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Regional Dimension in European Union: Shaping Key Performance Indicators for Financial Institutions

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Table of Content

Abbreviations used in the Thesis	4
Introduction	5
Aim of the Doctoral Thesis	6
Tasks of the Doctoral Thesis	7
Hypotheses of the Doctoral Thesis	8
Scientific novelty of the Thesis	10
Practical significance	11
1 Theoretical Aspects of Selecting KPIs for Financial Institutions	15
1.1 KPIs selection for financial institutions in EU	15
1.2 Fintech genesis	18
1.3 Digital financial products within EU region	19
1.4 Crypto-asset taxonomy and life cycle	19
1.5 Pricing digital currencies and cryptocurrencies	20
2 Regional Aspects of Financial Products Market	22
2.1 Regional aspect of financial institutions operations in EU	22
2.2 Regional and national EU policies: Impact on fintech	23
2.3 ECB operations within regional financial policy	24
2.4 Fintech as a development trend: International nature	24
2.5 Case studies: In-depth review reports	25
3 Fintech financial governance based on KRIs typical for EU	27
3.1 Fintech operations in smart city: Regional economic aspect	27
3.2 Sharing of financial services in EU economy	29
3.3 KRIs and risk indicators	30
3.4 Internal processes KRIs of the EU fintech based on KRIs	34
3.5 Fintech compliance with regional EU legislation: KRIs and KRIs ...	37
Conclusions	41
Recommendations	45
List of publications, reports on the topic of the Thesis	51
References	53
Annexes	63
Annex 1	64
Annex 2	67
Annex 3	68
Annex 4	69

Abbreviations used in the Thesis

AI	Artificial Intelligence
AIS	Account Information Service
AML	Anti-Money Laundering
AVE	Average Variance Extracted
CRR	Capital Requirements Regulation
ECB	European Central Bank
EU	European Union
ICO	Initial Coin Offer
IFRS	International Financial Reporting System
ICT	Information and Communication Technology
KPI	Key Performance Indicators
KRI	Key Risk Indicators
PIS	Payment Initiation Services
PLS-SEM	Partial Least Squares – Structural Equation Modelling
PSD2	II Payment Services Directive
ROA	Return on Assets
ROE	Return on Equity
RQ	Research questions
VIF	Variance Inflation Factor

Introduction

Relevance of the research topic

Industry 4.0 marks a transformation from traditional manufacturing to an advanced data-driven paradigm integrating physical and digital systems and other modern technologies (Vaidya *et al.*, 2018; Ardito *et al.*, 2019; Tupa & Steiner, 2019). This revolution facilitates business efficiency, productivity, significant societal benefits, improved access to education and healthcare, and better living standards (Alcácer & Cruz-Machado, 2019; da Silva *et al.*, 2020; Williams, 2021).

The development of fintech is the greatest change brought by Industry 4.0 (Fülöp *et al.*, 2022). The rise of fintech forces financial institutions to adapt to different regional economies, requiring an understanding of local regulations, financial literacy and consumer preferences (Phan *et al.*, 2020).

The European Commission recognises the necessity to develop financial services and launched the European Union Digital Financial Platform to foster innovation and promote a single digital financial market (Phan *et al.*, 2020).

The second Payment Services Directive (PSD2) introduces "passporting" in the EU, allowing financial institutions of one member state to operate in all EU countries, contributing to the creation of a single, integrated payments market. PSD2 aim is to promote competition and innovations and to ensure consumer protection; it creates the need for strong regulatory supervision.

The ECB stresses the great importance of technology in banking sector, drawing attention to the risks and the need for cyber-security measures. The ECB emphasises the necessity for sound digital governance, promoting proper risk management, customer trust, and secure banking environment (Kerstin af Jochnick, 2020).

Challenges, as highlighted by (Elderson, 2022), include the need for strong choice of KPIs considering the organisation's risk levels.

In response to the identified shortcomings in KPI and risk management integration, the ECB requires greater supervisory attention. A new approach to selection of KPIs based on risks meets the ECB's concerns for transparency in the financial sector.

