or support mechanisms in Latvia, however, blockchain activity can be analysed through the lens of actions undertaken by public authorities and certain international initiatives where Latvia participates overviewed in Chapter 3, section 3.2.

## 2.3. Overview of cryptocurrency and virtual asset regulation in the EU and Baltic States/ *Kriptovalūtu un virtuālo aktīvu regulējuma ES un Baltijas valstīs analīze*

### 2.3.1. Overview of cryptocurrency and virtual asset regulation in the EU/ *Kriptovalūtu un virtuālo aktīvu regulējuma Eiropas Savienībā analīze*

Blockchain technology application in various industries bundled with its cross–border nature create the necessity to assess its potential impact on relevant national and international regulatory enactments governing industry standards, and, in some instances, create the need for a new regulatory base in disruptive application areas, for example, crypto–currencies and fund–raising for crypto–projects.

Since the most prominent use case of blockchain technology implementation up to date are cryptocurrencies and virtual assets, a number of recommendations and opinions in this area have been issued by international and national competent authorities, regulatory authorities and think tanks all over the globe. A schematic overview of regulation of cryptocurrencies and virtual assets and recommendations and explanations issued by competent authorities are outlined in Annex 4. As of the date of the research, there are certain opinions issued by international and EU competent authorities, summarized below.

In December 2013, the **European Banking Authority** (EBA) published a warning on the risks associated with the use of virtual currency, such as Bitcoin, in various

transactions. EBA has indicated that consumer rights are not currently protected due to the lack of specific rules for transactions using virtual currency as a means of payment, thus running the risk of losing money (*EBA warns consumers…, 2013)*. The **European Central Bank** (2015) has also recognized that participation in virtual currency schemes (such as Bitcoin and similar instruments) may expose its users to liquidity, credit, legal and operational risks.

In 2016 the **International Monetary Fund** (2016) issued a staff discussion note considering the benefits and risks of distributed ledgers and stated that achieving a balanced regulatory framework that guards against risks, without suffocating innovation, is a challenge that will require extensive international cooperation.

European Central Bank (2016) in its report acknowledges blockchain and distributed ledger technology potential for the financial industry, but notes that the technology is not yet mature, the clarification of critical legal, operational and governance issues will take time and there is a risk of abuse of certain applications for criminal conduct, including money laundering and terrorist financing.

The **European Securities Markets Authority** (2016) published a Discussion Paper, which addresses potential benefits and risks that DLT could have on securities markets, especially from a public policy perspective. ESMA was seeking comments from the industry and, did not express any opinion as such, related to DLT.

The European Securities and Markets Authority warned investors and companies involved in ICOs about the high risks associated with investing in ICOs (*ESMA Highlights ICO*…, 2017):

- Regulation: most ICOs are not regulated, however, some ICO projects may require permission to conduct a public offering or provide investment services in accordance with requirements of the EU laws and regulations such as the Prospectus Directive, the Markets in Financial Instruments Directive (MiFID), the Alternative Investment Fund Managers Directive (AIFMD); or the Anti–Money Laundering Directive.
- Investor or depositor protection: ICOs that are not regulated are not subject of EU laws and regulations, therefore investors cannot benefit from investor protection.
- High risk of losing all investments: Many ICO projects are in the initial stage of development, it is not possible to properly assess the calculation of the price of the company or the token attached to the project. There is no guarantee that the company or project will be successful, nor is there a guarantee that the invested funds will be returned to investors.
- Price volatility: the price of a token, similar to the price of a cryptocurrency, can be very volatile, without any objective reasons.
- Opportunities for fraud: Some token issuers may use the funds raised for purposes other than those originally planned and presented in the project presentation or descriptive information.

European Securities Markets Authority (2016) states in its Discussion Paper on DLT that smart contracts, that are implemented on top of the ledgers, may help reduce the uncertainty attached to contract terms and increase the automation of the processing of corporate actions, even if their use may be limited to certain types of instruments or contracts for complexity reasons, at least in the short term. However, as noted by Boucher et al. (2017) there are various issues that need to be considered about the legal enforceability of smart contracts, and liability and accountability issues, as distributed ledgers currently lack the legal personality that is necessary for them to be assigned with responsibilities and liabilities. This issue is exacerbated by the fact that they operate

across borders and that smart contracts may not yet be capable of performing complex operations.

The most influence on regulatory treatment of cryptocurrencies and virtual assets have recommendations of **Financial Action Task Force on Money Laundering** (FATF), which develops world standards in the field of combating money laundering and the financing of terrorism (AML/ CFT), and also assesses the compliance of national AML/ CFT systems with these standards. FATF is an inter–governmental body established by the G–7 summit in 1989, currently counting 39 member countries and regional organisations (including European Commission), nine associate members and 23 observer organisations, committed to implement its recommendations (*About*, [n.y.]).

In June 2015, the FATF published its initial recommendations on money laundering and terrorist financing risk management, related to virtual currency, in its Guide to the Application of the Risk–Based Approach to Virtual Currencies (2015 Guide). The scope of the 2015 Guide was limited to the so–called 'Convertible virtual currency' and 'exchange service providers of convertible virtual currency'. Guidelines (Financial Action Task Force, 2015) define convertible (or open) virtual currency as a virtual currency, which has an equivalent value in real (fiat) currency and can be exchanged for real (fiat) currency and vice versa. Providers of convertible virtual currency exchange services are subject to FATF Recommendations only if they have facilitated an exchange between convertible virtual currency and real (fiat) currency. Financial Action Task Force (2015) explained that her risk assessment 'noted that at least in the near future, only convertible virtual currencies, which can be used to convert value to fiat currency and a regulated financial system, either of which are likely to represent the risks of money laundering and terrorist financing.

In October 2018, the FATF adopted amendments to the FATF Recommendations to explicitly clarify that the FATF Recommendations apply to financial activities using virtual assets. A key amendment to the FATF Recommendations was the addition of the definitions of 'virtual assets' and 'virtual asset services providers'. Definitions applied (Financial Action Task Force, 2019b):

- **Virtual Asset** is defined as a digital expression of value that can be digitally traded or translated and can be used for payment or investment purposes. Virtual assets do not include the digital expression of fiat currencies, securities and other financial assets that are already covered elsewhere in the FATF Recommendations.
- **Virtual Asset Services Provider** is defined as any individual or legal entity that is not covered elsewhere in the FATF Recommendations and that carries out as an entrepreneurial activity one or more of the following activities or operations for or on behalf of another natural or legal person:
  - exchange between virtual assets and fiat currencies;
  - exchange between one or more forms of virtual assets;
  - transfer of virtual assets;
  - storage and (or) administration of virtual assets or tools that allow you to control virtual assets; or
  - participation in the provision and provision of financial services related to the offer of the issuer and / or sale of a virtual asset.

These broad definitions, which include transactions between virtual assets, indicate a significant revision of the approach used in the 2015 Guide. The FATF acknowledged that not only virtual currency to fiat currency exchange transactions, but virtual asset exchange transactions among themselves can pose money laundering and terrorist

financing risks. These definitions are now also used in the 2019 Guidelines and Explanatory Note P15.

The 2019 Guidelines and Explanatory Note P15 provide more detailed recommendations on applying a risk–based approach to virtual assets and virtual asset service providers, including examples of regulatory approaches in a number of states. The key requirements of the 2019 Guidelines and Explanatory Note P15 are as follows (Financial Action Task Force, 2019a):

- **Initial Risk Assessment** requires national authorities and virtual asset service providers to conduct an initial risk assessment in order to properly assess and mitigate the risks associated with virtual asset activities and the provision of products and services by virtual asset service providers. The 2019 Guidelines provide examples of risk indicators that need to be taken into account in this context, including risks caused by the intersection of activities in the field of virtual assets with the traditional financial system and the intersection of the virtual system and various jurisdictions, risks associated with centralized and decentralized business models, and risks associated with cryptocurrencies or services with increased anonymity. With respect to cryptocurrencies with increased anonymity, the FATF proposes to refuse to list them if service providers in the field of virtual assets cannot reduce such risks.
- **Forwarding rule: receiving and transmitting information about the sender and the recipient.** One of the most controversial requirements of the new FATF rules is the application of the so–called 'forwarding rules' (Recommendation 16) to service providers in the field of virtual assets. In accordance with the transfer rule, traditional financial institutions must collect and transmit to each other information about the sender and the recipient of the electronic transfer operation. If applied to virtual asset service providers, the forwarding rule requires that the sender virtual asset service provider collects information about the sender and recipient of the virtual asset transfer transaction, such as sender's name, wallet number and address or information that identifies him, and transmits this information to the recipient virtual asset service provider. Both service providers in the field of virtual assets are required to further save this information and provide it for review at the request of law enforcement agencies. The 2019 Guidelines clarify that transfer obligations do not apply to transactions between users that occur exclusively directly (peer–to–peer), or in the case of a transfer of a virtual asset between a wallet that is serviced by a virtual asset service provider and a wallet that is not associated with such a provider. In the latter case, the involved virtual asset provider will still be required to collect and store information about its customer. The FATF also explains that national authorities have the right to set a minimum threshold for transfers of virtual assets in the amount of 1,000 USD or EUR, to which this requirement will not apply.
- **Registration and licensing of virtual asset service providers**. The FATF's requirement to register or license all virtual asset service providers is also particularly controversial. At a minimum, the FATF expects the virtual asset service provider to be registered in the country in which it was created, i.e. established or otherwise officially registered in accordance with corporate law, or, in the case of an individual, in the jurisdiction where the place of business of such person is located. Other jurisdictions may accept additional local licensing or registration requirements if the virtual asset service provider makes its services available to residents of that jurisdiction. The FATF, however,

emphasizes that national authorities are free to determine which of the categories of regulated activities should regulate service providers in the field of virtual assets, for example, as financial institutions, established non–financial enterprises and professions, or otherwise, a special category of activity. The regulation, supervision and control of virtual asset service providers of the FATF obliges national authorities to extend the AML/ CFT system of risk providers and risk–based control and supervision to the implementation of applicable FATF Recommendations to virtual asset service providers. An important conclusion from the 2019 Guidelines is the fact that the FATF believes that the only legitimate supervisory or controlling bodies are the **competent (national) authorities**, but not any self–regulatory bodies in the field of virtual assets. Such national authorities must have sufficient authority to ensure that virtual asset service providers comply with the FATF Recommendations, including the power to sanction virtual asset service providers or revoke, restrict or suspend their license or registration.

- **Preventive measures**. The 2019 Guidelines and Explanatory Note P15 also clarifies that the requirements of the FATF Recommendations on Preventive Measures (Recommendations 10 to 21) apply in the context of activities related to virtual assets to both national authorities and virtual asset service providers. Such preventive measures include checking clients (taking into account the threshold of an irregular transaction of 1,000 US dollars or Euro), keeping records (for at least five years) and reporting suspicious transactions. The FATF also clarifies that, as a rule, all measures applicable to 'property', 'income', 'cash', 'cash or assets' and other 'equivalent values' in accordance with the FATF Recommendations also apply to virtual assets.
- **International cooperation and coordination at the national level.** Given the cross–border and mobile nature of the activities of service providers in the field of virtual assets, the FATF believes that international cooperation is crucial. The FATF expects countries to create tools to enable them to cooperate and provide mutual legal assistance, including regarding the identification, freezing or seizure of assets in the form of virtual assets. The FATF also calls on national authorities and market participants to work closely with each other to ensure compliance with the FATF Recommendations, as well as the compatibility of AML/ CFT requirements with other regulations, including data protection and privacy laws.
- **Non–acceptance of de–risking service providers in the field of virtual assets**. Finally, the FATF clarified that it does not support the current practice of financial institutions in general to refuse or terminate business relations with the service providers sector in the field of virtual assets in order to avoid the risks associated with them. According to the FATF, such a situation is neither desirable nor rational. The FATF encourages financial institutions to manage such risks in accordance with the FATF Recommendations, rather than simply avoiding them.
- In author's view, despite the FATF recommendations being quite explicit and self–explanatory, there are certain problems and challenges that require further discussions and clarifications:
- **Broad definition of virtual assets.** One of the frequent criticisms of the new FATF requirements is the broad definition of 'virtual assets', which completely does not take into account the difference between a payment token, an investment token and a token secured by an asset. In the 2019 Guidelines, the

FATF notes that it deliberately makes no exceptions for certain assets, based on certain terms, such as a 'utility token'. From the FATF point of view, such terms do not have a common understanding in different jurisdictions or even within the industry. The FATF also argues that in the context of the ongoing rapid development of technologies and given the difficulty of quickly determining the legal nature of the token, regulation, in order to maintain flexibility, should remain technologically neutral and based on an essential approach to activities, rather than on industry terminology.

- **An Essential Approach to the Concept of Virtual Asset Service Providers.** Similarly, the new FATF requirements will apply to a very wide range of virtual asset service providers. The definition of virtual asset service providers covers virtual asset exchange platforms (both exchanging between fiat currencies and cryptocurrencies, as well as exchanging cryptocurrencies for other cryptocurrencies) and other virtual asset transfer services, wallet providers for their storage, escrow service providers in the field virtual assets, service providers in connection with the ICO, providers of brokerage services and services for the formation of the application book. In some cases, the scope of the concept is less obvious. For example, providers of trading platforms on which users interact directly with each other (peer–to–peer), decentralized exchanges (DEXs) or applications (Dapps) may fall under this definition if they facilitate the exchange or transfer of virtual assets or carry out such exchanges and transmission. The same logic applies to developers and sellers of applications and platforms.
- **Technological constraints.** As part of the consultation process, market participants clarified that certain requirements of the 2019 Guidelines and P15 Explanatory Note may require technological solutions that are not yet available. This applies in particular to the requirements of the 'forwarding rule'. The current possibilities of the blockchain infrastructure for transferring additional information between providers of services in the field of virtual assets, in particular information about the sender and the recipient, are limited. This may require a new infrastructure (possibly outside the blockchain) that will meet certain security requirements. Virtual asset service providers may also face the inability to check if the wallet is connected to another provider.
- **Implementation cost.** Compliance with the FATF Recommendations will undoubtedly be costly both technologically and in terms of licensing requirements. This can put too much strain on start–up opportunities and resources. This problem may emphasize the importance of the availability of regulatory sandboxes.
- **Unintended consequences.** Some market participants have voiced fears that the new strict FATF rules will entail the transition of users to transactions directly between themselves and the use of decentralized exchanges. This could lead to less transparency in the virtual asset industry.

The United States Financial Crimes Enforcement Network (FinCEN) issued guidance (*FinCEN Guidance*…, 2019), similar to the FATF (Financial Action Task Force, 2019b) in many ways. G20 finance ministers and central bank governors following their meeting in February 2020 issued a final communique calling on countries to implement cryptocurrency regulation standards in accordance with the FATF recommendations (*G20 Kicks Off..*, 2020). In the statement, the G20 finance chiefs wrote: 'We ask the FSB, in coordination with the Committee on Payments and Market Infrastructures (CPMI) and other relevant standard–setting bodies and international

organizations, to develop a roadmap to enhance global cross–border payment arrangements by October 2020.'

In 2018, the **EU Anti–Money Laundering Directive** was amended to reduce the risk of using virtual currency to launder proceeds from crime, which had to be incorporated into national laws of Member states by January 10, 2020. According to these changes, 'virtual currency platforms' and cryptocurrency service providers are required to follow the same requirements for identifying their customers and tracking suspicious transactions as other financial organizations, including banks (Directive (EU) 2018/843…, 2018). A European Parliament's report on crypto assets (2020) states that the fifth EU Anti–Money Laundering Directive 2018/843 (AMLD5) no longer complies with the stricter FATF standards, and to harmonize its approach with the international standards, the European Parliament recommends expanding the concept of cryptocurrencies and the list of related regulated companies in the EU.

A European Parliament's report on virtual currencies (2018) acknowledges the increased risks, which will require enhanced regulatory capacity and adequate technical expertise, while calling for a proportionate EU regulatory approach in order not to hamper innovation at such an early stage. This approach suggests that regulation should be occurring in response to technological developments and real applications of distributed ledgers rather than vice versa. Otherwise, the choice of the technological trajectory turns random and due to the increasing returns to adoption described by Arthur (1989) the economy risks to be locked–in to inferior technologies.

Judgment of the European Court of Justice C–264/14 of 2015 states that Bitcoin is not a product within the meaning of VAT law, thus exchanges of fiat currencies for cryptocurrencies are exempt from VAT.

The European Parliament presented the report (European Parliament, 2020) noting a significant growth of token–based platforms and suggests in this regard introducing 'private tokens' as a subcategory of cryptocurrencies. The document also says that the current regulation does not cover some participants in the cryptocurrency industry, including exchanges that do not support fiat currencies. Such enterprises must also comply with AML (anti–money laundering) requirements.

Additionally, the report emphasizes (European Parliament, 2020) that new coins are, by definition, 'clean', and if someone, for example, a bank, is ready to convert them into fiat currency or another cryptocurrency asset, the funds received will also be clean. However, this concept is difficult to address from regulatory point of view. To solve this problem, the first regulatory step may be the determination of the methods used, and in the future, the adoption of appropriate counter measures. The document also argues that at the same time, developers of coins and suppliers of non–custodian wallets are proposed to be exempted, since they provide only the technological infrastructure.

Apart from crypto–space, according to the European Parliament, there are four broad categories of action that governance institutions could mobilise in response to the emergence of blockchain technology (Boucher et al, 2017):

- One option is to respond to 'the problems to which blockchain is a solution' without using blockchain at all. For example, if demand for blockchain is based upon a desire for more transparency in processes, then citizens could be granted more access to government data and processes without using blockchain systems at all.
- The second option is to actively encourage development and innovation of blockchain by the private sector by granting legitimacy to their products. For example, under some conditions, transactions on blockchain could be given explicit legal recognition as records of executed transactions.

- The third option is to do the reverse of the previous one, i.e. discourage development by refusing to accept the legitimacy of blockchain–based transactions, for example by overruling and reversing the clauses in smart contracts.
- The fourth option is to adopt a permissioned blockchain in existing systems and structures, effectively maintaining the role and power of those responsible as intermediary by providing some of the basic functionality of blockchain, but without offering full decentralisation and transparency. The fourth option model is already observed in public sector use of blockchain technology, for example in the UK and Estonia, as well as in the private sector.

### 2.3.2. Overview of cryptocurrency and virtual asset regulation in Latvia/ *Kriptovalūtu un virtuālo aktīvu regulējuma Latvijā analīze*

In 2017, Latvia introduced amendments to the **Law on Prevention of Money Laundering and Terrorist Financing** (NILLTFNL) and added the following definitions (Noziedzīgi iegūtu līdzekļu…, 2017):

- **'virtual currency'** means a digital representation of a value that may be digitally transmitted, stored or traded and functions as a means of exchange but is not recognized as a legal tender, is not considered to be a banknote and coin, non–cash and electronic money, and does not have a monetary value, which is accumulated in a payment instrument in the cases referred to in Section 3, Paragraphs 10 and 11 of the Payment Services and Electronic Money Law (Maksājumu pakalpojumu…, 2011);
- **'virtual currency service provider'** – a person who provides virtual currency services, including a provider of virtual currency exchange services issued by other persons, who provides users with the opportunity to exchange virtual currency for another virtual currency, receiving a commission for it, or offers to buy and repurchase virtual currency using a recognized legal tender.

With the mentioned amendments, it stipulates that as of 1 July 2019, virtual currency service providers are subjects of NILLTFNL law, at the same time stipulating that virtual currency service providers are supervised and controlled by the State Revenue Service in compliance with the requirements of this law. Although amendments to the NILLTFNL law were introduced, a special authorisation or licence is not required for virtual currency service providers.

In 2018 the Ministry of Finance has issued an informative report 'On the benefits and risks of using virtual currencies, and further actions to promote the development of the area and reduce the identified risks' with an overview of considerations related to legal status of virtual currencies, their accounting and tax treatment and overall technological and security aspects and called for the following further actions to ensure greater certainty and transparency in the regulation of financial services, taxation, accounting and the prevention of money laundering and terrorist financing (Finanšu ministrija, 2018):

- to invite the FCMC to develop guidelines (explanations) regarding the extension of the existing regulatory enactments regulating the financial markets to the ICOs by 20 December 2018;
- to take note that the State Revenue Service will develop guidelines on:
  - the application of tax and accounting regulations to virtual currency service providers and ICOs;

- application of the regulatory framework for the prevention of money laundering and terrorist financing to virtual currency service providers and ICOs;

- The Ministry of Finance:
  - to prepare amendments to the Law 'On Personal Income Tax' in order to determine the procedure for taxing income from the alienation of virtual currency by 20 December 2018;
  - together with the incorporation of EU AMLD 5 to NILLTFNL, to determine the cases in which virtual currency service providers are required to conduct customer research, as well as additional conditions to ensure the effective performance of supervisory and control responsibilities.

The Central Bank of Latvia has been informing the society about the risks related to cryptocurrencies since 2014 and actualized its opinion in 2017 after the Judgment of the Court of Justice of the European Union of 22 October 2015 in case C–264/14 on the status of Bitcoin currency. The Latvian Central Bank (*Par bitcoin*, 2017) notes that the issuance and use of Bitcoin is not regulated or monitored, Bitcoin is not legally pegged to the official currency of any country, therefore, Bitcoin does not have the status of legal tender in any of the jurisdictions of the European Union, however it is considered as a contractual tender and can be used as a medium of exchange for other goods or services, if both parties agree and are willing to take all the risks associated with using Bitcoin.

The Financial and Capital Market Commission (2017b) draws attention to the fact that so–called virtual currencies (e.g. Bitcoin and similar instruments) are not subject to the regulatory enactments within the Commission's competence (e.g. Payment Services and Electronic Money Law, Financial Instruments Market Law, etc.). Consequently, the business of buying and distributing Bitcoin and similar instruments does not constitute the issue of financial instruments or electronic money or the provision of payment services. Consequently, natural or legal persons carrying out commercial activities related to the purchase and distribution of Bitcoin are not licensed or registered with the Commission as financial and capital market participants.

At the same time, the FCMC (*FKTK viedoklis par…*, 2017) emphasizes that Bitcoin and similar instruments cannot be considered as an official currency or legal tender, given that the issue and use of these types of instruments are not regulated and pegged to a country's national currency. Official currencies are a legal tender recognized by countries and payment systems and are accepted and used in circulation. By contrast, Bitcoin is not comparable to the national currency of any country, as it is not permitted by law and has not been issued by a competent authority, such as the Bank of Latvia or the European Central Bank.

The FCMC (*FKTK viedoklis par…*, 2017) also draws attention to the fact that a company wishing to carry on a business related to Bitcoin may have difficulty opening current accounts with credit institutions, as servicing such companies may jeopardize the reputation of credit institutions.

In November 2017 Latvian Financial and Capital Market Commission (*Brīdinājums investoriem par…*, 2017) issued a warning about ICOs defining ICOs as a form of public fundraising through the issue of crypto–currency or tokens and warned that ICOs are highly speculative, high–risk investments. Token represents a claim to the issuer, which can be represented through cryptocurrency, security or any right depending on its features. FCMC (*Brīdinājums investoriem par…*, 2017) warned that ICO might be organized in such a way that it would not fall under current financial markets regulation, leaving investors and their investments outside any customer protection mechanism such

as the Investor Protection Act or the Deposit Guarantee Act, with a high risk of losing all the funds invested. ICOs are also exposed to higher risks of fraud and illegal transactions due to their anonymity and ability to raise large sums of money in a short period of time. The FCMC (*Brīdinājums investoriem par…*, 2017) also noted that it would evaluate each ICO model separately, as there are different ICO structure models and in some cases the token may in essence correspond to the financial instruments under the Financial Instruments Market Law (Finanšu instrumentu tirgus…, 2020), therefore there may be situations where FIML requirements apply to such tokens.

Before deciding to get involved in ICO transactions, the FCMC (*Brīdinājums investoriem par…*, 2017) recommends conducting a detailed study of the project and draws attention to the fact that the investor must be very experienced and confident about the ICO project and its quality, initially researching the project business plan or 'White paper' and specifically draws attention to the possibility of misleading marketing:

The ICO usually provides only 'white paper' information that is comparable in purpose and substance to the prospectus, but does not comply with the requirements governing the content of the prospectus. The information set out in the White Paper may be misleading and may not contain all the information necessary for the client to make an informed and informed decision. Very good technical knowledge is required to understand and evaluate the characteristics and risks of the token.

Misleading and false advertising to customers may be distributed during the ICO and product distribution techniques may be used that aggressively highlight information about the benefits of tokens or virtual currencies to be issued (mostly the expected price without any economic justification), omitting risk information.

In 2019 the FCMC published guidelines on the possibilities and the applicable regulation of the usage of virtual assets and ICOs, clarifying the following definitions (Finanšu un Kapitāla Tirgus Komisija, 2019):

- **Virtual asset** is a digital representation of value, which may be digitally transmitted, stored or traded, and which may function as an exchange for the settlement of goods or services with persons who accept virtual currency by mutual agreement, including reasonable expectations of financial gain or to grant the right to the distribution of the issuer's, its project's profit (income) or to grant administrative (voting) rights in the issuer's company or voting rights in determining the development of the project.
- **ICO** is a public fundraising by issuing virtual assets or tokens.
- **Token** is a coupon that, depending on the characteristics assigned to it, represents a virtual asset, security or some other claim against the issuer. Tokens exist only in a virtual way and are not considered legal tender or securities in the classical sense, however, if the invested funds are repayable to the issuer of tokens, assessing the essence of each token issue individually, the raising of such funds may be subject to some of the applicable regulations.

The FCMC authorisation is not required if the virtual asset or token serves the following functions (Finanšu un Kapitāla Tirgus Komisija, 2019):

- **Billing function.** A virtual asset is used as a contractual means of payment (settlement) to settle goods or services with the persons who accept it. The performance of such activities is governed by a contractual relationship between the parties based on private law transactions (Civil Law, Regulations on Distance Contracts, Consumer Rights Protection Law, Advertising Law, etc.)
- **Exchange function**. A virtual asset is acquired as a result of an exchange or used as a medium of exchange for another means of payment (exchange of virtual currency). The Law on the Prevention of Money Laundering and

Terrorist Financing applies to the performance of such activities (Noziedzīgi iegūtu līdzekļu…, 2020). Execution of the mentioned activities from 01 July 2019 are supervised by the State Revenue Service.

- **Consumption function.** Virtual assets that grant access rights to the issuer's platform of virtual assets or the right to use a product or service produced by the issuer may be considered as virtual assets of a consumer function. The use of such assets is primarily regulated by the Civil Law, the Regulations on Distance Contracts, the Consumer Rights Protection Law, the Advertising Law, etc. law.
- **Charity function.** A virtual asset is used as a transfer of a certain digital value (donated, voluntarily given (usually for charity) without expectation of financial return) to a person who accepts it for charity (Law On Taxes and Duties, Law on Public Benefit Organizations, Law on Advertising.)

- The virtual asset qualifies as a transferable security / financial instrument within the meaning of the Financial Instruments Market Law (Finanšu instrumentu tirgus…, 2020) if it has the following features (Finanšu un Kapitāla Tirgus Komisija, 2019):
  - **Equity security.** Virtual assets that grant rights to shares in the issuer's company with the right to receive dividends or with a claim to a share of the issuer's profits or income with or without the right to participate in the management of the company.
  - **Debt security.** Virtual assets that confer a claim on repayable funds with or without a pre–determined return on investment and with or without the right to participate in the management of the company.
  - **Other securities**. Virtual assets that grant the right to purchase or dispose of equity or debt securities or that provide for settlement in means of payment (cash or contractual means of payment) determined by securities, currency, yield, commodities, index multiplier.
  - **Structured finance products.** Virtual assets that are created for the purpose of transferring credit risk associated with a single financial asset or a set of financial assets that entitle the holder to regular payments that depend on the cash flows generated by the underlying asset.
  - **Derivative financial instruments.** Virtual assets that by their economic nature comply with financial instruments described in Section 3, Paragraphs 4–11 of the Financial Instruments Market Law (Finanšu instrumentu tirgus…, 2020).

If the virtual asset used by the ICO is to be classified as a financial instrument within the meaning of the FIML (transferable security or derivative financial instrument), then the ICO organizer is subject to the following rules (Finanšu un Kapitāla Tirgus Komisija, 2019):

- **An ICO organizer qualifies as an issuer that raises funds publicly**. An ICO organizer, or a person who publicly raises funds from investors, may be considered an issuer in accordance with FIML requirements. If it is planned to raise funds up to EUR 100,000, then the issuer does not have to inform the FCMC; if it is planned to attract funds from EUR 100,000 to 1,000,000, the issuer must submit an offer document to the FCMC; if the funds raised could exceed EUR 1,000,000, the issuer must submit a prospectus.
- **An ICO organizer qualifies as an investment service provider (investment services and investment ancillary services).** If the token issued by an ICO organizer qualifies as a transferable security or derivative financial instrument,

then such services as receiving and sending orders for financial instruments, executing orders on behalf of clients, trading on own account, portfolio management, investment advice, initial placement of financial instruments, and organization of a DT and OT system is considered to be the provision of investment services, which are authorized to be performed by an investment service provider (for example, a credit institution or an investment brokerage company). At the same time, it would be assessed whether ancillary investment services are offered and provided, the provision of which must also be subject to appropriate authorization.

- **An investment brokerage firm or credit institution must be involved in the initial issue and its execution.** If the ICO organizer issues and offers to investors a virtual asset that qualifies as a security / financial instrument, then the ICO organizer is only entitled to make an initial offer of such virtual assets through an investment brokerage firm or a credit institution.
- **Should an investment brokerage firm or credit institution be involved in maintaining a virtual account for virtual assets?** A system maintained by the ICO organizer, which is the initial register of virtual assets qualifying as a security / financial instrument and which only reflects the tokens owned by investors (top–level account or depository function), should not be considered as holding financial instruments and maintaining such an information system, therefore an investment brokerage company or credit institution should not be involved. On the other hand, the maintenance of such virtual asset accounts at the second and subsequent levels, including the holding of funds necessary for transactions with such virtual assets and the provision of other services related to the holding or administration of virtual assets, should be considered as holding financial instruments and requires investment brokerage company or credit institution license.

FCMC (Finanšu un Kapitāla Tirgus Komisija, 2019) also clarifies regulatory treatment of other potential activities with ICOs and virtual assets:

- If the organizer of the ICO grants loans in his own name and publicly raises repayable funds to secure this activity, this activity would be treated as an activity of a credit institution.
- If an ICO organizer raises capital (not virtual currency) from several investors to invest for the benefit of those investors in accordance with its investment policy and invests in certain investment objects, such as securities or real estate, it should be treated as an alternative investment fund manager and requires an FCMC license.

If a person sets up an investment attraction platform where investors are free to choose development projects located there that are not related to the organizer, but it attracts collective funds to finance these projects, a co–financing regulation might be applicable for services related to capital investments or loan investments. The project applicant may be a natural or legal person, but may not be a financial service provider (including a lender) that would like to refinance the issued loans with public funds. The co–financing regulation is applicable after the adoption of the co–financing services law. However, even in this case, it should be assessed whether this type of funding does not meet the requirements of the FIML (whether the investment is not classified as a transferable security or a derivative financial instrument).

Although there is no specific regulation of cryptocurrencies in Latvia, legal and natural persons must comply with tax and accounting regulations when conducting transactions, including with cryptocurrencies.

The Law on Annual Accounts and Consolidated Annual Accounts stipulates that the purchase price is the amount payable in cash or cash equivalents or the fair value of the consideration given to purchase a good or service at the time the asset is acquired (Gada pārskatu un …, 2018). Hence, the cryptocurrency must be recorded in the company's accounts as an asset (similar to a commodity) and must be valued and, if necessary, revalued at the end of the period.

The Law on Accounting stipulates that entries are made in the accounting registers on the basis of justification documents and defines what is a justification document (Par grāmatvedību…, 2020). When selling or converting a cryptocurrency into an official currency, the gain or loss must also be determined and reflected in the annual report.

If natural persons carry out transactions with virtual currency, then these persons must register as economic operators. The economic activity of a natural person is any activity aimed at the production of goods, trade, performance of works and provision of services for remuneration.

Section 11 of the Law on Personal Income Tax determines the case when the private person must register as a performer of economic activity (Par iedzīvotāju ienākuma…, 2020). Income from cryptocurrency trading can be considered as a capital gain. Tax rates are specified in Section 15 of the PIT Law (Par iedzīvotāju ienākuma…, 2020).

### 2.3.3. Overview of cryptocurrency and virtual asset regulation in Lithuania/ *Kriptovalūtu un virtuālo aktīvu regulējuma Lietuvā analīze*

The opinion of Bank of Lithuania on regulatory treatment of virtual currencies was initially published in 2014 (*Warning on Virtual…*, 2014), was subsequently supplemented with the Position of the Bank of Lithuania on Virtual Assets and Initial Coin Offerings (*Position of the Bank…*, 2017, *Position of the Bank…*, 2019), Guidelines on Security Token Offerings (STOs) in 2019 (*Guidelines on Security…*, 2019) and amendments to the Law on The Prevention of Money Laundering and Terrorism (Lietuvos Respublikos pinigų…, 2019).

The regulatory treatment of virtual currencies and assets in Lithuania can be summarized as follows (*Warning on Virtual…*, 2014, *Position of the Bank…*, 2017):

- Regulated participants in financial markets providing financial services such as credit institutions, payment institutions and electronic money institutions are prohibited from conducting operations and providing services related to virtual currencies since 2014. This ban is aimed primarily at preventing the participation of credit institutions in the exchange of cryptocurrencies for fiat currencies, as well as the preparation and conduct of ICOs. In addition, the Bank of Lithuania separately indicates that credit institutions should refrain from activities related to investing in cryptocurrencies. This prohibition does not apply to virtual currencies that are sold as financial instruments.
- Financial market participants are obliged to refrain from mixing financial services and services related to virtual currencies. As part of this requirement, credit institutions are prohibited from any way linking the provision of financial services with virtual currencies. Thus, the actual prohibition, in particular, includes (1) services for the use of means of payment provided by credit institutions to accept virtual currencies for payment for goods or services (for example, bank cards), and (2) linking means of payment to accounts, designed to use virtual currencies. In addition, credit institutions are required to protect their trademarks, commercial designations, domain names and not to allow their use in activities related to virtual currencies. This rule applies, inter alia, to internal communications of credit institutions. Information posted on platforms

and applications of credit institutions should not contain information on virtual currencies that could mislead consumers and create the false impression that the financial services provided are related to virtual currencies.

- When providing financial services to persons involved in activities related to virtual currencies, credit institutions are required to ensure compliance with legislation to prevent the laundering of proceeds from crime and the financing of terrorism. The Bank of Lithuania considers operations with virtual currencies as a source of increased risks associated with the laundering of proceeds from crime and the financing of terrorism. Accordingly, the obligation to minimize them is assigned to credit institutions that have the necessary funds and opportunities to identify such sources. In addition, credit institutions must make sure that consumers of financial services involved in activities related to virtual currencies also properly comply with financial security legislation, including:
  - identify their customers;
  - comply with the requirements of the AML procedure (AML) and the customer identification procedure (KYC);
  - monitor financial transactions.

If the consumer of financial services does not provide the proper level of financial security, financial services providers are obliged to independently minimize the risks associated with this.

The position of the Bank of Lithuania is not legally binding, and also cannot be used in the interpretation of legislative acts. However, it should be considered as a general guideline when carrying out activities within the jurisdiction of the Republic of Lithuania. In particular, this is due to the fact that credit institutions that neglect these rules run the risk of being left without a license. The Bank of Lithuania has made it clear that cryptocurrency transactions are not the subject of financial services, and accordingly, such activities do not comply with the terms of a license of credit institutions.

Jekaterina Govina (2018), Advisor to Board Member, Bank of Lithuania, notes that financial market needs clarity. With the development of crowdfunding industry, Lithuania has introduced a crowdfunding law in 2016 (Lietuvos Respublikos sutelktinio…, 2016) and ICO guidelines in 2017 (*Position of the Bank*…, 2017) at the moment of its rising popularity, clarifying four important areas:

- Regulation
- Taxation
- Accounting
- AML/ CFT

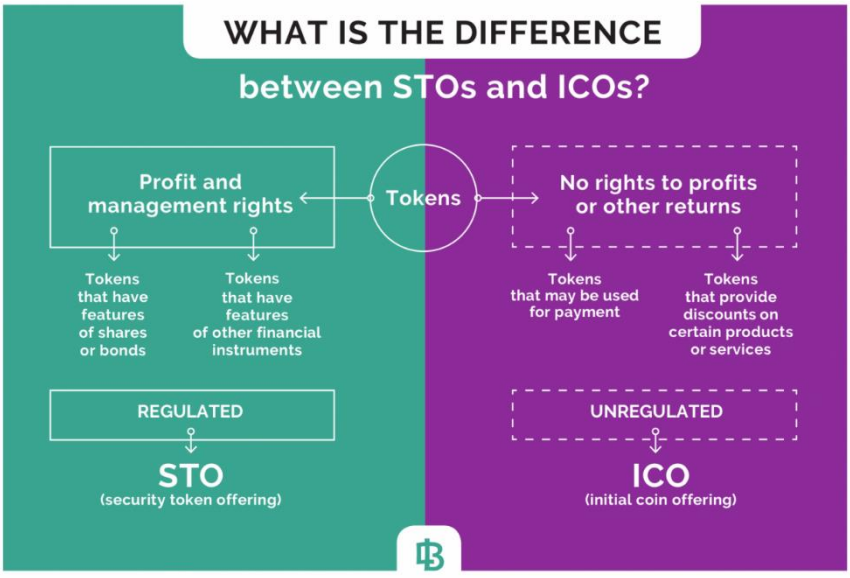
As in many other jurisdictions, the Bank of Lithuania takes a liberal approach to treatment of ICOs, according to which the use of virtual currencies, depending on actual circumstances, can be regulated by the legislation of the Republic of Lithuania. In particular, the following laws depending on its nature (*Position of the Bank*…, 2017) may regulate ICOs:

- **Securities legislation**, for example, in the case when o tokens are by nature financial instruments, including mediation of the transfer of property rights, corporate rights, distribution of profits, etc.; or tokens can be transferred to third parties and act as an object of sale in the secondary market.
- **Crowdfunding legislation**, when the ICO meets the legal definition of ‘project’;
- **Legislation on collective investment**, when the issuer of tokens invests the collected funds in order to make a profit, and not necessarily only in projects related to virtual currencies;

- **Legislation on the provision of investment services** when tokens are financial instruments – a license is required for their implementation;
- **Legislation on the secondary financial market**, when tokens are financial instruments – a license is required to organize trading;
- **Legislation on the formation of the primary capital of a credit institution**, when the funds collected through the ICO are planned to be used as the authorized capital of a recently established financial institution.

Lithuanian Audit, Accounting, Property Valuation and Insolvency Management Authority (AVNT) published guidelines on 'Cryptocurrency and Token Accounting Guidelines' in June 2018 and stated that these guidelines are part of the Lithuanian Ministry's of Finance general position on crypto activities (Accounting Guidelines on…, 2018). The Lithuanian AVNT justifies the adoption of these guidelines on the grounds that, in the absence of a regulatory framework, cryptocurrency transactions should be accounted for by their economic nature and based on the company's accounting policies. The accounting policy recommendations in the guidelines are based on the assumption that the cryptocurrency is a financial asset. The valuation of the cryptocurrency as an asset also found that the cryptocurrency is intangible and similar in this respect to intangible assets. However, the value of intangible assets must be gradually reduced through annual write–downs. Given the economic nature of the cryptocurrency, a gradual write–down is not allowed. Therefore, the Lithuanian AVNT concluded that the cryptocurrency is not an intangible investment but rather a financial asset that should be measured at fair value through profit or loss. If it is not possible to determine the fair value of a cryptocurrency, it should be measured at cost, with an annual impairment test and, if any, a write–down. The guidelines recommend that the cryptocurrency be indicated in the balance sheet as current asset, but in the chart of accounts as a sub–item in the group 'Bank accounts' (if used as a means of payment) or in the group 'Other investments' (if used to generate investment income). The guidelines also state that all costs associated with 'mining' a cryptocurrency should be expensed immediately.

The Bank of Lithuania has become one of the first market regulators in the world to issue guidelines on STOs (*Guidelines on Security*…, 2019).




*Source: Bank of Lithuania, 2019*

Fig. 2.2./ *2.2. att.* **Difference between STOs and ICOs/** ***Starpības starp sākotnējiem un arkārtotajiem žetonu piedāvājumiem***

STO is a token that looks like an ICO, but the main difference is that STOs are regulated, which provides greater security and consumer protection to potential investors.

Lithuania introduced a comprehensive crypto–regulation in 2019, being one of the first countries in the world to introduce recommendations approved by the Financial Action Task Force on Money Laundering seeking to regulate the activities of companies engaged in activities with cryptocurrencies and virtual assets, as well as introduced an obligation to ensure the effective prevention of money laundering and terrorist financing.

On 12 June 2019, the Cabinet of Ministers approved amendments to the Law on The Prevention of Money Laundering and Terrorism, prepared by the Ministry of Finance (Noziedzīgi iegūtu līdzekļu…, 2020), in which the Fifth Directive on the Prevention of Money Laundering of the European Union and recommendations approved by the Financial Action Task Force on Money Laundering were transferred to Lithuanian law.

The amendments stipulate that crypto–related companies must be registered with the Center of Registers and receive one of the following types of authorisations:

- Activities of virtual currency exchange operator.
- Activities of virtual currency depository wallet operator.

Crypto–related companies also have to follow the law on the prevention of money laundering and terrorist financing and set–up a KYC process. They must establish and verify the identity of the client before the provision of the service if the amount of transactions exceeds EUR 1000, and also provide the Financial Crime Investigation Service (SRPF) information if the amount of transactions is not less than EUR 15 thousand, and these requirements apply not only when converting cryptocurrencies into traditional and back, but also when exchanging one cryptocurrency for another.

The amendments were approved by the Parliament of the Republic of Lithuania on 3 December 2019 and entered into force on 10 January 2020 (*Lietuvos Respublikos pinigų…*, 2019).

Taking into account the recommendations of the SRFP, the initiators of the ICOs also must establish the identity of customers, however, a higher transaction line is set for them – EUR 3000. ICO initiators are also required to store certain information and collaborate with the SRPF.

### 2.3.4. Overview of cryptocurrency and virtual asset regulation in Estonia/ *Kriptovalūtu un virtuālo aktīvu regulējuma Igaunijā analīze*

Since Estonian authorities are quite friendly with respect to blockchain technology, which is considered a priority area of the State development, the Estonian government was one of the first to adopt special amendments to the law on combating money laundering and the financing of terrorism in 2017, which facilitated the crypto business in the country.

According to amendments to Money Laundering and Terrorist Financing Prevention Act (MLTFPA) passed in 2017 a special authorisation is required for conducting activities in the areas of ‘providing services of exchanging a virtual currency against a fiat currency’ and ‘providing a virtual currency wallet service’, applying the following definitions (Money Laundering and…, 2017):

- **‘virtual currency’** means a value represented in the digital form, which is digitally transferable, preservable or tradable and which natural persons or legal persons accept as a payment instrument, but that is not the legal tender of any country or funds for the purposes of Article 4(25) of Directive (EU) 2015/2366 of the European Parliament and of the Council on payment services in the internal market, or a payment transaction for the purposes of points (k) and (l) of Article 3 of the same Directive;

- **'virtual currency wallet service'** means a service in the framework of which keys are generated for customers or customers' encrypted keys are kept, which can be used for the purpose of keeping, storing and transferring virtual currencies.

Amendments to the MLTFPA entered into force on 10 March 2020, requiring licensed virtual asset service providers to apply the same AML/ CFT measures as financial institutions, including internal AML rules and procedures, monitoring business relationships, compliance officer appointment, KYC procedure on all clients with other changes including the following (Money Laundering and…, 2020):

- The state fee for a license increased from EUR 345 to 3300.
- The place of permanent establishment, the board and actual business location must be in Estonia.
- A payment account needs to be maintained at a financial service provider in Estonia or in any other EEA member state.
- 12 000 EUR (paid in) minimum share capital.
- Stricter requirements to the reputation and experience of management board members.
- 60 days to consider the authorisation request, which may be extended to 120 days.

The Estonian Financial Regulator (EFSA) has published ICO guidelines in 2016 and updated in 2018 (*Virtuaalraha (ICO)*, 2018) and determined that tokens issued as part of the ICO may be financial instruments. According to EFSA, in the analysis of tokens, factual circumstances should be taken into account, and the content should prevail over the form:

- Tokens that grant investors rights in relation to the issuer, or tokens whose value is tied to future profits or activities of the company, are more likely to be recognized as financial instruments. Thus, the issue of such tokens can be recognized as the issue of financial instruments and regulated by the legislation on securities. In this case, there is the need to go through all the necessary procedures for notification and registration.
- In addition, in some cases, the activities of ICO organizing companies, as well as persons selling tokens in the secondary market, may be recognized as the provision of investment services. The implementation of such activities requires the availability of appropriate licenses and permits. If a company provides loans at the expense of funds raised as part of the ICO, the norms of legislation on credit institutions may apply to its activities.

In accordance with the decision of the Supreme Court of Estonia (*Case number 3…*, 2016), the sale of Bitcoins as an entrepreneurial activity is considered as the provision of services in relation to **alternative means of payment**. In accordance with Estonian legislation on combating the laundering of proceeds from crime and the financing of terrorism, the permission of the authorities is required to carry out such activities.

## Summary of the Chapter 2/ *2. nodaļas kopsavilkums*

Innovation policy developments, official public opinions and public sector initiatives in blockchain space, both in the EU and Latvia, lead to a conclusion that public bodies and regulators acknowledge that blockchain technology has high potential in private and public sector of the EU and Latvia due to its perceived benefits, but also acknowledge potential risks and explore opportunities to effectively address such risks within and beyond current regulatory environment.

Taking into account that public opinions up to date are primarily centered around cryptocurrencies and virtual assets, it can be concluded that regulatory impacts and likely regulatory actions will continue developing in this particular area more actively than in other possible areas of blockchain technology applications that are broadly unaddressed in regulatory space.

The fifth EU Anti–Money Laundering Directive (AMLD5) no longer complies with the stricter FATF standards issued in 2019, which provides more detailed recommendations on applying a risk–based approach to virtual assets and virtual asset service providers. Thus, market participants in financial services industry may want to start evaluating their existing systems, in particular with respect to compliance with the forwarding rules and preventive measures described in FATF Guidelines. Lithuania has already elaborated the most recent FATF recommendations into its AML/ CFT law in 2019, and Estonia has tightened regulation for virtual asset service provider in 2020, requiring the same compliance under national AML/ CFT law as financial institutions.

A positive aspect of the new FATF rules for virtual assets could be the fact that the virtual asset industry will finally gain more certainty regarding the global AML / CFT obligations that it has been waiting for so long. In addition, compliance with the FATF requirements in the virtual asset industry can contribute to the widespread recognition of virtual assets and increase their acceptance by traditional financial institutions.

In other blockchain technology application areas, apart from financial services industry, it is reasonable to assume that Latvia will be following other European countries when the technology will become more mature and/ or will be standardized by European or international regulation, thus, Latvia is most likely to follow the fourth category of action as defined by the European Parliament, which will result in adoption of a ‘permissioned blockchain in existing systems and structures’.

In Estonia, cryptocurrencies are considered as alternative means of payment and such activities require a specialized license since 2017. In Lithuania, a comprehensive regulation of cryptocurrencies and virtual assets was introduced in 2019, requiring a specialized license. In Latvia, activities with cryptocurrencies and virtual assets do not require a specialized license, however virtual asset service providers in Latvia must comply with the legislation on anti–money laundering and prevention of terrorist financing, the same as in Estonia and Lithuania. Latvia can learn from neighbouring countries and introduce a licensing regime for virtual asset service providers in order to ensure a more structured approach to regulatory oversight.

The Central Bank of Lithuania has banned banks and financial institutions from working with cryptocurrencies and virtual assets in order to minimize risks for traditional financial system. In Estonia and Latvia, no such restriction is in place.

All Baltic regulators have issued guidelines requiring examination of tokens issued through ICOs and, if certain criteria are met, they can be recognized as financial instruments and fall under the regulation of financial securities or other laws such as crowd–funding or co–investment laws. ICO guidelines were published in 2016 in Estonia, 2017 in Lithuania and 2019 in Latvia, however Latvian FCMC published a warning about ICOs in 2017 mentioning about high risks and potential regulatory requirements, although no further details were outlined until 2019.

Overall, it can be concluded, that regulators need to work with blockchain innovation as it evolves, making guidelines to ensure the rights of developers and end users yet taking consideration not to disrupt the flow of further technological advancement.

# 3. ASSESSMENT OF BLOCKCHAIN TECHNOLOGY ADOPTION WORLDWIDE AND IN BALTIC STATES/ *BLOKĶĒDES TEHNOLOĢIJAS IEVIEŠANAS PASAULĒ UN BALTIJAS VALSTĪS IZVĒRTĒJUMS*

## 3.1. Analysis of blockchain technology adoption worldwide/ *Blokķēdes tehnoloģijas ieviešanas pasaulē analīze*

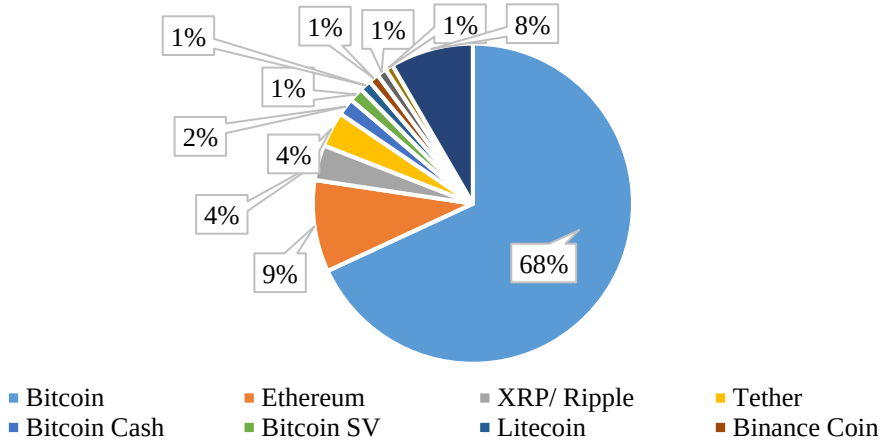
### 3.1.1. Analysis of global crypto activity/ *Starptautiskās kripto–aktivitātes analīze*

The chapter aims to analyse blockchain technology adoption trends worldwide and in the Baltic States by interpreting crypto activity indicators, analysing interconnections between crypto activity and economic competitiveness and studying publicly available information on blockchain initiatives and use cases.

In current era of globalization and digitalization all countries are competing in technological space. Nowadays, it does not matter where the technological solution is developed, it can seize global market from any part of the world. It is also true for blockchain solutions, specifically being developed in crypto space, where geographical location does not matter, since blockchain is technologically distributed throughout jurisdictions and creates unprecedented business models not only in crypto space but also in e–commerce, e–government and e–participation.

Blockchain solutions are developing at different paces throughout the world. The most prominent use case of blockchain technology implementation up to date is cryptocurrencies, associated virtual assets and crypto infrastructure, such as cryptocurrency exchanges, wallets for virtual asset storage, Bitcoin automatic teller machines (ATMs), etc.

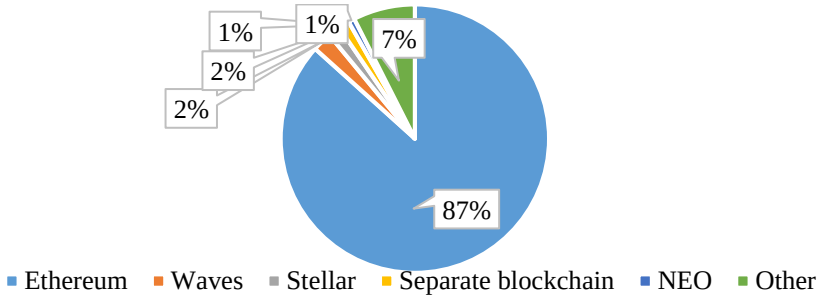
As evidenced by figure 3.1. the total capitalization of cryptocurrencies as at May 2020 is circa USD 255 trillion, with Bitcoin's market share of 68%, followed by Ethereum (9%), XRP/ Ripple (4%), Tether (4%) and Bitcoin Cash (2%). Whilst Bitcoin's primary functions are medium of exchange, store of value and unit of account, which corresponds to traditional money functions, the majority of other cryptocurrencies incorporate functions beyond pure monetary constructs, for example, serving as decentralized application platforms, allowing anyone to build own blockchain solutions on their basis.




*Source: author's constructions based on data from All crypto–currencies..., 2020*

Fig. 3.1./ *3.1. att.* **Capitalization of cryptocurrencies, 2020/** ***Kriptovalūtu kapitālizācija, 2020***

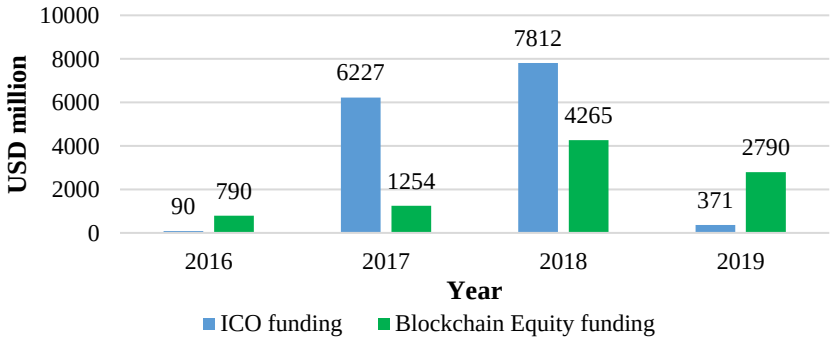
As evidenced by figure 3.2. the most popular decentralized application platform up to date is Ethereum – 87% of public blockchain solutions being programmed on this platform, followed by Waves (2%), Stellar (2%) and NEO (1%).




*Source: author's constructions based on data from* Stats and Facts…, *2020*

Fig. 3.2./ *3.2. att.* **ICOs by platform, 2020/** ***Pirmreizējie monētu piedāvājumi pēc platformas, 2020.***

Any blockchain solution, built on decentralized application platform can attract financing through initial coin offerings (ICOs), which is equivalent to initial public offerings (IPOs) in financial industry, when companies are publicly offering their shares, thus, it is a good indicator for measuring crypto–industry activity. The main difference between ICOs and IPOs is that ICOs do not necessarily offer shares in a crypto company/ project, may have various other attributes and the funds go directly to the wallet of a crypto project promoter without any formal control by a regulator, exchange or advisor. When ICO activity began in 2013 with an ICO of Mastercoin, many financial industry regulators all over the globe became concerned with associated risks and published guidelines explaining in which cases tokens offered through ICOs must be considered and regulated as a financial instrument and in which cases those offerings may stay unregulated. In the meantime, many crypto–projects managed to collect funds through ICOs. The ICO procedure allowed blockchain project founders to raise billions of dollars through the sale of tokens, without the participation of venture funds and crowdfunding sites. An overall ICO activity decreased considerably in 2019, as many crypto–projects failed, investors lost their funds and there was no formal mechanism developed to weigh any responsibility or liability upon crypto project promoters. As evidenced by the figure 3.3., in 2019 the amount of funds that blockchain projects raised using traditional investment procedures already significantly outstripped financing received at the ICO in comparison to 2018 – ca. 7.5 times more equity funding in 2019 versus ca. 2 times less in 2018 (*The Blockchain Report..., 2020*).




*Source: author's constructions based on The Blockchain Report..., 2020*

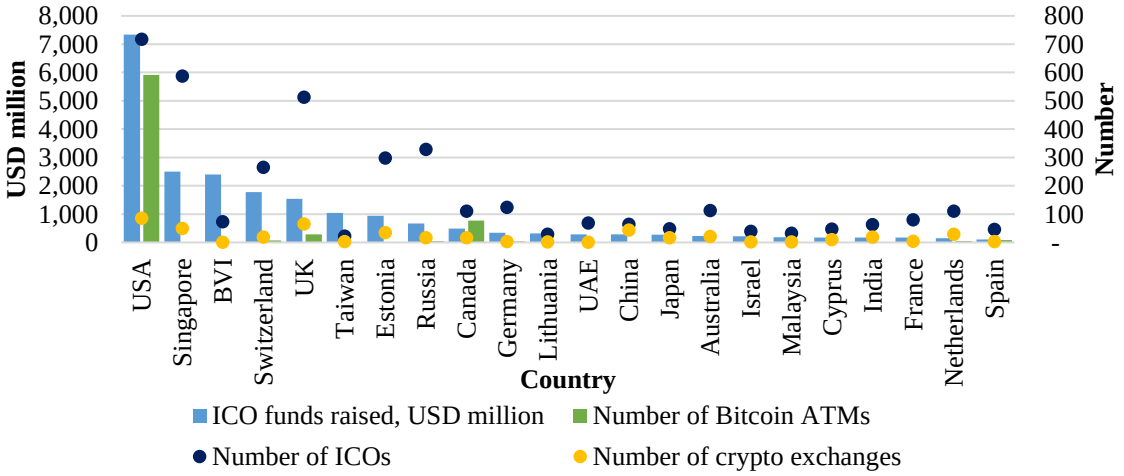
Fig. 3.3./ *3.3. att.* **ICO funding and blockchain equity funding, USD million/** ***ICO finansējums un blokķēdes tehnoloģiju kapitāla finansējums, miljoni ASV dolāru***

In 2019 equity investments in the blockchain industry came noticeably less – USD 2.8 billion in 2019 versus USD 4.3 billion in 2018 (*The Blockchain Report...*, 2020). According to *The Blockchain Report...* (2020), among the risks that hinder the growth of equity investments are the volatility of cryptocurrencies, the ambiguity, and in many cases even the absence of regulators and lawsuits regarding a number of projects, especially in the USA. Nevertheless, the figure 3.3. demonstrates that equity investments in blockchain projects exceed the 2017 figures in 2019.

According to *The Blockchain Report...* (2020), the most transactions are with early stage blockchain companies – the number of Series A seed transactions and investment rounds increased from 80% in 2017 to 88% in 2019, share of middle–level transactions (series B and C), remains relatively unchanged, while transactions of a later stage (series D and later) are practically absent.

Since 2018, other forms of crypto offerings emerged – Initial Exchange Offerings (IEOs) and Security Token Offerings (STOs). IEOs are ICOs organized via crypto–exchanges, which take full responsibility for the listing process and implementation of investor rights for security tokens. STOs are regulated ICOs when tokens qualify as securities that provide certain rights to investors and vetting rights may be implemented by respective regulators and third parties.

In order to analyse geographical trends in development of blockchain solutions in crypto space, ICO statistics can serve as the basis for analysis, since more granular statistical data is publicly available for this type of offerings in comparison to IEOs and STOs. Other indicators evidencing crypto activity include Bitcoin ATMs and crypto exchanges. Figure 3.4 demostrates that USA is an undisputed leader globally in terms of crypto activity by all indicators – ICO funds raised (USD 7.3 billion), number of ICOs (717), number of crypto exchanges (85) and number of Bitcoin ATMs (5.9 thousand).




*Source: author's constructions based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020*

Fig. 3.4./ *3.4. att.* **Crypto–activity statistics in countries with more than USD 100 million raised in ICOs/** ***Kriptoaktivitātes statistika valstīs ar vairāk nekā 100 miljonu ASV dolāru piesaistītajiem līdzekļiem no pirmreizējām monētu emisijām***

Estonia and Lithuania take the 7th and 11th place by ICO funds raised globally, whilst Latvia takes only 34th place (see Annex 5 for the full list of countries). Also, Latvia's crypto–regulatory rank is considerably below the ranks of Estonia and Lithuania. Lithuania is the leading country among Baltic States ranking the 4th in the world, followed by Estonia's 14th rank, whilst Latvia substantially lags behind with the 81st rank.

Since 2013, there has been 27 ICOs in Latvia with USD 28 million funds raised in comparison to 298 ICOs and USD 946 million funds raised in Estonia and 29 ICOs and USD 323 million funds raised in Lithuania. Estonia is also leading by the number of crypto exchanges (34) in comparison to Latvia (0) and Lithuania (1).

ICOs in Latvia include:

- Cryder (EUR 30 thousand) – decentralized taxi service;
- Digipulse (EUR 0.9 million) – digital asset inheritance platform;
- HashRush (EUR 1.5 million) – a computer game that allows to earn cryptocurrencies while playing;
- Aeternum (EUR 3 million) – a platform where researchers can invest in intellectual property rights;
- Forty Seven Bank (EUR 10.9 million) – digital bank;
- Globitex (EUR 9.7 million) – a global crypto–currency exchange platform (headquarters registered in the United Kingdom).

In order to understand if crypto–activity indicators are inter–connected, a correlation analysis was performed. Based on analysed data on 56 countries, correlations among four indicators of crypto activity were found significant at 0.01 level (2–tailed) as demonstrated by table 3.1.

Table 3.1./ *3.1. tabula*

**Correlation analysis among crypto activity indicators/ *Kriptoaktivitātes rādītāju korelācijas analīze***

| Indicator | Attribute | ICO funds raised, USDm | Number of ICOs | Number of crypto exchanges | Number of Bitcoin ATMs |
|---|---|---|---|---|---|
| **ICO funds raised, USDm** | Pearson Correlation | 1 | .828** | .754** | .866** |
| | Sig. (2–tailed) | X | 0.000 | 0.000 | 0.000 |
| | N | 56 | 56 | 56 | 56 |
| **Number of ICOs** | Pearson Correlation | .828** | 1 | .870** | .623** |
| | Sig. (2–tailed) | 0.000 | X | 0.000 | 0.000 |
| | N | 56 | 56 | 56 | 56 |
| **Number of crypto exchanges** | Pearson Correlation | .754** | .870** | 1 | .625** |
| | Sig. (2–tailed) | 0.000 | 0.000 | X | 0.000 |
| | N | 56 | 56 | 56 | 56 |
| **Number of Bitcoin ATMs** | Pearson Correlation | .866** | .623** | .625** | 1 |
| | Sig. (2–tailed) | 0.000 | 0.000 | 0.000 | X |
| | N | 56 | 56 | 56 | 56 |

*Source: Author's analysis based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020*

All correlations are positive and above average, which indicates that dimensions of crypto–activity are developing in parallel and interconnectedly.

A fairly strong positive relationship was observed between:

- ICO funds raised and number of ICOs (0.828)
- ICO funds raised and number of Bitcoin ATMs (0.866)
- Number of ICOs and number of crypto exchanges (0.870)

A moderate positive relationship was observed between:

- ICO funds raised and number of crypto exchanges (0.754)

- Number of ICOs and number of Bitcoin ATMs (0.623)
- Number of crypto exchanges and Number of Bitcoin ATMs (0.625)

An important factor, which may be linked to crypto–activity, is cryptocurrency regulation, which differs in each country. Blockchain Regulations... (2019) publishes crypto–regulatory country rank, which may serve as a good benchmark in analysing crypto regulation and its correlation with crypto activity. Based on data analysed for 55 countries, where the most of crypto–activity is observed, the only significant correlation among four analysed indicators of crypto–activity was found between the number of ICOs and crypto regulation – a positive correlation 0.303 at the 0.05 level (2–tailed) was observed (see table 3.2.).

Table 3.2./ *3.2. tabula*

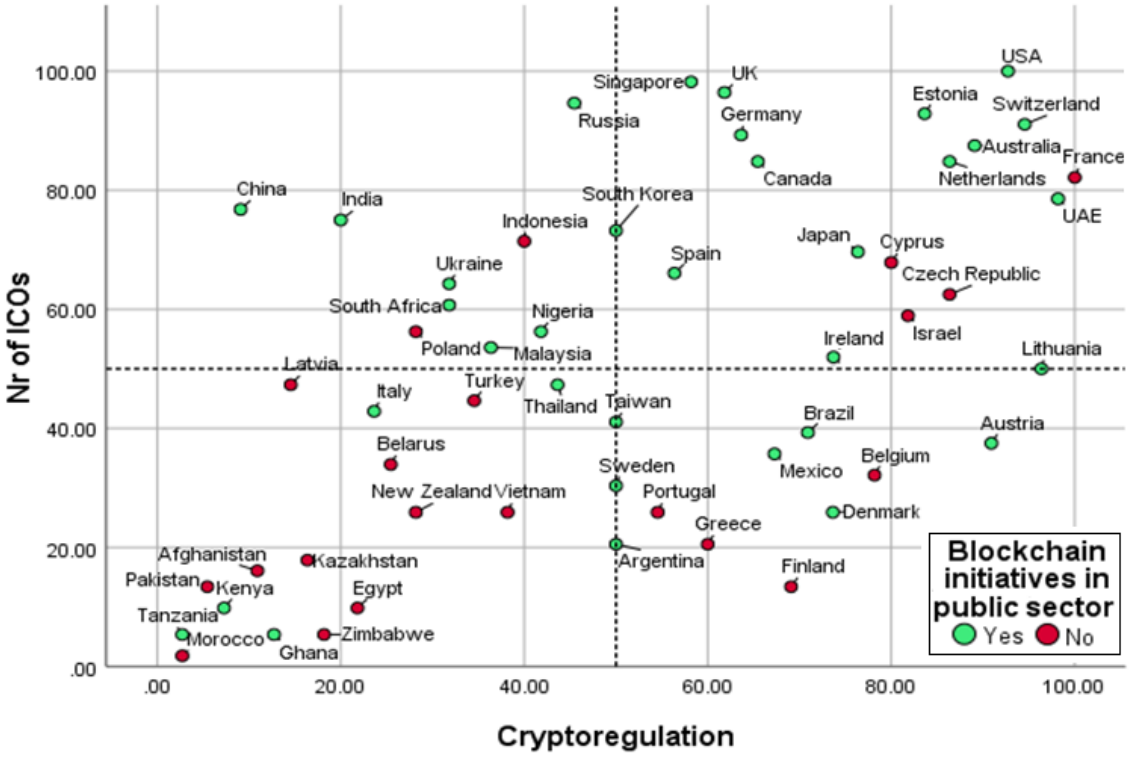
**Correlation analysis between crypto activity indicators and crypto regulation/**
***Korelācijas analīze starp kriptoaktivitātes rādītājiem un regulāciju***

| Indicator | Attribute | Crypto regulation |
|---|---|---|
| **ICO funds raised, USDm** | Pearson Correlation | 0.251 |
| | Sig. (2–tailed) | 0.065 |
| | N | 55 |
| **Number of ICOs** | Pearson Correlation | .303* |
| | Sig. (2–tailed) | 0.024 |
| | N | 55 |
| **Number of crypto exchanges** | Pearson Correlation | 0.221 |
| | Sig. (2–tailed) | 0.105 |
| | N | 55 |
| **Number of Bitcoin ATMs** | Pearson Correlation | 0.172 |
| | Sig. (2–tailed) | 0.209 |
| | N | 55 |

*Source: Author's analysis based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020*

Although the correlation is weak, it displays a positive relationship. Therefore, it can be assumed that there are also other factors that influence crypto–activity. One of such factors may be blockchain initiatives in public sector as they may serve as a good practice example to promoters of crypto solutions, enhancing visibility and demonstrability of blockchain technology use cases and increases overall awareness about blockchain technology in society. Based on publicly available information on blockchain initiatives in public sector, for further analysis each country was marked 'Yes' or 'No' depending on whether information on blockchain initiatives in public sector was found by the author. Such initiatives include proof–of–concept projects, pilot projects and functioning projects implemented by either public administration or regulatory authorities. In order to make data visually comparable, indicators 'Number of ICOs' and 'Crypto regulatory rank' were converted to fractional rank expressed in percentage using SPSS function 'Rank cases'.

As evidenced by the figure 3.5., countries that show above average ICO activity also show more blockchain activity in public sector in comparison to countries showing below average ICO activity – among 28 countries falling in the top half of the analysed sample 21 countries have also blockchain initiatives in public sector representing 75% in comparison to only 44% in the bottom half of the sample (12 out of 27).




*Source: Author's analysis based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020*

Fig. 3.5./ *3.5. att.* **Interconnections among Nr of ICOs, crypto regulation and blockchain initiatives in public sector/** ***Likumsakarības starp ICO skaitu, kriptoaktivitāšu regulāciju un blokķēžu iniciatīvām publiskajā sektorā***

The same trend is observed with the relationships between the top and bottom half of crypto regulation distribution – countries showing above average crypto regulation show also more activity with blockchain initiatives in public sector – 70% (21 out of 30) versus 48% (12 out of 25) in comparison to bottom half. Also, the Quadrant 1 shows considerably higher activity in blockchain initiatives in public sector in comparison to the Quadrant 3 – 74% (14 out of 19) versus 31% (5 out of 16), accordingly, evidencing that demonstrability of blockchain use cases in public sector has positive relationships with development of crypto–activity and crypto–regulation.

A few examples of blockchain solutions developed and tested by public authorities include:

- Blockchain sandbox for fintech start–ups in Lithuania
- E–health and E–law systems in Estonia
- Chromaway property transactions in Sweden – Sweden is studying the possibilities of using blockchain as a technical solution for real estate transactions.
- uPort decentralised identity in Zug, Switzerland
- Infrachain governance framework in Luxemburg
- Pension infrastructure in the Netherlands
- Stadjerspas smart vouchers in Groningen, the Netherlands
- Exonum land title registry in Georgia
- Blockcerts academic credentials in Malta

### 3.1.2. Analysis of interconnections between crypto activity and economic competitiveness/ *Likumsakarību analīze starp kriptoaktivitāti un ekonomisko konkurētspēju*

In order to understand relationships between crypto activity and attributes of knowledge economy, further called as 'economic competitiveness', the author selected several indicators for further analysis – GDP per capita displaying overall economic development, Global Competitiveness Index displaying nation's productivity and prosperity, E–government and E–participation indices displaying overall digitalisation levels. The author did not include in the analysis Knowledge economy and Knowledge indices as the latest data were published for 2012, which would not be relevant for the analysis of current trends. DESI index was also not selected by the author as it is only prepared for the EU countries, whilst the sample of analysed countries includes many countries outside of the EU.

Based on analysed country data, three indicators of crypto activity ('ICO funds raised', 'Number of ICOs' and 'Number of crypto exchanges') display significant correlations at 0.01 level (2–tailed) with all or some of competitiveness indicators (see table 3.3.).

Table 3.3./ *3.3. tabula*

**Correlation analysis between crypto activity indicators and competitiveness indicators/** ***Korelācijas analīze starp kriptoaktivitātes rādītājiem un konkurētspējas rādītājiem***

| Indicator | Attribute | GDP per capita | GCI | EGDI | EPI |
|---|---|---|---|---|---|
| **ICO funds raised, USDm** | Pearson Correlation | 0.384** | 0.372** | 0.251 | 0.225 |
| | Sig. (2–tailed) | **0.003** | **0.006** | 0.067 | 0.102 |
| | N | 56 | 53 | 54 | 54 |
| **Number of ICOs** | Pearson Correlation | 0.422** | 0.427** | 0.355** | 0.322* |
| | Sig. (2–tailed) | **0.001** | **0.001** | **0.008** | **0.018** |
| | N | 56 | 53 | 54 | 54 |
| **Number of crypto exchanges** | Pearson Correlation | 0.325* | 0.416** | 0.338* | 0.385** |
| | Sig. (2–tailed) | **0.014** | **0.002** | **0.012** | **0.004** |
| | N | 56 | 53 | 54 | 54 |
| **Number of Bitcoin ATMs** | Pearson Correlation | 0.252 | 0.243 | 0.153 | 0.148 |
| | Sig. (2–tailed) | 0.061 | 0.079 | 0.270 | 0.287 |
| | N | 56 | 53 | 54 | 54 |

*Source: author's constructions based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020; GDP per Capita…, 2019; The Global Competitiveness…, 2019, Country Data, 2018*

Although correlations are fairly weak, they are positive, which indicates that crypto–activity and competitiveness are positively interconnected. For further investigation of interconnections between crypto–activity and competitiveness, the author utilizes a factor analysis in SPSS. As evidenced by table 3.4. KMO and Bartlett's Test indicates that the factor analysis is useful for further analysis of data. Proportion of variance in variables that might be caused by underlying factors is 70.9% and variables are related at 0.01 level of significance.

Table 3.4./ *3.4. tabula*

**KMO and Bartlett's Test/ *KMO un Bartleta tests***

| | | |
|---|---|---|
| **Kaiser–Meyer–Olkin Measure of Sampling Adequacy.** | | **0.709** |
| **Bartlett's Test of Sphericity** | Approx. Chi–Square | 492.213 |
| | df | 28 |
| | Sig. | **0.000** |

*Source: Author's analysis based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020; GDP per Capita…, 2019; The Global Competitiveness…, 2019, Country Data, 2018*

The author further utilized a principal component analysis as and extraction method. The analysis divided analysed indicators into two components explaining 84.63% of variance (see table 3.5.).

Table 3.5./ *3.5. tabula*

**Total Variance explained/ *Kopējās dispersijas izskaidrojums***

| **Component** | **Initial Eigenvalues** | | | **Extraction Sums of Squared Loadings** | | | **Rotation Sums of Squared Loadings** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumu–lative % | Total | % of Variance | Cumu–lative % | Total | % of Variance | Cumu–lative % |
| 1 | 4.641 | 58.009 | 58.009 | 4.641 | 58.009 | 58.009 | 3.427 | 42.834 | 42.834 |
| 2 | 2.130 | 26.621 | **84.630** | 2.130 | 26.621 | 84.630 | 3.344 | 41.796 | 84.630 |
| 3 | 0.518 | 6.479 | 91.109 | X | X | X | X | X | X |
| 4 | 0.387 | 4.836 | 95.946 | X | X | X | X | X | X |
| 5 | 0.132 | 1.656 | 97.601 | X | X | X | X | X | X |
| 6 | 0.105 | 1.308 | 98.909 | X | X | X | X | X | X |
| 7 | 0.071 | 0.889 | 99.798 | X | X | X | X | X | X |
| 8 | 0.016 | 0.202 | 100.000 | X | X | X | X | X | X |

*Source: Author's analysis based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020; GDP per Capita…, 2019; The Global Competitiveness…, 2019, Country Data, 2018*

The author applied a Varimax with Kaiser Normalization rotation method, which converged in three iterations. There are two mutually independent components (see table 3.6.). Indicators representing crypto–activity are included in Component2, and indicators representing competitiveness are included in Component 1.

Table 3.6./ *3.6. tabula*

**Rotated component matrix/ *Apgrieztā komponentu matrica***

| **Indicator** | **Component** | |
|---|---|---|
| | **1 – Competitiveness** | **2 – Crypto–activity** |
| GDP | **0.840** | 0.223 |
| GCI | **0.934** | 0.230 |
| EGDI | **0.958** | 0.114 |
| EPI | **0.875** | 0.120 |
| ICO funds raised, USDm | 0.150 | **0.968** |
| Number of ICOs | 0.272 | **0.879** |
| Number of crypto exchanges | 0.259 | **0.855** |
| Number of Bitcoin ATMs | 0.036 | **0.880** |

*Source: Author's analysis based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020; GDP per Capita…, 2019; The Global Competitiveness…, 2019, Country Data, 2018*

As countries are analysed on comparative basis, the author transformed factors to fractional percentage of rank. Further, the author performed a cluster analysis to visualize distribution of countries depending on interconnections between those two factors. Case processing summary in table 3.7. demonstrates 52 valid observations within the analysed sample.

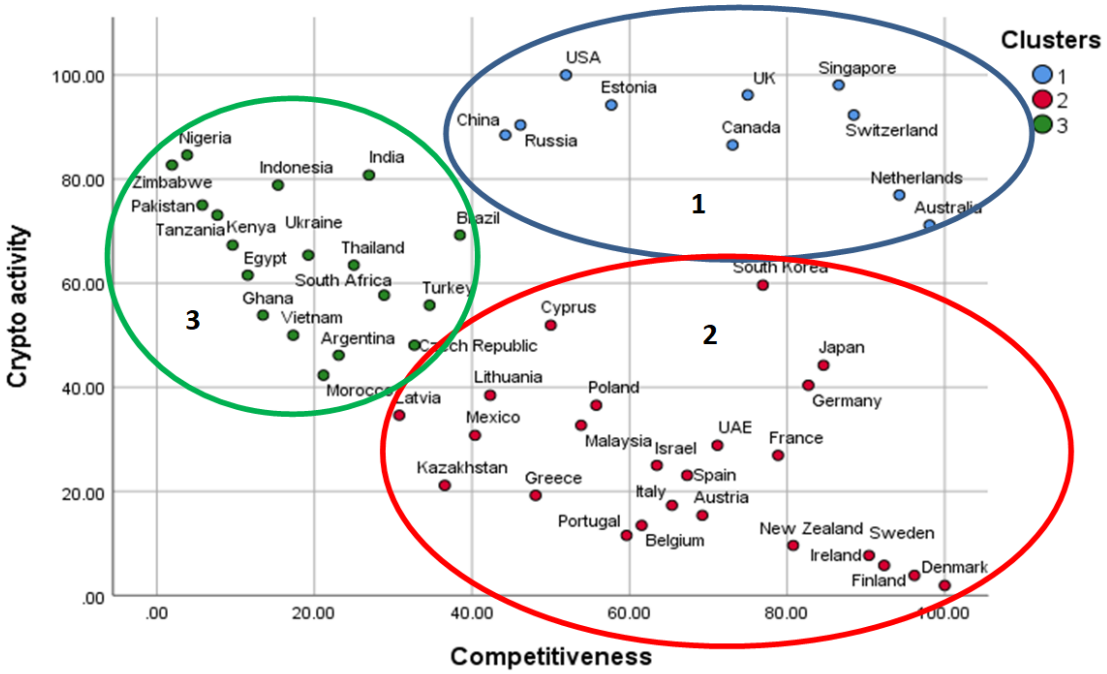
Table 3.7./ *3.7. tabula*

**Case processing summary/** ***Novērojumu apstrādes kopsavilkums***

| Valid cases | | Missing cases | | Total cases | |
|---|---|---|---|---|---|
| N | Percent | N | Percent | N | Percent |
| **52** | 85.2 | 9 | 14.8 | 61 | 100.0 |
| a. Squared Euclidean Distance used | | | | | |
| b. Average Linkage (Between Groups) | | | | | |

*Source: Author's analysis based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020; GDP per Capita…, 2019; The Global Competitiveness…, 2019, Country Data, 2018*

Agglomeration schedule (see Annex 6) displays that the largest gap occurs between stages 49 and 50 indicating a three cluster solution. For further analysis, the author visualized a sample of countries on a scatter plot (see figure 3.6.).



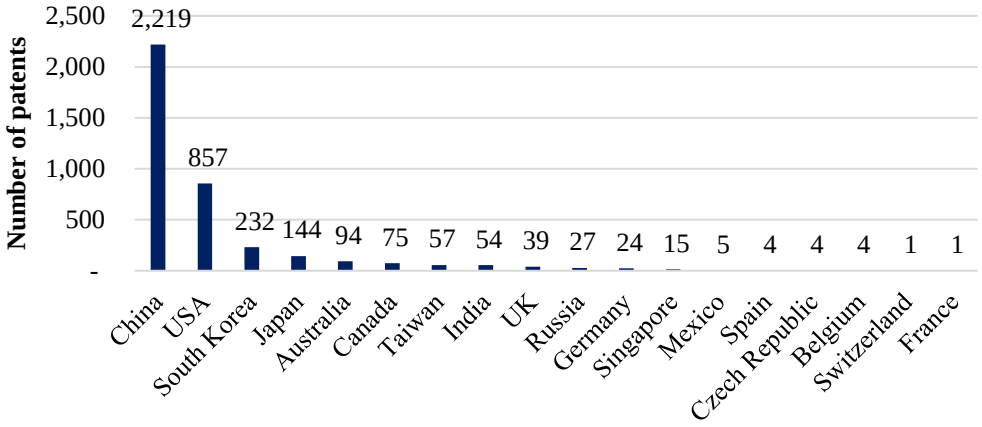

*Source: Author's construction based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020; GDP per Capita…, 2019; The Global Competitiveness…, 2019, Country Data, 2018*

Fig. 3.6./ *3.6. att.* **Cluster analysis of global crypto activity and competitiveness/** ***Pasaules kriptoaktivitātes un konkurētspējas klāsteru analīze***

The Cluster 1 indicates countries, which show global leadership in blockchain technology innovation and adoption, therefore it can be derived that a balanced combination of above average competitiveness and high crypto activity indicators may serve as antecedents to blockchain technology adoption. Estonia is in the Cluster 1 among the leading countries, whilst Lithuania and Latvia are included in the Cluster 2, where predominantly developed countries with below average crypto activity are grouped.

Those countries show mixed blockchain technology innovation and adoption trends with either facilitating or implementing blockchain solutions beyond crypto space (for example, Lithuania, UAE, South Korea, Germany) or not developing any solutions at all (for example, Latvia, Kazakhstan, Portugal). The Cluster 3 predominantly comprises developing countries with low competitiveness and high crypto–activity indicators, which also proves a broadly emphasized statement that blockchain technology, specifically in decentralized finance area, may solve various problems and challenges that developing countries are facing – starting from financial inclusion and ending with trust and compliance system establishment, which institutions and businesses in those countries are not always able to provide.

Apart from blockchain solutions in crypto space, there are also other areas of commercial blockchain technology applications, predominantly implemented by blockchain consortia or corporations, that can be evidenced by a number of patent applications submitted demonstrated in figure 3.7.

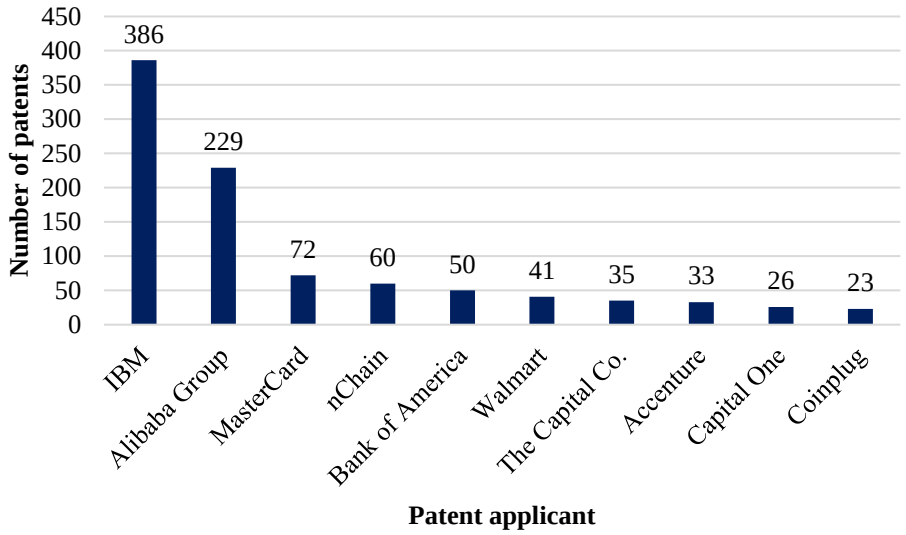



*Source: Author's based on Blockchain Patents Unchained…, 2018*

Fig. 3.7./ *3.7. att.* **Number of blockchain patent applications, 2015–2018 / *Blokķēžu patentu pieteikumu skaits, 2015.–2018.gg.***

Despite an overall ban on activities related to cryptocurrencies in China, it considerably supersedes other countries by the number of patents filed on the topic of blockchain – in the period between 2015 and 2018, China has filed 2219 patent applications (Blockchain Patents Unchained…, 2018). The 2nd most active country in terms of blockchain patents filed is the United States with 857 patents, followed by South Korea, Japan and Australia with 232, 144 and 94 patents accordingly. China's example shows that blockchain technology may be widely utilized beyond crypto space. Almost all countries that filed patents also display blockchain developments in areas outside crypto space – through piloting and implementation of blockchain initiatives and solutions by either public authorities, corporations or blockchain collaboration consortiums in the respective countries. The exceptions are Czech Republic and Belgium.

According to *The Blockchain Report...* (2020), the leaders by patent applications globally are IBM (USA) and Alibaba Group (China), which filed 386 and 229 patents in 2015–2019, accordingly (see figure 3.8.). It also evidently displays that corporates based in the USA and China compete for global dominance in blockchain IPRs.




*Source: Author's based on The Blockchain Report..., 2020*

Fig. 3.8./ *3.8. att.* **Top blockchain patent players by number of patents filed, 2015–2019/** ***Vadošie Blokķēžu patentu spēlētāji pēc iesniegto patentu skaita 2015.–2019. gados***

A few examples of blockchain solutions developed by global corporations include:

- **Walmart**, an American retail conglomerate has piloted a Food Traceability Blockchain Initiative, which tracks green peppers and leafy greens throughout supply chain helping Walmart to identify where a shipment may have been contaminated and allowing it to target recalls more precisely and reduce food waste (*How Walmart Brought…*, [n.y.]).
- **Maersk**, the world's biggest container operator and integrated conglomerate, headquartered in Denmark, has piloted a Tradelens project in cooperation with IBM, which improves international cargo shipping process through reducing errors and delays (*Maersk and IBM…,* 2018).
- **British Airway**s in cooperation with IT firm SITA has piloted a FlightChain project – a permissioned blockchain for storing and managing flight data via smart contracts (*Blockchain: the Future…,* [n.y.]).
- **FedEx** has launched a blockchain–based pilot program for customer dispute resolution (*FedEx Moves Forward…*, 2018).