Level of scientific development of the problem

Scholars all over the world study the issue of KPIs and their usage in the financial sphere. However, the level of scientific development of the problem still exists. Such prominent scientists as C. Kruger, J. Boyer, E. Fama and others have reached important results in examining KPIs, but the issue of the interconnection of KPIs and KRIs, as well as the impact of regional trends still require exploration. The contribution of Latvian scholars, such as V. Dombrovskis, H. Skadina, and R. Rupeika-Apoga, is also significant, especially in the process of selecting KPIs.

The scientific publications focus mainly on a limited set of traditional KPIs. Nevertheless, such an approach may ignore other vital factors that influence performance. Financial institutions are very different in their activities, and they cannot have a one-size-fits-all set of KPIs due to their unique operations and objectives. Therefore, it is very important to develop a consistent approach to KPI selection, which could allow the individual financial institutions to tailor and adjust the specific KPIs to their performance taking into account existing risks and regional trends.

Aim of the Doctoral Thesis

The aim of the doctoral research is to develop the Key Performance Indicators based on Key Risk Indicators for financial institutions in the EU regional dimension.

Tasks of the Doctoral Thesis

The following tasks are set to reach the aim of the Thesis:

1. To analyse the scientific publications on the selection of KPIs for financial institutions, to identify the research gaps and to determine the approach to the assessment of fintech and digital products, taking into account the role of the European regulatory authorities in the operations of financial institutions as issuers of digital financial products.
2. To determine and analyse the impact of the EU regional dimension and regional economic trends on the operations of financial institutions as well as an assessment of the sharing of financial services in smart cities in the EU.
3. To analyse the opportunity to use the traditional KPIs together with risk-based KPIs for estimating the performance on the spot.
4. To evaluate the criteria for the selection of risk indicators considering the digitalisation and regionalisation trends in the EU.
5. To construct and validate the statistical models for internal and compliance-related processes of the financial institutions for analysis of the interconnections of the KPIs and KRIs.
6. To suggest recommendations for selecting risk-based KPIs on the basis of the offered statistical models.

Object of the Doctoral Thesis

Financial institutions and their operations in the EU regional dimension.

Subject of the Doctoral Thesis

Formation of the KPIs of financial institutions in the EU regional dimension on the basis of KRIs.

Hypotheses of the Doctoral Thesis

1. The EU financial institutions can set up the KPIs on the basis of the KRIs for their financial governance.
2. The same set of KPIs is suitable for the financial governance of the EU financial institutions of different types.

Theses for the defence

1. Financial institutions should apply KPIs based on risks in addition to traditional KPIs.
2. The EU regional policy has an impact on national regulations and, accordingly, the risk structure of financial institutions operating in the EU.
3. The EU financial institutions of different types can use the same set of KPIs based on risks.

Research Questions

1. Does the comprehensive approach to selecting the proper KPIs in the financial sector exist in the EU?
2. Does the EU provide homogenous conditions for fintech as a form of a financial institution development across all countries considering economic policies implications, regulations, supervision, legislation?
3. Do the traditional KPIs cover all the requirements of the contemporary fintech company?
4. Does the suggested new approach to digital product within EU regional context affect the risk environment of a fintech company?
5. Does sharing economy create additional compliance and regulatory risks for the fintech company?
6. Do KRIs of the financial institution determine KPIs related to financial governance?

Research methods, data collection tools, and techniques

The analysis of primary and secondary data and the Delphi method were used for selecting risk indicators; the monographic method was applied to review the scientific publications and documents related to regional policies and normative regulatory acts; the qualitative and quantitative analyses were applied to risk assessment and development of classifications, taxonomies and algorithms; the case study method was employed for comparing the regulatory environment in different EU countries; the Cost-benefit analysis and the total cost of ownership methods were used to develop the cost functions; the Partial Least Squares – Structural Equation Modelling (PLS-SEM) method was employed for constructing and estimating the statistical models; the quality of the statistical models was assessed via item reliability, convergent validity, discriminant validity, coefficient of determination, standardised path coefficients, effect size, variance inflation factor (VIF), fit measures. The PLS-SEM analysis was carried out using SmartPLS software.

Research limitations

1. The study is based on operations of fintech as a form of financial institutions. Other forms of financial institutions were considered only in the theoretical part of the Thesis.
2. Limited representation of financial institutions operating in businesses: the research is based on the data related to financial fintech, payment fintech and asset management fintech. However, the findings might not fully cover the financial and capital adequacy risks faced by other types of financial institution.
3. Construct of the statistical models: The model generated is constrained by the factors included in its construction. The inclusion of other factors might result in different functional dependencies. Additionally,

alternative methods of data analysis might potentially present different result.