### 3.1.3. Overview of blockchain initiatives, use cases and forecasts worldwide/ *Starptautisko blokķēdē balstīto iniciatīvu, risinājumu un prognožu pārskats*

According to the report issued by the Bank for International Settlements (2017), some of the world's largest economies are either testing or plan to issue digital fiat currencies or Central Bank Digital Currencies (CBDC) based on blockchain. China tests its virtual renminbi in Shenzhen before rolling the system out countrywide. Russia also announced its goal of launching a virtual rouble, the launch of which is only a matter of time. The U.S. Federal Reserve, the Bank of England, Sweden and Singapore are all exploring ways to issue their respective national digital fiat currencies. ECB is also piloting, analysing and exploring optimal design for CBDC and will continue to do so. ECB notes that currently there is a lack of 'business case' for CBDC, nonetheless ECB is committed to be well prepared if a policy decision to issue a digital currency will ever be

taken (*An ECB Digital…, 2020)*. Overall, ECB respects 'technological neutrality' and at the same time takes 'keen interest in digital innovation' (*An ECB Digital…, 2020)*.

The experience of the selected countries in blockchain technology adoption is summarized further.

**United States of America**

The federal government has adopted an approach that allows state governments to create and implement their own blockchain policies and rules. In an effort to attract innovation, some states have adopted an approach to removing legal barriers to blockchain adoption by developing blockchain–friendly legislation. For example, Illinois has published the blockchain Technology Act, which outlines the permitted use of blockchain for business and prohibits local government restrictions on blockchain or smart contracts (*Blockchain Technology Act*, 2020). Another state that has taken the lead in creating permit policy is Wyoming. The state has passed 13 laws on blockchain and cryptocurrencies (*What Do Wyoming's…*, 2019).

New York State has taken a more restrictive approach by creating BitLicense, which is issued by the New York State Department of Financial Services. In this mode, any business operating in the virtual assets space must first obtain permission for a license to carry out activities.

At the end of March 2020, the US Department of Homeland Security published recommendations regarding the coronavirus pandemic. In this document, managers of blockchain projects that distribute food and agricultural products are called 'critical infrastructure workers' (US Department of Homeland Security, 2020).

Blockchain allows to accurately tracking the movement of goods in the supply chain. Several US food manufacturers and technology firms are actively using blockchain to validate product identity and inventory management. One such initiative is the IBM Food Trust, whose members use blockchain technology to control the supply of food from the farm to the market (*IBM Food Trust…*, 2020). US organizations using the IBM Food Trust blockchain include Albertsons, Drakes, Raw Seafoods, the National Fisheries Institute, and Walmart, among many others.

In the healthcare sector, blockchain systems are used to manage patient data, control insurance, maintain suppliers' catalogues and track employee credentials.

**Singapore**

Singapore is usually called one of the 'crypto havens' in the world, not only because it is a global financial centre, but also as a result of its balanced legal and regulatory regime created by the Monetary Authority of Singapore (MAS). As for cryptocurrency, it is not regulated in Singapore, however, the activities associated with it, or its characteristics arising from its activities, determine whether it will be regulated by securities or other legislation. In 2018, MAS issued a warning to eight cryptocurrency exchanges, which were trading coins that were securities in Singapore. Consequently, cryptocurrencies may only be listed on regulated exchanges or recognized market operators.

Overall, the government is supportive of blockchain technology solution development, as evidenced by Project Ubin implemented by MAS. The Ubin project is a joint project with the financial industry participants aimed at exploring the use of blockchain and DLT technologies for clearing and settlement of payments and securities (*Project Ubin…*, 2020). The project aims to help MAS and the industry better understand the technology and the potential benefits that it can bring through practical

experimentation. It has the ultimate goal of developing easier to use and more efficient alternatives to today's digital token systems issued by the central bank. The Ubin project is a multi–year multi–stage project, each stage of which is aimed at solving urgent problems that the financial industry and the blockchain ecosystem are facing. The project currently is in the fifth phase and has since its launch published five project reports.

**United Kingdom**

United Kingdom introduced the Digital Strategy in 2017, which is aimed at developing a world–leading digital economy; it contains seven priority areas and outlines key technologies to be applied, including blockchain technology (*UK Digital Strategy*, 2017).

Since 2016, the Bank of England has been developing a digital cryptocurrency and experiments with restructuring its settlement system in such a way that it can interact with private blockchain platforms. In addition, the Bank of England, together with colleagues from Singapore, Canada and several private companies, is working on the transfer of international payments to the blockchain. According estimates, only the UK can save up to 600 million pounds a year by switching to a new system.

The Government expresses the view that the use of crypto–currencies pose minimal risks to the financial stability of the UK, and the regulation of cryptocurrencies is able to prevent their criminal use and support innovation in this area.

**Switzerland**

Switzerland has created the most developed ecosystem for crypto start–ups and ICOs in the world. Since 2013, Zug has become the largest international centre for the development of blockchain technologies. This is the capital of the so–called Swiss Crypto Valley, where one of the best ecosystems in the field of distributed ledger and blockchain technologies has been created.

In early 2017, the unofficial name of Crypto valley was secured by the creation of the Crypto Valley Association, a non–profit organization that brings together entrepreneurs, investors, educational institutions and authorities to promote advanced research and development (*Welcome to Crypto*…, [n.y.]). Among the founders of the Crypto Valley Association are major international players (Thomson Reuters, PwC, Luxoft, Bitcoin Suisse, Bussmann Advisory), scientific and educational organizations (University of Applied Sciences Lucerne Hochschule Luzern), as well as the government of the canton of Zug and Municipality of Zug.

A ‘Crypto valley’ is the birthplace of the Ethereum Foundation, the headquarters of Monetas, Lykke and dozens of other globally recognized blockchain projects. Switzerland was one of the first countries in the world to establish a favourable regulation for ICOs, ensuring compliance with international AML/ CFT standards, and public and private sectors are actively involved in blockchain innovation.

The canton of Zug is now one of the richest in Switzerland, despite the fact that it is very small. This was made possible because the authorities were very creative in attracting business. An example of a creative approach by the authorities is the fact that Zug became the first city in the world where, for example, a fine for incorrect parking can be paid in Bitcoin. In addition, some banks here freely exchange cryptocurrencies for ordinary money. Soft tax policies (which are regulated by local authorities) and favourable legislation have made Switzerland a hotbed for blockchain start–ups.

**China**

Since September 2017, a ban on ICOs and crypto exchanges has been enacted, which has led to a drop in the rate of top 10 cryptocurrencies by more than 15%. On the other hand, the regulator of China did not prohibit the operation for the storage and transfer of cryptocurrencies between individuals. However, it is worth adding that China's authorities support development of blockchain technology solutions in other areas apart from crypto space.

In October 2019, Chinese President Xi Jinping urged the country to accelerate the adoption of blockchain technologies as central elements of innovation. Xi stressed that the introduction of integrated blockchain technology is key in promoting technological innovation and industry transformations (*China's President Xi…*, 2019).

Edith Chung, a partner in the blockchain–oriented venture fund Proof of Capital, says she believes China will 'definitely' deploy its new digital currency in the course of 2020, since she believes that China hopes to become the first country in the world to release a digital embodiment of its national currency (*China's President Xi…*, 2019).

According to white paper of Industrial and Commercial Bank of China (2020), more than 70 financial services companies in China, including the largest technology companies and each of the four state–owned banks, are implementing blockchain–based financial applications, such as digital billing, payments, and other purposes (*ICBC Unveils First…*, 2020). A white paper states that the blockchain will also be used by Baidu, Alibaba, Tencent and JD to develop their own financial services applications.

Overall, China competes with the United States to dominate the blockchain landscape, as evidenced by China's dominant position in blockchain patent filings.

**Canada**

Tapscott (2018) argues that Canada has the biggest blockchain ecosystem in the world, comprising of the biggest incubators and the most promising start–ups (Paycase, Nuco/ Aion, Decentral, Tendermint/ Cosmos). The founder of Ethereum, Vitalik Buterin, studied at Canada's University of Waterloo. Government overall is supporting and encouraging blockchain initiatives and the Bank of Canada is innovating blockchain solutions itself. In addition, the global blockchain think–tank Blockchain Research Institute headed by Dan Tapscott, one of the most prominent blockchain visionaries, is located in Toronto.

**Russia**

The position of the Russian authorities regarding the regulation of cryptocurrencies has changed several times. Initially, they wanted to ban operations with cryptocurrency and tokens, and after that, they thought about creating a crypto rouble. Currently, the draft law is being actively developed, which would clarify the current market situation. Earlier, the Bank of Russia and Rosfinmonitoring have repeatedly expressed their negative attitude to cryptocurrencies, which is caused by the anonymous nature of cryptocurrencies due to the complexity of regulatory regulation. Officials also note the fact that such currencies are regularly used by cybercriminals to circumvent existing tax laws and the laws that govern AML/ CFT.

However, blockchain innovation apart from crypto space is supported and encouraged by government. Russia government is actively developing a defence laboratory, which would monitor and prevent cyber threats with the help of blockchain technology.

In 2020, Rostech has prepared a roadmap for the development of distributed ledger technologies, including blockchain, which was conceptually approved by the Russian

government, however it requested to incorporate a number of modifications (*Утверждены планы «Ростеха»…*, 2020). Blockchain solutions are being actively developed and tested also by businesses, specifically in financial industry. For example, the FinTech Association is developing the Masterchain platform – an industry solution for financial institutions in such areas as bank mortgages, digital letters of credit, bank guarantees, storage and exchange of the results of KYC procedures, factoring operations, etc. (*В России потратят…*, 2020).

**Australia**

In 2020, Australia developed a National blockchain Roadmap providing a set of targets for 2020–2025, including establishment of the National blockchain Roadmap Steering Committee (*A Look at…*, 2020). The government will also study the use of blockchain by other countries and develop programs and initiatives to support its local blockchain industry and facilitate cooperation with foreign players.

The Australian government has also funded an energy–trading platform PowerLedger, based on blockchain, through its Smart Cities and Suburbs Program (*Energy, Reimagined*…, 2017).

**Netherlands**

In 2016, a blockchain campus opened in the Netherlands with the support of the government, in which banks and financial companies jointly develop payment applications based on blockchain technology. The government is crypto–friendly and believes that the potential of blockchain technology can be realized in the coming years.

The Bitcoin Foundation of the Netherlands has been working on blockchain awareness and education since 2013, allowing students to experiment with blockchain technology innovation (*Blockchain Education in…*, [n.y.]).

Overall, the Netherlands has a very active blockchain ecosystem, with many blockchain initiatives being realised by the government, industry, and research institutes. The Dutch blockchain Coalition brings blockchain initiatives and participants together to create reliable applications with several initiatives already approaching the prototype phase and envisaged to be operational within a few years (*Blockchain…*, [n.y.]).

**India**

In India, the use of technology, including blockchain, has grown significantly over the past few years. This development has not gone unnoticed by most regulators, such as the Reserve Bank of India (RBI). While the current government is supporting innovation for the development of a digital or cashless economy, cryptocurrency is still falling short. Despite a vague cryptocurrency declaration, the government is moving towards a total ban on the use of cryptocurrency.

On the other hand, at the end of November 2019, Indian Minister of Electronics and Information Technology Sanjay Dhotre announced the launch of a national blockchain deployment program in the country (Agarwal, 2019). It is intended for the widespread adoption of technology in all sectors. Dhotre said that blockchain is one of the most important research areas for the Ministry of Electronics and Information Technology and has huge potential for applications in sectors such as banking, finance, management and cybersecurity.

**South Korea**

The South Korean government has introduced a rule allowing cryptocurrencies to be traded only from bank accounts with real names (the ‘system of accounts with real

names') starting January 30, 2018 (Financial Services Commission, 2017). Cryptocurrency dealers must have contracts with banks regarding cryptocurrency transactions. Banks check dealer management and cybersecurity systems before signing such contracts. In order to deposit into your electronic wallet with a cryptocurrency dealer, the cryptocurrency trader must have a bank account, which also has an account with the cryptocurrency dealer. The bank verifies the identity of the trader (client) when it opens an account for the trader, and the trader reports his bank account to the dealer. The dealer also verifies the identity of the trader and submits an application for registering the trader's account with the bank.

**United Arab Emirates**

The UAE has embarked on a broad and multifaceted blockade thematic initiative called Emirates Blockchain Strategy 2021. The goal of this strategy is to move 50 percent of applicable government transactions to blockchain by 2021 (*Emirates Blockchain Strategy*, 2020). As part of this initiative, Smart Dubai has set up a blockchain platform as a service to host government use cases, and more than 30 blockchain projects are currently being developed (*Dubai Advances towards…*, 2020). Through this policy, government bodies are encouraged to establish integration channels with the aim of improving the performance of services covering the responsibilities of several entities and increasingly enabling digital integration with the private sector *(Smart Dubai.., 2020).*

The Dubai government, together with IBM and ConsenSys, is working on a pilot project that will cover the whole country. According to the plans of the companies, this project will simplify the verification of identification data and enable the digitization and tracking of medical records, wills and various contracts (*Smart Dubai…*, 2020).

In Abu Dhabi, the Global Financial Services Authority has proposed a regulatory sandbox and issued guidelines for regulating encryption assets to establish rules for the secure operation of cryptocurrency–related fintech businesses, while the Central Bank of the UAE has issued warnings confirming that cryptocurrencies are not considered valid / recognized currencies under applicable regulations / legislation and are prohibited from being used in the context of commercial transactions.

In addition, the Emirates Standardization and Metrology Authority is one of the twelve observer states monitoring ISO / TC 307 blockchain standards.

The UAE authorities began to actively regulate the cryptocurrency market in October 2017. A basic guide on cryptocurrencies and ICOs has been released. In this document, the status of the cryptocurrency was determined and a number of requirements for conducting operations with cryptocurrencies were introduced.

Now virtual currencies (and cryptocurrencies are included in this concept) are regarded as goods that are not a specific investment. Companies that for the implementation of their activities received licenses from a government agency and provide / use digital currencies in the provision of financial services must comply with AML / CFT requirements.

There were no regulation issues regarding the use of cryptocurrency by individuals, and legal entities that did not receive the relevant licenses.

**The Democratic Republic of Congo**

In February 2018, it became known that the blockchain was first used to monitor the supply of cobalt from the mines of the Democratic Republic of Congo to the final products used in the production of smartphones and electric vehicles (Lewis, 2018). As a result of introducing blockchain, they will be able to track the delivery of cobalt for the production of lithium–ion batteries so that children do not engage in metal mining.

Tracking the supply of cobalt poses many problems for manufacturers, since it requires monitoring a fairly large number of mines and taking into account all the intermediate players in the supply chain. At the same time, data have to be collected from remote areas of poor countries with high crime rates.

In addition, companies are under increasing pressure from consumers and investors who demand evidence that human rights were not violated in the supply of cobalt used by manufacturers. Large Chinese producers (the main consumers of cobalt from the mines of the Congo), who were joined by such IT giants as Apple and Samsung, took up the problem of child labour in cobalt mining.

Blockchain is already being used to monitor digital fingerprints of diamonds from African mines, but cobalt delivery is much more difficult to track. However, the authors of the initiative hope at the first stage to cover at least those stages of supply at which a violation of the law is most likely.

A representative of the committee dealing with this problem explained to the agency that cobalt production has significant economic and political significance and, as a rule, limits the use of conventional technological solutions, however, blockchain can make a difference.

**The European Union**

EC–led initiatives on digital issues open up new opportunities for large–scale deployment of blockchain technology solutions in the public sector between EU Member States, where Latvia participates. Since the establishment of the EU Blockchain Observatory and Forum in February 2018, as well as the Declaration on Blockchain Partnership supported by EU Member States, pilot projects and planned actions at government level at EU level have been launched. These actions are targeted to take advantage of the many opportunities offered by blockchain in the foreseeable future and to avoid a fragmented approach by promoting interoperable infrastructures that will facilitate the availability of reliable digital services. During 2018–2019, significant work has already been done in identifying examples of use in the field of cross–border public sector digital services that could be improved with the opportunities provided by blockchain technology.

One of the initiatives that has been welcomed in the framework of the EC Blockchain Declaration Partnership is the proposal to set up a pan–European public blockchain infrastructure with a legally binding digital identity, which would make existing electronic signatures interoperable with the self–sovereign identity model using decentralized identifiers (European Commission, 2019d). This roll–out of the self–government identity blockchain platform is planned as part of a common self–government identity ecosystem based on interoperable standards and real competition between solution providers. The identity infrastructure that will be created is best explained as a decentralized register infrastructure shared by all 28 Member States of the European Union.

Several EU Member States and EEA countries have submitted a joint request to work on the development of a cross–border data exchange platform using blockchain technology – a system that can verify the authenticity of the academic title / degree / professional qualification obtained while maintaining privacy. In Latvia, this initiative is overlooked by the Ministry of Education and Science. The aim of this project is to establish good cooperation with other institutions and to develop a convincing case of blockchain technology applications for a government initiative or system that provides benefit to all students or citizens and institutions in the EU. A student or citizen who wants to continue his / her studies at a foreign institution or apply for a job of interest

abroad often faces the challenge – to share the obtained or required educational document and its acceptance as an authentic document. This procedure, which has so far been based on the preparation of paper documents, creates additional work and inconvenience for students, jobseekers and the administration involved, and does not give confidence in the submitted document and does not limit the possibility of fraudulent activities. This goal was formulated in the report of the Joint Research Center on the blockchain in education with several use scenarios:

- using a blockchain for permanently secure certificates;
- using a blockchain to verify multi–level accreditation;
- using a blockchain as a perpetual passport to education.

Other potential use cases that are investigated include asylum seeker registry, vaccine and health document registry, etc. DG TAXUD, the developer and implementer of EC customs policy, proposes to introduce a distributed register of Import One–Stop–Shop VAT identification numbers, potentially using an EU–wide blockchain infrastructure as one of the possible solutions. This project would allow traders established outside the EU to appoint an intermediary in one Member State to fulfil their VAT obligations.

The experience of some countries, such as China, shows that government's crypto–friendliness is not necessarily pre–requisite for facilitating blockchain technology adoption in other areas of application, however, in this case a strong government support and/ or visibility of blockchain technology experimentation and piloting in public sector seems to be necessary, as evidenced by large scale corporate collaborations and a number of blockchain–related patent applications filed by China, which supersedes USA, a global leader by all crypto–activity indicators.

The global blockchain activity clearly shows that blockchain technology solutions are increasingly being developed around the globe and different countries are taking various directions, however there is certainly one common trend – all countries, which show real leadership have also put efforts in the exploration of the technology. In terms of blockchain technology prospects, Gartner (2018) estimates that:

- Through 2022, only 10% of enterprises will achieve any radical transformation with the use of blockchain technologies.
- By 2022, at least one innovative business built on blockchain technology will be worth USD 10 billion.
- By 2026, the business value added by blockchain will grow to slightly over USD 360 billion, then surge to more than USD 3.1 trillion by 2030.

IBM estimates that the market for global blockchain technology will grow to from USD 315 million just a couple years ago, to USD 20 billion by 2024 (*How Blockchain and…,* 2019). The model of blockchain business value forecast (Gartner, 2018), which is based on the concept of economic added value assigned to countries, regions, industries and time displays that the current phase of irrational excesses emphasizes that blockchain adoption is low (until 2021) when companies are exploring the ways how to reap the greatest benefits (see Annex 7). According to Gartner (2018) this initial phase will be followed by focused large–scale initiatives and many successful business models (2022–2026) in the 2nd phase, whereas the 3rd phase will see a global, large–scale value added, and by 2030, blockchain technology will provide USD 3 trillion in value worldwide, combining cost reductions with revenue growth.

According to Furlonger and Uzureau (2019), blockchain does not yet display a digital revolution–taking place in business ecosystems, and it may not happen earlier than in 2028, when Gartner expects blockchain to become fully technically and functionally

scalable. In terms of blockchain applications, Furlonger and Uzureau (2019) expect that the 'plateu of productivity' for blockchain technology, smart contacts, consensus mechanisms, cryptocurrency wallets and mining may occur within the next 2 to 5 years, whereas for such applications as blockchain platforms, decentralized identity, blockchain interoperability, decentralized applications, blockchain and IoT, distributed storage in blockchain, smart contract oracles and zero–knowledge proofs the plateau may be reached within 5 to 10 years (see Annex 8 for the overview of maturity cycles of blockchain technology applications).

The days of trouble–free compatibility and cross–functionality of blockchains have not yet arrived, allowing one smart contract to update several blockchain platforms using one process. However there are many developments in blockchain technology that will change the current models and by 2023, when blockchain platforms are expected to be scalable, interoperable, and will support intelligent contract portability and cross–chain functionality, also supporting trusted private transactions with the required data privacy, bringing us much closer to the decentralized web, also known as Web 3.0 (Gartner, 2020).

According to Forrester Research (2020), blockchain will continue to evolve in 2020 thanks to mass digitalization, which, in turn, is due to the COVID–19 pandemic, and at the same time, blockchain has some problems that have yet to be solved:

- There is a gap between pilot testing and commercial launch, which is not only technical in nature, since the business has not yet fully understood the technology, which is still at an early stage of its development.
- Technical problems involve integration with enterprise ERP systems and the need for companies to find ways to interact with several blockchain platforms, the number of which is growing steadily.
- Non–technical problems primarily refer to state regulation.

## 3.2. Analysis of blockchain technology adoption beyond crypto space in the Baltic States/ *Blokķēdes tehnoloģijas ieviešanas analīze Baltijas valstīs citās jomās, izņemot kriptovalūtas*

### 3.2.1. Latvia's participation in European blockchain initiatives/ *Latvijas līdzdalība Eiropas mēroga blokkēžu tehnoloģiju inciatīvās*

On the 10 of April 2018, Latvia together with other European countries and Norway signed the declaration of 'Cooperation on a European Public Blockchain Partnership' (*European Countries Join*…, 2018), which calls for 'building on existing leading initiatives, pooling forces and collaborating further on specific actions towards a European blockchain Infrastructure for services of public interest'. It also concludes the establishment of a European blockchain Services Infrastructure (EBSI) that supports the delivery of cross–border digital public services, with the highest standards of security and privacy. Several pilot projects have been started and a number of cross–border digital services have been identified, where blockchain technology might be implemented. Latvia as one of the Declaration signatories has actively participated within the European Blockchain Partnership working group meetings since their beginning. It should be noted, that those working group meetings are attended by the representatives of the Ministry of Economics and there is no evidence of participation of representatives of the Ministry of Regional Development and Environmental Protection, which is responsible for development and implementation of a national digital transformation strategy.

Following the EC–led initiative and the intention to launch cross–border cooperation within the framework of the Blockchain Partnership Declaration to review

and implement potential public sector pilot projects for blockchain technology, the Ministry of Economics (Ekonomikas Ministrija, 2019) has started negotiations with industry experts, working groups and public sector representatives. As a result of the negotiations, two potential pilot projects have now been identified that could be examined in more detail, described below.

The Central Bank of Latvia is participating in a pilot project of the European Central Bank, which is developing a digital EUR based on blockchain technology, where central banks of the European Union act as nodes in the blockchain ecosystem.

### 3.2.2. Potential blockchain pilot projects in public sector in Latvia / *Potenciālie blokķēdē balstītie pilotprojekti Latvijas publiskajā sektorā*

In 2019, the Ministry of Economics has prepared an informative report 'On examples of the use of blockchain technology, perspectives and further actions to promote the development of the field'. Its aim is to thoroughly evaluate the perspectives of using blockchain technology in the public sector, to identify further actions to promote its development in Latvia, as well as to evaluate the legal and technological aspects related to blockchain technology and submit it to the Cabinet of Ministers by January 1, 2019 (Ekonomikas Ministrija, 2019).

In order to fulfill the above and summarize the proposals for the use of blockchain technology in the public sector, a working group has been established (Order No. 3.7–1_2018_24 of the Ministry of Economics of 12 October 2018), which includes experts from the Ministry of Economics, the Ministry of Finance, the Bank of Latvia, The Latvian Investment and Development Agency, the State Revenue Service, the Ministry of Environmental Protection and Regional Development, if necessary, involving representatives of other responsible ministries, as well as industry associations and companies. The working group's proposals for further action on the wider use of blockchain technology to improve the efficiency and security of public administration services, activities to promote the use of technology in the private sector, as well as identified barriers and proposals for technology support measures are summarized in the information report (Ekonomikas Ministrija, 2019).

Considering the potential of blockchain technology to improve the efficiency and security of public administration services, as well as to make many business processes more efficient, thus promoting the competitiveness of Latvian companies, as well as technology as a new IT perspective, which would allow Latvian start–ups to enter the global market, Ministry of Economics in its informative report emphasizes that it is important to promote the use of technology in public administration and the private sector, as well as to prepare proposals for measures to support technology within the working group of blockchain technology operation perspectives, also involving representatives of the private sector (Ekonomikas Ministrija, 2019).

Considering that one of the priorities of the Ministry of Economics and its subordinate institutions is to promote the use of digital solutions in business, digitization of public services, as well as to promote the development of the Digital Economy and Society Index (DESI) components, it is planned to continue activities related to the identification and use of the potential of blockchain technology solutions, including negotiation cycles, public education events and discussions on the development in the blockchain field (Ekonomikas Ministrija, 2019).

In order to promote the implementation of the planned pilot projects, follow the global development trends of blockchain technology and the development of the EU policy in this field, as well as effectively defend the position and interests of Latvia, ensure smooth inter–institutional information exchange, coordinate public awareness and

education activities, ensure cooperation with the private sector, as well as to identify barriers to technology development and offer solutions to overcome them, the Bank of Latvia and the Ministry of Economics propose (Ekonomikas Ministrija, 2019):

- to continue the work of the established working group under the order No. 3.7–1_2018_24 of 12.10.2018 of the Ministry of Economics at least until the end of 2019 with one of the tasks to prepare a regular report of achievements in 2019 and **proposals for further measures in support of technology** and to **submit the regular report of the working group** to the Cabinet of Ministers for consideration by 1 January 2020.
- to invite the **Ministry of Justice to evaluate and provide an opinion** to the working group on the extension of the existing legal framework to blockchain transactions and smart contracts, and the need to create a new framework in Latvia for them to be recognized as legal.

Also, the report of the Ministry of Finance 'On adaptation of information systems for receipt and processing of electronic invoices for tax administration' (Finanšu Ministrija, 2018) listed several proposals to promote the development and use of blockchain technology in Latvia:

- in order to promote the use and development of technology, it is essential to obtain a **consistent vision and a national strategy**, and **a specialized framework must be progressively developed**, based on which transactions registered in the blockchain would be recognized as legitimate.

The **development of IT companies in this area needs to be stimulated**, but at the same time, the often incorrect linking of this IT direction to virtual currencies and unjustified restrictions must be reduced.

In order to assess the potential of technology to improve the efficiency and security of public administration services, to promote the use of technology in the private sector, to identify barriers and prepare **proposals for measures to support the technology**, to **establish an expert working group under the Ministry of Economics**. One of the tasks of the working group would be to assess the above issues in depth and to **prepare proposals for the efficient and safe use of technology in public administration and the private sector**.

Following up on action points defined in the report (Ekonomikas Ministrija, 2019), on 16 July 2020 the Ministry of Economics submitted the report 'On the possibilities of using blockchain technology in cash registers and other devices for the reduction of the shadow economy' to the Cabinet of Ministers, primarily **outlining economic justification of the potential pilot project for blockchain technology integration with cash registers**, which is likely to be integrated with supervisory activities of the State Revenue Service. However, as at the date of research 'a consistent vision and national strategy', 'proposals for measures to support the technology', 'proposals for the efficient and safe use of technology in public administration and the private sector' mentioned in the report of the Ministry of Finance (2018) have not yet been developed.

According to the Ministry of Economics (Ekonomikas Ministrija, 2020), the development of a technical solution in electronic devices and equipment (such as smartphones, cash registers and other smart devices) to implement reliable trade data transfer to the State Revenue Service online using blockchain or equivalent technology will significantly prevent malicious data manipulation and fraud and will comply with objective interests of the parties. However, the Ministry of Economics (Ekonomikas Ministrija, 2020) also acknowledges that Latvia does not have a clear vision on how to develop or purchase existing modern blockchain technology solutions, as well as there is no conceptual vision on how to ensure the adaptation and maintenance of existing

information systems to service existing processes and to ensure further compatibility with innovative solutions, including blockchain. Based on the report submitted by the Ministry of Economics (Ekonomikas Ministrija, 2020), the Cabinet of Ministers decided on the following that the inter–institutional working group mentioned in the information report 'On adaptation of information systems for receipt and processing of electronic invoices for tax administration' (Finanšu Ministrija, 2018) should also consider the use of blockchain technology for data registration in the cash registers and online data transfer to the SRS and **develop a conceptual solution by 1 March 2021**.

In the meantime, Latvian Blockchain Association advocates for recognition of 'existence of cryptocurrencies and blockchain importance for the array of industries' in government policies and has contributed to the report of the Ministry of Economics of the Republic of Latvia 'On examples of the use of blockchain technology, perspectives and further actions to promote the development of the field' (Ekonomikas Ministrija, 2019), however, it has not yet resulted in comprehensive national policies, targeted support mechanisms or crypto–regulations.

In author's view, the reason for such slow political developments and the lack of definitive government support measures are due to the following reasons:

- The lack of skillset of employees at ministries and its subordinated institutions related to blockchain technology practicalities, specifically related to setting up fit–for–purpose economic and governance models in blockchain's technological design.
- The scattered view on blockchain technology individual applications instead of development of a strategic vision in the framework of country's overall digital transformation, taking into consideration associated impact on national economy.
- The lack of initiative from government institutions to consult with blockchain experts and/ or to delegate a preparation of a comprehensive study to professional service providers with practical expertise in blockchain technology applications.
- The lack of initiative from Latvian Blockchain Association to engage in consultation processes, which is motivated by the fact that blockchain experts are scarce and they prefer to get engaged in commercial projects rather than policy making.

**Potential pilot project with the Register of Enterprises.**

According to the report of the Ministry of Economics (Ekonomikas Ministrija, 2019) Register of Enterprises sees the possibility and added value of the contribution provided by the blockchain technology in relation to the maintenance of the register of Limited Liability Companies' (SIA) participants. Currently, the Commercial Law (Komerclikums, 2020) stipulates that the board of Limited Liability Company is obliged to keep the register of participants with each owner or other changes in relation to the owners, as well as the board must submit the current version of the register of participants to the Register of Enterprises. The board must do so within 3 days of the change. In this case, the (Komerclikums, 2020) already stipulates that the information must be provided to a state institution, which then makes it public. Precise statistics on the frequency and number of changes are currently not available, as companies often make several changes at the same time when submitting the register of participants, such as changes in share capital (share capital is increased or decreased) or changes in membership, however, according to UR estimates, such cases could be about 25–30 thousand per year (Ekonomikas Ministrija, 2019).

As commented by the Ministry of Economics, after estimating the economic impact and financial expenses of the two potential blockchain solutions in public sector, it concluded that the potential pilot project with the SRS has greater impact, therefore currently there is no clarity whether/ when a potential pilot project with the Register of Enterprises will be implemented.

**Potential pilot project with the State revenue Service.**

Aware of the importance of cash register reform in promoting the elimination of the shadow economy, as well as the need to ensure favourable business environment, which is a prerequisite for the competitive development of the Latvian economy, the Ministry of Economics (Ekonomikas Ministrija, 2019) considers it necessary to ensure a reasonable balance between tax policy makers and business environment, hence, the development of a proportionate solution at the end of the first phase of the cash register reform, without jeopardizing business development, would be desirable in order to strengthen the fight to reduce the shadow economy.

In order to find a solution to the above–mentioned challenge – to implement cash register reform, taking into account the objective interests of all involved parties, Ministry of Economics (Ekonomikas Ministrija, 2019) considers it necessary to update the discussion on adapting cash register reform to the 21st century technological solutions and IT infrastructure, i.e. solutions that would strengthen SRS monitoring capacity and provide for a proportionate financial and administrative burden on economic operators to ensure compliance with the requirements imposed on them. It is expected that the potential solution will reduce the amount of grey economy and expenses that are associated with cash register certification and maintenance as well as improving the ease of doing business and obtaining real–time tax data from the merchants to the public authorities.

In the opinion of the Ministry of Economics (Ekonomikas Ministrija, 2019), one such solution, after the completion of the first stage of the cash register reform, would be the development of a technical solution in electronic devices and equipment to introduce the transfer of trade data to the SRS online using blockchain technology. The above–mentioned proposal should be implemented as a solution, which entrepreneurs could use on their own initiative for more convenient and efficient cooperation with the SRS.

The Ministry of Finance has already indicated that, in connection with the 26.4. Measure 'Introduction of Smart Cards in Cash Registers' included in the Government Action Plan at the end of 2016 a vision for the second stage of the cash register reform was already prepared. In addition, the Ministry of Finance drew attention to the fact that the second stage of the cash register reform, i.e. the introduction of the online electronic cash register system, was to be implemented by strengthening the technical requirements for electronic cash registers by integrating a control module for electronic cash register signing. Electronic signing of the electronic cash register check would ensure the authenticity of each cash register check and control the accuracy and preservation of the identification data of the check. Depending on the chosen specific technological solution, the sending of the information registered in the electronic cash register to the SRS could also be envisaged.

In order to further, develop this use case with the direct involvement of every stakeholder a Hackathon organized to develop the blockchain concept project for SRS. Hackathon is a well–known cooperation platform within the start–up environment that facilitates the solving of business and process related problems in a short time, working together with specialists from different backgrounds. Tailored to the corporate environment, it brings together experienced IT company teams with industry

professionals, promoting cross–sectoral dialogue, creating digital, effective and innovative solutions to business problems. Within the framework of this hackathon, it was planned that the SRS would present its challenges, while the IT companies and start–up teams look for the most effective solutions applicable for the 21st century technological possibilities. The hackathon's target audience, therefore, was set as start–ups and IT companies who want to collaborate in building new services / solutions within 48 hours that would also help themselves in conducting day to day business activities. In order to participate, the IT company had to create a team of five people that included programming, user experience, business development, marketing and design competencies. Meanwhile, public sector representatives shared the data and scope of the challenges.

The expected outcome of this hackathon was and still is to launch a cross–industry collaboration between start–ups, IT companies and the public sector by developing a solution that addresses the challenges including tax fraud, online cash register, big data and modern technologies and digital transformation, not only on a national but also on a global scale. This all was facilitated by completing three different tasks the teams took to complete the hackathon:

- Validate the potential of solution idea through experiment and research,
- Validate existing/emerging problem–solving processes through experiment and research,
- Create/sketch a prototype solution through experiment and research.

Ministry of Economics saw this first ever Hackathon for Public service blockchain based solution development as a platform of cooperation not only between the private and public sector, but also between Latvia and the tech world. This hackathon reached over 100 blockchain enthusiasts all around the world from more than 11 countries and placed them in Riga for 48 hours.

The main prize went to Z Book who developed blockchain–based solution to eliminate tax fraud on every transaction by adding blockchain electronic signature as QR code on every document from ERP and cash register systems (*Blokķēžu eksperti hakatonā…*, 2019). Following up on the result of the hackathon Ministry of Economics is in further talks with the SRS to implement the cash register pilot project by 2021 including all the necessary changes in regulatory requirements. Over the period of the next two years, it is planned to continue the activities related to the identification and use of blockchain technology potential, including negotiation cycles, public education activities and discussions on the development of a blockchain based public service.

Currently international presence is more crucial to facilitate the development of modern and innovative solutions than ever. Therefore, Ministry of Economics approached colleagues from Finland and the Finnish SRS who also showed great interest in tackling grey economy and fraudulent actions on POS devices. Initiatives like this will help the EU to foster cross–border cooperation and to become the frontrunners of public service digitalisation with the help of start–up ecosystem, IT experts and blockchain enthusiasts.

Regarding the further development of the identified use case, the Ministry of Economics has started negotiations with industry experts who have already practiced developing solutions based on blockchain technology for accounting systems, audit and payment purposes and generally support the introduction of new technologies for cash registers.

### 3.2.4. Blockchain ecosystem in Latvia/ *Blokķēdes tehnoloģiju ekosistēma Latvijā*

In March 2017, the ‘Latvian Blockchain Association’ was registered in order to represent blockchain ecosystem stakeholders and inform the public about trends in the

field of blockchain technology, as well as to ensure cooperation in the research and implementation of development opportunities provided by the blockchain technology. The association brings together companies involved in blockchain technology and cryptocurrency enthusiasts.

According to the Ministry of Economics (2019), there are about 25 start–ups in the blockchain sector in Latvia operating in the fields of computer games, authentication and cryptographic assets, for example:

- AndIT Solutions has developed a cryptocurrency acceptance and exchange platform used by merchants around the world to accept cryptocurrencies as an alternative payment method.
- Globitex, has created a globally recognized Bitcoin crypto–exchange to meet the need for a government–level exchange platform with advanced IT solutions compatible with both individual and institutional Bitcoin market players.
- Monetizr has developed a special IT solution, blockchain protocol and cryptocurrency reward system for game developers.
- BitFury, which specializes in providing blockchain infrastructure and development, has become one of the leading companies in the industry.

However, both companies, which are globally recognized examples of blockchain technology applications originating in Latvia – Bitfury and Globitex – migrated their headquarters to other countries – the Netherlands and the United Kingdom, accordingly. In author's view, it indicates that other countries have managed to create a more favourable ecosystem and regulatory clarity for blockchain start–ups.

In the public sector, starting from 2014, the Bank of Latvia actively informed the Latvian population about the risks associated with the purchase and use of Bitcoin in settlements, while explaining to the Latvian population the features and potential of blockchain technology outside virtual currencies and improving many economic processes. Currently, the Bank of Latvia participates in the European Central Bank project, within the framework of which various prototypes of the payment system developed in blockchain technology are being tested.

There are also a few organisations in Latvia, which educate developers about the possibilities of using and implementing blockchain solutions. Blockvis is a blockchain development company specializing in development of IT solutions using public blockchains and blockchain training. CryptoLab trains and provides various types of advice on investment opportunities in cryptocurrencies and their daily use. At the same time, conferences, discussions and networking events are organized by public and private partners (Techchill, Digital Freedom Festival, Startin.lv, LIAA, RIGA COMM) to discuss, among other topics, the importance and potential applications of blockchain technology. In addition, an annual Baltic Honey Badger Bitcoin conference, which gathers global leaders in Bitcoin–related entrepreneurship and focuses on technological and commercial advancements in Bitcoin–related businesses, takes place in Riga since 2017.

General start–up support in Latvia has been promoted through various activities. For example, in January 2017, the Law on Operational Support for New Enterprises entered into force, as well as a number of state support instruments were introduced through the joint stock company 'Development Financial Institution Altum'. In order to develop solutions based on blockchain technology, support is available to entrepreneurs within the framework of existing state support programs, including acceleration and risk capital funds. In order to support further blockchain solution development and implementation, start–ups may join specialized pre–acceleration programmes and attract capital through venture funds, which fund blockchain projects.

As evidenced by the case of a potential blockchain pilot project with SRS, the approach of the Ministry of Economics seems to be aiming to create a cooperation platform in the form of hackathons and working groups between the public sector and blockchain industry experts to address the concerns of the social partners and potentially lead to the development of pilot projects. However, there were no other hackathons since 2019 and the Latvian Blockchain Association was not further involved in the working group of the potential pilot project with SRS, which, in author's view indicates the gap between the public sector's approach towards blockchain piloting and actual capabilities of blockchain industry experts.

One of the priority directions in the Ministry of Economics action plan for the development of start–up ecosystem since 2018 is to raise public awareness of start–ups and promote their cooperation between the academic sector and corporations whereas in 2019 more focus has been brought towards the cooperation among start–ups and Information Communication Technology (ICT) companies, state owned companies, corporations and other public sector bodies (Ekonomikas Ministrija, 2019). Such collaboration primarily enables companies and public service providers to become more digital and more efficient, with the help of experienced mentors and start–up ecosystems, at the same time gaining in–depth understanding of the sector's needs and the possibilities of scalable technology solutions. Moreover, the Ministry of Economics (Ekonomikas Ministrija, 2019) notes that the development and improvement of the Digital Economy and Society Index (DESI) components is in the field of competence of the Ministry of Economics and its subordinate institutions, which, in author's view, is becoming increasingly crucial for the establishment of 'excellent businesses' as facilitation of blockchain technology adoption by public sector can create a pipeline for 'excellent businesses' and improve DESI components.

### 3.2.5. Blockchain technology in Latvian fintech applications/ *Blokķēdes tehnoloģiju pielietojums finanšu tehnoloģiju jomā Latvijā*

One of the FCMC's strategic directions is the support of FinTech, as well as the promotion of financial system innovations and in cooperation with other state institutions, the FCMC aims to create a FinTech–friendly environment that would promote innovative financial services in Latvia and attract new companies to provide these services.

The Innovation Sandbox provides a process by which companies can test innovative financial products, financial services or business models in accordance with a specific testing plan agreed with the FCMC, overall, the sandbox is open to innovative financial solutions that would make a positive contribution to the sound functioning and development of the financial market, as well as improve and expand consumers' and investors' access to financial services (*Inovāciju smilškaste*, [n.y.]).

An innovative financial service that could be tested in the Innovation Sandbox is a new or significantly improved electronic payment or electronic money service in Latvia. This service must be aimed at making a clear contribution to the users of the service. The company should be able to prove this contribution, and the service should be primarily aimed at Latvian service users, which does not exclude the possibility to offer the service further in other European Union countries. The contribution to consumers could take one of the following forms (*Inovāciju smilškaste*, [n.y.]):

- increase competition in the sector: the service to the customer would be more advantageous, cheaper, simpler; certain intermediate stages would be excluded from the traditional service supply chain (e.g. exclusion of card scheme involvement);

- the idea of an innovative service in the market could potentially provoke a response from traditional market players, either by improving their service or by adopting a new innovative business model;
- consumers and non–professional customers would be given access to a market share that has not traditionally been available to them.

The FCMC is responsible for financial sector supervision. Therefore, in parallel with consultations on FinTech or the application for participation in the Innovation Sandbox, issues of fair commercial practice, consumer protection, personal data management and business–related taxes must be considered that fall within the competence of the State Revenue Service, Consumer Protection Center or State Data Inspectorate. Support for start–ups in various programs is also offered by the Latvian Investment and Development Agency, as well as associations established by market participants – the Latvian Financial Industry Association, the Latvian Association of Payment Services and Electronic Money Institutions, the Start–up Association, the Latvian Association of Alternative Financial Service Providers and others.

At the beginning of 2020, the Financial and Capital Market Commission (FCMC) conducted a survey of Latvian financial and capital market participants in order to identify the scope of innovative financial technologies (FinTech) used. 188 market participants were invited to participate in the survey, of which 76 respondents answered the survey questions, 26 of which indicated that they already use innovative solutions for financial services, and 19 of them have a special team for implementation and development of innovative solutions, whilst 11 respondents indicated that they plan to start using innovative financial services solutions in 2020 (*Latvijas finanšu un…*, 2020).

A survey conducted by the FCMC reveals that strong authentication solutions, application interface development with the aim of providing an open banking platform, biometric data and big data are the most frequently used innovations currently used by Latvian financial and capital market participants.