4. Sample. The author assumes the sample to be representative; the model is built on the values of 217 threats and 78 vulnerabilities. In total, 2950 indicators are considered for different financial institutions. However, the results may not be fully representative for the entire number of financial institutions.
5. Risk categories used. The statistical models are constructed on the risk categories associated with internal and external processes, defined by the experts in the process of Delphi survey.
6. The study deals with the specific form of financial institutions commonly referred to as fintech.

Scientific novelty of the Thesis

1. A new way to assess the EU financial institutions' KPIs with a regional focus is offered. The study shows the need for financial institutions to use the risk-based KPIs in addition to the traditional ones.
2. A classification of fintech and the segmentation of digital products were developed. They allow revealing the related risk factors.
3. The taxonomy of digital products was developed for connecting the production of various digital products.
4. The classification of electronic money and crypto assets and the taxonomy of money by law, as well as the algorithm for token classification were developed.
5. The pricing strategies for the digital products were offered. The risks inherent in the price formation methods were identified and analysed.
6. The factors of regional dimension affecting the fintech operations were identified. It is shown that the traditional resource theories are not applicable to the operations with digital products.

7. The new approach to the life-cycle and stages of production of the digital assets in the EU was developed. It is proven that digital assets production should be reflected in inventories but not in capital section in financial reporting, which contradicts the numerous scientific publications but supported by the approach of IFRS.
8. The comprehensive approach to the assessment of the inherent risk by determining the average likelihood and impact associated with each combination of threats and vulnerabilities contributing to the specific risk was developed.
9. The function of costs distribution between financial institutions and smart city administration for implementing shared financial services was developed. The specific compliance and regulatory risks based on market volatility were defined.
10. The new approach to the selection of KPIs for financial institutions on the basis of risk indicators was proven by the statistical models

Practical significance

1. The usage of traditional KPIs together with risk-based KPIs allows estimating the performance on the spot, which improves the decision-making process, covers the modern needs in risk control and facilitates the development of risk strategies for the EU financial institutions.
2. The developed classification of fintech types and the generated segmentation of digital products can be used by financial institutions for choosing those digital products that fully match their functionality, as well as for decreasing compliance related risks.
3. The developed taxonomy of digital products allows connecting the production of various digital products and facilitating the activities of financial institutions.

4. The offered taxonomies of crypto assets and money by law, classification of electronic money and algorithm for classification of tokens can be used by financial institutions for issuance of digital assets and for decreasing the compliance-related risks of financial institutions.
5. The developed characteristics of the EU regional fintech trends can provide the financial institutions with safe and well-controlled digital production. Moreover, these characteristics may provide benefits to other industries, working in the area of digital production.
6. The analysis of the EU regional trends and regulations relevant to the operations of financial institutions enables these institutions to select a jurisdiction that suits their digital production and distribution needs.
7. The offered KPI selection approach allows financial institutions to manage the operations more effectively.
8. It is proven that the production of digital assets should be reflected in inventories but not in the capital section in financial reporting. This allows financial institutions to improve their financial statements and reduce the compliance-related risk.
9. The cost analysis and cost distribution functions can be used by smart cities for the development of financial service sharing.
10. The developed statistical models allow financial institutions to delegate the ICT solutions to specialised businesses and to monitor the implementation of these operations with controlled risks.
11. The proposed approach to the selection of KPIs can be used by supervising authorities at the EU and national levels to monitor efficiently the internal and compliance-related processes of financial institutions considering the risk issue; it can be used by governance of financial institutions and by scholars for development of similar models in relation to specific risks, actual for each financial institution.

12. The EU and national supervising authorities can use the results of this study for assisting the financial institutions in the process of selecting the KPIs.

Evaluation of the research results

The author has widely disseminated the principal findings of the research and presented them to the stakeholders in:

- 8 publications in the scientific journals indexed in Scopus and Web of Science, and 5 of them are in journals included in Q1;
- 12 international scientific conferences and symposia, including 3 presentations at the Plenary Sessions;
- lectures and seminars in financial institutions and associations;
- presentation of the research results related to financial institutions regulation to the Bank of Latvia as national representative of the ECB;
- presentation of the research results to the *Association of Financial Institutions of the Czech Republic*;
- presentation of the research results to the financial institution in Malta.

Recognition of the value of the Thesis

- *Correspondence to the challenges stated by the ECB*: in the Newsletter (Annex 1) the ECB emphasises the necessity of the banks to improve the KPIs basis for estimating the banks performance and foretells that it will assess the banks' progress in improving risk culture through peer benchmarking, sharing good practices and ongoing industry dialogue.
- *Bank of Latvia* has recognised the relevance of the Thesis, and emphasised that the developed techniques can serve as a knowledge basis for policy making to increase the efficiency of supervision, and has practical applicability for supporting integrity and sustainable development of local fintech sector. (Annex 3)

- *Association of Financial Institutions of the Czech Republic* estimates the Thesis as relevant and potential and will offer it to the companies-members of the Association for practical implementation for more transparent, efficient, risk-aware financial management. (Annex 2)
- *Financial Institution in Malta* notes the topicality of the study and the Board of Directors has taken a decision to start implementing some of the findings in practice. (Annex 4)

The structure of the Doctoral Thesis

The Doctoral Thesis includes abstracts in English and Latvian, the list of abbreviations, introduction, three chapters, conclusions and recommendations, bibliography, 11 annexes. The volume of the Thesis is 142 pages including the bibliography, which comprises 316 sources. The List of author's publications consists of 8 publications in the scientific journals indexed in Scopus and WoS, and 5 of them are in journals included in Q1.

1 Theoretical Aspects of Selecting KPIs for Financial Institutions

The process of determining the area of research for this Thesis comprised several stages. The first step was to define whether the requirements of ECB for financial institutions to base their KPIs on risk indicators have a sound scientific basis. The second stage was to develop a genesis of fintech as a type of financial institutions used for the development of new approach to KPIs based on KRIs.

All other stages of determining the area of study are connected with regional aspect and include the defining the region of the research application, analysis of impact of regional and national EU policies on fintech, exploring the ECB as an instrument of regional financial policy, and investigation of the influence of globalisation on fintech.

1.1 KPIs selection for financial institutions in EU

The ECB criticised the current state of fintech governance for not aligning KPIs with the risks inherent in fintech operations (Annex 1). The ECB stresses the need for a transparent methodology for selecting indicators that correlate directly with the risks posed by fintech, especially in financial governance, where financial risk and capital adequacy risk play a key role. Fintech faces challenges such as standardisation, security and understanding among decision-makers that need to be addressed in order to fully exploit its potential to transform financial institutions and services.

The study is devoted to a literature review in order to create the taxonomy for the selection of KPIs in fintech. This area should be in the focus of research in the scientific literature. To confirm or reject this assumption, the following research questions (RQs) were set:

RQ1. The area of KPIs for financial institutions is well covered by the scientific articles indexed in Scopus and WoS databases.

RQ2. The factors influencing the choice of KPIs for the financial institution are described in scientific articles.

RQ3. The classification of KPIs for financial institutions exists and is applicable for practical use for financial institutions.

This study employs a methodology commonly used in other scientific research fields, focusing on less-explored problems. The initial stages involve planning and defining the research objectives, questions, and the selection of appropriate keywords is an essential step. After setting the RQ, the following keywords were determined: “fintech” OR “Financial institutions” AND “KPIs OR “metrics”.

Inclusion and exclusion criteria were defined and databases were searched from September 2022 to January 2023. Following strict inclusion criteria, 590 articles were identified, of which 122 were excluded due to duplication or inconsistency. Abstract screening reduced this number to 121, which was reduced to 9 relevant articles after full-text reading. Snowballing added seven more articles to the sample, and 16 articles were subjected to qualitative analysis.

Further, the qualitative analysis was used.

The analysis determines the specific academic fields the selected articles address. The outcome limited success in identifying relevant areas, with only liquidity management (two articles) and cybersecurity (three articles) needing to be specified. The categorisation of the remaining articles into distinct areas is challenging. Moving forward, the qualitative analysis of the chosen articles evaluates the extent of topic within academic literature. This evaluation aids in identifying problematic aspects within the field. The analysis involves reviewing each article's coverage and its alignment (or lack thereof) with relevant research areas of this study.