Currently, there are two directions of innovation in the Latvian financial and capital market: one stems from market regulation (the second is the Payment Services Directive, strong customer authentication, near–field communication (NFC), application programming interfaces (API)), while the other is based on the own initiative of financial and capital market participants (artificial intelligence, biometrics, big data, automated consulting, machine learning, etc.), among them there was identified 1 distributed ledger technology case, implemented by a bank to ensure operational stability and prevent data loss.

Analysing individual market segments, it can be seen that the largest share of market participants using Fintech solutions is in the credit institution segment. Almost all banks that participated in the survey have a team to develop or implement innovative financial technology solutions. On the other hand, the share of payment and electronic money institutions that use innovative financial solutions is low, despite the support provided by the state and the FCMC to this sector to promote innovation.

In 2017, increased interest in blockchain technology and DLT led to increased interest in Europe and the rest of the world. This technology has the potential to increase the efficiency of certain business processes and reduce costs, including in the accounting and transaction record–keeping in the financial sector. The Bank of Latvia (2017) continued to study blockchain technology and DLT and the opportunities has organized a workshop for market participants on the opportunities and potential of these technologies to improve certain financial processes and business models. At the same time, the Bank of Latvia, together with other European central banks, launched a project

to develop a prototype payment system using blockchain technology and DLT. In this project, the Bank of Latvia provides one of the distributed record–keeping nodes.

### 3.2.6. The case of Lithuania/ *Lietuvas piemērs*

Marius Jurgilas, Member of the Board of the Bank of Lithuania, who advocates for innovation in the financial system, in one of his speeches notes that the priorities of blockchain technology developers in fintech area should be demonstration of viable business use cases, consultation with regulators and government agencies and provision of explicit explanations on how blockchain technology works in certain use cases (Jurgilas, 2016). Govina (2018) also notes that general awareness about crypto–currencies among population and demonstrable blockchain use cases are important for facilitating further development of blockchain solutions.

The subsequent initiative of the Bank of Lithuania clearly demonstrates that the Central Bank also takes steps to facilitate blockchain technology innovation in fintech area. In 2018, the Bank of Lithuania introduced Phase I of an LBChain Sandbox (*LBchain…*, 2020) with an ambition to create environment for start–ups to develop and test blockchain solutions in fintech area, where Bank of Lithuania acts as an accelerator, which creates a technological framework for building blockchain solutions.

On 26 May 2020, the LBChain completed its third and final stage of work. Among the presented projects, a blockchain–based regulatory reporting solution, a blockchain platform for issuing green bonds and a blockchain–based digital bank were proposed. At all three stages, the sandbox project allowed 11 fintech companies from eight countries to conduct blockchain–related research in a controlled regulatory environment.

The Bank of Lithuania plans to launch LBChain in the fourth quarter of 2020, as well as complete commercial purchases with the fintech and service providers that are currently participating in the LBChain project. In earlier stages, Bank of Lithuania chose Deloitte, IBM, and Tieto to work with fintechs to develop and test their proposed solutions.

An LBChain project manager Andrius Adamonis (2020) noted that in response to feedback from financial institutions, the regulator focused its research and development on managed systems, rather than on public blockchain. Therefore, the Bank of Lithuania decided to create LBChain based on Corda and Hyperledger Fabric.

The project successfully attracted foreign investment, stimulated cooperation with educational institutions and expanded the Bank's technological capabilities with the help of blockchain. It also demonstrates a clear willingness of the Bank of Lithuania to attract more international blockchain start–ups, strengthen cooperation between the public and private sectors and creates awareness in the society from the regulatory and technological perspectives.

At the final meeting, Adamonis said the bank plans to go beyond LBChain and develop the Lithuania Chain (LTChain) blockchain platform for deployment outside the financial services sector (Adamonis, 2020). As part of LTChain, the bank will collaborate with other government agencies and attract start–ups from non–financial sectors, including energy, healthcare and transport.

Apart from swift regulatory responses and an LB Chain initiative promoted by the Bank of Lithuania, it also attracts attention of blockchain developers with a launch of a the world's first blockchain–based digital collector coin dedicated to the day of signing of the Independence Act of Lithuania, which took place on February 16, 1918 (*Digital Collector Coin…*, 2020).

*Source: Bank of Lithuania, 2020*

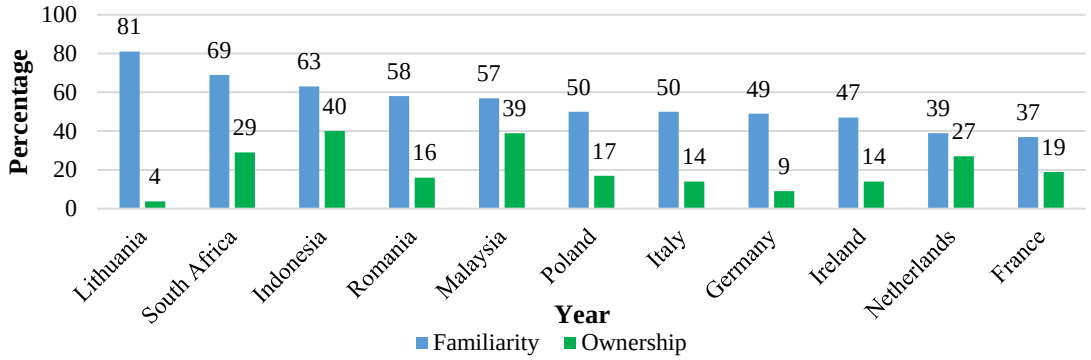
Fig. 3.9./ *3.9. att.* **Digital collector coin 'LBCoin'/** ***Kolekcijas monēta 'LBChain'***

The coin has a face value of EUR 19.18 and, despite its name, is a rectangle in shape similar to a credit card, as demonstrated by the image above. The image on the coin consists of 36,500 pixels – about as many days have passed since the signing of the Act. It is planned to issue 24,000 tokens, each of them will have an image of one of the 20 signatories. Tokens will be divided into six categories of activity, 4000 in each. Cryptocurrency buyers will receive six random tokens. They need to collect tokens from all six categories in order to be sent a physical silver coin.

Despite the coin is not a legal tender, it creates certain visibility of blockchain solutions implemented in Lithuania, acts as an international marketing tool for Lithuanian blockchain eco–system as well as provides opportunities to the Bank of Lithuania to test blockchain solutions in financial sector.

In addition, a Blockchain Center Vilnius was founded in 2018, which is a part of an international network with centres in Shanghai and Melbourne (*About us…*, [n.y]). Apart from co–working space, acceleration programmes and community–building and educational activities, the international platform helps European blockchain companies to reach the Asian and Australian markets, and vice versa helps Asian and Australian businesses to reach the European market. As noted by Eglė Nemeikštytė, CEO of blockchain Centre Vilnius, the Ministry of Finance played an important role and supported the initiative, because the development of blockchain technology itself began with the creation of financial instruments for the implementation of the project, and legal certainty was also very important for the centre itself, and for any business that wants to cooperate with the centre (*Руководитель блокчейн–центра…*, 2018).

According to Lungo (2018) Lithuania has the highest awareness about crypto–currencies and also the highest distribution between familiarity with crypto–currencies and actual ownership of those among the sample of countries (figure 3.10).




*Source: Author's based on Crypto Market in…, 2018*

Fig 3.10./ *3.10. att.* **Familiarity versus ownership of crypto–currencies in Lithuania/** ***Kriptovalūtu atpazīstamība un turēšana Lietuvā***

It reflects that development of blockchain projects in crypto space is not directly associated with ownership of crypto–currencies by Lithuanian residents, however highly correlates with the general awareness of those among population.

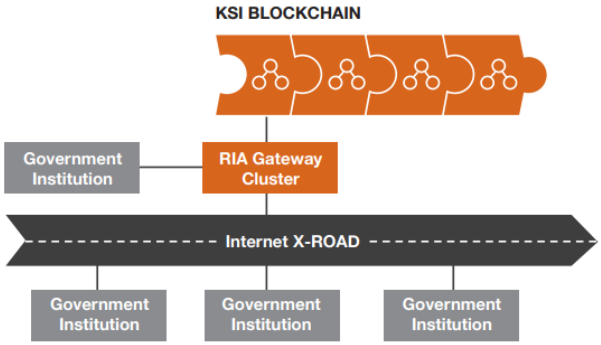
### 3.2.7. The case of Estonia/ *Igaunijas piemērs*

Being a small state, Estonia has utilized the opportunity to differentiate the blockchain technology and cryptocurrency and together with blockchain technology gradual integration into e–government services created preconditions for taking the digital society to the next level. A well–targeted policy of state digitalization has become a foundation to the versatile blockchain technology adoption in Estonia, for example:

By 2002, the government had built a free Wi–Fi network covering a high percentage of populated areas.

- In 2007, the Estonian authorities introduced electronic voting.
- In 2012, Estonia installed a massive fibre–optic cable infrastructure for ultra–high–speed data transmission.
- In 2014, Estonia introduced an e–Residency programme.

Blockchain technology against the background of these facts looks only a logical continuation of the general state digitalisation policy. In addition, after the cyber–attack on its government databases in 2007, Estonia has developed a cyber–security strategy and worked out so–called Keyless Signature Infrastructure (KSI), a cryptographic algorithm, developed by a technology development company Guardtime, which was subsequently integrated with blockchain technology and applied in a number of Estonian e–government services (*Security and Safety…*, [n.y.]).




*Source: PwC, 2019b*

Fig. 3.11./ *3.11. att.* **E–government infrastructure in Estonia/** ***E–pārvaldības infrastruktūra Igaunijā***

Blockchain technology via KSI blockchain is being increasingly integrated into the basic software of e–government systems in Estonia. The State Information System Authority (RIA) enables blockchain technology to ensure the integrity of data, systems and processes, as well as the control and verification of data creation time. As a basic service of one basic infrastructure, RIA mediates blockchain technology to both state agencies and other institutions performing public functions. The national data exchange layer X–Road integrated databases have been gradually secured using blockchain technology. Blockchain technology is deployed in Estonia's e–government systems since 2012 and is currently implemented in six government registries (PwC, 2019b):

- Healthcare registry
- Property registry
- Business registry
- Succession registry
- Digital Court System
- State Gazette

The registries use a blockchain e–based timing, which adds an extra layer of security to the system. It also supports blockchain technology to make the X–Road more secure. For the Center of Registers and Information Systems (RIK), which provides the innovative environment for integrated e–services in Estonia, the main value of blockchain is the ability to regularly and quickly check large amounts of data and to ensure that there have been no malicious changes to the data. As a result, the work of national registers becomes faster and more efficient as there is no intermediary in the transactions. The RIK, which currently acts as an intermediary, can redirect its resources and the system controls itself. The probability of detecting fraud and evidence–based data also increases, where the RIK can quickly forward information to the relevant investigative bodies. With such a solution, for example, the Land Register, the Commercial Register, the Riigi Teataja, Public Notices, Digital File, etc. are secured in the administrative area of the RIK.

The NATO Cooperative Cyber Defence Centre of Excellence and the EU Agency for large–scale IT systems are both based in Tallinn, demonstrating Estonia's cutting edge leadership in digitalization and cybersecurity on global level and European level. In addition, Estonia is considered one of the most advanced users of blockchain technology in Europe in the provision of public services with intention to increase cyber security and transparency of processes.

Estonia reacted very quickly to new trends and growing interest in cryptocurrencies and was one of the first countries in the world to introduce regulation in this area in 2017 offering cryptocurrency licenses to cryptocurrency trading and exchange companies. Thanks to the total digitalization of public services and the E–residency program launched in 2014, which enables digital entrepreneurs to start and manage a business online (*The New Digital…*, [n.y]), opening a crypto company in Estonia was possible remotely from any part of the world. Due to low competition globally at that time, there is close to 1300 cryptocurrency licenses issued in Estonia as at the end of 2019 (Estonian Financial Intelligence Unit, 2020).

In the private sector, the best–known developer of blockchain technology in Estonia is Guardtime, which offers blockchain based solutions for the defence industry, telecommunications, insurance, supply chain management, etc.

In 2015 Estonian government e–Residency program partnered with Bitnation project to offer public notary services on blockchain to e–residents, including marriage registration, birth certificate, and some types of commercial contracts (*Bitnation to*

*offer…*, 2015). Bitnation notary services are characterized by decentralization and the ability to use them from anywhere in the world.

In 2016, the Guardtime project, specializing in data security, announced a partnership with the Estonian E–Health Foundation (*Blockchain Startup to…*, 2016). The solutions proposed by Guardtime are based on KSI blockchain – a blockchain solution that provides large–scale data authentication without relying on a centralized trusted authority. The project aims to protect medical records. According to the Guardtime developers, the KSI infrastructure is embedded in the Oracle database engine and thanks to this integration, changes in patient history can be seen in real time.

The prospects of blockchain technology were also relevant for the Estonian banking sector. An example of this is LHV Bank, which, with the support of the Swedish company ChromaWay, developed the Cuber Wallet. The functioning of the solution is based on the open protocol of the Bitcoin blockchain Coloured Coins. Cuber Wallet is available to owners of Android and iOS devices. Cuber Wallet users store private keys on their mobile phone. The wallet allows sending and receiving EUR instantly and for free.

AS Eesti Väärtpaberikeskus, part of the NASDAQ OMX Group, has been testing and developing an e–voting system for shareholders' meetings in Estonia, enabling shareholders who cannot attend the voting process to participate in the voting process and better record results.

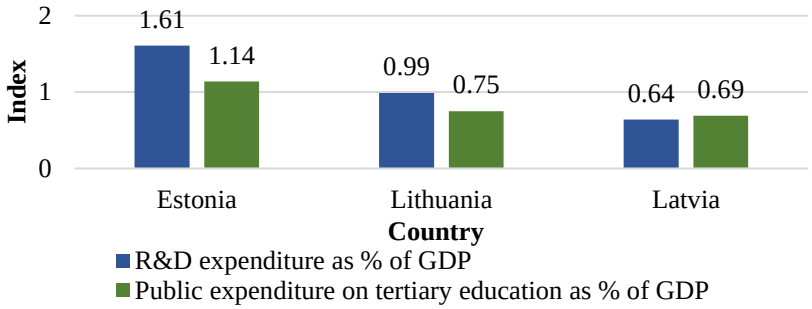
Estonia also expressed the intention to create its own digital currency Estcoin, which would be a secure cryptocurrency to enable e–residents to invest directly in Estonia with the aim to increase credibility in blockchain technology and involve the state among investors, with the proceeds directed to Estonia's development. However, the initiative was blocked by the European Central Bank as the only legal tender in the Eurozone is euro.

Overall, Estonia has all the prerequisites to integrate its whole IT infrastructure with blockchain technology – high development of the digital economy, high public confidence in e–services, experience in developing the country's e–services, existing X–Road data exchange layer, ICT knowledge, small community and ID card based identification. Already current e–government solutions allow Estonia to save up to 2% of GDP per year (European Parliament, 2017).

### 3.2.8. Blockchain adoption relation to regional competitiveness of the Baltic States/ *Blokķēdes tehnoloģiju ieviešanas sasaiste ar Baltijas valstu reģionālo konkurētspēju*

The previous analysis concluded that blockchain technology adoption levels, both in crypto space and beyond, are the highest in Estonia, followed by globally competitive blockchain adoption level in Lithuania (particularly in fintech area) and a fairly weak blockchain adoption level in Latvia. Hence, it is important to analyse interconnections with regional competitiveness indicators in order to understand possible reasons for such differences and any correlated economic consequences.

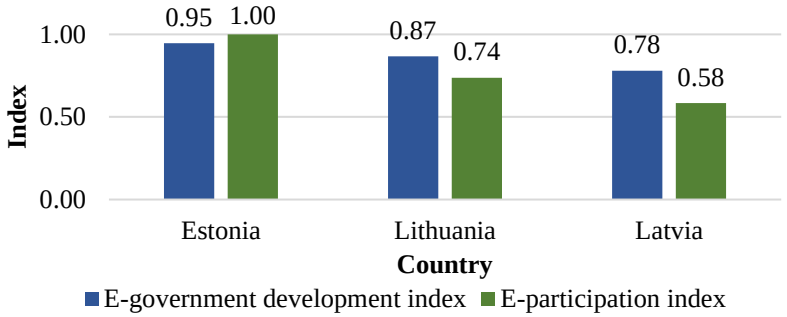
Since blockchain technology innovation and adoption processes clearly rely on the exploitation of the resource of knowledge, which is supported by the knowledge economy concept and demonstrated by empirical evidence on blockchain technology adoption patterns worldwide, support for R&D and education likely have correlations with the levels of blockchain adoption. As demonstrated by figure 3.12., Estonia has the highest levels of R&D expenditure and public expenditure on tertiary education, whilst Latvia has the lowest levels among three Baltic States.




*Source: Author's based on Gross Domestic Expenditure…, 2019; Public Expenditure on…, 2017*

Fig. 3.12./ *3.12. att.* **R&D expenditure and public expenditure on tertiary education as % of GDP in the Baltic States/** ***Pētniecības un attīstības izdevumi un valsts izdevumi par augstāko izglītību, Baltijas valstīs, % no IKP***

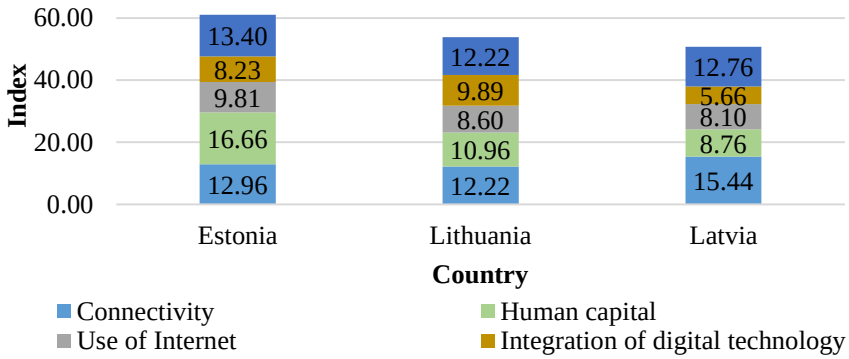
The same tendency is observed with the levels of blockchain adoption, hence it can be assumed that R&D activity and education are correlated with blockchain adoption, which is a fairly logical relationship, however the correlation itself does not yet imply causation, since many other factors may have more definitive influence on blockchain adoption, for example clear government strategies and related practical support, which exists in Estonia and Lithuania and has not yet resulted in any practicalities in Latvia. As demonstrated by the figure 3.13., Estonia is the leader in e–government and e–participation among Baltic States, driven by its higher level of digitalisation, including blockchain adoption in e–government registries.




*Source: Author's construction based on Country Data, 2020*

Fig. 3.13./ *3.13. att.* **E–indices in the Baltic States/** ***E–indeksi Baltijas valstīs***

Hence, it can be derived that blockchain adoption is directly correlated with the levels of e–government and e–participation as it supports more efficient data exchange processes and is technologically capable of establishing necessary trust system between the government and population. Digital progress of three Baltic countries can be also measured through the components of the Digital Economy and Society Index. As evidenced by the figure 3.14., Estonia has the highest DESI among Baltic States – 61.07 versus 53.89 in Lithuania and 50.71 in Latvia with the Human Capital component contributing to the difference the most.

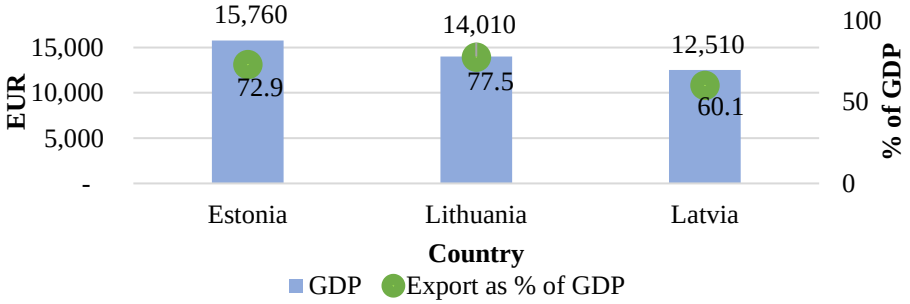



*Source: Author's construction based on DESI by Components, 2020*

Fig. 3.14./ *3.14. att.* **DESI index by components in the Baltic States/** ***DESI indekss pa komponentēm Baltijas valstīs***

Human Capital relates to digital skills of population and quantity of ICT specialists, which are pre–requisuite in the digital transformation process. This tendency is also in line with the tendencies observable with regard to Estonia's higher expenditure on R&D and tertiary education. There is a direct correlation between DESI index and e–government and e–participation indices. Although Latvia demonstrates the lowest DESI index among Baltic States, it shows the best result in Connectivity, which relates to fixed and mobile broadband take–up. However, as evidenced by the cases of Estonia and Lithuania other factors such as a clear political direction and a skillset of both political leaders and overall population may play a more important role in driving a digital transformation process and blockchain adoption.

As evidenced by the figure 3.15., Estonia has the highest GDP per capita among Baltic States, which can be substantiated by cost savings and operational efficiencies driven by higher levels of e–government and e–participation as well as more digitalized economic models, supported by blockchain technology adoption, among other digitally oriented support measures.




*Source: Author's construction based on Exports of Goods…, 2019; Real GDP per Capita, 2019*

Fig. 3.15./ *3.15. att.* **Real GDP per capita and exports as % of GDP in the Baltic States/** ***Reālais IKP uz vienu iedzīvotāju un eksports Baltijas valstīs, % no IKP***

The highest level of exports is in Lithuania, which can be explained by targeted activities of Lithuanian policy makers in attracting globally competitive technology enerprises, specifically in fintech area favouring blockchain based solutions, which contributes to higher levels of exports. Hence, there are likely direct and indirect effects on GDP and exports from blockchain technology adoption.

## Summary of the Chapter 3/ *3. nodaļas kopsavilkums*

Current deployment of blockchain technology globally would predominantly correspond to the third stage of Rogers' (2003) depicted innovation–decision process – 'Decision', which includes weighing the advantages/ disadvantages of using the innovation to decide whether to adopt or reject the innovation. Although fragmented adoption decisions have already been made by certain organisations, institutions and countries, blockchain technology adoption has not yet reached a global critical mass reflected by 'early majority' category as per Rogers' adoption curve of innovation diffusion process. Based on expert estimates it may reach the early majority adoption level by 2028.

Although low positive correlation was noted between crypto activity and economic and digital competitiveness among a sample of countries, the factor and cluster analysis indicated that the countries showing real leadership in blockchain technology up to date also show high crypto–activity and above average economic and digital competitiveness. Estonia is included in the cluster of countries showing global blockchain leadership, which is underpinned by its state promoted digitalisation strategy within the last two decades.

Latvia and Lithuania are included in the cluster of countries with below average crypto–activity and disperse distribution in competitiveness, however Lithuania supersedes Latvia by crypto–activity indicators and overall blockchain technology adoption level, therefore other non–quantifiable factors must be further analysed to understand the reasons for the difference in blockchain technology adoption trends in Latvia and Lithuania.

Countries with low competitiveness and high crypto activity show that blockchain solutions in crypto space are actively emerging in developing countries, where blockchain can provide necessary trust system, transparency and financial inclusion, overcoming governance barriers and corruption challenges.

Despite no significant correlation noted between ICO statistics and crypto–regulatory rank globally, top countries by blockchain technology adoption predominantly demonstrate above average crypto regulatory rank and implementation of blockchain initiatives in public sector, therefore, it can be concluded that those are important factors for blockchain technology adoption beyond crypto space.

Estonia and Lithuania are 7th and 11th by ICO funds raised globally and their crypto regulatory rank is in top decile, whilst Latvia takes only 34th place and its crypto–regulatory rank is within the 9th decile, therefore it can be concluded that regulation is an important factor for blockchain technology adoption in crypto space in Baltic States. It is a clear indicator for potential strengthening crypto regulation in Latvia, also, evidenced by the trend of relocation of headquarters of successful crypto start–ups founded in Latvia to the countries with better crypto regulation.

In Latvia, the Ministry of Finance and the Ministry of Economics have issued informative reports in 2018, 2019 and 2020, accordingly, and a national working group has been established under the Ministry of Economics investigating blockchain technology's use cases in public administration and the private sector, resulting in the potential pilot project to be implemented by 2021 in cooperation with the Ministry of Finance and State Revenue Service. Although the Ministry of Finance has highlighted in its report the necessity to obtain a consistent vision and a national strategy on blockchain technology, and develop a specialized framework, no such vision, national strategy or framework has yet been developed as at the date of this research.

The Ministry of Economics of the Republic of Latvia recognizes a potential of blockchain technologies in public and private sectors and participates within the European Blockchain Partnership working group and European Blockchain Services Infrastructure initiatives. There are two potential blockchain pilot projects identified in public sector in Latvia, however none of them has yet reached the implementation stage. In 2019, a hackathon was organized by the Ministry of Economics for the potential pilot project with a State Revenue Service, which would allow for real–time transfer of trade data to the SRS and is expected to reach a piloting phase by 2021.

Despite overall supportive position of the Ministry of Economics of the Republic of Latvia regarding potential blockchain technology applications, activities of public administration and regulatory authorities towards blockchain solution development in public sector in Latvia substantially lag behind in comparison to Estonia and Lithuania, where certain blockchain solutions in public sector have already passed through the piloting phase and reached implementation phase, for example, e–Health and e–Law registries in Estonia and LBChain project in Lithuania.

There are no targeted blockchain support programmes or initiatives in Latvia, however support is available within general start–up programmes from acceleration and risk capital funds. In addition, various events on blockchain topics take place occasionally. At least two globally recognized blockchain start–ups have emerged in Latvia, which indicates the ability of Latvian technology developers to create feasible and globally competitive blockchain solutions.

In author's view, the reason for low political developments and the lack of definitive government support measures in Latvia are due to (a) the lack of skillset of employees at ministries and its subordinated institutions related to blockchain technology practicalities, (b) the scattered view on blockchain technology individual applications instead of development of a strategic vision in the framework of country's overall digital transformation, (c) the lack of initiative from government institutions to consult with blockchain experts and/ or to delegate a preparation of a comprehensive study to professional service providers and (d) the lack of initiative from Latvian Blockchain Association to engage in consultation processes.

Estonia demonstrates leadership in the majority of regional competitiveness indicators among Baltic States, which is supported by its leading position in blockchain adoption not only in Baltic States, but also worldwide. In contrast, Latvia substantially lags behind Estonia and Lithuania in all analysed indicators, which is weakened by the lack of specific actions and support measures from the government for blockchain innovation and adoption. Hence, experience of Estonia in blockchain adoption in e–government area and experience of Lithuania in blockchain adoption in fintech area can serve as basis for Latvian political leaders to formulate similar opinions and initiate similar actions for blockchain adoption in Latvia.

# 4. ANALYSIS OF OPPORTUNITIES TO FACILITATE BLOCKCHAIN TECHNOLOGY ADOPTION IN THE ECONOMY OF LATVIA/ *BLOKĶĒDES TEHNOLOĢIJU IEVIEŠANAS IESPĒJU ANALĪZE LATVIJAS TAUTSAIMNIECĪBĀ*

## 4.1. Analysis of blockchain adoption factors and scenarios/ *Blokķēdes tehnoloģiju ieviešanu veicinošo faktoru un ieviešanas scenāriju analīze*

The chapter aims to develop recommendations for blockchain technology adoption in Latvia based on expert assessment of significant blockchain adoption factors and scenarios. In the Chapter 1, various frameworks for technology and innovation adoption were discussed. It was concluded that TOE, DOI, TAM and PIMT frameworks could be relevant for studying factors driving blockchain technology adoption. TOE, DOI and PIMT frameworks were already applied in the context of blockchain adoption analysis, therefore they can be efficient for further analysis of blockchain adoption factors and can serve as a starting point in definition of blockchain adoption factors to be evaluated by the experts. Both frameworks have Technology as intersecting factor group, whereas Environmental factor group in TOE framework can be subdivided into Market and Institutional factor groups applied in PIMT framework. Further analysis can either utilize Environmental factor group combining Market and Institutional factor groups or separating those two factor groups. Taking into account, that author's research is focused primarily on macro–economic level with importance to study behaviour of different stakeholders, the author chooses to distinguish Market and Institutional factors for further analysis with Market factors being attributable to business and industry related factors and Institutional factors being attributable to regulatory and governance issues. For blockchain adoption both market participants and governments/ regulatory authorities are important, however it is necessary to separate those two factor groups for further definition of different scenarios where various stakeholders have distinguished roles.

One of the most important factors in TOE framework identified by Acton and Clohessy (2019) is perceived benefits, that overall corresponds to an independent construct 'perceived usefulness' in TAM model defined by Davis (1989) as 'the degree to which a person believes that using a particular system would enhance his/ her job performance'. From business perspective, this definition can be attributed to enhancement of organizational performance in terms of time and cost savings resulting from blockchain's technological benefits such as disintermediation, speed/ real time updates, irreversibility, fraud reduction, accurate/ traceable information, privacy & transparency. Operational efficiencies are achieved as private record keeping becomes obsolete, when all transactions are recorded in a distributed ledger, which is shared across the network. Reconciliation of transactions across private ledgers takes a lot of time and requires human intervention (Iansiti and Lakhani, 2017), whilst blockchain can provide significant cost savings through automation of reconciliation processes. Therefore, Irani's et al. (2020) 'distributed ledger' and Action & Clohessy's (2019) factor 'disintermediation' are also captured by the 'perceived benefits' factor.

Relative advantage factor described by both Acton and Clohessy (2019) in TOE framework overall corresponds to Rogers' (2003) definition of relative advantage as 'the degree to which an innovation is perceived as being better than the idea it supersedes'. Moore and Benbasat (1991), Adams et al. (1992), Plouffe et al. (2001) have noticed similarities between 'perceived usefulness' and 'relative advantage' factors, therefore

those two factors can overall be considered synonymous. Meister et al. (2008) argues that for comparison of alternative ICTs relative advantage should be distinguished from perceived usefulness. However, taking into account that blockchain technology at this moment does not compete with alternative ICTs due to non–existence of such, it is appropriate to merge Acton's and Clohessy's (2019) identified 'Relative advantage' factor with the 'Perceived Benefit' factor, for the purpose of factor grouping. Both factors refer to benefits of blockchain technology that were outlined in the Chapter 1. Since relative advantage of blockchain technology is well described under 'perceived benefits' factor, author therefore chooses to use a 'perceived benefits' factor for further analysis.

The 'Complexity' factor suggested by Acton's and Clohessy's (2019) framework corresponds to Rogers' (2003) 'Complexity' and Moore and Benbassat's (1991) 'Ease of use', rooted in DOI theory. Chen et al. (2016) notes that blockchain technology's proof–of–work consensus algorithm is complex as all involved parties or 'nodes' execute computations to sustain the network, which is considered inefficient from the technological complexity perspective, however nowadays also other consensus algorithms are existent, such as proof–of–stake and proof–of–elapsed time, that bring efficiency into the computational process. Therefore, 'complexity' can be seen as a dynamically developing factor in blockchain technology adoption.

Chen et al. (2016) notes that most of technological features of blockchain are immature due to the lack of standardization and analyses maturity by four indicators: networks, information systems, computing methodologies, and security and privacy, according to the ACM Computing Classification System 2014. Although from this perspective 'Compatibility' and 'Data security' factors indicated by Acton and Clohessy (2019) can be grouped under the 'Maturity' factor, the author decides to analyse those factors separately as 'data security' and 'compatibility can be ensured also by 'immature' technological implementations. For further analysis, 'compatibility' refers to the ability of blockchain technologies to align with legacy systems (e.g., CRM integration, system architectures, provider integration etc.) and 'maturity' refers to standardization and generally acceptable technological implementations. Also Irani's et al. (2020) factor 'information exchange and transactions' refers to maturity aspects such as block size, transaction processing time, scalability and standardisation, therefore it is accounted for under 'maturity' factor.

'Smart contract coding' and 'permissions (public vs. private)' factors defined by Acton and Clohessy (2019) broadly refer to technology's architecture, therefore the author separately distinguishes 'Architecture' factor for further analysis, assuming that it includes smart contract coding, permission management, programming, system element interaction and data management issues as well as certain hardware requirements such as ASIC or SGX enabled processors for enabling consensus algorithms on blockchain.

Acton's and Clohessy's (2019) technological factor group category can be supplemented by Irani's et al. (2020) 'shared infrastructure' factor, as other two factors 'information exchange and transactions' and 'distributed ledger' are already accounted for under Acton's and Clohessy's (2019) 'maturity' and 'perceived benefits' factors. IT infrastructure considerations relate to IT platforms on which new IT innovations can be developed (Lacovou et al., 1995). In the case of blockchain technology, such platforms should be 'shared' by blockchain network participants, which requires technological capabilities and integrations.

Organisational factors are often viewed as the most significant determinants of IT innovation adoption in enterprises (Kimberly and Evanisko, 1981; Tornatsky and Fleischer, 1990; Damanpour, 1991). Therefore, such factors as top management support, organizational size, IT experience, and innovativeness have been broadly analysed in the

IT adoption process (Grandon and Pearson, 2004; Van de Weerd et al., 2016). Acton's and Clohessy's (2019) factor 'organisational readiness' includes human resources, financial and infrastructure facets and distinguishes 'top management support', 'organizational size', 'innovativeness' and 'blockchain knowledge' as separate factors, however those factors can be considered as components of 'organizational readiness'. In order to conduct a more comprehensive analysis of organizational factors, the author chooses a more granular approach distinguishing organizational factors to the extent possible.

The presence of employees with the required IT knowledge, experience and skills to develop and adopt an IT innovation is mentioned as an important factor by many researchers (Wang et al., 2010). Financial resources committed by organisations are mentioned by many researchers when analysing adoption of an IT innovation (e.g. Lacovou et al., 1995, Weiner, 2009). Therefore, two important factors are added separately to the list of organizational factor group – 'employees with IT knowledge' and 'financial resources', whilst 'organizational readiness' is removed as an umbrella factor and 'blockchain knowledge' is removed due to its horizontal nature already accounted for under 'top management support' and 'employees with IT knowledge' factors, since those are two key stakeholder groups, who can utilize 'blockchain knowledge' and implement a top–down or bottom–up blockchain innovation and adoption process, accordingly.

Acton's and Clohessy's (2019) factor 'business model readiness' and Irani's et al. (2020) factor 'business processes' can be grouped, since both factors refer to readiness of business models and processes. Although it can be argued that some business processes and business model considerations can also be attributed to market factors, as evidenced by Irani's et al. (2020) attribution of 'business processes' to market factor group, such 'business processes' are captured by Acton's and Clohessy's (2019) factor 'market dynamics' described further. Acton's and Clohessy's (2019) factor 'technological readiness' is broadly covered by technological factor group as combination of technological factors results in technological readiness. Acton's and Clohessy's (2019) factor 'participation incentives' is a specific factor relevant for blockchain business models. It refers to the system of incentives used in a blockchain network to incentivize user participation and cooperation, which is rooted in a game theory and is applicable to peer–to–peer networks. Whilst this factor is very important in token economy applications, it may have considerably lower significance in blockchain applications for businesses and governments. Therefore, a further investigation of the significance of this factor is justified.

Acton's and Clohessy's (2019) environmental factor 'market dynamics' refers to the rapidly changing blockchain technological landscape and associated competitive pressure and Irani's et al. (2020) 'market structure' factor predominantly refers to the degree of computerization. Therefore, those two factors can be grouped under 'market dynamics' factor in market factor group. For further analysis factor 'market dynamics' refers to general and blockchain specific digitalisation trends, happening in the global and local markets.

Acton's and Clohessy's (2019) factor 'Industry pressure' can be seen through the lens of Moore's and Benbassat's (1991) factor 'voluntariness' or Rogers' (2003) 'optional' decision–making. In addition, a 'voluntariness' factor is depicted in TAM 2 model of Davis & Venkatesh (2000). Blockchain technology adoption up to date is clearly 'voluntary', whilst 'industry pressure' and specifically industry standards can make blockchain technology adoption more imperative, therefore, this factor is clearly attributable to market factor group. 'Trading partner support' factor can also be seen

through the ‘voluntariness’ lens, however it is located on the opposite side of the ‘voluntary to imperative’ axis, therefore it is indeed important to analyse it separately, especially when ‘imperativeness’ is not yet reached, which would make this factor obsolete at later stages of innovation diffusion process. The variation of adoption factors at different implementation stages of technology is consistent with the results of previous research (Collerette et al., 2003). In this regard, ‘trading partner support’ can be classified as ‘early adopters’ according to Rogers’ (2003) adoption curve of innovation diffusion process and can be also attributed to market factors group.

Acton’s and Clohessy’s (2019) factor ‘Business use cases’ correspond to Moore and Benbassat (1991) ‘visibility’ and ‘trialability’ factors derived from the ‘observability’ factor mentioned in Rogers’ (2003) DOI theory. In addition, it corresponds to ‘experience’ and ‘demonstrability’ factors depicted in TAM 2 model of Davis & Venkatesh (2000). Certainly, demonstrability of existing use cases and opportunities to trial readily available solutions are important factors for diffusion of any innovation, including blockchain technology.

Acton’s and Clohessy’s (2019) factor ‘Critical user mass’ is attributable to a market factor group and can be seen as an ‘early majority’ according to Rogers’ (2003) adoption curve of innovation diffusion process. Therefore, it is important to analyse it in the innovation diffusion process.

Irani’s et al (2020) factor ‘Contracts and agreements’ primarily refer to smart contracts already captured by a technological factor ‘architecture’, where ‘smart contract coding’ is included. It can be argued that ‘contracts and agreements’ may also be partially attributed to market factor group as those are agreements between market participants, however, at this stage technological implementations of smart contracts, that would ensure compliance with existing market frameworks are more relevant than the change of market frameworks themselves, including legal framework, at least until the ‘early majority’ phase is reached, which would serve as a catalyst for the change in market and legal frameworks. For now, smart contract coding is focused on mimicking existing market and legal frameworks, and one of the major challenges is addressing a technological irrevocability, which does not exist in traditional market and legal frameworks.

Acton’s and Clohessy’s (2019) ‘regulatory environment’ factor intersects with Irani’s et al. (2020) ‘regulations and legislations’ factor in the institutional factors group. As concluded by the analyses conducted in the Chapter 3, a ‘regulatory environment’ is certainly a significant factor for blockchain technology innovation and adoption, particularly in crypto space.

Irani’s et al. (2020) institutional factor ‘norms and cultures’ refers to cultural resistance to change and the general lack of knowledge of blockchain technology. It also corresponds to ‘subjective norm’ factor depicted in TAM 2 model of Davis & Venkatesh (2000). Taking into consideration, that blockchain technology adoption is still in its infancy, it may be an important adoption factor at end user level, however, it may be of equal importance in all scenarios due to its generalistic nature. Acton’s and Clohessy’s (2019) factor ‘blockchain knowledge’ can be also attributed to ‘norms and cultures’ as the increase in general knowledge would potentially decrease the resistance to change.

Irani’s et al. (2020) institutional factor ‘governance’ refers to such issues as loss of government control and necessity to establish an appropriate governance framework, which would deal with dispute resolution, liability provisions, approving/ rejecting participants, correction mechanisms, detection of market manipulation etc. Since blockchain technology is also classified as an institutional technology, a governance aspect may be an important adoption factor requiring appropriate institutional response,

either through adaptation of existing or establishment of completely new institutional environment to govern the arising issues.

Acton's and Clohessy's (2019) 'government support' factor can be attributed to the institutional factor group. As concluded by the analyses performed in the Chapter 3 supportive government policies, especially in the context of innovation policies, and regulatory regimes are important factors for blockchain technology adoption. Both these factors are already covered by 'regulatory environment' and 'innovation system' factors, where government plays a key role, therefore a 'government support' factor can be excluded from further analysis.

Blockchain technology adoption factors can be also seen through the lens of seven success factors for global blockchain hotbed described by the renowned blockchain visionary and researcher Dan Tapscott (2018):

Incubators and entrepreneurship – accounted for under 'innovation system' factor in institutional factor group

- Corporate leadership – accounted for under 'top management support' in organizational factor group
- Educational institutions – accounted for under 'innovation system' factor in institutional factor group
- Investment climate – attributable to general economic development and competitiveness
- Government support – accounted for under 'innovation system' factor in institutional factor group
- Regulatory environment – accounted for under 'regulatory environment' factor in institutional factor group
- Communities of talent – accounted for under 'innovation system' factor in institutional factor group

Five out of seven factors mentioned by Tapscott (2018) are attributable to institutional factor group, three factors are attributable to 'innovation system' factor, one factor is attributable to organizational factor group, and one factor is attributable to overall country's economic development and competitiveness, which is out of scope of this analytical framework and was analysed in the Chapter 3.

Based on author's analysis, the structure and categorization of blockchain adoption factors was developed.

Table 4.1./ *4.1. tabula*

**Significant blockchain technology adoption factors/ *Būtiskie blokķēdes tehnoloģiju ieviešanu veicinošie faktori***

| **Technological factors** | **Organizational factors** | **Market factors** | **Institutional factors** |
|---|---|---|---|
| Perceived benefits | Top management support | Critical User mass | Regulatory environment |
| Ease of use | Innovativeness | Existing use cases | Innovation system |
| Maturity | Business model readiness | Market dynamics | Governance framework |
| Data security | Financial resources | Industry pressure | Norms and cultures |
| Compatibility with legacy IT systems | Employees with IT knowledge | Trading partner support | X |
| Architecture | Participation incentives | X | X |
| Shared IT infrastructure | Organizational size | X | X |

*Source: Author's constructions based on performed analysis*

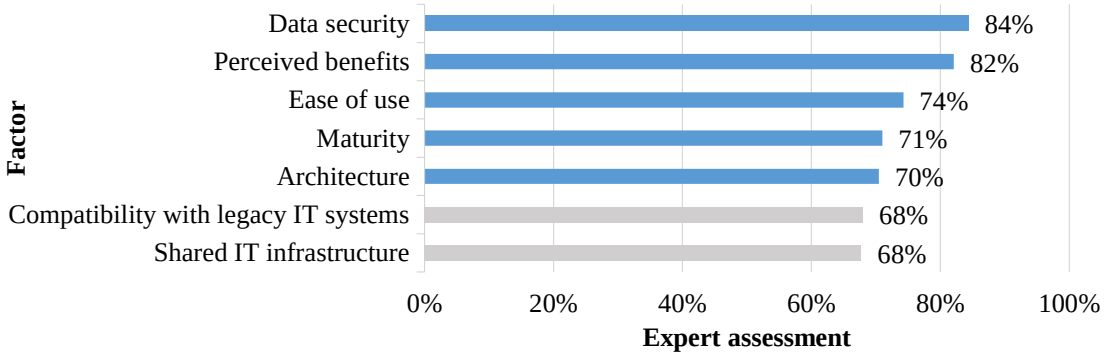
The factors represented in this combined structure of TOE and PIMT frameworks (technological factors, organizational factors, market factors, institutional factors) seem valid for further analysis of blockchain technology adoption in the national economy. It can be anticipated that institutional factor group and particularly 'innovation system' factor may have significant impact on blockchain technology adoption, supporting the change process and facilitating adoption, since three out of seven Tapscott's (2018) success factors belong to innovation system.