The analysis identifies the specific academic fields covered by the selected articles. The identification of the relevant areas revealed only two

articles in liquidity management and three articles in cyber security. It was difficult to categorise the remaining articles into specific areas. Further, the qualitative analysis of the selected articles was used to assess the degree of exploration of the topics in academic literature.

This systematic literature review aimed to answer three research questions. The results revealed negative answers to all three research questions, indicating that more coverage is needed in the scientific literature.

Nonetheless, the central question of precisely selecting appropriate KPIs for specific businesses, even within scientifically explored domains, still needs to be answered. Research allows companies to identify the most relevant KPIs for their unique needs for strategic decision-making.

The Doctoral Thesis research question – 1. *Do we have the comprehensive approach to selecting the proper KPIs in financial sector?* – **answered**. There is no comprehensive approach for choosing the appropriate financial sector KPIs.

A systematic literature review reveals a lack of clarity and consistency in selecting the relevant KPIs for different types of fintech. The absence of a universally accepted framework for KPI selection can lead to confusion and inefficiency in decision-making. A pragmatic approach initially considers common and traditional KPIs as a baseline before exploring more specific ones. Conventional KPIs like ROE, ROA, liquidity indicators, capital turnover and so on may not fully reflect fintech success, they do not evaluate risk management, capital allocation, and long-term sustainability.

In the area of financial management, DuPont analysis and ROE, ROA, liquidity indicators, capital turnover are established tools for evaluating performance. However, their effectiveness in measuring success in the digital and fintech sectors is under debate. DuPont analysis and ROE remain relevant

but should be used together with new KPIs to accurate financial assessment of fintech.

However, the challenge lies in the matching KPIs with potential risks. The ECB emphasised the need for KPIs that reflect a transparent, risk-aware approach. In the absence of risk-based KPIs, fintech may fail to identify accurately vulnerabilities and assess risk effectively.

The Doctoral Thesis research question – 3. *Do the traditional KPIs cover all the requirements of the contemporary fintech company?* – answered. Traditional KPIs without proper relationship to the risk of a fintech company do not cover the needs of the modern fintech.

1.2 Fintech genesis

The emergence of Industry 4.0 started the new era in financial services, driven by fintech innovation. The combination of finance and technology created opportunities to simplify operations, improve customer experience, and make data-driven decisions across the EU.

The historical evolution of fintech began in the 19th century and continues today, influencing business models and customer interactions. It is difficult to define fintech, but it generally includes technological systems that provide financial services directly or improve the efficiency of the financial system.

The benefits of digital applications are clear, including cost reduction, faster services, increased competition, and accessibility. However, fintech also presents challenges that require regulatory adjustments across the EU countries.

The need to monitor fintech in the EU arises due to the rapid growth and adoption of digital financial services. While fintech offers opportunities for inclusion and efficiency, it also presents risks (Ahern, 2021). The main reason is to protect consumers and investors via data security and privacy in fintech services. Supervision imposes strong cybersecurity measures for trust and

financial stability (Tsai & Peng, 2017; Rupeika-Apoga & Wendt, 2022). Supervision monitors systemic risks and vulnerabilities to ensure overall financial system stability. Harmonised regulations prevent arbitrage and promote cross-border innovation (Athanasiou & Mas-Guix, 2008; Armstrong, 2016; Buchak *et al.*, 2018; Richter, 2020).

1.3 Digital financial products within EU region

Digitalisation is now an essential aspect of modern banking that allows more efficient and cost-effective delivery of financial services. Financial institutions operating in the EU offer a wide range of financial products. Fintech became significant players in the EU market by introducing innovative digital solutions (Dhar & Stein, 2016; European Commission, 2017; Agarwal & Zhang, 2020; Boyer, 2021; Barroso & Laborda, 2022).

The taxonomy of digital financial products plays an important role in improving communication between financial institutions and fintech companies by providing standardised terminology

1.4 Crypto-asset taxonomy and life cycle

The Thesis distinguishes three distinct crypto-asset subtypes: 1. Utility tokens, issued for access to electronic services or digital platforms; 2. Asset-referenced tokens, linked to a single currency or another item; 3. Payment tokens (coins, electronic money tokens, e-money tokens), primarily intended as means of payment.