The above outlined factor categorization structure is further used to empirically validate the importance of each factor, based on international blockchain expert survey. Selected blockchain experts belong to international community of blockchain practitioners and have experience in blockchain innovation, implementation and advice to businesses and governments. The purpose of the survey was to gain global view and suggestions on blockchain adoption scenarios and factors influencing blockchain technology adoption that are further utilized to define the matrix of analytical hierarchy process for assessment of blockchain technology adoption scenarios within the economy of Latvia. The experts were approached by e–mail on 29th of April 2020 with the invitation to participate in a survey. The survey took place between 29th of April and 5th of May and collected 82 responses from 30 countries (see the questionnaire in Annex 9). The detailed geographical breakdown is presented in Annex 10.

Based on the factor grouping defined by the author, international experts were asked to assess the significance of factors for blockchain technology adoption process within each factor group on a scale from 'very low' to 'very high' and add any other factor or comment on what they consider important. For further analysis, the author has estimated each factor's significance by calculating weighted average percentages from all expert assessments by applying a 0% to 100% scale. The threshold for factor selection for analytical hierarchy process was set at 70%, indicating the importance of the factor for further assessment by national expert group.

In the Technological factor group the most important factors included Data security (84%), Perceived benefits (82%), Ease of use (74%), Maturity (71%) and Architecture (70%).

Figure 4.1. demonstrates that 'Data security' and 'perceived benefits' are the most highly rated factors within technological factor group, both are unarguably pre–requisite for kicking off the technology adoption process.



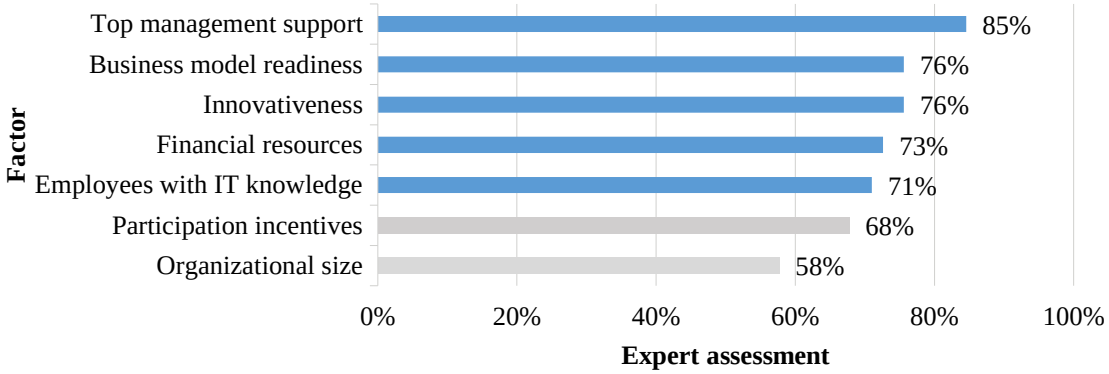

*Source: Author's construction based on international blockchain expert survey results*

Fig. 4.1./ *4.1. att.* **Expert assessment of Technological factor influence on blockchain technology adoption, globally/** ***Ekspertu vērtējums par tehnoloģisko faktoru ietekmi uz blokķēdes tehnoloģiju ieviešanu pasaulē***

There are plenty of blockchain technology benefits as evidenced by the analysis performed in Chapter 1 – starting from micro level benefits such as cost savings and more

efficient administrative processes and ending with macro level benefits such as more transparent and secure digital environment, where parties can interact with one another without the need for trusted intermediaries. Certainly, a 'data security' factor is important in designing and maintaining a blockchain infrastructure. It is also closely interlinked with a maturity factor as the global community of developers and end–users must agree on standardized protocols before the technology can gain a diffusion momentum on global scale (like agreement on *http://* protocol acceptance accelerated Internet's diffusion). Protocols certainly must be tested for such technological attributes as data security, ease of use, compatibility, etc., which will take time and depended on many various stakeholders, who should come to agreement. In the meantime, blockchain adoption on local scale can also happen before its global maturity, which is indicated by experts' higher assessment of 'data security', perceived benefits' and 'ease of use' factors in comparison to 'maturity' factor, implying that any organisation, government or technology developer can develop and adopt blockchain solutions, if a 'data security' component is ensured. This requires either strong internal technical blockchain knowledge to securely adapt open–source blockchains to relevant organisational needs or reliance on renowned blockchain–as–a–service providers, who can take responsibility for ensuring data security and resilience to cyber threats. Such providers include IBM, Accenture, Deloitte, Tieto, etc.

In the Organizational factor group, the most important factors included Top management support (85%), Innovativeness (76%), Business model readiness (75%), financial resources (72%) and Employees with IT knowledge (72%). As evidenced by the figure 4.2., 'Top management support' factor clearly stands out in the organizational factor group and demonstrates that top management has significant influence on blockchain adoption process within the organisation.



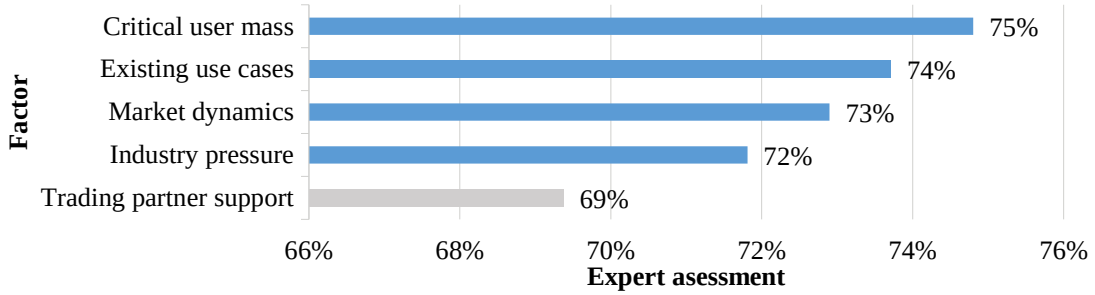

*Source: Author's construction based on international blockchain expert survey results*

Fig. 4.2./ *4.2. att.* **Expert assessment of Organizational factor influence on blockchain technology adoption, globally/** ***Ekspertu vērtējums par organizatorisko faktoru ietekmi uz blokķēdes tehnoloģiju ieviešanu pasaulē***

At the macro level the function of top management is performed by policy makers and respected opinion leaders, therefore their support is crucial for facilitating blockchain technology adoption process in national economy. Overall, it is a logical course of action with technologies, which have not yet reached maturity, when policy makers, opinion leaders and top management of private and public organisations can exercise their power to facilitate or to hinder the adoption process. Next two equally important factors are 'business model readiness' and 'innovativeness', which are rooted in organisational culture and ability to adapt to changing business landscape. Clearly, organisations with innovative and flexible mind–set will be the first adopters of new technologies, as they have internal capabilities not only to react by adapting a business model to new

technological developments, but also to drive the change through innovative process. Such expert rating also indicates that co–existence of those two processes within the organisation are equally important and synergies can be reached, when going hand in hand. The following two factors refer to 'financial resources' and 'employees with IT knowledge', which are certainly important for implementing technological initiatives requiring funding and skills. However, since factors of 'business model readiness' and 'innovativeness' precede factors 'financial resources' and 'employees with IT knowledge', it can be concluded that blockchain technology adoption process worldwide is still in nascent stage requiring more visionary and awareness building actions before actual implementation and adoption can be organised as a structured process, which would only depend on human and capital resources. This is also in line with blockchain's current position at Roger's innovation diffusion curve (2003) and Furlonger and Uzureau's blockchain maturity cycles (2020) (see Annex 8).

In the Market factor group the most important factors included Critical user mass (75%), Existing use cases (74%), Market dynamics (72%) and Industry pressure (72%). As demonstrated by the figure 4.3., there is a minor 3% percentage difference between the highest rated 'critical user mass' factor and lowest rated 'industry pressure' factor, among factors which trespassed a 70% barrier. It overall indicates that top rated factors go hand in hand in blockchain adoption process, and there is no general consensus on the prevalence of one factor over the other.



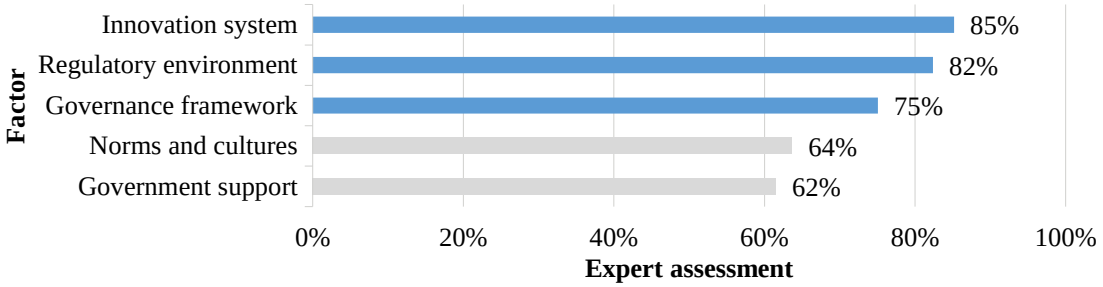

*Source: Author's construction based on international blockchain expert survey results*

Fig. 4.3./ *4.3. att.* **Expert assessment of Market factor influence on blockchain technology adoption, globally/** ***Ekspertu vērtējums par tirgus faktoru ietekmi uz blokķēdes tehnoloģiju ieviešanu pasaulē***

All four indicated factors are important in blockchain technology adoption process from the market perspective. Unarguably, a critical user mass is important in the adoption process of any technological solution, which can be supported by demonstration of successful blockchain use cases. This is proven by the examples of Bitcoin, Ethereum and other public blockchains in the domain of cryptocurrencies and virtual assets, including associated infrastructure, which have demonstrated successful adoption process starting from Roger's (1995) identified stage of 'knowledge', when a use case became known to general public, transitioning to 'persuasion' stage, where a use case persuaded target audience about its perceived benefits, leading to a 'decision stage', where a decision to adopt was made by 'early adopters', continuing with 'implementation' stage, which proved viability of a use case to provide promised benefits and ending with 'confirmation' stage, where a continued decision to adopt was reiterated by end users. A turning point for public blockchains in the domain of cryptocurrencies and virtual assets in the adoption process was support by 'early majority' as per Roger's classification, in other words, a critical user mass, which demonstrates the viability of an innovation, therefore drives further market adoption. A 'critical user mass', in this sense, drives a line between nascent use cases and marketable solutions, which have proven its viability to 'early adopters'

and ‘early majority’, further focusing on attracting ‘late majority’ and ‘laggards’ as per Roger’s (2003) classification. Certainly, before ‘critical user mass’ is reached such factors as ‘existing use cases’, ‘market dynamics’ and ‘industry pressure’ are all contributing to building up a ‘critical mass’ of end users, who base their decisions to adopt or reject an innovation. In this regards, demonstration and ability to participate in approbation of use cases, overall market tendency towards digitalisation, decentralization and efficiency as well as pressure from competitors, who make a decision to adopt, are accelerating the progression through Roger’s innovation diffusion curve driving blockchain adoption process until a critical mass is reached.

In the Institutional factor group, the most important factors included Innovation system (85%), Regulatory environment (82%) and Governance framework (75%). Figure 4.4. illustrates that ‘Innovation system’ and ‘regulatory environment’ factors clearly stand out in the institutional factor group, which indicates a necessity to ensure a collaborative innovation process and adequate regulatory response to technological developments in order to facilitate a blockchain adoption process.




*Source: Author’s construction based on international blockchain expert survey results*

Fig. 4.4./ *4.4. att.* **Expert assessment of Institutional factor influence on blockchain technology adoption, globally/** ***Ekspertu vērtējums par institucionālo faktoru ietekmi uz blokķēdes tehnoloģiju ieviešanu pasaulē***

It is also evidenced by experience of blockchain savvy countries, such as Switzerland and Estonia, which have built up internal knowledge, invested financial resources, implemented awareness– and community–building activities and expressed clear supportive political will for blockchain adoption, which lead to creation and continuous support of blockchain innovation system and development of transparent regulation in fintech and crypto area. International community now regards both countries as heavens for blockchain–based fintechs and crypto entrepreneurs. It is a successful demonstration of how synergies between ‘innovation system’ and ‘regulatory environment’ factors can bring unprecedented results in blockchain adoption process adding value not only to targeted sectors, but also building up general awareness in society and providing spill–over effects in other sectors. It is important to mention that a financial industry regulator takes important part in community building activities in both countries, provides guidance and involves in open dialogue with market participants, which brings clarity to project promoters and conveys a message that blockchain innovation is encouraged and regulatory mechanisms can be agreed in the process of piloting, which gives opportunity to project promoters to adapt their solutions to regulatory specifics or vice versa, meaning that there is a room for regulatory environment to be adapted to specifics of blockchain solutions. It is a tremendous competitive advantage of such jurisdictions, which considerably reduces compliance risks and, therefore, possible operational disruptions, when the solution is launched to market. The next significant factor is ‘governance framework’, which is a blockchain specific factor given its technological design, which by default requires consensus among multiple stakeholders on how and by whom the blockchain network will be governed, how

regulatory compliance will be ensured and how dispute resolution process will be organized, which, again requires cooperation between project promoters and regulators. Those are important considerations dependent on standardisation of technical protocols and agreement to adopt certain technological components by key market participants for various types of blockchain use cases. In this sense, the first factor 'innovation system' creates a blockchain innovation environment the third factor 'governance framework' sets up blockchain operational environment, and the second factor 'regulatory environment' serves as a bridge between those two. Expert assessment also clearly demonstrates the sequence of necessary actions for establishing a well–functioning institutional environment for blockchain technology adoption process, in which a participatory position of regulators play a significant role in innovation, piloting and go–to–market activities.

For definition of blockchain technology adoption scenarios in the national economy the author has relied on the types of blockchain solutions summarized in the Chapter 3, attributed them to relevant stakeholders, who take the lead in promoting each solution type, based on international experience overview, and validated proposed scenarios by surveying blockchain experts worldwide, which serves as a basis for definition of blockchain technology adoption scenarios in the economy of Latvia. The scenarios are summarized below.

**Initiative of technology developers –** includes blockchain solutions in such domains as decentralized payments, crypto/token economy, digital identity, etc., promoted independently by technology developers or in partnerships with other organisations. Definitions:

- **Technology developers** involve both companies that develop and offer digital services/ products/ infrastructures/ tools or rely on them as their primary revenue source and communities of programmers, who develop and/ or contribute to open source code depositories.
- **Decentralized payments** are mediated through cryptocurrencies and rely on associated digital blockchain based infrastructure, which therefore excludes third party authorisations and enables peer–to–peer transfer of funds without the involvement of financial intermediaries.
  - **Cryptocurrency** examples are Bitcoin, Litecoin, Ethereum, Dash, Tezos, etc. Cryptocurrency infrastructure includes cryptocurrency ATMs, crypto–currency exchanges and digital wallets, although this infrastructure is not based on blockchain technology per se.
  - **Globitex** – a cryptocurrency exchange platform founded in Latvia with offices in Riga, Vilnius and London (*About Globitex*, [n.y.]). Its subsidiary Nexpay, UAB, holds a licence of electronic payment institution from the Lithuanian Central Bank (*About Globitex*, [n.y.]).
- **Crypto/token economy** relies on a cryptocurrency–based incentive system that stimulates the behaviour of participants in open access blockchain based projects. These projects are typically built on public blockchain platforms, such as Ethereum, Polkadot, Cosmos, and commonly raise funds through initial currency offers (ICO) or initial exchange offers (IEO). Examples:
  - **Monetha** – a solution developed in Lithuania in 2017 to integrate blockchain–based reputation services into e–commerce transactions and business processes (*Monetha, ICO that…,* 2019).
  - **HashRush** – a real–time strategy game founded in Latvia in 2018, which allows players to compete with each other for cryptocurrency and other virtual rewards (*Hash Rush*, [n.y.]).

- **Digital identity** provides tools for online user authentication and verification, enabling users to securely manage their personal data, e.g. confirming their identity and ensuring compliance with the conditions for the use of online services. In comparison to traditional online authentication solutions (e.g. Internet banking), blockchain based digital identity solutions provide enhanced user control over their personal data, as data are not saved in centralised databases and are transmitted in an encrypted form. Examples:
  - **Notakey** – a solution developed in Latvia in 2016 for customer due diligence (KYC) in the digital environment, which was in line with the recommendations developed by the Financial Action Task Force (FATF) in the areas of prevention of money laundering and terrorist financing (AML/CFT) (*Notakey Announces…,* [n.y.]).

**Initiative of industry pioneers/ consortia** – includes blockchain solutions for supply chain traceability, self–enforcing contracts, fintech solutions, AML/CFT/KYC compliance solutions, etc., implemented through individual initiatives or initiatives promoted by industry consortia.

Definitions:

- **Industry pioneers** are defined as enterprises that develop innovative solutions and introduce innovations in business models in sectors of their core operations such as logistics, banking, agriculture, manufacturing, mining, wholesale, etc.
- **Industry consortia** are associations of two or more persons, companies, organisations or public institutions (or any combination thereof) whose purpose is to participate in cooperative activities or pool their resources in order to develop a common project. Examples of international blockchain consortia:
  - **BiTA** (Blockchain in Transport Alliance) brings together stakeholders interested in the supply chain solutions in the logistics/ transport industry – UPS, Fedex, P&G, Whirlpool, BASF, Schneider, etc. (*Blockchain in Transport Alliance*, [n.y.]).
  - **MOBI** (Mobility Open Blockchain Initiative) consortium aims to create and promote smart mobility blockchain initiatives and brings together auto industry actors – BMW, Ford, General Motors, Renault, etc. (*Mobility Open Blockchain Initiative*, [n.y.]).
  - **CBC** (Construction Blockchain Consortium) brings together actors in the construction industry – CBRE, AIG, Siemens, Canary Wharf Group, etc. for knowledge transfer, R&D and education & training related to blockchain technology (*Construction Blockchain Consortium*, [n.y.]).
  - **ABCD** initiative in agriculture industry to optimize and digitize international grain trades promoted by the world's largest agribusiness companies – Archer Daniels Midland Co, Bunge Ltd, Cargill Inc. and Louis Dreyfus Co (*ABCD Quartet…*, 2018).
  - **Financial industry consortium R3 CEV** combines more than 70 leading financial services providers (e.g. Credit Suisse, HSBC, BMO Financial Group, Natixis, Royal Bank of Scotland, TD Bank, UBS, UniCredit, Wells Fargo, etc.) with the aim of developing blockchain solutions in the financial services industry (Major global banks…, 2017).
- **Supply chain traceability** ensure procurement transparency, product origin verifications, improvement of logistics processes, which may be enhanced through integrations with the Internet–of–Things sensor technologies. Examples:

- **Walmart food security solution** developed by the US supermarket chain 'Walmart' in 2016 for quality control of goods and traceability of the delivery process from farm to supermarket in real–time mode (*How Walmart Brought…*, [n.y.]).
- **Maersk's and IBM's pilot blockchain solution** developed in 2018 in collaboration with 94 participants, including global freight forwarder CEVA Logistics, Pacific International Lines and a network of 20 port and terminal operators, minimized cargo transportation documentation errors and reduced cargo delivery time by 40% (*Maersk and IBM…,* 2018).

- **Self–enforcing contracts** rely on smart contracts that facilitate automatic enforcement of contractual clauses between counterparties through blockchain and may also trigger automatic payments if certain contractual clauses are enforced. Examples:
  - AXA has piloted a **self–enforcing flight delay insurance** through the Fizzy platform, which records each purchase on a blockchain, monitors flight delays in relevant databases and, as soon as the delay is registered, a compensation is enforced automatically (AXA turns to…, 2017).
- **Fintech solutions** reinvent traditional financial services through application of various technologies, including blockchain. They aim to improve back–office and front office processes associated with financial services – from payments to securities clearing and settlement. Examples:
  - **Voltron** – a pilot blockchain based solution developed in 2018 in trade finance area, which included the issuance of a letter of credit and automated payments made between HSBC and ING banks for the sale of soybean purchase/sale transaction from Argentina to Malaysia between two Cargill subsidiaries and resulted in reduction in execution time of the transaction from 5–10 to one day (*HSBC, ING and…*, 2018).
  - **Komgo** – in 2019, Rabobank implemented a trade finance transaction in the newly created product trading ecosystem, supported by 15 leading banks in trade finance transactions (ABN–AMRO, BNP Paribas, Credit Agricole, Citi, Gunvor, ING, Koch Supply & Trading, Macquarie, Mercuria, MUFG Bank, Natixis, Rabobank, SGS, Shell, Societe Generale) resulting in reduction in transaction execution time from 10 days to one hour (*Catalyzing the Global…,* [n.y.]).
  - **Ripple** – a real–time settlement solution developed in 2012 for international money transfers and currency exchange transactions used by 300 + financial services providers worldwide (e.g. American Express, MoneyGram, Santander, etc.) to reduce transaction processing time and commissions and to provide a settlement infrastructure in regions where traditional financial services are not available (*Frequently Asked…*, 2020).
  - **LINQ** – a solution developed in 2015 by Nasdaq Stock Exchange, in cooperation with the Chain.com for trading shares via blockchain, which reduces administrative burdens, costs and fraud risks (*Nasdaq Linq Enables…*, 2015).
  - **Digital Asset** – a DLT–based solution developed by Australian Securities Exchange in 2016 used for securities after–sales services to expedite the clearing process and mitigate settlement risk (*ASX Selects Digital…*, 2016).
  - **Sygnum Bank** – a virtual asset bank with a bank license in Switzerland offers services for transactions with virtual assets, one of which is the use of Swiss franc virtual representation in the crypto ecosystem, as well as standard

financial services such as the issuance of credits against pledge of digital assets, digital asset management, brokerage, e–commerce, etc. (*Sygnum Bank Launches*…, 2020).

- **KYC/AML/CFT compliance** procedure implementation through blockchain based self–sovereign identities and smart contracts ensure more transparent and prompt client on–boarding process and automated compliance with regulatory reporting obligations in the fields of anti–money laundering and prevention of terrorist financing. Examples:
- **KYC Utility** – a blockchain–based solution developed by R3 consortium in cooperation with 39 banks for the exchange of KYC data between financial service providers, which not only speeds up the customer due diligence process, but also helps to reduce administrative burden and regulatory reporting costs (*R3 and 39 Firms…*, 2018).
- **LBChain** – a sandbox solution of the Central Bank of Lithuania, which is intended for testing and adapting blockchain solutions developed by fintech companies to the requirements of financial sector regulatory enactments, including KYC/ AML/ CFT (*LBChain*, 2020).

**Initiative of state/ regulatory authorities –** covers blockchain based e–government and e–participation solutions, such as more effective provision of public services, more effective regulatory monitoring, or enhancing public administration transparency. Definitions:

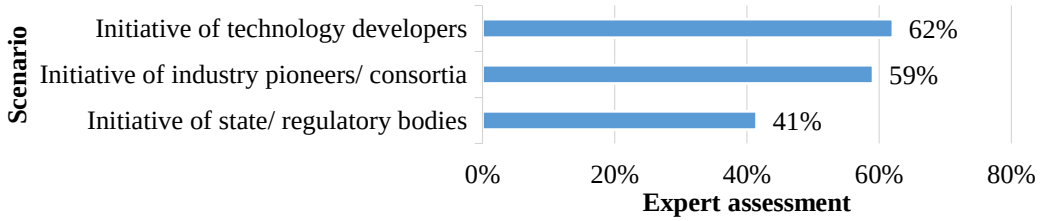
- **E–government** solutions reduce costs, time and administrative burden, and in blockchain based implementations automate information exchange between public administration bodies and society, provide transparency on data modifications and access through public registries, therefore improving administrative functions of public administration. Examples:
  - **Exonum** – a solution used by the National Public Records Agency of Georgia for real estate transactions and their automated entry into the Land Registry (*Improving the Security…,* [n.y]).
  - **Blockcerts** – a solution used by the Maltese Ministry of Education and Employment for issuing and verifying qualifications in the digital environment (*Press Release by…,* 2019).
  - **Chromaway** – a solution used by the Swedish Land Register for real estate transactions and their automatic entry into the Land Registry (*The Land Registry…,* 2017).
  - **Shenzhen Speed** – a solution for automated invoicing used by the Shenzhen Tax Office since 2019, which not only saves time and money for companies and significantly reduces the possibility of using false invoices, but also improves the process of monitoring corporate tax deductions and payments, which has already completed transactions worth close to USD 1 billion (*China's Shenzhen District…,* 2020).
  - **E–health** – a solution used by the Estonian Center for Health and Welfare Information Systems for accessing and managing personal data of citizens' health care, which integrates data from several IT systems and medical institutions (*Blockchain Startup to…,* 2016*)*. The solution uses Guardtime's KSI (Keyless Signature Infrastructure) encryption tool, which is also used in other Estonian national IT systems to ensure data integrity and transparency, as well as NATO's Joint Cyber Defence Centre of Excellence, the US

Department of Defence and Pentagon's main arms supplier Lockheed Martin (*Blockchain Startup to…,* 2016*).*

- **E–participation** solutions generally enhance participation of society in political and social engagement processes, facilitated by the use of various digital tools, and in the case of blockchain based solutions, ensure enhanced trust to public authorities, since blockchain based algorithms are no longer solely controlled by the government. Examples:
  - **uPort** – a solution used by the city of Zug for verifying and managing the digital identity of the population, which will give the population of Zug in the future access to various e–participation and e–government services such as opinion polls, use of public bicycles, tax filing and possibly electronic elections in the future (*Swiss City of Zug…,* 2018).

Based on the scenarios defined by the author above, international experts were asked to assess the progress of each blockchain technology adoption scenario within their countries on a scale from 'very low' to 'very high' and add any other scenario or comment on what they consider important. For further analysis, the author has estimated each scenario's development progress by calculating weighted average percentages from all expert assessments by applying a 0% to 100% scale.

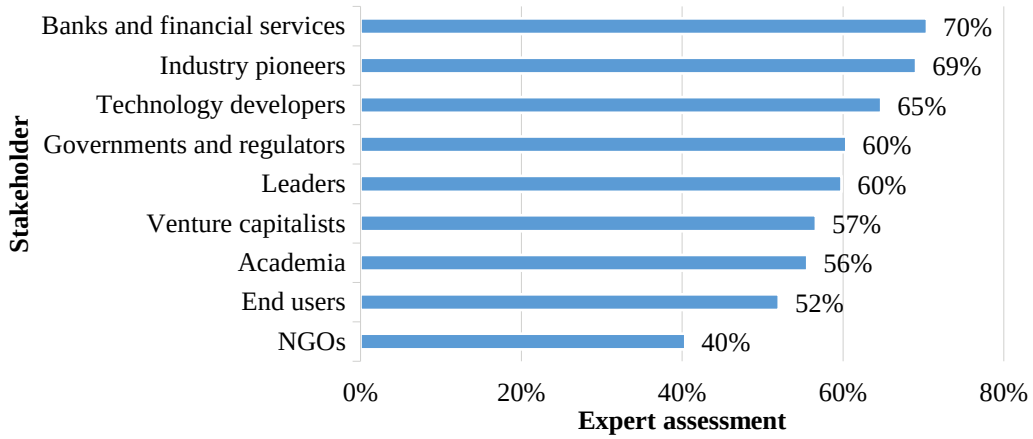
Figure 4.5. demonstrates that the level of adoption of blockchain solutions promoted by technology developers was rated the highest (62%) closely followed by solutions promoted by industry pioneers/ consortia (59%) with solutions promoted by government institutions/ regulators lagging behind (41%).




*Source: Author's construction based on international blockchain expert survey results*

Fig. 4.5./ *4.5. att.* **Expert assessment of blockchain technology adoption scenarios worldwide/** ***Ekspertu novērtējums par blokķēdes tehnoloģiju ieviešanas scenārijiem pasaulē***

Interestingly, that the highest score has reached only 62%, indicating somewhat 'medium' to 'high' level of adoption even for the most widely adopted scenario of technology developers. It also corresponds to position of blockchain solutions at Roger's (2003) innovation curve, as identified before, implying that a 'critical mass' point has already been passed through globally at least for use cases in the domain of cryptocurrencies and virtual assets, promoted by technology developers. Although, banks and financial institutions, which promote blockchain solutions, can be considered as industry pioneers in financial services industry, several international experts have suggested distinguishing blockchain solutions promoted by banks and financial institutions within a separate solution type due to its cross–sectoral impact and more stringent regulation. In addition, banks and financial institutions were assessed by international experts as the most influential stakeholder group for blockchain innovation and adoption (72%), as indicated by the figure 4.6.




*Source: Author's construction based on international blockchain expert survey results*

Fig. 4.6./ *4.6. att.* **Expert assessment of stakeholder influence on blockchain technology innovation and adoption, globally/** ***Ekspertu vērtējums par ieinteresēto pušu ietekmi uz blokķēdes tehnoloģiju inovācijām un ieviešanu pasaulē***

All other stakeholder groups closely follow the leading stakeholder group –industry pioneers (69%), technology developers (65%), government and regulators (60%), leaders (60%), venture capitalists (57%), academia (56%), end users (52%). The only group substantially lagging behind other stakeholders are NGOs (40%). Concentrated levels of influence among stakeholder groups indicates the necessity of collaboration and exchange of knowledge blockchain technology adoption process. Top four influential groups also represent the promoters of blockchain solutions that are defined within identified blockchain adoption scenarios. Other stakeholders influence blockchain technology development to the lesser extent, as they are normally not being actively involved in innovating blockchain solutions, however they express visionary opinions, provide research and resources, which is also important for diffusion of innovations. Taking into account that a financial services industry is a significant contributor to the economy of Latvia, the author has decided to separate this scenario from other industry–driven blockchain solutions for further assessment by national blockchain technology experts. Therefore, the scenario 'Initiative of industry pioneers/ consortia' is split into two scenarios for further analysis.

**Initiative of industry pioneers/ consortia** – includes blockchain solutions for supply chain traceability, self–enforcing contracts, fintech, AML/CFT/KYC compliance, etc., implemented through individual initiatives or initiatives promoted by industry consortia

**Initiative of banks/ financial services industry** – Initiative of banks/ financial services industry includes development of blockchain solutions in fintech and AML/CFT/KYC compliance areas, etc. through participation in international consortia or by implementing own initiatives. These solutions are separated into an individual scenario as they are interdisciplinary in nature and the financial sector is regulated more stringently than other industries.

It is important to note, that scenarios are non–exclusive, can be developed simultaneously and can either contribute to development of one another or develop independently as it is also evidenced by the experience of neighbouring countries – Estonia and Lithuania. For example, technological companies in Estonia actively develop blockchain solutions within crypto space and the state is implementing and offering blockchain based e–government services to the citizens, however development of two types of blockchain solutions do not directly contribute to development of one another as

they co–exist in completely different spaces – crypto world and e–government, respectively. In Lithuania, on the contrary, the LBChain Regulatory Sandbox project promoted by Lithuanian Central Bank directly contributes to development of blockchain solutions being promoted by technological companies in financial services industry, as it allows technological companies to test compliance of their innovative solutions with financial services regulation, and Lithuanian Central Bank provides testing environment, guidance and regulatory advice. For the purpose of scenario definitions, it should be noted, that pure regulatory actions such as laws, regulations, policies, action plans etc. covering blockchain topic and, more commonly, cryptocurrency regulation should not be confused with blockchain solutions being evaluated in the context of initiative of state/ regulatory authorities (such as Sandbox or other type of solutions being developed by the public body or the regulator in any given industry).

### 4.2. Assessment of factors and scenarios for blockchain technology adoption in the economy of Latvia/ *Blokķēdes tehnoloģiju ieviešanu Latvijas tautsaimniecībā ietekmējošo faktoru un scenāriju izvērtējums*

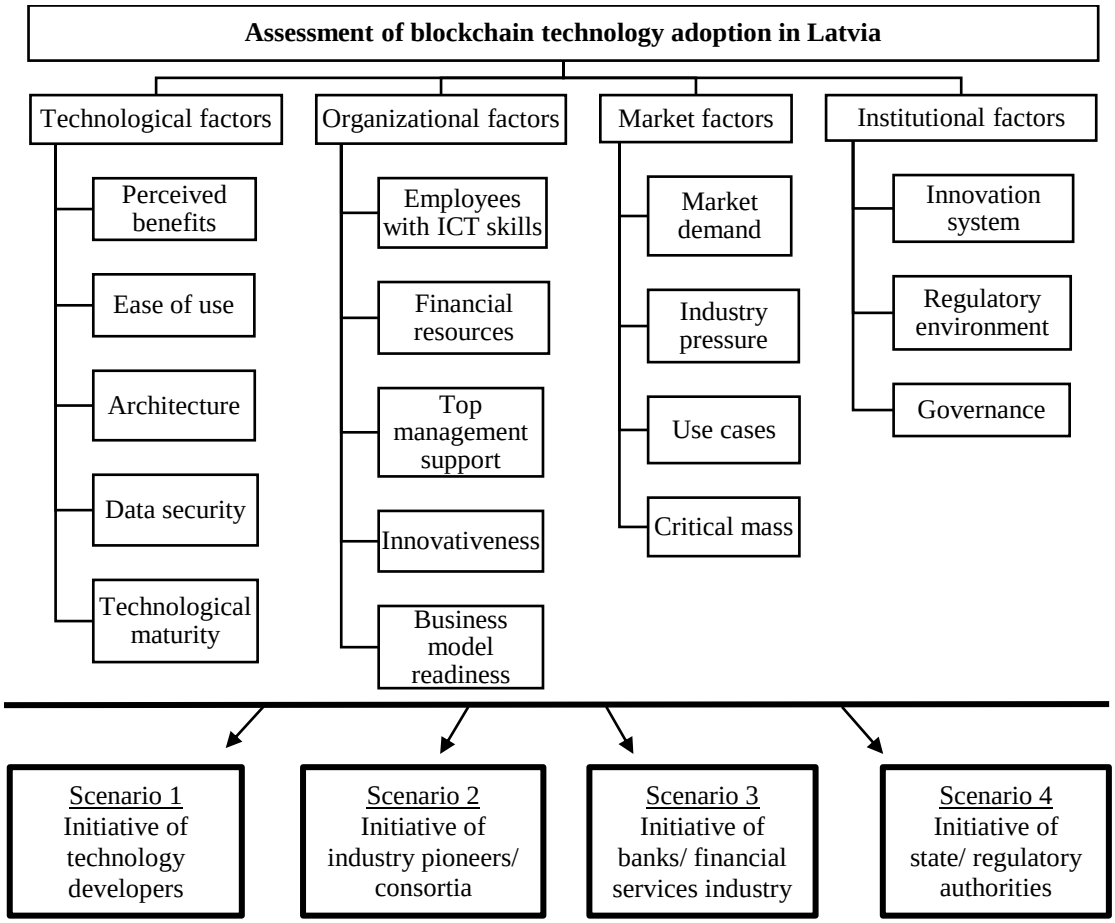
Based on the selected factors and identified scenarios analysed and validated in 4.1. section, blockchain technology adoption scenarios in Latvia are further evaluated by selected national blockchain experts using one of a Multi–Criteria Decision Analysis (MCDA) methods – Hierarchy Analysis Method (AHP), developed by T. Saaty (1980).

Multi–Criteria Decision Analysis methods consist of four steps (Blaunstein, Linkov, 2019):

1. creating a set of criteria relevant to the decision at hand;
2. defining the preference parameters of the model (criteria weights, thresholds, etc.);
3. measuring the performance of each alternative with respect to each criterion on possibly heterogeneous scales; and
4. aggregating the information defined in Steps 1–3 to solve the question at hand: to choose the best alternative, to rank the alternatives, or to sort them into pre–defined categories.

Hierarchy Analysis Method (AHP) establishes priority weights for alternatives by organizing objectives, criteria, and sub criteria in a hierarchic structure (Bernasconi et al., 2010) and allows assessing scenarios based on a set of pre–defined criteria and their weights. AHP is a widely applied method in business, process management, industry, health, education, etc. (Christe et al., 2015).

Based on the analysis of factors and scenarios described in previous section, the author outlined the AHP matrix, which was further used for surveying local experts in Latvia (see figure 4.7.).




*Source: Author's construction based on AHP analysis*

Fig. 4.7./ *4.7. att.* **AHP hierarchy matrix for assessment of blockchain technology adoption in Latvia/** ***AHP hierarhijas matrica blokķēdes tehnoloģiju ieviešanas novērtēšanai Latvijā***

Defined factors and scenarios were assessed by seven national experts (see Table 4.2.), with expertise and/ or experience in blockchain technology. They have either been involved in blockchain based solution development or evaluated blockchain technology applicability to represented organisations and, in case of Ministry of Economics and European Commission, its broader impacts on private and public sectors.

Table 4.2./ *4.2. tabula*

**Characteristics of experts involved in AHP analysis/ *AHP analīzē iesaistīto ekspertu raksturojums***

| Experts' characteristics | | | Spatial level of activity |
|---|---|---|---|
| **Code** | **Name** | **Represented organisation** | |
| A | Ingus Valtiņš | Financial Capital Markets Commission, Senior Legal Adviser, Licensing Division, Legal and Licensing Department | Licensing and oversight of financial services providers, including consulting on Fintech solutions |
| B | Deniss Fiļipovs | Bank of Latvia, Head of Payment Systems Policy division | Oversight of payment systems and payment instruments in Latvia, including Fintech and blockchain |
| C | Ina Gudele | Latvia Internet Association, Executive Director | Latvian digital space development and e–commerce support |
| D | Edgars Ozoliņš Ozols | Ministry of Economics of the Republic of Latvia, Senior Expert at start–up support division, Digitalisation Team Lead | Innovation policy development and implementation, including blockchain vision |
| E | Pēteris Zilgavis | European Commission, Head of Unit, Digital Innovation and blockchain, Digital Single Market Directorate | European Union blockchain policy development and implementation |
| F | Anatolijs Ressins | Blockvis, Co–founder and CEO<br>Latvian blockchain Association, Board member | Blockchain technology development |
| G | Sandris Muriņš | SIA Muriņš Start–up, Founder and entrepreneur | Blockchain project development and promotion |

*Source: Author's constcution*

An AHP assessment process involved pairwise comparisons of factor and factor group significance and pairwise comparisons of each factor contribution to each pre–defined scenario (see the questionnaire comprising of 22 pairwise comparison matrices in Annex 11).

Each pairwise comparison matrix A = $(a_{ij})_{n*n}$ is reciprocal:

$$a_{ij} = \frac{1}{a_{ij}} \text{ for i,j} = 1,\ldots, \text{n} \qquad (4.1.)$$

Where $a_{ij}$ – rating

The ratings for pairwise comparison were based on the distribution and explanation of the Saaty's (1980) fundamental scale for pairwise comparisons:

Table 4.3./ *4.3. tabula*

**The Analytical Hierarchy Process relative scale/** ***Analītiskās hierarhijas procesa relatīvā skala***

| **Scales** | **Degree of Preferences** | **Descriptions** |
|---|---|---|
| **1** | Equally | Two activities contribute equally to the objective |
| **3** | Moderately | Experience and judgment slightly to moderately favour one activity over another |
| **5** | Strongly | Experience and judgment strongly or essentially favour one activity over another |
| **7** | Very strongly | An activity is strongly favoured over another and its dominance is showed in practice |
| **9** | Extremely | The evidence of favouring one activity over another is of the highest degree possible of an affirmation |
| **2, 4, 6, 8** | Intermediate values | Used to represent compromises between the preferences in weights 1, 3, 5, 7 and 9 |

*Source: Saaty, 1980*

The priority vectors for pairwise comparisons of factor and factor group significance and each factor contribution to the development of each evaluated scenario were calculated as per Saaty's (1980) equation:

$$A * \omega = \lambda_{max} * \omega \quad (4.2.)$$

where A – the comparison matrix;
ω – the priorities vector;
$\lambda_{max}$ – the largest Eigen value.

The consistency of expert assessment was evaluated by calculating Saaty's (1980) Consistency Index and Consistency Ratio for each pairwise comparison matrix:

$$CI = \frac{\lambda_{max} - n}{n-1}, \quad (4.3.)$$

$$CR = \frac{CI}{RI}, \text{ where} \quad (4.4.)$$

where CI – Consistency Index
$\lambda_{max}$ – the largest Eigen value
n – the size of comparison matrix
CR – Consistency Ratio
RI – Random Consistency Index

The random consistency index values were selected based on the size of comparison matrix as per Saaty's (1980) random index table:

Table 4.4., *4.4. tabula*

**The Average Random Consistency/** ***Vidējā varbūtējā saskaņotība***

| n | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| RI | 0 | 0 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 | 1.51 |

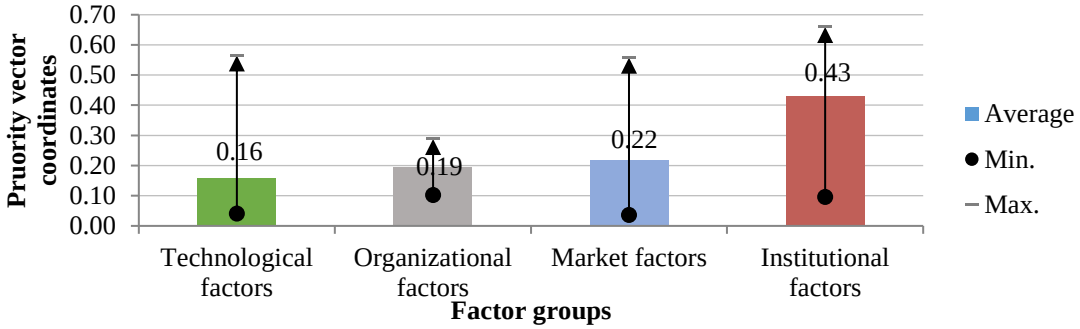
*Source: Saaty, 1980*

As per Saaty's (1980) CI value is acceptable at ≤ 0.10. If CI > 0.1, it indicates that an expert assessment may be illogical, therefore the author in such cases asked the expert to reevaluate a pairwise matrix for improving consistency. The experts had to complete

the questionnaires in order to express their views using a materiality rating scale. Each expert first evaluated factor groups, then evaluated each factor within each factor group and concluded with assessment of each factor development level within each scenario.

The developed blockchain adoption factor groups, factors and scenarios outlined in 4.2. Section were introduced to the invited experts, who, based on their experience, filled in the hierarchy analysis matrices. In the next step, the author summarized expert evaluations and calculated the average priority vector coordinates, as well as determined the minimum and maximum evaluations.

Figure 4.8. demonstrates that technological factor influence on blockchain adoption in Latvia has the lowest expert assessment (0.16), whilst institutional factor influence has the highest expert assessment (0.43).

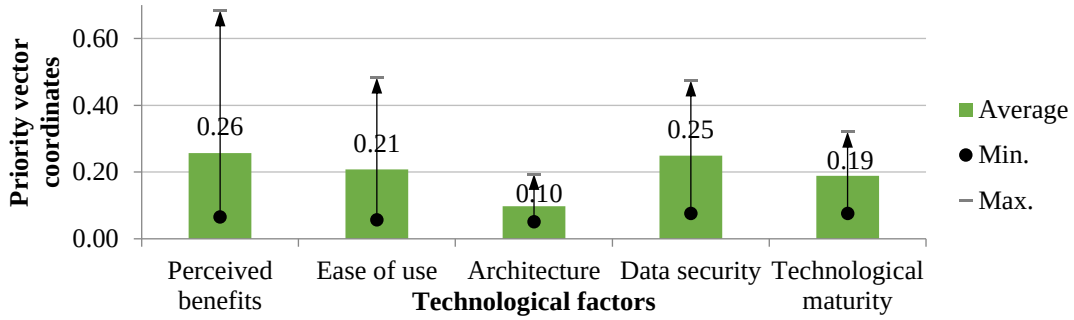



*Source: Author's construction based on AHP results*

Fig. 4.8./ *4.8. att.* **Expert rating for comparison of factor group significance influencing blockchain technology adoption in Latvia/** ***Ekspertu vērtējums faktoru grupu salīdzināšanai blokķēdes tehnoloģiju ieviešanai Latvijā***

Several experts have commented that blockchain's technological benefits are broadly clear to various stakeholders in Latvia, and various technological implementations are widely available, therefore technological factors gradually become of a lesser importance in blockchain adoption decision–making process. Some of the experts have noted that institutional factors become increasingly significant in a decision–making process to adopt blockchain technology, specifically, it is critically important that various blockchain specific issues are present in political agenda and addressed in a regulatory framework.

As demonstrated by the figure 4.9., 'Perceived benefits' (0.26) is the highest rated factor among technological factors based on average expert assessment and it also shows the widest dispersion in opinions.

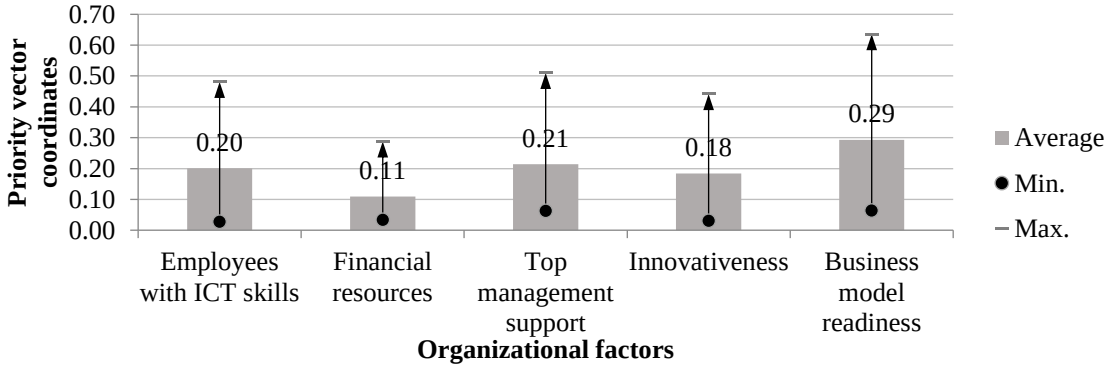



*Source: Author's construction based on AHP results*

Fig. 4.9./ *4.9. att.* **Expert rating for comparison of factor significance within technological factor group influencing blockchain technology adoption in Latvia/** ***Ekspertu vērtējums faktoru nozīmības salīdzināšanai tehnoloģisko faktoru grupā blokķēdes tehnoloģiju ieviešanai Latvijā***

Experts, who have attributed the lowest assessment to the factor 'Perceived benefits', have commented that this factor becomes of a lesser important in blockchain adoption decision–making process due to developing understanding about blockchain and its benefits among various stakeholders in Latvia. On the other hand, experts, who have attributed the highest assessment to 'Perceived benefits' factor, consider that blockchain's ability to address unique technological challenges should not be underrated. The following factors, such as 'Data security' (0.25), 'Ease of use' (0.21) and 'Technological maturity' (0.19) are overall important factors for adoption of any ICT solution. The factor 'Architecture' (0.10) has received the lowest average expert assessment among technological factors with the narrowest dispersion in opinions. It indicates that there is no uniform agreement on technological standards for blockchain 'Architectures' up to date, which correlates with the current position of blockchain technology within the innovation diffusion process and maturity cycle.

As demonstrated by the figure 4.10., 'Business model readiness' (0.29) is the highest rated factor among organizational factors based on average expert assessment and it shows the widest dispersion in opinions. The lowest assessments have been attributed by the representatives of public administration/ regulatory authorities. It can be explained by the fact that certain technological solutions in public sector can be introduced as soon as there is a political will and/ or necessity to upgrade existing IT systems.

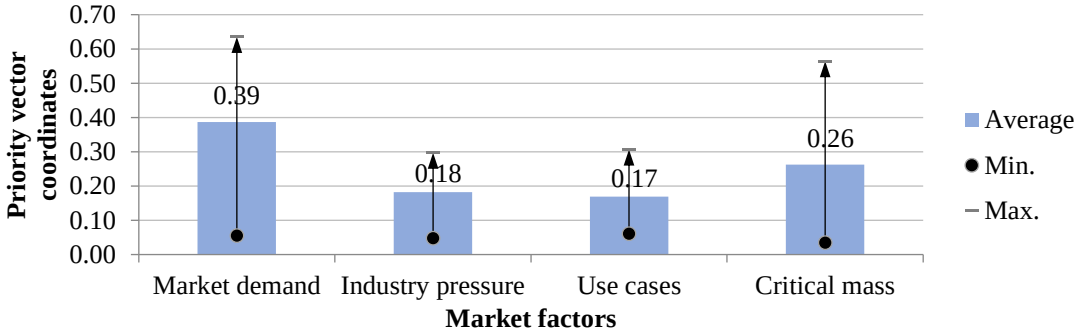



*Source: Author's construction based on AHP results*

Fig. 4.10./ *4.10. att.* **Expert rating for comparison of factor significance within organisational factor group influencing blockchain technology adoption in Latvia/** ***Ekspertu vērtējums faktoru nozīmības salīdzināšanai organizatorisko faktoru grupā blokķēdes tehnoloģiju ieviešanai Latvijā***

A 'Business model readiness' factor is of a bigger importance in business environment as internal processes within enterprises and transactions with counterparties must be adapted to blockchain solutions. The average expert assessments of the factor 'Top management support' (0.21), 'Employees with ICT skills' (0.20) and 'Innovativeness' (0.18) indicate that those factors are of equal importance in the blockchain adoption process. The lowest average expert assessment has been attributed to the factor 'Financial resources' (0.11) with the narrowest dispersion in opinions. It can indicate that Latvia has not yet reached a general level of understanding of magnitude of transformative effects provided by blockchain technology and a clear necessity to start active process of development and implementation of blockchain solutions, in which certainly financial resources are pre–requisite for kicking–off any R&D activities, piloting or project implementation. An aggregated opinion of local experts implies that a bottom–up approach might currently have more influence on blockchain adoption process in Latvia contrary to international expert rating, which suggested a top–down approach with strong support from top management, policy makers and opinion leaders.

As demonstrated by the figure 4.11., 'Market demand' factor (0.39) is the highest rated factor among market factors based on average expert assessment and it also shows the widest dispersion in opinions.

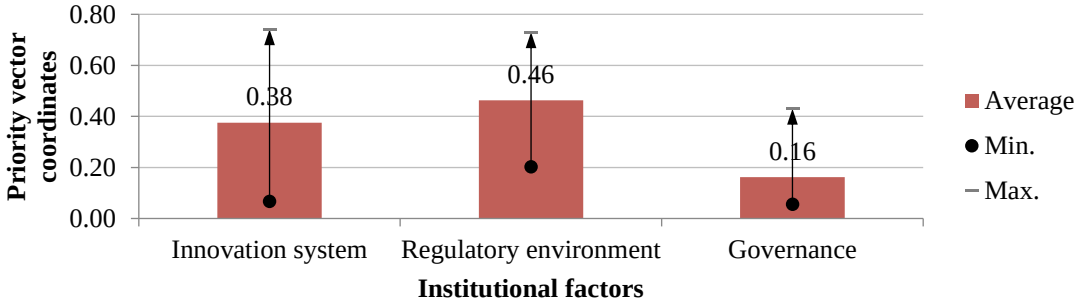



*Source: Author's construction based on AHP results*

Fig. 4.11./ *4.11. att.* **Expert rating for comparison of factor significance within market factor group influencing blockchain technology adoption in Latvia/ *Ekspertu vērtējums faktoru nozīmības salīdzināšanai tirgus faktoru grupā blokķēdes tehnoloģiju ieviešanai Latvijā***

The lowest assessment of the 'Market demand' factor (0.06) was attributed by the The Central Bank representative, who has attributed the highest assessment to the 'Critical mass' factor (0.56). The explanation is that initiatives of Central Banks must be aligned among all EU Central Banks considering potential impacts on the whole EU monetary system. The lowest assessment (0.06) to the 'Critical mass' factor was attributed by the blockchain developer clarifying that blockchain solutions may be targeted at specific target audiences, hence a critical mass is not mandatory in such cases. The following factors – 'Industry pressure' (0.18) and 'Use cases' (0.17), have been equally assessed and displayed narrow dispersions in opinions.

As demonstrated by the figure 4.12., among 'Regulatory environment' (0.56) is the highest rated factor among market factors based on average expert assessment and it also shows the wide dispersion in opinions.



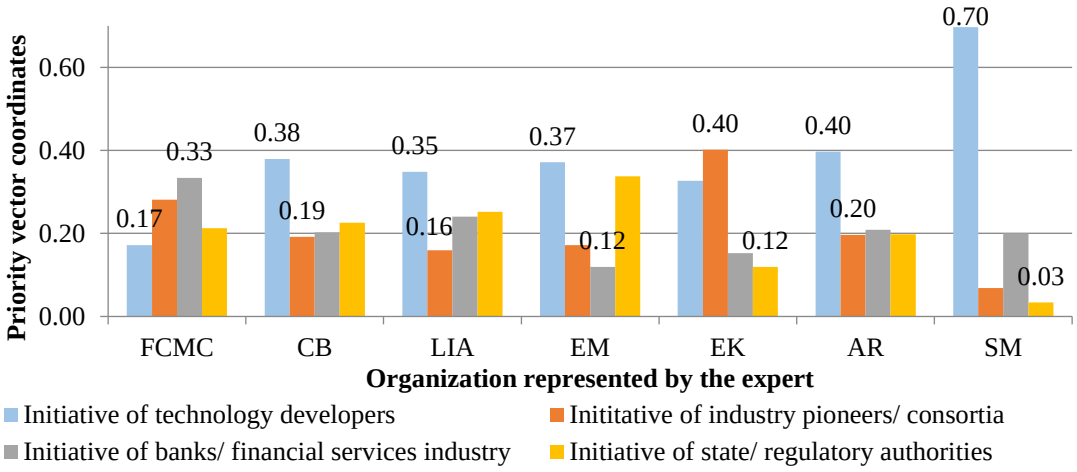

*Source: Author's construction based on AHP results*

Fig. 4.12./ *4.12. att.* **Expert rating for comparison of factor significance within technological factor group influencing blockchain technology adoption in Latvia/ *Ekspertu vērtējums faktoru nozīmības salīdzināšanai institucionālo faktoru grupā blokķēdes tehnoloģiju ieviešanai Latvijā***

The FCMC representative and a blockchain entrepreneur have both attributed the lowest score of 0.20 to the 'Regulatory environment factor, which is surprising, given high assessments attributed by other stakeholders. The highest assessments by both experts have been attributed to the 'Innovation system' factor (0.70 and 0.74, accordingly), indicating the need for a blockchain ecosystem targeted at establishing a

platform for dialogue and cooperation between a crypto community and the regulator. The 'Innovation system' factor (0.38) also displays a wide dispersion in opinions. The representative from the Ministry of Economics has attributed the lowest score (0.07) to the 'Innovation system' factor, since the ministry actively engages in a start–up community since 2018 and considers that blockchain specific issues can be adequately addressed within this general framework. Considering that other experts have attributed the highest scores to this factor, it can be derived that there is the lack of activities targeted at the establishment of a specific blockchain ecosystem in Latvia. The 'Governance' (0.16) factor is the lowest rated factor among market factors based on average expert assessment and it shows the narrowest dispersion in opinions. It indicates the readiness of experts to consider various 'Governance' structures, which correlates with the current position of blockchain technology within the innovation diffusion process and maturity cycle.

As demonstrated by the figure 4.13., five out of seven experts have attributed the highest scores to the 'Technology developer initiative' scenario versus other scenarios.




*Source: Author's construction based on AHP results*

Fig. 4.13./ *4.13. att.* **Individual expert opinions on blockchain technology adoption scenarios in Latvia/** ***Individuālie ekspertu atzinumi par blokķēdes tehnoloģiju ieviešanas scenārijiem Latvijā***

The blockchain entrepreneur has attributed the highest expert assessment (0.70) to the 'Initiative of technology developers', whilst, the FCMC representative has attributed the lowest assessment (0.17). Such dispersion in opinions displays the need of a multi–stakeholder engagement to facilitate the dialogue and cooperation in the domain of decentralized finance applications**,** which is the most common type of initiatives promoted by technology developers.

Overall, the experts attribute higher assessments to either familiar scenarios or scenarios that may be introduced by their represented institutions. For instance, the representative of a Ministry of Economics has attributed the 2nd highest assessment to the 'Initiative of state/ regulatory authorities' (0.34) as the Ministry of Economics together with a Ministry of Finance are currently engaged in the concept development for a blockchain based solution to combat shadow economy. The FCMC representative has attributed the highest assessment to the 'Initiative of bank/ financial services industry' (0.33) as FCMC knows that one of the banks already experiments with blockchain based solutions.

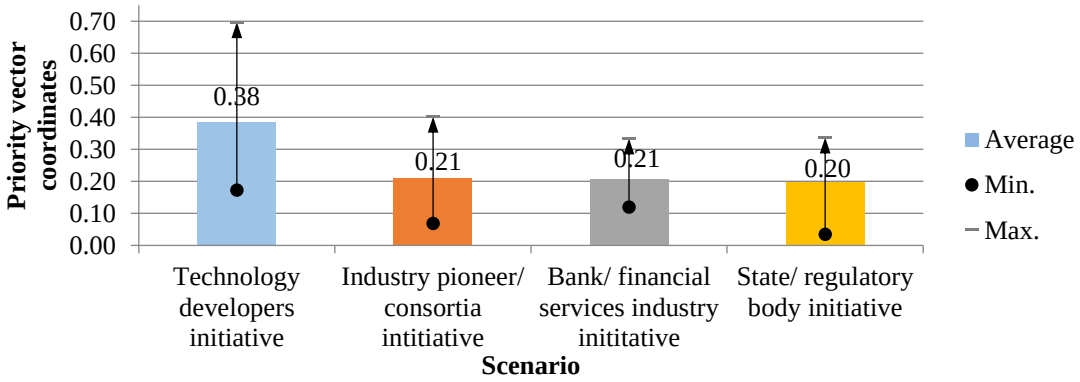
The representative from the European Commission has attributed the highest assessment to the 'Initiative of industry pioneers/ consortia initiative' (0.40). The expert

has noted that blockchain has potential to provide the greatest impact on the financial services industry, however blockchain adoption is not limited to financial services industry and will span across other industries.

The lowest individual expert assessments among all expert assessments have been attributed by a blockchain entrepreneur to the 'Initiative of a state/ regulatory authorities' (0.03) and the 'Initiative of industry pioneers/ consortia' (0.07). The expert has noted that public authorities and industry representatives have displayed the lack of action during the blockchain experimentation boom during 2017–2018, hence he does not see any reasons that may change the behaviour of public authorities and industry representatives beyond financial services at this moment.

The highest individual expert assessment has been also attributed by a blockchain entrepreneur to the 'Initiative of technology developers' (0.70). The expert has stressed that decentralized finance solutions will likely develop the most actively by technology developers. He has stressed that solutions brought by technology developers and targeted at developing countries (e.g. countries in Africa, Asia, South America) will likely gain the most momentum in the nearest future, due to problems with governance and transparency issues, amplified by the economic consequences brought by Covid–19. According to him, the biggest value added of decentralized finance solutions in developing countries is their ability to provide payment infrastructures for unbanked population, which may be more resilient than local currencies that are periodically exposed to substantial devaluations.

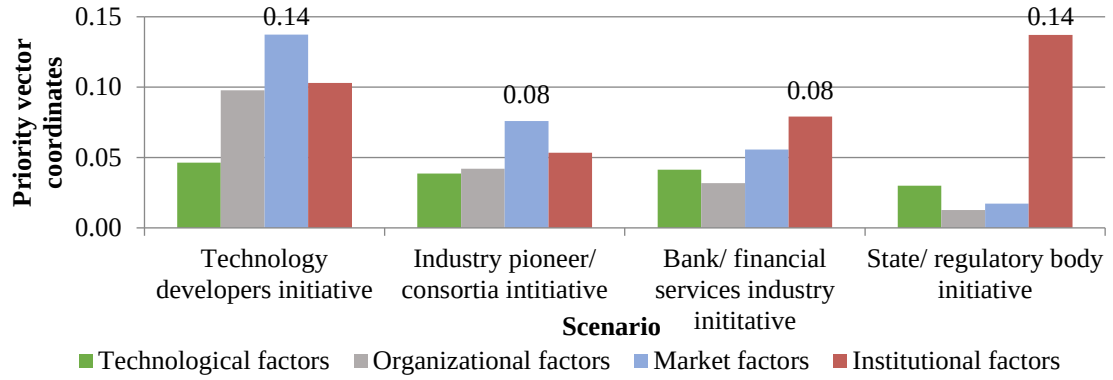
As demonstrated by the figure 4.14, the 'Technology developers initiative' (0.38) has received the highest average expert assessment, whilst other scenarios – 'Initiative of industry pioneers/ consortia' (0.21), Initiative of bank/ financial services industry' (0.21) and 'Initiative of state/ regulatory authorities' (0.20) – have received similar average expert assessments, that are twice lower than the Technology developers initiative'. Such assessments indicate twice slower but simultaneous adoption paths within these scenarios.




*Source: Author's construction based on AHP results*

Fig. 4.14./ *4.14. att.* **Aggregated expert opinion on blockchain technology adoption scenarios in Latvia/** ***Ekspertu kopīgais atzinums par blokķēdes tehnoloģiju ieviešanas scenārijiem Latvijā***

In terms of factor group influence (see figure 4.16), it was concluded by the experts that the most significant factor group influencing 'Technology developers initiative' and 'Industry pioneer/ consortia initiative' was 'Market factors' (rated 0.14 and 0.08 accordingly), whilst the most significant factor group influencing 'Bank/ financial service industry initiative' and 'State/ regulatory body initiative' was 'Institutional factors' (rated 0.08 and 0.14 accordingly).

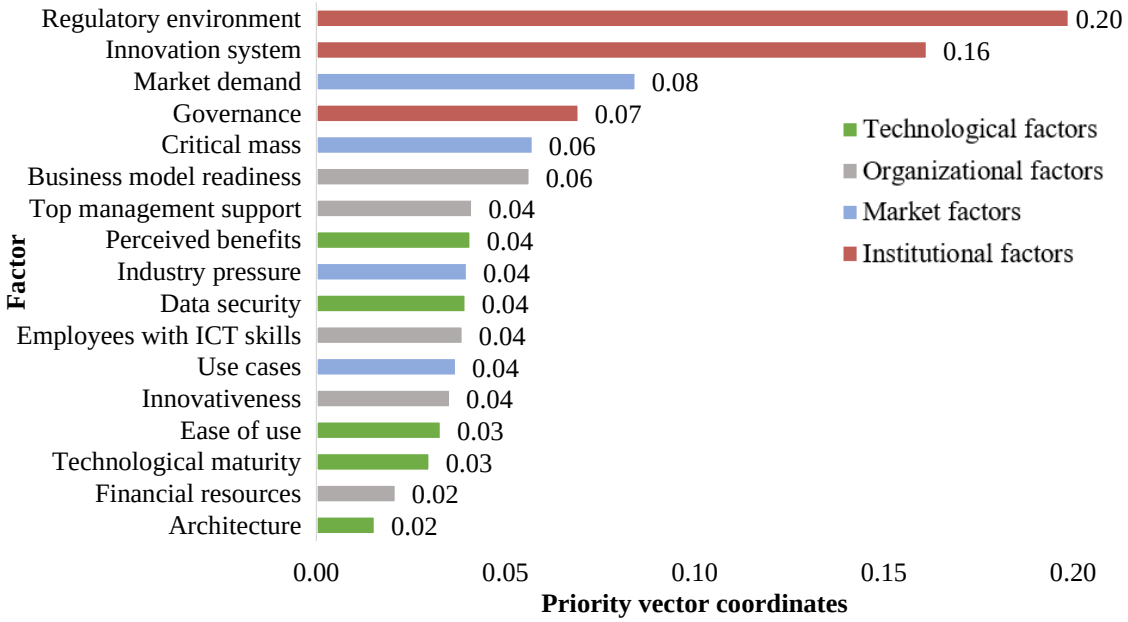



*Source: Author's construction based on AHP results*

Fig. 4.15./ *4.15. att.* **Expert evaluation of the priority axes of factors within factor groups for blockchain technology adoption in Latvia/** ***Ekspertu vērtējums par faktoru prioritārajām asīm faktoru grupās blokķēdes tehnoloģiju ieviešanai Latvijā***

It is overall explained by the nature of the respective sectors with activities of financial service industry and public administration bodies being subject to more stringent procedures, supervision and monitoring, requiring institutional environment compatible with blockchain solutions.

The figure 4.16. represents each criteria weight for blockchain technology adoption in Latvia. As evidenced by the figure, more than 50% of blockchain technology adoption in Latvia are facilitated through four factors. The two factors, which have received the highest average expert assessment – 'Regulatory environment' (0.20) and 'Innovation system' (0.16) – are within the group 'Institutional factors'. The following two factors are 'Market dynamics' (0.08) and 'Governance' (0.07).




*Source: Author's construction based on AHP results*

Fig. 4.16./ *4.16. att.* **Expert evaluation of the significance of factors for blockchain technology adoption in Latvia/** ***Ekspertu vērtējums par faktoru nozīmīgumu blokķēdes tehnoloģiju ieviešanai Latvijā***

'Regulatory environment', 'Innovative system' and 'Governance' factors all belong to institutional factor group and can be strengthened through actions of public authorities

in a form of public policy and blockchain technology applications in public digital initiatives, therefore, the role of government takes a central role to facilitate blockchain technology adoption in Latvia. The same finding is also evidenced by the course of actions taken by other countries with strong blockchain ecosystems and concentration of blockchain projects being developed in various sectors of economy. Both factors are also present among seven success factors outlined by Tapscott (2018).

### 4.3. Recommendations to facilitate blockchain technology adoption in the economy of Latvia/ *Ieteikumi blokķēdes tehnoloģijas ieviešanas veicināšanai Latvijas tautsaimniecībā*

In order to understand opportunities and recommend actions that can be undertaken by public bodies to facilitate blockchain technology adoption in Latvia, the author will further outline courses of actions suggested by the most prominent blockchain technology researchers and competent authorities as well as relevant international experience and will analyse its potential feasibility for application in Latvia. It is also important to acknowledge relevant experience of neighbouring Baltic countries, which have higher levels of blockchain technology adoption as evidenced by the Chapter 2, and its applicability for facilitating blockchain technology adoption in Latvia.

As evidenced by international experience, countries are taking various courses of actions in blockchain adoption such as publishing high–level scientific reports on technology perspectives (USA, UK, Australia, European Union, Dubai, China, Singapore, Germany), introducing crypto regulation (Estonia, Lithuania, Liechtenstein, Switzerland), creating an eco–system and incentives for blockchain start–ups (Lithuania, Switzerland, UK, Netherlands, France) and developing blockchain solutions in public sector in collaboration with blockchain technology developers (Sweden, Switzerland, Georgia). Several countries have included blockchain into digital and e–government investment strategy (China, Estonia, Singapore), developed and implemented strategic initiatives to move government services to blockchain (Dubai, canton of Zug) and created special crypto–economic zones (Isle of Man, Gibraltar). Many countries have instructed their financial regulators to issue detailed guidance on the regulatory, legislative and tax treatment of virtual assets, stimulating the general deployment of cryptocurrency in their jurisdictions.

Dyatlov et al. (2018) identified two perspectives for consideration by public authorities regarding blockchain technology solutions:

- usage of blockchain technology for own processes, such as the provision of public and municipal services, where blockchain technology is used to manage transactions.
- blockchain technology management, which defines how the blockchain should look like, how to adapt to changes and ensure the ability to implement the goals and objectives of public authorities, as well as the social needs of the population.

According to this classification and based on the expert interview results underscoring the importance of factors ‘innovation system’ and ‘regulatory environment’, it can be concluded that further actions for blockchain technology development in Latvia should bring more emphasis on blockchain technology management, however usage of blockchain technology for provision of public services can certainly complement this direction with visible use cases.

Tapscott (2018) suggests ‘creating a National Task Force on the Digital Economy, chaired by a well–respected non–government leader and consisting of thoughtful and well–respected leaders from business, government and civil society’. It is certainly

important to establish a responsible body on national level and consult with all stakeholders in order to develop a feasible blockchain strategy and systematic action plan.

House of Lords outlines the governance framework for distributed ledger technologies for government, which proposes an establishment of an independent organization with responsibilities to develop awareness, highlight challenge areas and create problem statements for projects nominated by various government departments as well as to align them with policy actions and arrange partnerships with industry sponsors (*Distributed Ledger Technologies…,* 2017).

Berg et al. (2017) notices that 'the geography of invention is not always the same as the geography of innovation'. The same idea was also mentioned by a blockchain entrepreneur within the expert interview process, underscoring that, for example, blockchain solutions in the decentralized finance domain are cross–border by technological design and may have more traction for development in the unbanked regions, where they do not compete with standard financial services providers. Taking into account the current 2.5 billion of unbanked population globally, it is a huge market opportunity, which is also evidenced by the cluster analysis performed in the Chapter 3.

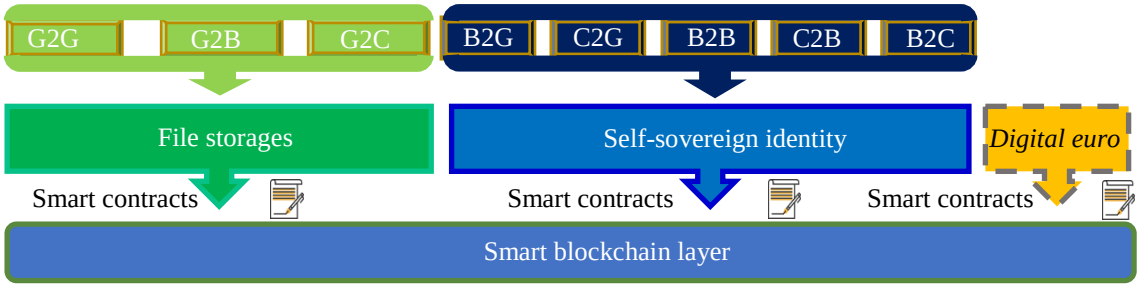
In developed regions with mature financial systems (such as the European Union, United States, Switzerland) decentralized finance solutions must offer much more than just payment functionality in order to compete with fintech solutions developed by banks and other regulated financial services providers, which provide same level of digital advancement, speed and user friendliness, and in the same time offer more security and funds protection mechanisms. As also evidenced by the global blockchain activity analysis in the Chapter 3, blockchain adoption dynamics in more developed regions spans beyond crypto space.

The research of global blockchain activity in the Chapter 3 displays that blockchain adoption level is higher in countries with higher crypto activity and crypto–regulation rank and existence of blockchain solutions in public sector. Janssen et al. (2017) notes that blockchain offers benefits in the domain of e–government and argues that blockchain experimentation by governments is paramount in order to gain a deeper understanding of blockchain technology applications as a complex socio–technical system and to find and possibly reinvent government functions and role within institutional environment. The institutional environment was also found by the interviewed experts as the most significant factor group for blockchain technology adoption with 43% share. Therefore, strengthening such institutional factors as 'Regulatory environment', 'Innovation system' and 'Governance' is possible through coordinated actions in the context of national digital transformation. The research results indicate that foreseen blockchain pilot project promoted by the Ministry of Economics of the Republic of Latvia can contribute to building up general knowledge on applicability of blockchain solutions in the economy of Latvia, however more pilot projects in e–government sector and activities aimed at strengthening institutional frameworks for blockchain technology adoption would accelerate the process of acknowledging government's role within the institutional environment. In particular, with rapid technological advancements in the global landscape, it is necessary to formulate a clear government's position and retain focus in further policy actions and support measures. In addition, successful introduction of blockchain technology also requires informing the public and potential promoters about its technological benefits and practical applications.

At the moment of this research, Latvian National Digital Transformation Guidelines 2021–2027 (*Digitālās transformācijas pamatnostādnes…*, 2020) are undergoing public consultation process coordinated by the Ministry of Environmental Protection and Regional Development of the Republic of Latvia. In author's opinion, it is important to

realize that the inclusion of blockchain technology within the priority directions of national digital transformation is prerequisite for meeting Ministry's ambition for Latvia to become a country actively involved in building the world's common knowledge and in the advancement of technological development.

The first draft of the National Digital Transformation Guidelines 2021–2027 superficially referred to blockchain technology only within two priority directions – Development of digital financial assets and Digital skills in healthcare (*Digitālās transformācijas pamatnostādnes…*, 2020), which is clearly not enough for becoming a globally competitive digital nation. In line with the European Commission's *Digital Europe* vision blockchain technology potential can facilitate several other priority directions of Digital Transformation in Latvia, such as Service and Systems Creation, Digital Security Policy, Electronic Identity and Trust Services, Social well–being and health of society, Fully digitised and data–driven core public administration, Human resources – competence centres and skills, Information systems, Promotion of digitisation of commercial activities and involving more precise actions in Development of digital finanical assets direction. The author has presented to the Ministry an integrated digital transformation vision, which is visualized in the figure 4.17.




*Source: author's construction*

Fig. 4.17./ *4.17 att.* **An integrated national digital transformation vision/ *Blokķēdes tehnoloģiju ieviešanu Latvijā ietekmējošo faktoru nozīmības ekspertu novērtējumi***

An integrated digital transformation vision relies on a smart blockchain layer, which is interlinked with file storages, self–sovereign identity and digital euro components via smart contracts. In the presented concept a combination of a smart blockchain layer with governmental file storages/ registries (both centralized and decentralized) can make G2G, G2B and G2C interactions more efficient, transparent and secure, whilst a combination of a smart blockchain layer with self sovereign identity can ensure B2G, C2G, B2B, C2B, B2C transactions. In addition, as soon as a digital euro is introduced, a variety of economic models can be developed utilizing the presented technological base creating synergies and economies of scale. Moreover, the author has suggested and presented to the Ministry a number of proposals, which are summarized below.

**Service and Systems Creation.** The Guidelines state that the ICT sector has a horizontal impact on other sectors of the economy and, consequently, there is a clear need to ensure the professionalism and skills of all parties involved in the development of services and systems. In author's view, as blockchain technology has a particularly strong potential to transform the economy, it requires strengthening skills of specialists employed in public administration in the use of blockchain technology in the piloting, development and implementation of blockchain based solutions.

**Cybersecurity policy.** The Guidelines provide for the improvement of the resilience of public administrations to cyber–threats in line with new technological opportunities and encourage cooperation between public administrations and the private sector. In author's view, blockchain can be used in all cybersecurity directions – from

tracking access controls to preventing erasure of information, which is impossible in the case of conventional databases. For instance, following the 2007 cyber attacks on Estonian information systems, a scalable blockchain layer was developed to ensure the integrity of data stored in Estonian government registries and to protect data from internal and external threats (*Security and Safety*…, [n.y.]). Currently, the blockchain developed in Estonia is also used by NATO, the US Department of Defence, Lockheed Martin, etc. (*Blockchain in Estonia*…, [n.y.]).

**Electronic identity and trust services.** The Guidelines encourage use of qualified electronic identification tools and trust services. In this context, author sees that blockchain technology allows creation of new electronic identity frameworks based on the concept of decentralised digital identity – potentially including a subset of decentralised identity known as self–sovereign identity. In the system of decentralised identity, a major role is attributable to the authorised credentials. They are inherently digital versions of physical credentials, such as passports or driving licences, albeit with additional characteristics provided by their digital nature. Decentralised identity and authorised credentials have many advantages. Not only they provide for enhanced user control over personal digital identity, but also make it much easier to use. Gartner (2020) points out that decentralized identities are the basis of the decentralized internet Web 3.0, which will enable end users to control their digital identity and data.

**Social well–being and health of society.** The Guidelines stress that data storages can now only be available at selected workstations due to obsolete technical architectures, although it would be more appropriate to use data repositories to which access would be organised through sectoral and national data–mixers. Author sees that blockchain technology can facilitate data compatibility between different local and national systems. As an example, the Organisation for Economic Cooperation and Development (2019a) proposes the use of a blockchain layer to ensure data integrity and manage access to data by connecting it to data repositories, thereby creating a 'bridge' between data repositories. The technology has already been introduced this way in Estonian *E–Health* system. Therefore, a blockchain layer can ensure integration and secure data exchange among various national e–health systems and information systems of healthcare facilities.

**Fully digitised and data–driven public administration.** The Guidelines see the need to perform a targeted transition to fully digitized public administration processes, information circulation and inter–institutional cooperation through the use of modern digital technologies. In this regards, the author highlights the European Commission's opinion that a new national digital governance paradigm should focus on providing innovative and user–oriented public services applying an *agile* approach, which requires consideration and application of modern digital technologies such as blockchain. Therefore, integration of separate sharing platforms and their components companies into multi–institutional processes requires application of modern digital technologies, which ensure safe and effective process interaction and prevent duplication of processes. European Commission (2019a) stresses that application of blockchain technology in regulatory oversight solutions ensures better transparency of information by allowing supervisory authorities to monitor the entire system without asymmetry, to detect hazards or breaches without delay, and to reduce costs.

**Human resources – competence centres and skills.** The Guidelines encourage transition to services of community–based shared service providers and consolidation of resources in specialised competence centres allowing for transparent cooperation with the private sector, in particular in the approbation of modern digital technologies. Aggregated expert opinion indicates that development of blockchain innovation and governance systems are prerequisite for blockchain technology adoption in Latvia. Therefore, in

author's view, competence centres need to develop and strengthen specialized competences in innovation, approbation and adoption of blockchain technologies, ensuring interaction and cooperation between various stakeholders.

**Information Systems (IS).** The Guidelines aim at application of sustainable and environmentally friendly IS architecture in public administration. Technological sustainability to great extent involved compatibility of national IS with EU and global IS, therefore, in author's view, it is necessary to follow modern technology based IS development initiatives and participate in relevant working groups. One example of an EU–wide IS is the European Blockchain Services Infrastructure (EBSI), which is being developed within the framework of the European Blockchain Partnership. Guidelines also indicate that open–code solutions with the appropriate technical support are preferred. Since blockchains in majority are open–code solutions, the author sees that blockchain applications in national IS can reduce potential costs and increase operational efficiency, which has to be taken into account when assessing and planning life cycles of technological solutions. Furlonger and Uzureau (2019) points out that although the future of internet technologies will be more decentralised, centralised institutions and systems will not be ruled out, as they will play a key role in the management and monitoring of digital ecosystems. The need to strengthen blockchain technology governance in Latvia is also emphasized by the aggregated expert opinion.

**Promoting digitisation of commercial activities.** The Guidelines indicate the need to develop cooperation between state and local authorities, entrepreneurs and non–governmental organisations and the creation and support of the innovation ecosystem. An aggregated expert opinion suggests the need to strengthen the innovation ecosystem for blockchain technologies and to develop a market for blockchain–based solutions in Latvia. Therefore, in author's view, it is necessary to implement specific targeted and mutually interconnected activities for design, piloting and adoption of blockchain technologies in Latvia.

**Development of digital financial assets.** The Guidelines express support for development of digital financial assets. Aggregated expert opinion from AHP process indicates that the regulatory environment and clarity are imperative to facilitate blockchain technology adoption in Latvia. As indicated by the analysis of blockchain adoption in Baltic States, performed in the Chapter 3, Latvia considerably lags behind Estonia and Lithuania in the field of virtual assets, as both countries already have introduced licensing and supervisory regimes for virtual asset service providers, however in Latvia activities of virtual assets service providers are not formally licensed. Although in all Baltic States, activities with virtual assets are subject to the requirements of AML/KYC laws, this is not sufficient to provide regulatory clarity, which is also emphasized by the FATF recommendations (Financial Action Task Force, 2019b), underlining the need for a competent national supervisory authority with the capacity to withdraw, limit or suspend the licence of virtual asset service providers. Therefore, appropriate licensing regime for virtual asset service providers is critical for strengthening Latvia's competitiveness in the field of virtual assets in Baltic and European regions. In addition, the author considers that adaptation of the regulatory environment to blockchain technology adoption in other areas must be in line with the business logic without hindering technological development. The guidelines also outline the need for development of a KYC (*know your customer*) tool, which would enable businesses to share customer due diligence data. In this context, in author's view, blockchain technology is capable of reducing customer data asymmetry and data duplication, thereby contributing to the fight against financial crime, while at the same time ensuring secure

exchange of personal data in accordance with the General Data Protection Regulation 2016/679.

The author considers that national digital transformation guidelines should serve as a foundation for blockchain technology adoption in Latvia, which will not only enhance Latvia's digital competitiveness, but also significantly accelerate country's digital transformation and integration with modern international information systems and Web 3.0. Of course, this now depends on decision–makers, their understanding and desire to make a real contribution to economic development and keep pace with the ongoing global technological revolution. As Latvia's neighbouring countries have already built upon the technological advantages of blockchain technology by gradually incorporating blockchain–based components into functions of public administration and financial sector regulatory oversight, it is critically important to learn good practice experience, which can accelerate digital transformation of the country.

The need for blockchain technology adoption in public administration is demonstrated both by experience of other countries, technological advantages and potential transformative impact on the economy as a whole. Janssen et al. (2017) argues that interdisciplinary research going beyond technology–driven approach is necessary for studying blockchain technology applications and implications for government. From the government's perspective, it is also necessary to study potential socio–economic costs and benefits. Swan et al. (2019) suggest utilizing a social welfare analysis for estimating blockchain economics in delivery of public services based on the estimation of marginal productivity benefits, considering economic analysis of substitute technologies with a key calculation parameter being the utility gain to citizens, which should be accounted for in the social choice function. Identification of specific use cases is therefore necessary for performing this analysis. There are many examples of piloting and implementation of blockchain solutions in public and regulatory space worldwide, and Latvia can learn from experience of other countries, adjusting it to local specifics. For example, USA is very successful in blockchain innovation, however the adoption process is hurdled by regulatory complexities, therefore cooperation between innovators and regulators is important to create feasible regulatory regimes. In this context, regulatory agility becomes a very important factor for blockchain technology adoption, which may favour smaller countries and states due to less complex coordination efforts and lower costs. Such countries, states and cities as Estonia, Lithuania, Zug, Singapore, and Dubai are following this route and Latvia can certainly consider this course of action, being a small country, which can ensure agility in regulatory space, however this process requires strong political will and leadership.

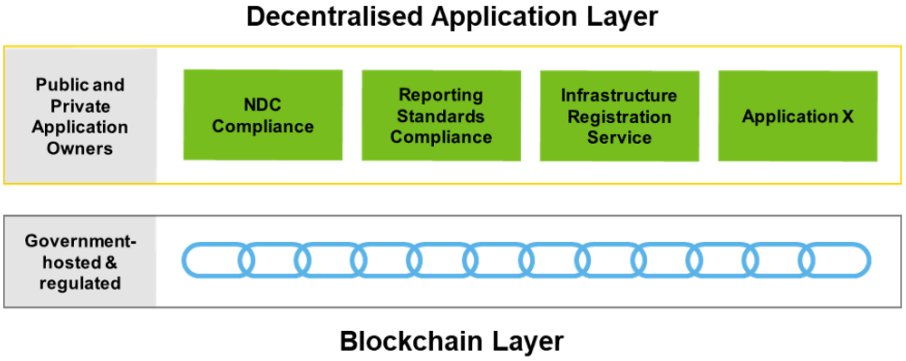
For example, in Estonia digital signature and authentication system is estimated to save 2% of GDP annually: 50 times more efficient connected police; 1/3 less queues in hospitals; 2.5 times cheaper i–voting; 300 meters high stack of paper saved each month, plus, Estonia is the best tax collector in the world (European Parliament, 2017). Obviously, economic effect from introduced e–government services considerably outweighs the cost of investment, which is also the case for blockchain technology. Bank of England estimates that an issue of a government crypto–currency would result in a 3% gain in GDP, predominantly due to tax collection and transaction efficiencies (Barrdear & Kumhof, 2016). World Economic Forum (2015) estimates that 10 percent of world GDP will be stored in the blockchain by 2027. In any case, a comprehensive study needs to be performed in order to understand potential priority areas and economic benefits of each blockchain technology application area.

The Organisation for Economic Cooperation and Development (2019a) suggests a 3–phased approach to blockchain pilot implementation. Such approach can be applied to

blockchain solution piloting in public sector. Taking into account that the Ministry of Economics is already considering piloting a blockchain solution for combatting shadow economy, application of an effective implementation approach would result in a higher economic benefit to the society.

A 3–phased approach (design, implementation, operation) developed by the Organisation for Economics Development (2019b) suggests application of certain evaluation criteria at the end of each phase, therefore a justified 'go' or 'no–go' decision to proceed or terminate can be taken (see Annex 12 for details). The Organisation for Economic Cooperation and Development (2019a) suggests testing the criteria related to technical feasibility, collaboration model and business feasibility. As blockchain solutions, per se, require involvement and collaboration of multiple actors, a well–established blockchain innovation system would facilitate more fluid piloting of blockchain solutions and its potential adoption at later stages. Therefore, a blockchain innovation system is important for not only technology developers and innovation community, but also for the government, as it creates a trustful environment among various stakeholders and provides a platform for blockchain solution piloting in various application areas.

The Organisation for Economic Cooperation and Development (2019a) also suggests a foundational blockchain layer, which would allow building suitable blockchain solutions by various public bodies and private stakeholders, allowing them to leverage a compliant technological base, which would also result in interoperability and efficiency gains and potentially higher economic benefit to the society (see figure 4.18).




*Source: Organisation for Economic Cooperation and Development, 2019a*

Fig. 4.18./ *4.18. att.* **Schematic illustration of the two–layer architecture/ *Divslāņu arhitektūras shematisks attēlojums***

A similar approach is already undertaken by Estonia with its digital backbone 'X–Road'. Lithuania currently considers a harmonized approach to blockchain applications in public sector, which may also result in similar implementations. Furlonger & Uzureau (2019) suggest developing a clear vision on how blockchain's decentralized nature can benefit each organization, taking into consideration anticipated blockchain integrations with other technological solutions such as Internet of Things and Artificial Intelligence.