The life cycle of each type of crypto asset is based on its unique characteristics, and every stage in this life cycle corresponds to a transaction involving the crypto asset. This is true to all types of crypto assets.

1.5 Pricing digital currencies and cryptocurrencies

The price formation of cryptocurrencies cannot be explained by conventional economic theories. According to (Hanley, 2013), the value of cryptocurrencies fluctuates against other currencies as a purely market-based valuation. According to (Woo *et al.*, 2013), cryptocurrencies may have some equitable value due to its money-like properties as a medium of exchange and a store of value, but it has no other foundation. (Bouoiyour & Selmi, 2014) regress its market price against a number of independent variables, for example, the market price of gold. (Polasik *et al.*, 2014) conclude that the price of cryptocurrencies is predominantly the result of their popularity. (Gandal & Halaburda, 2014) examine the competition between cryptocurrencies on the market and four online exchanges.

"Electronic money" is defined as money that is accepted and is stored electronically, including magnetically. It is issued for the purpose of conducting payment transactions. The Electronic Money are issued by the Electronic Money Institution. The authorisation to issue electronic money is governed by the national laws of the EU member states.

The transformative impact of digitisation and innovative business models in the digital economy made it essential to identify the pricing factors affecting financial products in the digital economy (Verhoef *et al.*, 2021). Customers now expect 7/24 availability of products and services, which creates a challenge in measuring its impact accurately (Williams, 2021). Understanding these factors is essential to effectively manage the associated fintech risks.

Eugene F. Fama, the Nobel prize winner, contributed to the theory of capital market efficiency. (Fama, 1970) proposed three kinds of effectiveness, distinguished by the type of information included in price: (i) strong form, (ii) semi-rigid form, and (iii) poor performance.

The weakest form of efficiency is the aggregation of historical price data only, which can be predicted as a trend in historically aggregated prices. The medium form of efficiency assumes that all publicly available information is already reflected in prices. The strong form of efficiency takes into account all information, comprising the private information included in the price; it states that no monopoly information can be profitable; in other words, insider trading cannot be profitable in a market with strong efficiency.

Financial management, from the perspective of digital product pricing should consider the wider list of metrics. The approach for this metrics selection and assessment of their influence to the KPI of the company should be developed.

2 Regional Aspects of Financial Products Market

2.1 Regional aspect of financial institutions operations in EU

The research focuses on companies registered in the EU member states. Regulatory harmonisation is ensured by agreements involving the ratification of EU legislation by the EU member states European Union, 2022).

EU financial institutions play a crucial role in the regional economy by facilitating cross-border trade and investments. This regional framework is closely connected with globalisation, since it allows these institutions to be engaged in global financial markets. Globalisation introduces complex links in socio-ecological systems, affecting sustainability processes. This impact is reflected in all aspects of fintech.

Financial services are crucial for success of businesses in the digital economy, providing access to capital for investments, expansion, and risk management. Considering fully digital nature of financial services it is necessary to determine the regional economic aspects.

The digital economy covers economic activities that depends on or improved by digital resources (Cernisevs *et al.*, 2022). Only financial and insurance service providers fully operate in the digital sphere, conducting digital production, distribution, and communication (Pilat *et al.*, 2020; Williams, 2021).

(Shibusawa, 2000) highlights digital economy characteristics, including the digitalisation of goods and services through technology, moving them from physical to cyberspace.

The relationship between fintech and the digital economy is symbiotic, involving the integration of financial services and technology into the digital sphere (Cernisevs *et al.*, 2022). Fintech includes innovative solutions enabling efficient financial service delivery (European Commision, 2014; Serrano, 2018; Panov *et al.*, 2019; Pilat *et al.*, 2020; Spence, 2021). Globalisation plays a crucial role in integrating labour, technology, information and assets (Khizbullin *et al.*,

2017). 21st-century regional development theories, based on Schumpeterian ideas, consider innovation and knowledge as crucial factors, creating new opportunities and reshaping markets (Schumpeter & Opie, 1934). In regional economics, focusing on spatial economic aspects, innovation and competence serve as equilibrium factors between regions. The development of the digital economy contributes to globalisation and allows operations across regions.