Deloitte (2017b) identifies 10 most active blockchain use cases in public sector worldwide:

- Digital currency/ payments
- Land registration
- Voting (elections)
- Identity management
- Supply chain traceability
- Health care

- Voting (proxy)
- Corporate registration
- Taxation
- Entitlements management

PwC (2019a) notes that a digital identity issuance and management by a trusted source can substantially accelerate blockchain adoption through facilitating interoperability between blockchain networks. This is one potential area, where the government should undertake leadership and establish a digital trust system for developing national blockchain solutions. It is already clear that blockchain technology innovation will continue its rapid development in the following years, and decisions undertaken by policy makers on the priority areas and the ways of involvement in blockchain innovation will define the new global leaders in the knowledge economy of the new digital age.

Aggregated expert opinions concluded the importance of strengthening a blockchain innovation system to facilitate blockchain technology adoption in Latvia. As concluded by the Chapters 1 and 3, information and knowledge sharing are pre–requisite for the formation of innovative systems, which in turn affects the wealth of a nation.

Rogers (2010) notes that public opinion is influential in disseminating positive or negative information about the innovation. The two–step flow of communication model developed by Katz and Lazarsfeld (1955) argue that most people form their opinions under the influence of opinion leaders, who, in turn, are influenced by the media. In contrast to the one–flow theories, according to which people are directly influenced by the media, according to the two–step flow model, the ideas flow from the media to opinion leaders and from them to the wider population. Opinion leaders convey their own interpretations of the information in addition to the actual media content. In addition, opinion leaders have the greatest influence during the evaluation phase of the decision–making stage, where Latvia is currently located in terms of blockchain technology diffusion process.

Overall, countries showing real leadership in blockchain technology clearly demonstrate a new generation of leaders emerging within corporations, regulators and policy makers, who are balancing innovation with the responsibilities to protect financial markets and their respective industries from abuse and fraudulent activities. Therefore, the development of blockchain innovation system in Latvia can be accelerated by blockchain–friendly opinion leaders, who have impact on the media, established contact with change agents, social influence and well regarded status in the society and innovative communities. Political leaders all over the globe have made a number of statements broadly supporting blockchain innovation and adoption in their countries. A similar course of action can be undertaken by political leaders in Latvia.

As concluded by the Chapters 1 and 2, regional innovation systems (RIS) concept underlines the increasing role of the direct involvement of authorities to stimulate innovation and competition on regional level, whilst currently innovation policy documents in Latvia do not specifically outline priority directions or support measures for supporting a specialized blockchain innovation system, which in turn would stimulate blockchain technology adoption in Latvia. In addition, in comparison to other Baltic States, this area is underdeveloped in Latvia, since Estonia has historically created a strong digital nation image recognized worldwide and Lithuania actively promotes itself as a fintech heaven for fintech and blockchain enthusiasts, which specifically attracts blockchain developers nationally and internationally. Despite certain supportive measures for start–up communities and the opinions issued by the Ministry of Economics, the overall directions and support measures for blockchain eco–system development in

Latvia are vague, which is also evidenced by the expert opinions. The Organisation for Economic Cooperation and Development (2019b) notes that blockchain innovations in private sector, especially in financial industry, have been substantially influenced by public policy. A vocal political clarity on blockchain fintech solutions is currently absent in Latvia, in comparison to Estonia and Lithuania, that hinders development of this popular blockchain application area.

As with any new technological developments, the government's position is important, not only to instil confidence on technology developers and adopters, but also to understand collaboration possibilities within the innovation system, which is particularly important for such knowledge intensive and transformative general–purpose technology like blockchain. In addition, it is important to note, that in terms of blockchain leadership, the countries compete for global talent, and the nations, which show real blockchain leadership manage to attract international talent. Therefore, each country's 'selling point' is increasingly important, which cannot be achieved by private efforts alone and requires government's leadership and guidance.

PwC (2019a) notes that a good blockchain policy should outline tangible and achievable goals, define government's involvement and operational compliance, and assign the responsible authorities, allowing for continuous policy improvement cycle and adapting to lessons learned and changes in technological developments.

The Organisation for Economic Cooperation and Development (2019b) concludes that governments and policy makers need a deep understanding of blockchain technology to develop regulatory frameworks and policies, therefore, communication and collaboration between governments and other stakeholders involved in blockchain activities, should be encouraged and easily accessible. This statement clearly underlines the importance of fluid communication channels between the government and blockchain community that would be certainly enhanced by a well–defined blockchain innovation system.

Aggregated expert opinions concluded the importance of strengthening a regulatory framework to support blockchain technology adoption in Latvia. Blockchain industry leaders also acknowledge the importance of clear regulation, specifically in the domains of crypto activities. Vytautas Karalevičius, founder of the Lithuanian fintech company Bankera, which raised USD 150 million through ICO, in one of his interviews has stated that clear licensing and operating rules are essential for the cryptocurrency businesses as regulation can significantly decrease fraudulent schemes and eliminate the presumption that cryptocurrencies are a primary haven for illegal activities (*Lithuania to Adopt…*, 2019). The Organisation for Economic Cooperation and Development (2019b) also states that legal ambiguity about crypto activities (such as ICOs, tokenisation of assets) creates uncertainties and risks for participants and the markets, and hence needs appropriate policy responses, including on issues of financial consumer protection.

According to Dan Tapscott (2018) countries, showing real leadership in blockchain technology development have managed to navigate governance and regulatory uncertainties. Although Silicon Valley continues to dominate the global technological development landscape, Tapscott (2018) sees possibilities for economic value geographical redistribution by blockchain realized through adequate regulation, when global prosperity centres may emerge anywhere in the world and follow blockchain's decentralized design.

The Organisation for Economic Cooperation and Development (2019b) notes that collaboration with blockchain industry organisations and leaders is necessary for the development of a regulatory framework of blockchain policy principles as they provide valuable inputs, which may direct the blockchain innovation development to the right

direction and enable governments to anticipate regulatory trends. A consultation process can be facilitated through an established innovation system, which brings together all stakeholders and creates collaborative frameworks. Organisation for Economic Cooperation and Development (2019b) also notes that blockchain industry organisations could contribute to the collaboration process by establishing communication channels and creating key messages and narratives. Although, representatives of the Latvian blockchain Association have participated in a working group established by the Ministry of Economics and contributed to the preparation of the informative report submitted to the Cabinet of Ministers, it has not yet communicated clear opinions on preferred policy actions and/ or regulatory treatment of blockchain applications in Latvia.

The example of the swift regulatory responses of the Bank of Lithuania to ICOs and STOs as well as development of a regulatory sandbox for blockchain fintech solutions clearly shows the viability of collaborative approach, resulting in clear priorities for blockchain innovation development in the country. One of the possible reason of agile response to technological developments of the Bank of Lithuania is also the fact that it is centralized, meaning that it implements the functions of financial market regulation, macro–prudential supervision and consumer rights protection, therefore, does not need to spend time on inter–institutional coordination, when inter–disciplinary topics like blockchain need regulatory response and treatment in all of these three areas.

### Summary of the Chapter 4/ 4. *nodaļas kopsavilkums*

Review of blockchain adoption factors presented by various authors, without limiting it to a specific context, helped to identify four groups of factors, namely technological (perceived benefits, architecture, data security, etc.), organizational (skilled employees, financial resources, top management support, etc.), institutional (norms and cultures, regulations, governance), market (market dynamics, industry pressure, etc.). The proposed factors and scenarios have been empirically verified by 82 blockchain experts from 30 countries. Based on the identified factors, the blockchain technology adoption assessment matrix was developed for blockchain technology adoption assessment in the economy of Latvia.

As indicated by the expert assessment results the most feasible scenario for blockchain technology adoption in Latvia is initiative of technology developers. Considering that the most blockchain based initiatives promoted by technology developers are developed on the basis of public blockchain platforms, blockchain applications to be developed within this scenario are likely to be connected with cryptocurrencies and virtual assets.

According to expert assessment, more than 50% of blockchain technology adoption in Latvia can be facilitated through four factors – ‘Regulatory environment’ (0.20), ‘Innovation system’ (0.16), ‘Market dynamics’ (0.08) and ‘Governance’ (0.07). Since three of four factors belong to institutional factor group, the role of government takes a central role to facilitate blockchain technology adoption in Latvia.

Expert assessment has identified that regulations is the most significant factor for blockchain technology adoption in Latvia. Hence, based on the evidence from other countries, a financial regulator in Latvia should formulate a clear opinion on its crypto–friendliness. Whilst Estonian and Lithuanian authorities are quite vocal and clear regarding their regulatory treatment of crypto–currencies and views and support mechanisms for blockchain technology innovation and adoption, which is also supported by relevant initiatives, the opinion of Latvian policy–makers and regulators is vague

despite some positive fragmented communique and initiatives by the Ministry of Economics and the fintech sandbox launched by FCMC.

Innovation system has been assessed as the 2nd most significant blockchain adoption factor in Latvia. The blockchain innovation system can be developed through blockchain specific support mechanisms, which can be integrated into relevant policies and action plans within the domains of innovation, digitalisation and technological exports as envisaged by the National Development Strategy 2030. As evidenced by experience of other countries (including Estonia and Lithuania), another crucial step is to formulate a clear political opinion on priority directions and industries, where blockchain technology innovation is supported and incentivized by the government.

Latvia can learn from experience of neighbouring countries – Estonia has been integrating blockchain elements in e–government services since 2016 and introduced a specialized virtual asset regulation in 2018, Lithuania started developing a blockchain fintech sandbox in 2018 and introduced a specialized virtual asset regulation in 2019. Depending on defined national development priorities, Latvia can either follow examples of neighbouring Baltic countries or explore possibilities for a unique proposition and support mechanism for blockchain technology adoption. In this case, a more holistic economic research and impact assessment would be required, like it was implemented in United Arab Emirates, China and Switzerland.

One of the success factors for blockchain technology adoption in Lithuania is an agile regulatory response to technological developments, which is also facilitated by the centralisation of financial market regulation, macro–prudential supervision and consumer protection functions within the Bank of Lithuania. Therefore, an envisaged merge of the Bank of Latvia with the Financial and Capital Markets Commission in 2022/ 2023 can improve a capacity and speed to respond to technological developments in fintech area more efficiently in future.

Although many initiatives are technology–oriented, the disruptive nature of the blockchain mainly affects the institutional level. Experience with cryptocurrencies shows that there are many ways to address blockchain technology adoption, and institutional factors, such as regulations, become very influential in the evolution of the adoption of blockchain technology. How the process of change in institutional environment is managed by organizations and markets will determine the future use of blockchain technology.

Based on assessment of factors and scenarios for blockchain technology adoption in the economy of Latvia, the analysis of experience of other countries and approaches suggested by international organisations, nine priority areas within the context of National Digital Transformation Guidelines for 2021–2027 have been identified, to which blockchain technology can contribute, therefore accelerating Latvia’s digital transformation and integration with global digital infrastructure, which is taking the course towards decentralized Web 3.0.

# CONSCLUSIONS/ *SECINĀJUMI*

1. Blockchain technology is a general–purpose technology and disruptive innovation, which demonstrates its ability to transform business models across an array of industries and public administration functions. Blockchain innovation and adoption relies on the exploitation of resource of 'knowledge' within the knowledge economy concept. The magnitude of potential transformative effects from blockchain technology mass adoption are comparable to the effects of the Internet, which would allow substituting data copying, currently ensured by the Internet with the transfer of ownership in secure digital environment, therefore contributing to the digitalization of the economy.
2. Blockchain technology has not yet reached a critical mass adoption level globally reflected by 'early majority' category as per Rogers' curve of innovation diffusion process as its current position within the Rogers' innovation–decision process would correspond to the stage 'Decision', which could result in 'adoption' or 'rejection'. However, there are countries, which have already made clear political adoption decisions in various blockchain technology application areas. For example, Estonia clearly facilitates blockchain adoption in e–government area, the Central Bank of Lithuania has taken steps to facilitate blockchain technology adoption in fintech area and Latvia has not yet formulated a clear political decision to facilitate blockchain innovation and adoption. This tendency correlates with higher DESI indices in Estonia and Lithuania, specifically within the components of 'Human Capital' and 'Integration of digital technology'.
3. Technologically a global critical mass adoption will be possible as soon as interoperability among various private blockchains is ensured, which relies on technological maturity and adoption of international technical and governance standards on blockchain and distributed ledger technologies, being developed by the International Standardisation Organisation. From the economic perspective, an adoption process clearly relies on collaboration efforts between multiple actors involved in blockchain innovation and a reasonable balance among innovation systems, business environment, policy–making and regulation with establishment of efficient communication channels, collaboration mechanisms and governance frameworks.
4. The approach to regulation of ICOs in the Baltic States is broadly similar – if certain criteria are met, ICO tokens can be recognized as financial instruments and fall under the regulation of financial securities. Latvia was the last country in the Baltic States to publish comprehensive ICO guidelines. Activities of virtual asset service providers, including activities with cryptocurrencies, must comply with the national and European legislation on anti–money laundering and prevention of terrorist financing, including FATF recommendations. Activities of virtual assets service providers require a specialized license in Estonia and Lithuania, whilst in Latvia such activities do not require a license. Latvia's global crypto rank is considerably below the neighbouring Baltic States – 81$^{st}$ place globally versus Lithuania's and Estonia's 4$^{th}$ and 14$^{th}$, accordingly. Blockchain technology regulation beyond crypto–currencies and virtual assets is non–existent in the Baltic States and the European Union.
5. The most prominent use case of blockchain technology adoption up to date is activities associated with cryptocurrencies and virtual assets. Crypto activity in the Baltic States region is globally competitive with Estonia showing global leadership (3$^{rd}$ place by ICO funds raised globally), Lithuania showing overall strong position (11$^{th}$ place) and Latvia substantially lagging behind (34$^{th}$ place). Despite no big

difference in number of ICOs conducted in Lithuania and Latvia (29 vs. 27), Lithuania has managed to attract 12 times more funding than Latvia, explained by Lithuania's successful international branding as a fintech heaven. Number of ICOs in Estonia is 10 times higher than in Latvia and Lithuania. Overall, digital leadership of Estonia can be explained by successful international branding as a pioneering digital nation. Both Estonia and Lithuania have made clear political decisions on blockchain technology adoption scenarios and undertaken relevant actions to promote their international image.

6. There are many examples of blockchain technology applications beyond crypto space worldwide. For example, Estonia has already implemented certain blockchain technology solutions in public administration and healthcare areas, and Lithuania has launched a blockchain–based sandbox to facilitate development of blockchain solutions in fintech area. In Latvia, there is currently no blockchain technology solutions piloted or implemented beyond crypto space, however the Ministry of Economics considers a pilot project in collaboration with the Ministry of Finance, which would allow for real–time transfer of trade data to the State Revenue Service. The adoption of this solution can potentially contribute to all components of the DESI index, if accompanied by relevant capacity building activities of public servants and general population.
7. Blockchain technology innovation and adoption worldwide can be categorized within 3 country groups through application of factor and cluster analysis methods, depending on the level of crypto–activity and economic development. The Cluster 1 comprises of predominantly developed countries showing global leadership in blockchain technology innovation and adoption beyond crypto space and high crypto activity. The Cluster 2 comprises of predominantly developed countries showing mixed blockchain technology innovation and adoption trends and below average crypto activity. The Cluster 3 comprises of predominantly developing countries showing low blockchain technology innovation and adoption trends beyond crypto space, but high crypto activity indicators. Therefore, it can be concluded that the level of crypto–activity is an important factor for blockchain technology innovation and adoption beyond crypto space in developed countries, however not the only one.
8. Analysis of innovation diffusion and technology acceptance models allowed defining a structured approach to the definition and categorization of blockchain technology adoption factors utilizing a combination of Technology–Organization–Environment and Process–Institutional–Market–Technology frameworks with intersecting elements from the Theory of Diffusion of Innovations and Technology Acceptance Model. The analysis resulted in categorization of blockchain technology adoption factors within a national economy in four factor groups: technological, organizational, institutional and market factors. The subsequent expert validation allowed illustrating a model of blockchain technology adoption in the national economy, based on expert opinions of international blockchain experts from 30 countries.
9. Technology developers' initiative was identified as the priority scenario for blockchain technology adoption in the economy of Latvia (38%) by the national blockchain expert group. Also, an aggregated expert opinion has identified two most significant factors for blockchain technology adoption – regulatory environment (20%) and innovation system (16%). Therefore, it can be concluded that blockchain technology adoption in the economy of Latvia can be efficiently facilitated through strengthening blockchain innovation system and crypto regulation, specifically taking into account that blockchain solutions of technology developers in Latvia predominantly utilize public blockchain networks, which are connected to crypto–

currencies and virtual assets. Implementation of technology developers' initiative scenario can potentially contribute to the GDP and technological exports.

10. International experience shows that formulation of a clear political opinion on national priority axes for blockchain technology innovation support and implementation of blockchain pilot projects in public sector facilitate overall blockchain technology adoption in the national economy. In Latvia, blockchain technology can contribute to nine priority areas within the context of National Digital Transformation Guidelines for 2021–2027, which can be supplemented by social welfare analysis in order to highlight potential socio–economic costs and benefits to society and outline a well–substantiated course of actions for blockchain technology adoption in Latvia. In author's view, Latvia can learn from good practice examples demonstrated by comparable countries and states such as Estonia, Lithuania, Zug, Singapore, and Dubai, which are capable of ensuring agility in regulatory and public policy space due to its smaller size, hence, less complex coordination efforts in comparison to bigger countries and states.
11. As evidenced by the performed analyses, Latvia lags behind Estonia and Lithuania in all analysed indicators of blockchain technology adoption. However, it is possible to facilitate blockchain technology adoption in the economy of Latvia by strengthening significant adoption factors and focusing on the priority scenario identified through the analytical hierarchy process and implementing the recommendations and solutions outlined in this thesis to increase Latvia's regional competitiveness within the Baltic States region and globally.

## PROBLEMS AND THEIR PROPOSED SOLUTIONS/ *PROBLĒMAS UN PRIEKŠLIKUMI TO RISINĀŠANAI*

**FIRST PROBLEM:** There is a need for developing blockchain innovation system in Latvia as evidenced by AHP results.

**Proposed solution.** As the development of innovation policy is in the competence of the Ministry of Economics, under its framework it should consider developing a national blockchain strategy in line with priorities set out in the Sustainable Development Strategy of Latvia until 2030, National Development Plan of Latvia for 2021–2027 and Smart Specialization Strategy's priority axes. The Ministry should also consider attracting a specialized blockchain policy advisor with international expertise. The steps can involve:

- conducting a comprehensive research on potential socio–economic costs and benefits, value added and associated risks from blockchain technology integration in various sectors of economy and functions of public administration,
- consulting with representatives from industries and areas where the most substantial impacts are identified (such as Finance Latvia Association, Association of Latvian Food Retailers, Association of Local and Regional Governments, Latvia Internet Association, etc.), regulatory authorities (such as Financial Capital Markets Commission, Food and Veterinary Service, State Revenue Service, etc.),
- identifying the priority areas for blockchain solution piloting, establishing support mechanisms and infrastructure for development of blockchain solutions in identified areas and visible public communication about supported measures for blockchain technology innovation in Latvia.

Support measures for blockchain innovation system establishment should either include blockchain specific activities within existing general start–up support programmes both for local and foreign start–ups or create new support programs for blockchain entrepreneurs. It is an efficient way to keep local and attract international blockchain talent, as relocation of headquarters of successful blockchain start–ups emerging in Latvia to other countries is clearly a problematic sign, which needs to be further investigated in order to strengthen necessary support measures.

Other support measures can include more frequent and regular industry–specific informative activities and discussions on blockchain technology benefits and prospects for blockchain integration within each particular industry, promotion of collaborative projects of international consortia in Latvia, facilitation of national blockchain pilot projects involving various stakeholders, including blockchain technology developers, industry pioneers, public and regulatory authorities, academia, venture capitalists, etc.

Moreover, the envisaged blockchain pilot promoted by the Ministry of Economics and the Ministry of Finance should set a good practice example of blockchain solution piloting, and therefore requires public visibility and demonstration of efficient piloting approach, such as a 3–phased model suggested by OECD.

In addition, a blockchain innovation system in Latvia should be strengthened by inclusion of blockchain technology into priority areas of the National Digital Transformation Guidelines for 2021–2027. The Ministry of Environmental Protection and Regional Development should undertake activities to strengthen technical skills of government and private partner employees in blockchain innovation and adoption and to promote cooperation between public and private partners in line with three identified priorities:

- Service and Systems Creation.

- Human resources – competence centres and skills.
- Promoting digitisation of commercial activities.

Those actions will not only strengthen blockchain innovation system, but also improve Latvia's digital competitiveness and human capital, therefore contributing to the Digital Economy and Society Index (DESI), E–government Development Index (EGDI), E–participation Index (EPI) and Global Competitiveness Index (GCI).

**SECOND PROBLEM:** There is a need for strengthening regulatory environment for blockchain solutions in crypto space and financial services industry in Latvia, as evidenced by AHP results.

**Proposed solution.** Ministry of Finance should consider conducting a joint research with the Ministry of Economics on economic benefits and associated risks from activities of virtual asset services providers in Latvia and define further steps to facilitate and efficiently supervise their activities. Subsequently, the Ministry of Finance should consider developing a specialized vision, regulation and/ or licensing regime for virtual asset service providers.

The Ministry of Finance should also consider attracting a specialized advisor with international expertise in virtual assets and cryptocurrencies, specifically on AML/ CFT aspects, to advise on development of such vision, regulation and/ or licensing regime, who should also train Financial Capital Markets Commission (FCMC) and/ or Consumer Rights Protection Centre (CRPC) personnel to efficiently supervise activities of virtual asset service providers. State Revenue Service in collaboration with FCMC and/ or CRPC should consider developing either in–house or collaborative solutions to supervise activities of virtual asset service providers, specifically in AML/ CFT area, in line with FATF requirements and with a technological capacity to add new requirements in a view of constantly evolving international AML/ CFT requirements.

In parallel, blockchain technology developers in fintech area should consider participating in a fintech sandbox facilitated by FCMC to simulate operational environment of their fintech solutions and agree on efficient reporting mechanisms compliant with regulation and national and international AML/ CFT requirements.

Those actions will not only strengthen regulatory environment, but will also facilitate development and commercialization of solutions in decentralized finance area by local blockchain technology developers, therefore, contributing to GDP and technological exports.

**THIRD PROBLEM:** There is the need for strengthening a blockchain governance framework in Latvia, as evidenced by AHP results.

**Proposed solution.** Blockchain governance framework in Latvia should be strengthened through inclusion of blockchain technology into priority areas of the National Digital Transformation Guidelines for 2021–2027, which is in the competence of the Ministry of Environmental Protection and Regional Development, which should consider developing a digital backbone for public administration functions and services (a blockchain layer as suggested by OECD) in line with six identified priorities:

- Fully digitised and data–driven public administration.
- Electronic identity and trust services.
- Social well–being and health of society.
- Information Systems.
- Digital security policy.
- Promoting digitisation of commercial activities.

In this way, technical standards and cyber security safeguards will be set and addressed by the government, which will also facilitate blockchain adoption by private sector through reducing uncertainties and providing opportunities for interoperability with public services.

In addition, a specialized blockchain governance association comprising of public and private partners should be established, which would address various governance issues in blockchain ecosystem ensuring relevant oversight. Those actions will not only strengthen blockchain governance framework, but also improve country's digital competitiveness, therefore contributing to the Digital Economy and Society Index (DESI), E–government Development Index (EGDI), E–participation Index (EPI) and Global Competitiveness Index (GCI).

The Ministry of Economics or a specialized advisor should be attracted to evaluate potential incremental benefits to each subsequent blockchain pilot in digital public services and its impact on national welfare through cost savings and increased efficiency in government services, with likely positive spill–over effects on GDP in long term.

**FOURTH PROBLEM:** There is a lack of market opportunities in Latvia for development of blockchain technology solutions, as evidenced by AHP results.

**Proposed solution.** Blockchain technology developers, project promoters, as well as academia and consultants should consider joint collaborations in researching and organising informative activities, such as industry specific publications in press, seminars and/ or workshops, on the topic of application of blockchain solutions in various areas, such as fintech, supply chain, insurance, agri–food, public administration, internet of things, etc. with hands–on demonstrations of blockchain benefits over existing solutions and their applicability to systems and business models in Latvia. Those activities would raise blockchain knowledge of top managers and employees in various organisations and institutions in Latvia and create local market demand for blockchain solutions, therefore contributing to the Digital Economy and Society Index (DESI), specifically the 'Human Capital' component.

In addition, blockchain technology developers and project promoters should consider consultation and collaboration with FCMC via a fintech sandbox to ensure compliance with financial services regulation in the development of blockchain solutions in crypto–space and fintech areas, which should also target global markets due to cross–border nature of blockchain applications. To support this collaboration, FCMC is encouraged to extend the applicability of fintech sandbox environment to possible blockchain solutions targeting developing countries, where there is more market demand for decentralized finance solutions in comparison to the EU. Commercialization of such solutions by local blockchain technology developers will contribute to GDP and technological exports.

As technological exports is one of the priorities of the National Development Plan for 2021–2027 and improvement of the Digital Economy and Society Index (DESI) components is in the competence of the Ministry of Economics, it should facilitate, encourage and support those activities through policies and actions described in previous points.

**FIFTH PROBLEM:** There is a lack of Latvia's visibility in the international blockchain landscape, as evidenced by Latvia's poor crypto activity in comparison to other countries and non–existence of blockchain solutions beyond crypto space.

**Proposed solution.** Taking into consideration that blockchain technology is a general–purpose technology and commercial blockchain solutions have cross–border

nature, countries compete both for keeping local and attracting foreign blockchain entrepreneurs. The Ministry of Economics should consider conducting international branding activities via the Investment and Development Agency targeted at improving Latvia's image in international blockchain landscape. However, before performing those activities, it is crucial to address preceding problems, targeted at developing a clear national blockchain strategy with associated support measures for blockchain innovation system support and setting–up a regulatory environment with clear supervision mechanisms for virtual asset service providers. Latvia should learn from Estonia's and Lithuania's experience, which succeeded in building up strong international images in blockchain landscape.

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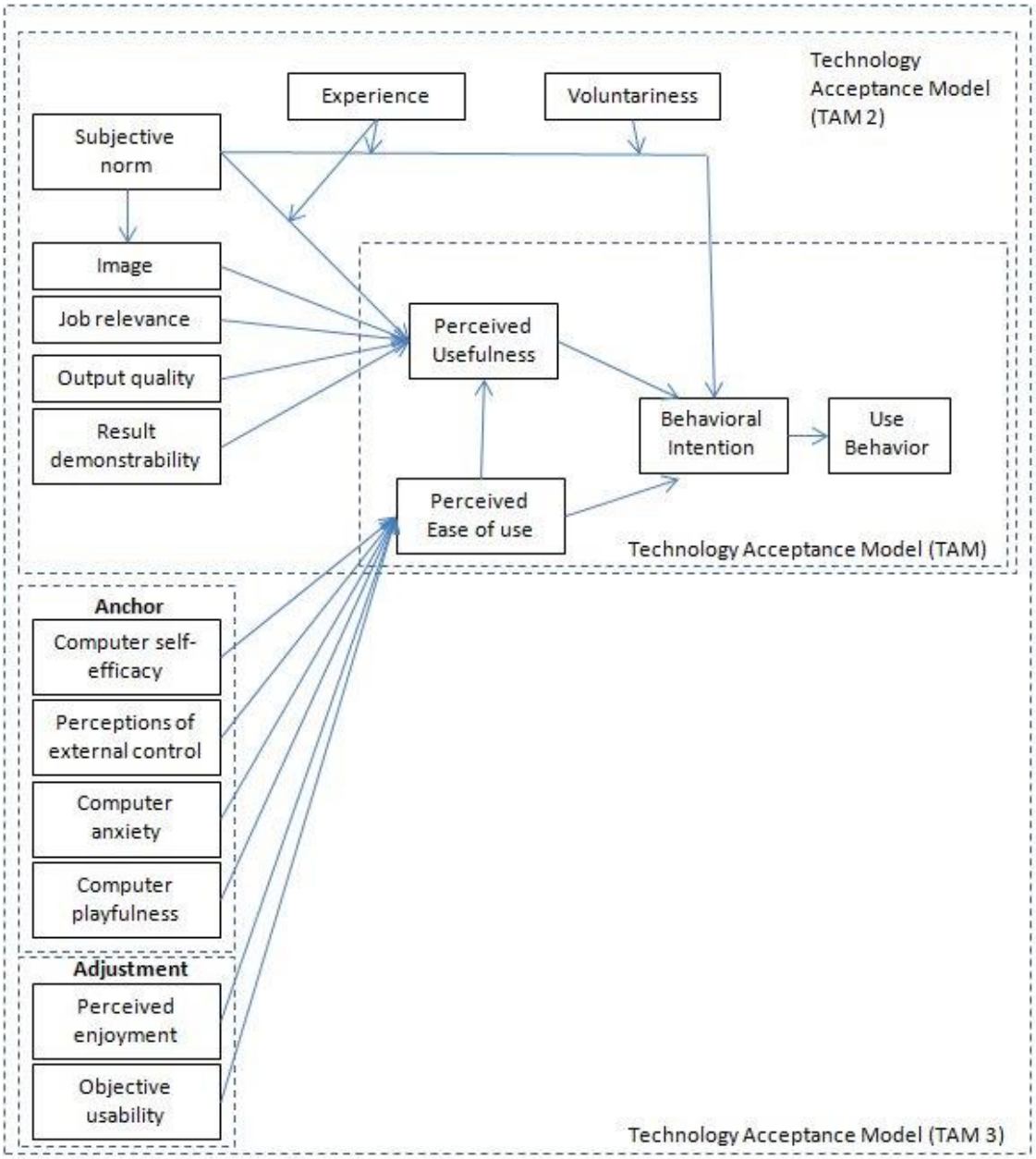
**ANNEXES/ *PIELIKUMI***

**Technology acceptance models 2 and 3/ *Tehnoloģiju pieņemšanas modeļi Nr 2 un 3***




*Source: Davis and Venkatesh, 2000; Bala and Venkatesh, 2008*

Annex 2/ *2. pielikums*

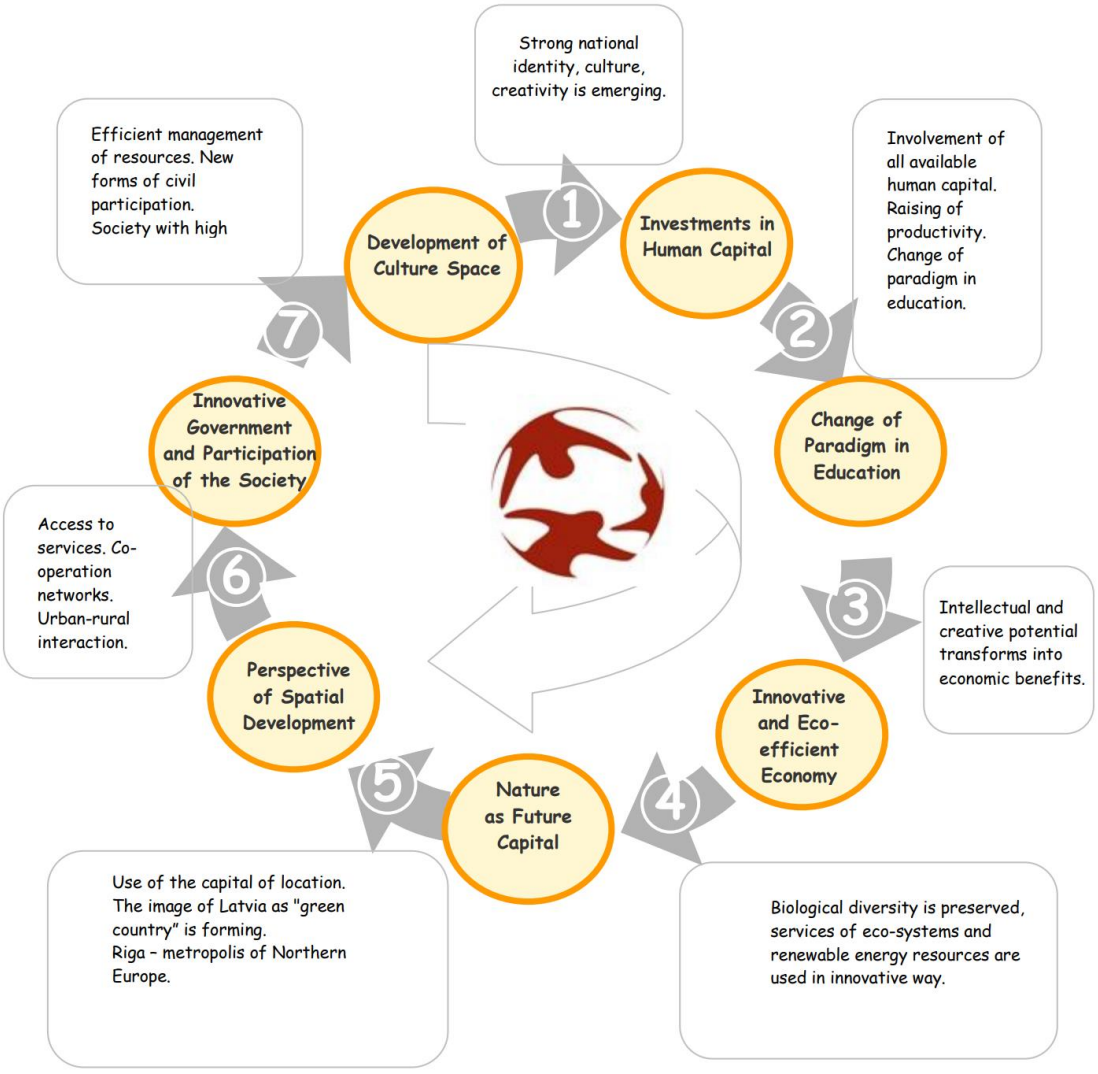
**Schematic overview of legislative base, innovation and digitalisation strategies, guidelines and programs and blockchain specific initiatives/ *Shematisks pārskats par likumdošanas bāzi, inovācijas un digitalizācijas stratēģijām, pamatnostādnēm un programmām un īpašām blokķēdes iniciatīvām***

| **Type** | **European level** | **National Level** | **International level** |
|---|---|---|---|
| **Legislative base** | Treaty of Lisbon | Law on Development Planning System | X |
| | Commission's Priorities for 2019 – 2024 | X | X |
| **Strategies, guidelines and programs** | EU Digital Single Market Strategy | Sustainable Development Strategy of Latvia until 2030 | X |
| | Digital Europe program | Guidelines for Science, Technology Development and Innovation 2014–2020 | X |
| | Horizon Europe program | National Development Plan of Latvia for 2021–2027 | X |
| | Connecting Europe facility | Smart specialization strategy (RIS3) | X |
| | X | National Digital Transformation Guidelines 2021–2027 | X |
| **Blockchain specific initiatives** | The European Blockchain Partnership | X | The International Association for Trusted Blockchain Applications (INATBA) |
| | European Blockchain Observatory and Forum | X | Technical committee on ISO TC 307 Blockchain and Distributed Ledger Technologies |

*Source: Author's construction*

Annex 3/ *3. pielikums*

**Priorities of Sustainable Development Strategy of Latvia until 2030/ *Latvijas ilgtspējīgas attīstības stratēģijas prioritātes līdz 2030.gadam***




*Source: Sustainable Development Strategy…, 2020*

Annex 4/ *4. pielikums*

**Schematic Overview of regulation of cryptocurrencies and virtual assets and recommendations and explanations issued by competent authorities/ *Shematisks pārskats par kriptovalūtu un virtuālo aktīvu regulēšanu, kā arī kompetento iestāžu sniegtie ieteikumi un paskaidrojumi***

| **Type** | **European level** | **National Level** | **International level** |
|---|---|---|---|
| **Regulation** | EU Anti–Money Laundering Directive (2018) | Law on Prevention of Money Laundering and Terrorist Financing (2020) | X |
| **Recommendations and explanations** | EBA warns consumers on virtual currencies (2013) | Warning to Investors regarding a new financial investment service – Initial Coin Offering (ICO) and its risks (2017) | Staff Discussion Paper. Virtual Currencies and Beyond: Initial Considerations (2016) |
| | Virtual currency schemes – a further analysis (2015) | Opinion on virtual currencies (2017) | Guidance for a risk–based approach. Virtual assets and virtual service providers (2019). |
| | Report on virtual currencies (2016) | X | International standards on combating money laundering and the financing of terrorism & proliferation (2019) |
| | Virtual currencies, Monetary dialogue (2018) | X | Application of FinCEN's Regulations to Certain Business Models Involving Convertible Virtual Currencies (2019) |
| | Crypto assets. Key developments, regulatory concerns and responses (2020) | X | X |

*Source: Author's construction*

Annex 5/ *5. pielikums*

**Crypto activity indicators by countries/ *Kriptoaktivitātes rādītāji pa valstīm***

| Nr. | Country | ICO funds raised, USD million | Number of ICOs | Number of Bitcoin ATMs | Number of crypto exchanges | Crypto regulatory rank |
|---|---|---|---|---|---|---|
| 1. | USA | 7,343.9 | 717 | 5912 | 85 | 6 |
| 2. | Singapore | 2,500.0 | 587 | 8 | 49 | 36 |
| 3. | BVI | 2,400.0 | 73 | 0 | 0 | – |
| 4. | Switzerland | 1,781.0 | 265 | 73 | 18 | 5 |
| 5. | UK | 1,536.1 | 512 | 284 | 65 | 34 |
| 6. | Taiwan | 1,046.4 | 22 | 10 | 3 | 41 |
| **7.** | **Estonia** | **946.4** | **298** | **5** | **34** | **14** |
| 8. | Russia | 667.0 | 328 | 51 | 16 | 45 |
| 9. | Canada | 490.5 | 110 | 777 | 16 | 32 |
| 10. | Germany | 341.7 | 123 | 38 | 3 | 33 |
| **11.** | **Lithuania** | **322.9** | **29** | **0** | **1** | **4** |
| 12. | UAE | 289.8 | 68 | 1 | 0 | 3 |
| 13. | China | 283.8 | 64 | 0 | 43 | 105 |
| 14. | Japan | 274.7 | 48 | 0 | 16 | 22 |
| 15. | Australia | 223.6 | 112 | 19 | 21 | 8 |
| 16. | Israel | 220.7 | 39 | 6 | 1 | 15 |
| 17. | Malaysia | 182.2 | 32 | 4 | 1 | 54 |
| 18. | Cyprus | 178.3 | 47 | 0 | 9 | 16 |
| 19. | India | 174.8 | 62 | 1 | 18 | 73 |
| 20. | France | 169.2 | 79 | 9 | 4 | 1 |
| 21. | Netherlands | 151.4 | 110 | 46 | 29 | 11 |
| 22. | Spain | 108.1 | 46 | 82 | 3 | 37 |
| 23. | Thailand | 99.2 | 27 | 2 | 8 | 47 |

**Crypto activity indicators by countries/ *Kriptoaktivitātes rādītāji pa valstīm***

| | | | | | | |
|---|---|---|---|---|---|---|
| 24. | Poland | 97.8 | 38 | 58 | 5 | 62 |
| 25. | South Africa | 88.0 | 40 | 8 | 8 | 60 |
| 26. | Ukraine | 80.7 | 45 | 19 | 3 | 59 |
| 27. | Czech Republic | 65.3 | 43 | 64 | 2 | 12 |
| 28. | Austria | 57.6 | 19 | 151 | 1 | 7 |
| 29. | Mexico | 52.6 | 17 | 11 | 1 | 31 |
| 30. | Indonesia | 49.2 | 53 | 0 | 9 | 50 |
| 31. | South Korea | 48.5 | 58 | 0 | 27 | 40 |
| 32. | Argentina | 40.2 | 9 | 11 | 3 | 44 |
| 33. | Nigeria | 31.6 | 38 | 1 | 3 | 48 |
| **34.** | **Latvia** | **27.6** | **27** | **1** | **0** | **81** |
| 35. | Zimbabwe | 24.5 | 2 | 1 | 0 | 75 |
| 36. | Afghanistan | 21.0 | 5 | 0 | 0 | 104 |
| 37. | Sweden | 19.5 | 11 | 0 | 3 | 39 |
| 38. | Vietnam | 16.7 | 10 | 6 | 2 | 52 |
| 39. | Turkey | 14.0 | 26 | 10 | 13 | 55 |
| 40. | New Zealand | 13.4 | 10 | 1 | 3 | 61 |
| 41. | Brazil | 11.1 | 21 | 0 | 21 | 26 |
| 42. | Tanzania | 11.0 | 2 | 0 | 0 | 164 |
| 43. | Denmark | 7.9 | 10 | 2 | 1 | 23 |
| 44. | Italy | 7.6 | 25 | 59 | 4 | 68 |
| 45. | Portugal | 6.6 | 10 | 0 | 0 | 38 |
| 46. | Kazakhstan | 6.5 | 8 | 3 | 0 | 78 |
| 47. | Finland | 6.1 | 4 | 11 | 2 | 27 |

**Crypto activity indicators by countries/ *Kriptoaktivitātes rādītāji pa valstīm***

| | | | | | | |
|---|---|---|---|---|---|---|
| 48. | Belarus | 5.7 | 15 | 0 | 2 | 66 |
| 49. | Ireland | 5.6 | 30 | 0 | 0 | 24 |
| 50. | Pakistan | 4.1 | 4 | 0 | 1 | 138 |
| 51. | Belgium | 3.2 | 14 | 11 | 1 | 18 |
| 52. | Morocco | 3.0 | 1 | 0 | 0 | 163 |
| 53. | Egypt | 2.9 | 3 | 0 | 0 | 71 |
| 54. | Kenya | 0.3 | 3 | 1 | 0 | 110 |
| 55. | Greece | 0.1 | 9 | 67 | 1 | 35 |
| 56. | Ghana | 0.0 | 2 | 2 | 1 | 87 |

*Source: Author's construction based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020*

**Agglomeration schedule for cluster analysis/ *Klasteru analīzes aglomerācijas grafiks***

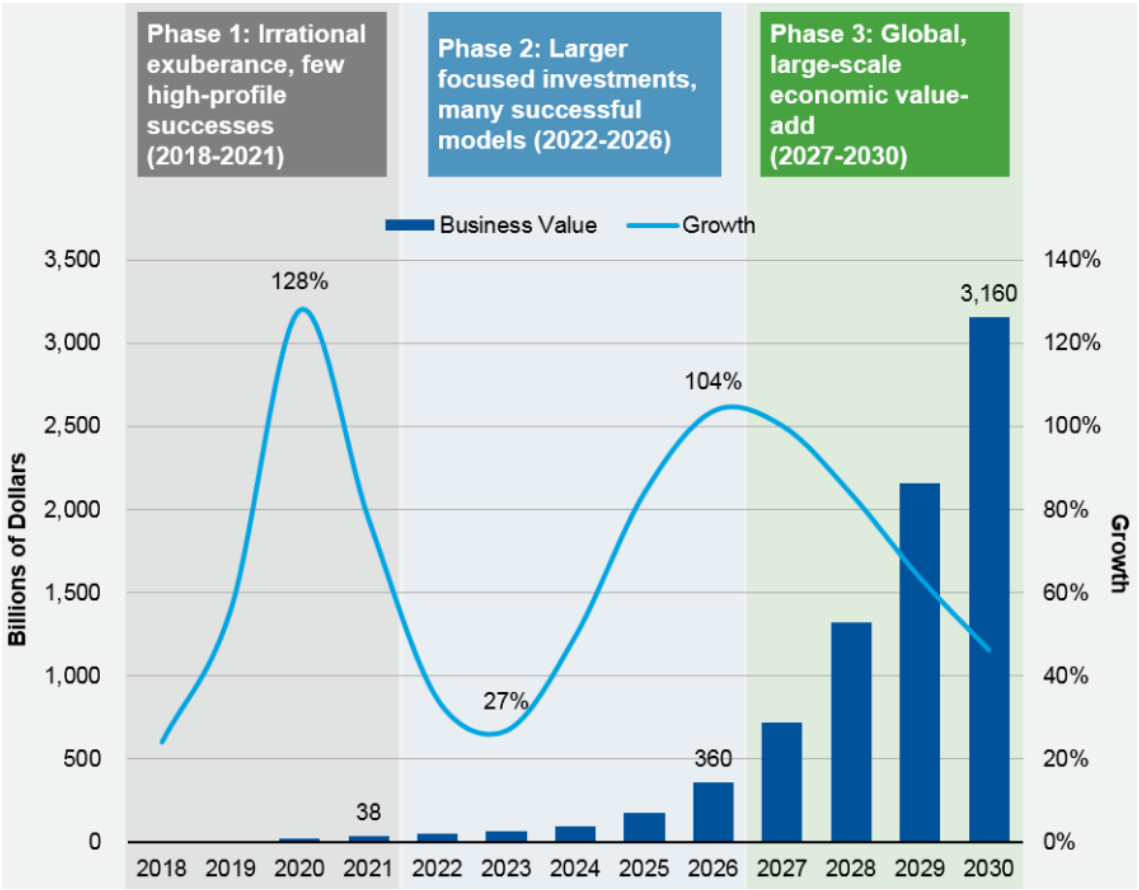
| Stage | Cluster Combined | | Coefficients | Stage Cluster First Appears | | Next Stage |
|---|---|---|---|---|---|---|
| | Cluster 1 | Cluster 2 | | Cluster 1 | Cluster 2 | |
| 1 | 45 | 51 | 7.396 | 0 | 0 | 20 |
| 2 | 37 | 49 | 7.396 | 0 | 0 | 21 |
| 3 | 33 | 35 | 7.396 | 0 | 0 | 28 |
| 4 | 42 | 50 | 7.396 | 0 | 0 | 25 |
| 5 | 8 | 13 | 7.396 | 0 | 0 | 32 |
| 6 | 32 | 52 | 18.491 | 0 | 0 | 26 |
| 7 | 43 | 47 | 18.491 | 0 | 0 | 21 |
| 8 | 28 | 44 | 18.491 | 0 | 0 | 20 |
| 9 | 17 | 24 | 18.491 | 0 | 0 | 39 |
| 10 | 16 | 22 | 18.491 | 0 | 0 | 18 |
| 11 | 10 | 14 | 18.491 | 0 | 0 | 40 |
| 12 | 38 | 56 | 29.586 | 0 | 0 | 26 |
| 13 | 53 | 54 | 36.982 | 0 | 0 | 31 |
| 14 | 25 | 39 | 36.982 | 0 | 0 | 23 |
| 15 | 23 | 26 | 36.982 | 0 | 0 | 31 |
| 16 | 2 | 4 | 36.982 | 0 | 0 | 34 |
| 17 | 15 | 21 | 48.077 | 0 | 0 | 44 |
| 18 | 12 | 16 | 61.021 | 0 | 10 | 30 |
| 19 | 11 | 29 | 62.870 | 0 | 0 | 27 |
| 20 | 28 | 45 | 66.568 | 8 | 1 | 33 |
| 21 | 37 | 43 | 66.568 | 2 | 7 | 35 |
| 22 | 1 | 7 | 66.568 | 0 | 0 | 32 |
| 23 | 25 | 27 | 85.059 | 14 | 0 | 36 |
| 24 | 5 | 9 | 96.154 | 0 | 0 | 34 |
| 25 | 30 | 42 | 99.852 | 0 | 4 | 28 |
| 26 | 32 | 38 | 116.494 | 6 | 12 | 36 |
| 27 | 11 | 34 | 127.589 | 19 | 0 | 38 |
| 28 | 30 | 33 | 134.369 | 25 | 3 | 41 |
| 29 | 46 | 55 | 136.834 | 0 | 0 | 38 |
| 30 | 12 | 20 | 150.394 | 18 | 0 | 33 |
| 31 | 23 | 53 | 151.627 | 15 | 13 | 41 |
| 32 | 1 | 8 | 170.118 | 22 | 5 | 48 |
| 33 | 12 | 28 | 227.441 | 30 | 20 | 46 |
| 34 | 2 | 5 | 229.290 | 16 | 24 | 44 |
| 35 | 37 | 40 | 235.762 | 21 | 0 | 49 |
| 36 | 25 | 32 | 265.348 | 23 | 26 | 45 |
| 37 | 19 | 41 | 266.272 | 0 | 0 | 43 |
| 38 | 11 | 46 | 297.707 | 27 | 29 | 42 |
| 39 | 17 | 18 | 327.293 | 9 | 0 | 42 |
| 40 | 10 | 31 | 349.482 | 11 | 0 | 47 |
| 41 | 23 | 30 | 380.178 | 31 | 28 | 43 |
| 42 | 11 | 17 | 482.249 | 38 | 39 | 46 |
| 43 | 19 | 23 | 653.764 | 37 | 41 | 45 |
| 44 | 2 | 15 | 684.172 | 34 | 17 | 48 |
| 45 | 19 | 25 | 844.348 | 43 | 36 | 50 |

**Agglomeration schedule for cluster analysis/ *Klasteru analīzes aglomerācijas grafiks***

| Stage | Cluster Combined | | Coefficients | Stage Cluster First Appears | | Next Stage |
|---|---|---|---|---|---|---|
| | Cluster 1 | Cluster 2 | | Cluster 1 | Cluster 2 | |
| 46 | 11 | 12 | 897.513 | 42 | 33 | 47 |
| 47 | 10 | 11 | 1470.430 | 40 | 46 | 49 |
| 48 | 1 | 2 | 1559.418 | 32 | 44 | 50 |
| 49 | 10 | 37 | **2061.001** | 47 | 35 | 51 |
| 50 | 1 | 19 | **4154.093** | 48 | 45 | 51 |
| 51 | 1 | 10 | 4883.649 | 50 | 49 | 0 |

*Source: Author's construction based on data from Stats and Facts…, 2020; Bitcoin ATMs..., 2020; List of All…, 2020; Blockchain Regulations..., 2020; GDP per Capita…, 2019; The Global Competitiveness…, 2019, Country Data, 2018*

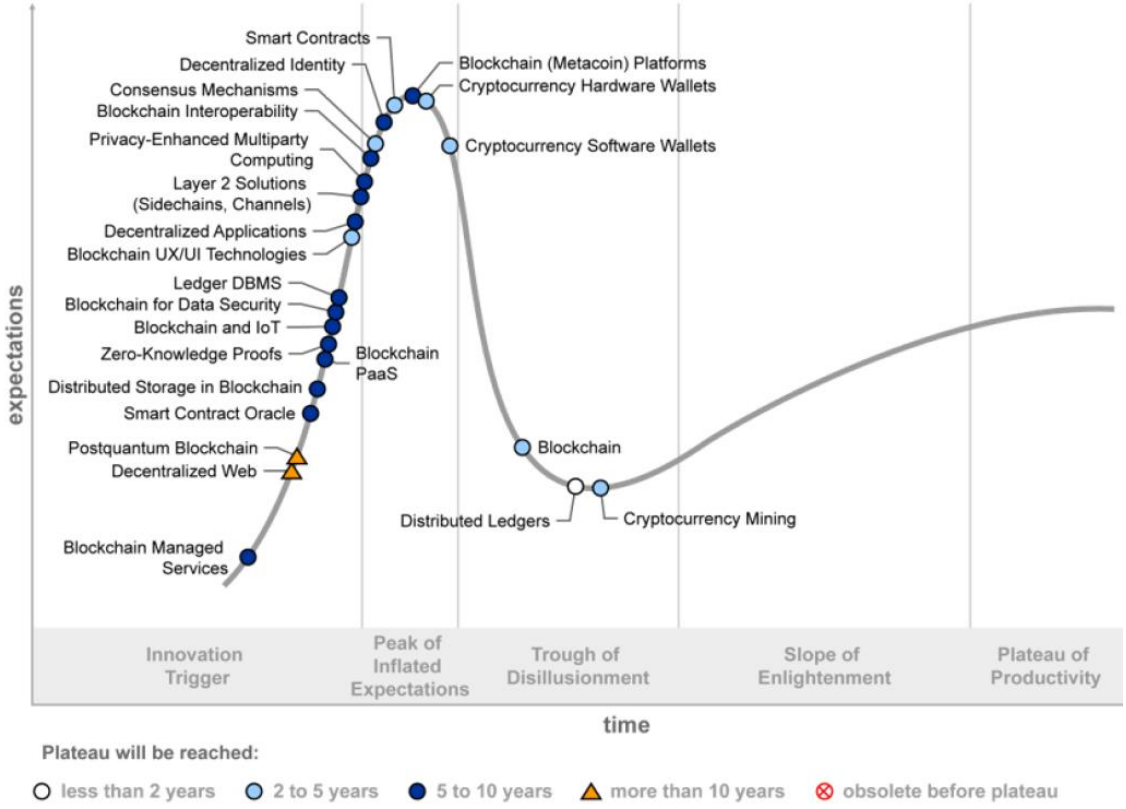
**Blockchain Business Value Forecast/ *Blokķēdes biznesa vērtības prognoze***




*Source: Gartner, 2018*

Annex 8/ *8. pielikums*

**Maturity cycles of blockchain technology applications/ *Blokķēdes tehnoloģiju lietojumu brieduma cikli***




*Source: Furlonger and Uzureau, 2019*

**Annex 9/ *9. pielikums***

**International blockchain technology expert survey questionnaire/ *Starptautisko blokķēdes tehnoloģiju ekspertu aptaujas anketa***

Dear Blockchain expert, your responses will be analysed to investigate factors that influence decisions to adopt Blockchain solutions in the national economy. Please, base your answers on your observations in the selected country and your experience with Blockchain innovation, implementation and advice.

* 1. Please, select a country, which you will be assessing:

* 2. On a scale from ‘very low’ to ‘very high’, please rate how you regard a specified Blockchain technology adoption scenario in the selected country. The more adopted you regard a scenario, the higher you would rate it. The more underdeveloped you regard a scenario, the lower you would rate it.

| | Very low | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| Initiative of government institutions/ regulators | ○ | ○ | ○ | ○ | ○ |
| Initiative of technology developers | ○ | ○ | ○ | ○ | ○ |
| Initiative of industry pioneers/ consortia | ○ | ○ | ○ | ○ | ○ |

Other (please specify)

* 3. On a scale from ‘Very low’ to ‘Very high’, please rate how you regard the influence of each Stakeholder group on Blockchain adoption process in the selected country. The more influential you regard a Stakeholder group, the higher you would rate it. The less influential you regard a Stakeholder group, the lower you would rate it.

| | Very low | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| Leaders | | | | | |
| Venture capitalists | | | | | |
| Academia | | | | | |
| NGOs | | | | | |
| Developers | | | | | |
| End users | | | | | |
| Industry pioneers | | | | | |
| Governments and regulators | | | | | |
| Banks and financial services | | | | | |
| Other (please specify) | | | | | |

**Question Title**

* 4. On a scale from ‘Very low’ to ‘Very high’, please rate how you regard the importance of each Technological factor that may influence a decision to develop/ implement a selected Blockchain solution. The more important you regard a factor, the higher you would rate it. The more unimportant you regard a factor, the lower you would rate it.

| | Very low | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| Architecture | | | | | |
| Shared IT infrastructure | | | | | |
| Data security | | | | | |
| Compatibility with legacy IT systems | | | | | |
| Maturity | | | | | |
| Perceived benefits | | | | | |
| Ease of use | | | | | |
| Other (please specify) | | | | | |

* 5. On a scale from ‘Very low’ to ‘Very high’, please rate how you regard the importance of each Organizational factor that may influence a decision to develop/ implement a selected Blockchain solution. The more important you regard a factor, the higher you would rate it. The more unimportant you regard a factor, the lower you would rate it.

| | Very low | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| Financial resources | | | | | |
| Organizational size | | | | | |
| Business model readiness | | | | | |
| Innovativeness | | | | | |
| Top management support | | | | | |
| Employees with IT knowledge | | | | | |
| Participation incentives | | | | | |
| Other (please specify) | | | | | |

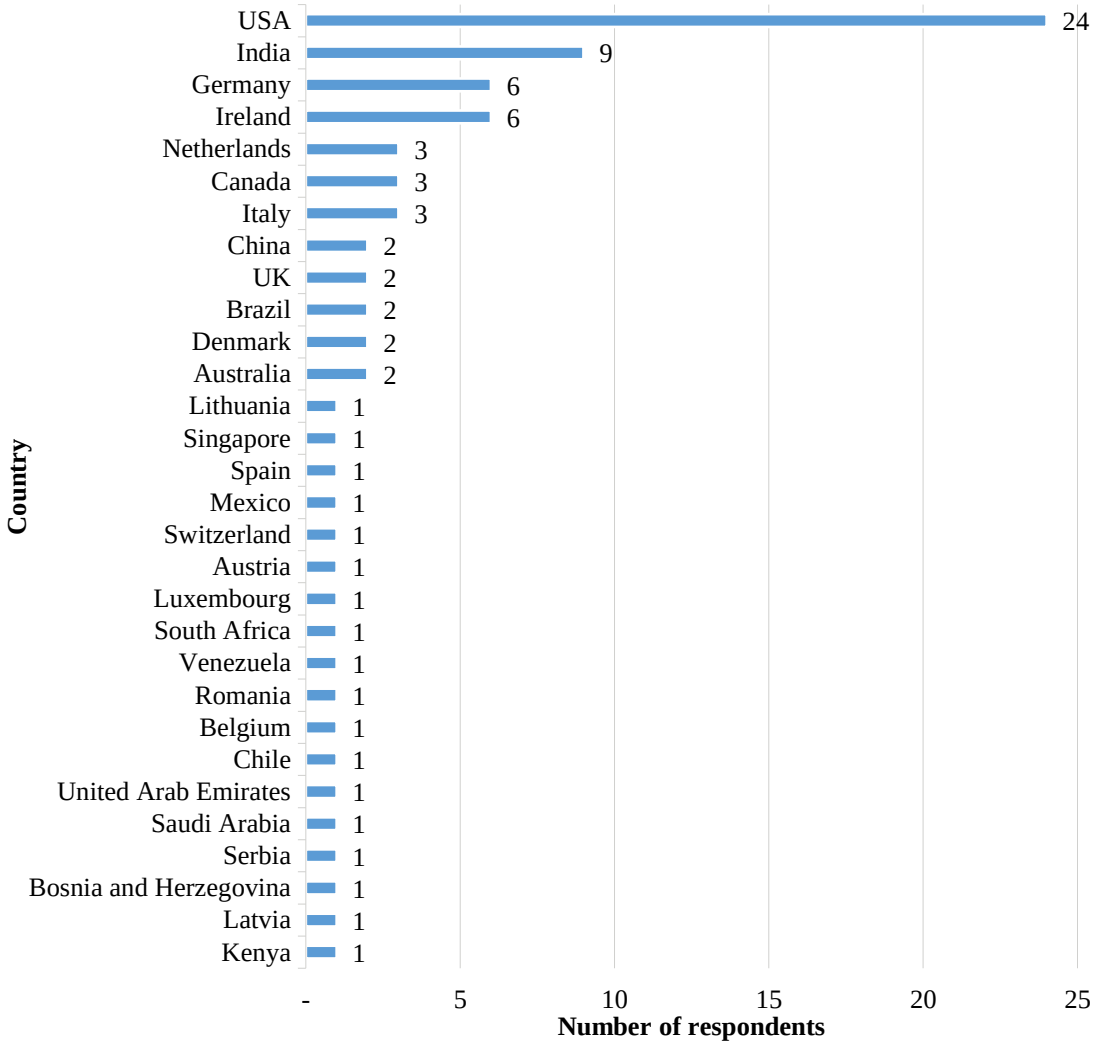
* 6. On a scale from ‘Very low’ to ‘Very high’, please rate, based on your experience, how you regard the importance of each Market factor, which may influence a decision to develop/ implement a selected Blockchain solution. The more important you regard a factor, the higher you would rate it. The more unimportant you regard a factor, the lower you would rate it.

| | Very low | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| Critical user mass | | | | | |
| Existing use cases | | | | | |
| Market dynamics | | | | | |
| Industry pressure | | | | | |
| Trading partner support | | | | | |
| Other (please specify) | | | | | |

* 7. On a scale from ‘Very low’ to ‘Very high’, please rate, based on your experience, how you regard the importance of each Institutional factor, which may influence a decision to develop/ implement a selected Blockchain solution. The more important you regard a factor, the higher you would rate it. The more unimportant you regard a factor, the lower you would rate it.

| | Very low | Low | Medium | High | Very high |
|---|---|---|---|---|---|
| Regulatory environment, incl. government regulation | ○ | ○ | ○ | ○ | ○ |
| Government support | ○ | ○ | ○ | ○ | ○ |
| Norms and cultures, incl. general blockchain knowledge | ○ | ○ | ○ | ○ | ○ |
| Governance framework, incl. standartization | ○ | ○ | ○ | ○ | ○ |
| Innovation systems/ clusters | ○ | ○ | ○ | ○ | ○ |
| Other (please specify) | ○ | ○ | ○ | ○ | ○ |

**International blockchain technology expert geographical distribution/**
***Starptautisko blokķēdes tehnoloģiju ekspertu ģeogrāfiskā izkliede***




*Source: Author's construction based on international blockchain expert survey results*

**National expert AHP assessment questionnaire for blockchain technology adoption in the economy of Latvia/ *Nacionālo ekspertu AHP vērtējuma anketa blokķēdes tehnoloģiju ieviešanai Latvijas tautsaimniecībā***

Cienījamais ekspert,

Paldies par piekrišanu sniegt vērtējumu par Blokķēdes tehnoloģiju ieviešanas iespējām Latvijas tautsaimniecībā. Aptaujas mērķis ir novērtēt Blokķēdes tehnoloģiju ieviešanu veicinošos faktorus un iespējamos ieviešanas scenārijus Latvijā, kuri izriet no starptautiskas prakses un ir pielāgoti Latvijas apstākļiem. Zemāk ir nodefinēti iespējamie blokķēdes tehnoloģiju ieviešanas scenāriji. Lūdzu, ņemiet vērā, ka scenāriji nav savstarpēji izslēdzoši un var attīstīties vienlaicīgi.

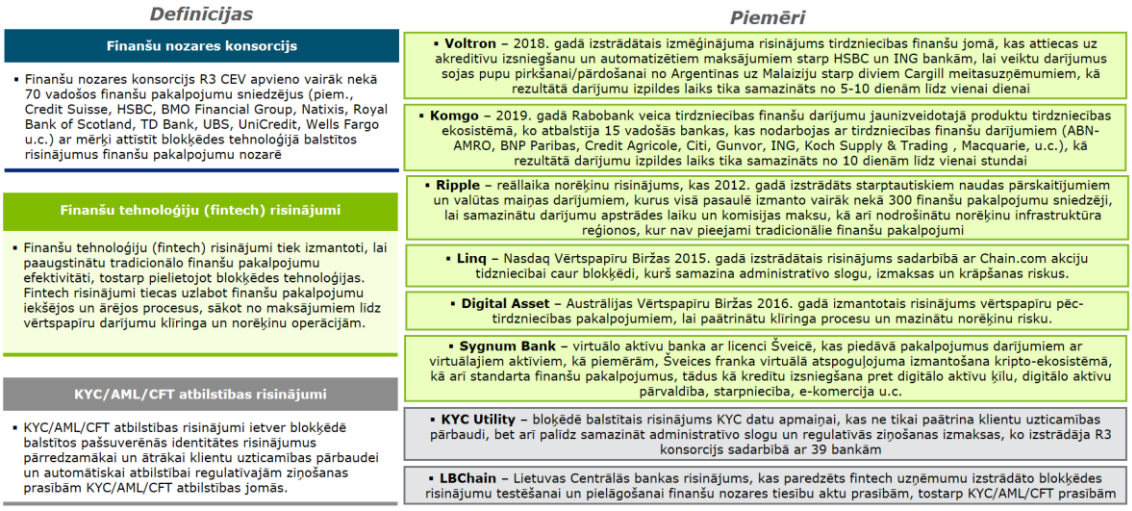
**1. scenārijs – 'Tehnoloģiju izstrādātāju iniciatīva'** attiecas uz blokķēdes tehnoloģiju risinājumu izstrādi tādās jomās kā decentralizēti maksājumu risinājumi, kripto/žetonu ekonomika, digitālās identitātes utt., ko tehnoloģiju izstrādātāji veicina neatkarīgi vai sadarbībā ar citām ieinteresētajām pusēm.

| *Definīcijas* | *Piemēri* |
|---|---|
| **Tehnoloģiju attīstītāji**<br>▪ Tehnoloģiju izstrādātāji var pārstāvēt gan atvērtā pirmkoda kopienas, kur programmētāji sniedz ieguldījumu programmas kodu izstrādē, gan uzņēmumus, kas izstrādā un piedāvā digitālos pakalpojumus/produktus/infrastruktūru/tehniskos rīkus vai izmanto tos kā savu galveno ienākumu avotu. | ▪ **Bitcoin, Litecoin, Ethereum, Dash, Aeternity**, utt. ir kriptovalūtu un publisko blokķēžu platformu piemēri. Kriptovalūtas infrastruktūras projekti iekļauj arī kriptovalūtu bankomātus, kripto-biržas un digitālos makus, kaut gan šie projekti var arī neizmantot blokķēžu tehnoloģiju per se. |
| **Decentralizētie maksājumu risinājumi**<br>▪ Decentralizētie maksājumu risinājumi tiek nodrošināti, izmantojot kriptovalūtas un attiecīgo blokķēdē balstīto tehnisko infrastruktūru. Kriptovalūtu sistēmā izmanto blokķēdes tehnoloģiju, lai izvairītos no trešajām pusēm, tādējādi nodrošinot iespēju pārskaitīt līdzekļus vienādranga lietotājiem, neiesaistot starpniekus, piemēram, banku vai maksājumu iestādi | ▪ **Globitex** – Latvijā dibinātā kriptovalūtu un digitālo aktīvu birža ar birojiem Rīgā, Viļņā un Londonā. Tās meitas uzņēmums Nexpay UAB ir saņēmis Lietuvas Centrālās Bankas izniegto elektroniskas maksājumu iestādes licenci. |
| **Kripto/ žetonu ekonomikas risinājumi**<br>▪ Kripto/žetonu ekonomikas risinājumi tiek īstenoti virtuālos brīvas piekļuves projektos, tajos tiek izmantota uz kriptovalūtām balstīta stimulēšanas sistēma, kas pastiprina un izraisa vēlamo uzvedību blokķēdes ekosistēmā. Šādi projekti parasti tiek izstrādāti, pamatojoties uz publiskām blokķēdes platformām, piemēram, Ethereum, Pokadot un Cosmos, un parasti tie piesaista finansējumu, izmantojot sākotnējos kriptonaudas piedāvājumus (ICO) vai sākotnējos maiņas piedāvājumus (IEO). | ▪ **Monetha** – 2017. gadā Lietuvā izstrādātais risinājums reputācijas pakalpojumu nodrošināšanai e-komercijas darījumos un blokķēžu risinājumu integrācijai biznesa procesos. |
| **Digitālās identitātes pārvaldības risinājumi**<br>▪ Digitālās identitātes pārvaldības risinājumi tiek izmantoti lietotāju autentifikācijai digitālajā vidē, kas lietotājiem ļauj droši pārvaldīt savus personas datus, piem., apstiprinot savu identitāti digitālajās sistēmās un nodrošinot atbilstību digitālā pakalpojuma izmantošanas nosacījumiem. Salīdzinājumā ar tradicionālajiem autentifikācijas risinājumiem (piemēram, internetbanka), blokķēdes risinājumi dod lietotājiem lielāku kontroli par savuiem personas datiem, jo tie netiek uzglabāti centralizētās datubāzēs un tos var izmantot šifrētā formā | ▪ **HashRush** - 2018. gadā Latvijā izstrādātā reāllaika stratēģijas spēle, kas ļauj spēlētājiem konkurēt savā starpā par kriptovalūtu un citām virtuālajām atlīdzībām.<br>▪ **Notakey** – 2016. gadā Latvijā izstrādātais risinājums klientu izpētei (KYC) digitālajā vidē, kurš atbilst Finanšu darījumu darba grupas (FATF) izstrādātajām rekomendācijām noziedzīgi iegūtu līdzekļu legalizācijas un terorisma finansēšanas novēršanas jomās (AML/CFT). |

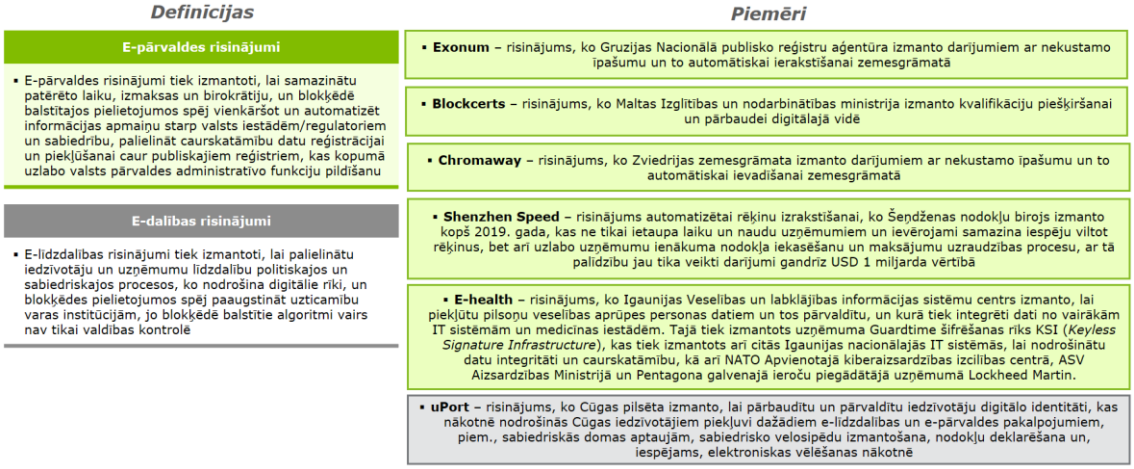
**2. scenārijs – 'Nozares pionieru/ konsorciju iniciatīva'** attiecas uz blokķēdes risinājumu izstrādi izsekojamībai piegādes ķēdē, automatizētai līgumu nosacījumu izpildei, utt., piedaloties starptautiskos konsorcijos vai īstenojot savas iniciatīvas.

| *Definīcijas* | *Piemēri* |
|---|---|
| **Nozares pionieri**<br>▪ Nozares pionieri ir uzņēmumi, kas izstrādā inovatīvus risinājumus un ievieš revolucionāras inovācijas uzņēmējdarbības modeļos savas pamatdarbības nozarēs, piem. nekustamais īpašums, loģistika, lauksaimniecība, apstrādes rūpniecība, kalnrūpniecība, vairumtirdzniecība utt | ▪ **MOBI** (Mobility Open Blockchain Initiative) konsorcijs auto nozarē (dalībnieki - BMW, Ford, General Motors, Renault) |
| **Nozares konsorciji**<br>▪ Nozares konsorciji ir divu vai vairāku personu, uzņēmumu, organizāciju vai valdību apvienības (vai jebkura šo vienību kombinācija) ar mērķi piedalīties sadarbības pasākumos vai apvienot savus resursus kopīga mērķa sasniegšanai | ▪ **BiTA** (Blockchain In Transport Alliance) loģistikas/ transporta nozarē, apvienojot arī interesentus piegādes ķēdes risinājumos (dalībnieki - UPS, Fedex, P&G, Whirlpool, BASF, Schneider, u.c.)<br>▪ **CBC** (Construction Blockchain Consortium) konsorcijs būvniecības nozarē (dalībnieki – CBRE, AIG, Siemens, Canary Wharf Group, u.c.) |
| **Risinājumi piegādes ķēdes izsekojamībai**<br>▪ Risinājumus piegādes ķēdes izsekojamībai izmanto, lai uzlabotu iepirkumu caurskatāmību, produkta izcelsmes izsekojamību, loģistikas un ražošanas procesus, bieži vien tie tiek izmantoti kopā ar lietu interneta sensoru tehnoloģijām. | ▪ **ABCD** konsorcijs lauksaimniecības nozarē (dalībieki - Archer Daniels Midland Co, Bunge Ltd, Cargill Inc, Louis Dreyfus Co).<br>▪ **'Walmart'** ASV lielveikalu ķēdes 2016. gadā izstrādātais pārtikas drošības risinājums, nodrošināja preču kvalitātes kontroli un piegādes procesa izekojamību no fermas līdz lielveikalam reāllaika režīmā. |
| **Risinājumi automatizētai līgumu nosacījumu izpildei**<br>▪ Risinājumos automatizētai līgumu nosacījumu izpildei tiek izmantoti viedie līgumi, kuros var ieprogrammēt gan automātisku līgumu punktu izpildi starp līguma pusēm caur blokķēdi, gan attiecīgu apmaksas kārtību | ▪ **AXA līdojuma kavēšanās apdrošināšana** ar automatizētu līgumu nosacījumu izpildi izmanto platformu Fizzy, kas reģistrē katru pirkumu blokķēdē, uzrauga lidojumu kavējumus attiecīgajās datubāzēs un, tiklīdz kavēšanās ir reģistrēta, kompensācija tiek izmaksāta automātiski. |

**3. scenārijs – 'Banku/ finanšu pakalpojumu nozares iniciatīva'** ietver blokķēdes risinājumu izstrādi finanšu tehnoloģiju (fintech) un AML/CFT/KYC jomās utt., piedaloties starptautiskos konsorcijos vai īstenojot savas iniciatīvas.




**4. scenārijs – 'Valsts iestāžu/ regulatoru iniciatīva'** ietver blokķēdes risinājumu izstrādi e–pārvaldes un e–līdzdalības jomā, piem., lai efektīvāk sniegtu publiskos pakalpojumus, efektīvāk veiktu pārraudzību atbilstoši tiesību aktu prasībām vai palielinātu valsts pārvaldes caurskatāmību un stiprinātu demokrātijas procesus.




Tālāk sekos jautājumi–matricas, kuru ietvaros Jūsu vērtēšanai tiek piedāvāti mainīgo lielumu pāri. Vērtēšanai tiek piedāvāta relatīva svarīguma skala:

- 9 – Ļoti stiprs 1. mainīgā lieluma pārsvars salīdzinājumā ar 2 mainīgo lielumu
- 7 – Nozīmīgs 1. mainīgā lieluma pārsvars salīdzinājumā ar 2. mainīgo lielumu
- 5 – Būtisks 1. mainīgā lieluma pārsvars salīdzinājumā ar 2. mainīgo lielumu
- 3 – Mērens 1. mainīgā lieluma pārsvars salīdzinājumā ar 2. mainīgo lielumu
- 1 – Vienāds svarīgums
- 1/3 – Mērens 2. mainīgā lieluma pārsvars salīdzinājumā ar 1. mainīgo lielumu
- 1/5 – Būtisks 2. mainīgā lieluma pārsvars salīdzinājumā ar 1. mainīgo lielumu
- 1/7 – Nozīmīgs 2. mainīgā lieluma pārsvars salīdzinājumā ar 1. mainīgo lielumu
- 1/9 – Ļoti stiprs 2. mainīgā lieluma pārsvars salīdzinājumā ar 1. mainīgo lielumu

**1. uzdevums (1 tabula)**

Lūdzu, atzīmējiet 1. faktoru grupas (horizontāli) svarīguma pārsvaru salīdzinājumā ar 2. faktoru grupu (vertikāli) Blokķēdes tehnoloģiju ieviešanai Latvijā, izmantojot relatīvo skalu no 1/9 līdz 9 atkarībā no kopējā mērķa – **Blokķēdes tehnoloģiju ieviešana Latvijā** (ietonēts zaļā krāsā), proti, jāizvērtē, kuras faktoru grupas ir nozīmīgākās Blokķēdes tehnoloģiju ieviešanai Latvijā. Faktoru grupu salīdzināšanas rezultāti jāieraksta tabulā, kas izveidota matricas formā.

**1.1. tabula**

| ***Kritēriju grupas Blokķēdes tehnoloģiju ieviešanai Latvijā*** | **'Tehnoloģiskie faktori'** | **'Organizatoriskie faktori'** | **'Tirgus faktori'** | **'Institucionālie faktori'** |
|---|---|---|---|---|
| **'Tehnoloģiskie faktori'** | 1 | | | |
| **'Organizatoriskie faktori'** | | 1 | | |
| **'Tirgus faktori'** | | | 1 | |
| **'Institucionālie faktori'** | | | | 1 |

**2. uzdevums (4 tabulas)**

Lūdzu, atzīmējiet 1. faktora (horizontāli) svarīguma pārsvaru salīdzinājumā ar 2. faktoru (vertikāli), katrā faktoru grupā (ietonēts zaļā krāsā), izmantojot relatīvo skalu no 1/9 līdz 9 atkarībā no kopējā mērķa – Blokķēdes tehnoloģiju ieviešana Latvijā, proti, jāizvērtē, kuri faktori ir nozīmīgākie katrā faktoru grupā Blokķēdes tehnoloģiju ieviešanai Latvijā. Faktoru salīdzināšanas rezultāti jāieraksta tabulā, kas izveidota matricas formā.

**2.1. tabula**

| ***Faktori faktoru grupā 'Tehnoloģiskie faktori'*** | **‘Paredzamie ieguvumi’** | **'Lietošanas ērtums'** | **'Arhitektūra'** | **'Datu drošība'** | **'Tehnoloģijas briedums'** |
|---|---|---|---|---|---|
| **‘Paredzamie ieguvumi’** | 1 | | | | |
| **'Lietošanas ērtums'** | | 1 | | | |
| **'Arhitektūra'** | | | 1 | | |
| **'Datu drošība'** | | | | 1 | |
| **'Tehnoloģijas briedums'** | | | | | 1 |

**2.2. tabula**

| *Faktori faktoru grupā 'Organizatoriskie faktori'* | **'Darbinieki ar IT zināšanām'** | **'Finanšu resursi'** | **'Augstākās vadības atbalsts'** | **'Novato riskums'** | **'Biznesa modeļa gatavība'** |
|---|---|---|---|---|---|
| **'Darbinieki ar IT zināšanām'** | 1 | | | | |
| **'Finanšu resursi'** | | 1 | | | |
| **'Augstākās vadības atbalsts'** | | | 1 | | |
| **'Novatoriskums'** | | | | 1 | |
| **'Biznesa modeļa gatavība'** | | | | | 1 |

**2.3. tabula**

| *Faktori faktoru grupā 'Tirgus faktori'* | **'Pieprasījums trigū'** | **'Nozares spiediens'** | **'Lietošanas gadījumi'** | **'Kritiskā masa'** |
|---|---|---|---|---|
| **'Pieprasījums trigū'** | 1 | | | |
| **'Nozares spiediens'** | | 1 | | |
| **'Lietošanas gadījumi'** | | | 1 | |
| **'Kritiskā masa'** | | | | 1 |

**2.4. tabula**

| *Faktori faktoru grupā 'Institucionālie faktori'* | **'Inovāciju sistēma'** | **'Tiesiskā vide'** | **'Pārvaldība'** |
|---|---|---|---|
| **'Inovāciju sistēma'** | 1 | | |
| **'Tiesiskā vide'** | | 1 | |
| **'Pārvaldība'** | | | 1 |

**3. uzdevums (17 tabulas)**

Jāizvērtē četri alternatīvie scenāriji Blokķēdes tehnoloģiju ieviešanai Latvijā atkarībā no katra faktora (kritērijs ietonēts zaļā krāsā katrā tabulā). Lūdzu, atzīmējiet 1. scenārija (horizontāli) pārsvaru salīdzinājumā ar 2. scenāriju (vertikāli), atkarībā no katra faktora (t.i., cik lielā mērā faktors šobrīd ir vairāk attīstīts vai tam ir potenciāls straujākai attīstībai, salīdzinot katru scenāriju pāri?).

! Piemērām, ja faktors 'Biznesa modeļa gatavība' tiek novērtēts ar 'Būtisku pārsvaru' (jeb 5) vairāk attīstīts scenārijā ‘Banku/ finanšu pakalpojumu nozares iniciatīva’ salīdzinājumā ar scenāriju 'Valsts/ kontrolējošo iestāžu iniciatīva', tas nozīmē ka banku/ finanšu nozares biznesa modeļi Latvijā ir būtiski vairāk gatavi Blokķēdes tehnoloģiju ieviešanai nekā valsts/ kontrolējošo iestāžu biznesa modeļi.

**3.1. tabula**

| ***'Uztvertās priekšrocības'*** | **Tehnoloģiju attīstītāju iniciatīva'** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **'Valsts/ kontrolējošo iestāžu iniciatīva'** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.2. tabula**

| ***'Lietošanas vienkāršība'*** | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.3. tabula**

| *'Arhitektūra'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.4. tabula**

| *'Datu drošība'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.5. tabula**

| *'Tehnoloģijas briedums'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.6. tabula**

| *'Darbinieki ar IT zināšanām'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.7. tabula**

| *'Finanšu resursi'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.8. tabula**

| *'Augstākās vadības atbalsts'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.9. tabula**

| *'Novatoriskums'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.10. tabula**

| *'Biznesa modeļa gatavība'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.11. tabula**

| *'Tirgus pieprasījums'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.12. tabula**

| *'Nozares spiediens'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.13. tabula**

| *'Pielietojuma piemēri'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.14. tabula**

| *'Kritiskā masa'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.15. tabula**

| *'Inovāciju sistēma'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

**3.16. tabula**

| *'Normatīvā vide'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

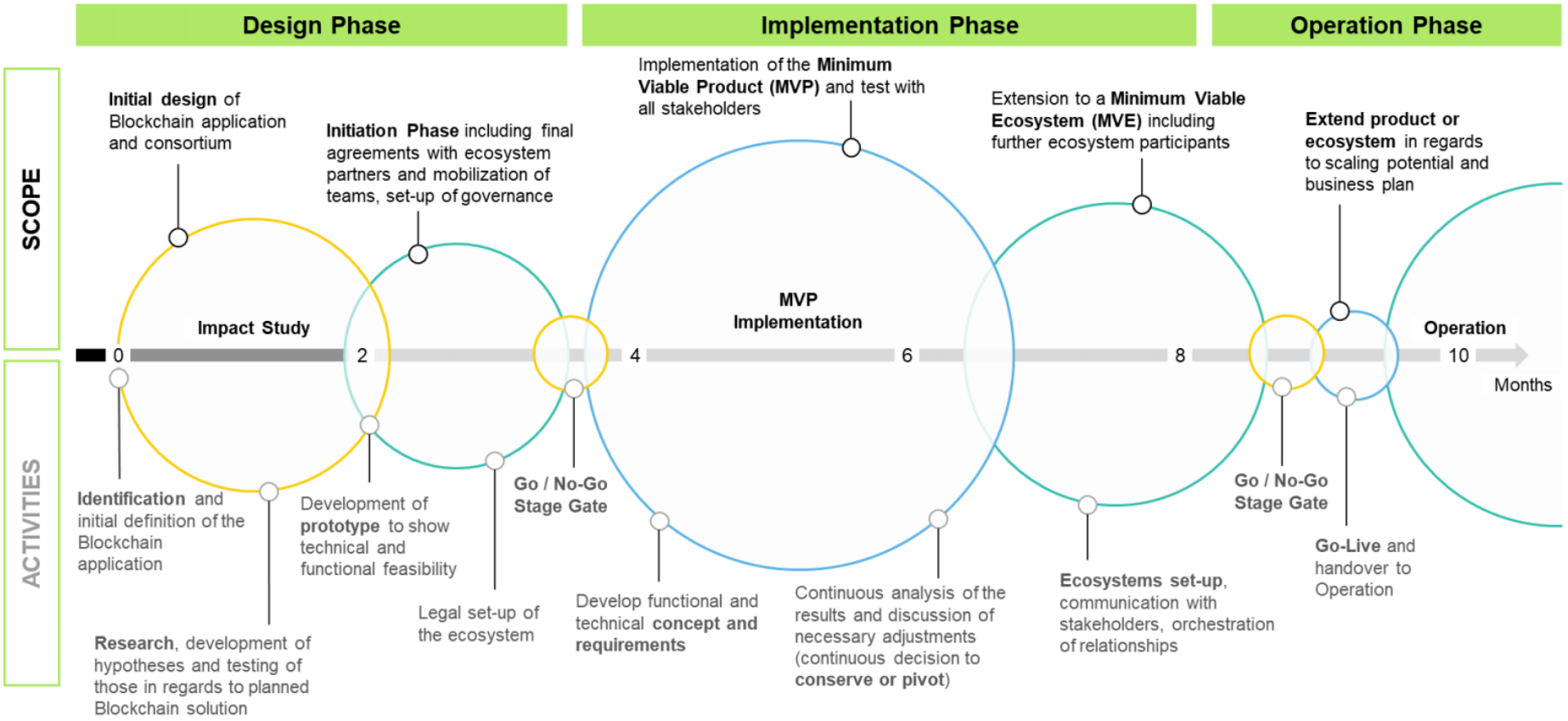
**3.17. tabula**

| *'Pārvaldes sistēma'* | **‘Tehnoloģiju izstrādātāju iniciatīva’** | **'Nozares pionieru/ konsorciju iniciatīva'** | **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | **‘Valsts iestāžu/ regulatoru iniciatīva’** |
|---|---|---|---|---|
| **‘Tehnoloģiju izstrādātāju iniciatīva’** | 1 | | | |
| **'Nozares pionieru/ konsorciju iniciatīva'** | | 1 | | |
| **‘Banku/ finanšu pakalpojumu nozares iniciatīva’** | | | 1 | |
| **‘Valsts iestāžu/ regulatoru iniciatīva’** | | | | 1 |

Paldies par Jūsu laiku un sniegto viedokli!

Annex 12/ *12. pielikums*

**Roadmap for a three–phased approach to blockchain pilot implementation/** ***Ceļvedis trīs posmu pieejai blokķēžu pilotprojektu ieviešanai***




*Source: Organisation for Economic Cooperation and Development, 2019*