Fintech plays a key role in the ecosystem of the financial services industry, facilitating collaboration and innovation (Moore, 1999). Fintech contributes to the localisation of production theory in the regional economy by connecting traditional financial institutions and fintech to offer comprehensive solutions (Cernisevs *et al.*, 2022).

Schumpeter's innovation concept as well as Richardson's theories (Richardson, 1964; Richardson, 1972; Richardson, 1990) affect regional development in the digital era. The presented model simplifies regional interactions, considering production, resources, and tax characteristics, emphasising the role of taxation in cross-border transactions.

2.2 Regional and national EU policies: Impact on fintech

The transformative nature of the digital economy and the integration of advanced ICT technologies into financial services led to significant shifts in the financial industry (Kurpayanidi, 2020, 2021). Fintech plays a key role in this transformation (Dhar & Stein, 2016; European Commission, 2017; Agarwal & Zhang, 2020; Boyer, 2021). The digital economy is influencing economic processes and creating new benefits for business. However, the digital economy also brings new risks and challenges. The evolution shows the impact of national policies and regulation on the growth and development of fintech, which varies across the EU and shapes the future of the financial sector (Sukhorukov *et al.*, 2018). It focuses on key challenges in the EU, revealing persistent gaps in the achievement of social objectives. These gaps underline the difficult task of policy

coordination across member states (Lavrinenko et al., 2023). The EU cohesion policy recognises the socio-economic differences between countries, contributing to additional risks for fintech companies linked to external regulation (Sánchez & Jiménez-Fernández, 2023).

2.3 ECB operations within regional financial policy

The ECB is a financial regulator for fintech in the EU. The ECB mitigates risks associated with fintech. The ECB's pan-European regulatory role promotes fair competition and harmonises practices across member states. It improves consumer protection, sets transparency standards and monitors fintech impact on the financial system.

Globalisation affects the ability of the ECB to achieve domestic goals due to financial ties across nations (The Economist, 2019). The ECB faces the challenges and mitigates the risks associated with globalisation. The ECB's role also includes supervising and regulating the financial sector, ensuring compliance with EU standards and regulations.

2.4 Fintech as a development trend: International nature

In the context of globalisation, fintech plays a key role in facilitating the transfer of technology and skilled labour across borders (Samimi & Jenatabadi, 2014). The integration of human capital and financial systems in globalised countries contributes to the efficient technology transfer and promotes economic growth.

Studies indicate that external investors tend to invest less in innovative industries within globalised processes, and the relationship between fintech and regional funds reinforces the concept of global convergence. Moreover, the role of fintech in digitising public services is an important aspect of globalisation (Alvarenga *et al.*, 2020). Governments' efforts to digitise public services

underline the contribution of fintech to the development of critical infrastructure for globalisation.

The differences between countries in the fintech sector are significant and can have a major impact on various aspects of operations. For instance, implementing regulations like MiFID II in equity management requires specific capital adequacy measures and expertise in asset management. While passporting facilitates the expansion of financial services across the EU countries, the different regulatory principles in different countries influence advantages and challenges in this process. The example of Germany and Estonia illustrates the differences in ICT security requirements, language barriers, legal aid and ease of registration of online businesses.

2.5 Case studies: In-depth review reports

The Thesis considers two case studies to analyse the conditions for the development of fintech in different EU member states. The examination of France and Italy's performance demonstrates the significant challenges and the complexities of harmonizing policies and strategies faced by the EU member states (Bandola-Gill et al., 2022). The analysis reveals that the regional disparities existing within national economies present a multifaceted set of challenges for various sectors of economies including fintech. As fintech plays an increasingly crucial role in transforming financial services, these regional discrepancies can influence not only the strategies and preferences of fintech suppliers but also the financial behaviour and access to services for end customers across different regions (Lavrinenko et al., 2023). Embracing innovative solutions and fostering cooperation among member states will be vital in achieving the objectives of financial inclusion and stability.

The Doctoral Thesis research question – 2. *Does the EU provide the homogenous conditions – economic policy, regulations, supervision, legislation*

– *for fintech development across all countries?* – **answered.** As the result of the case study 1 and case study 2 and assessment of the globalisation impact on fintech it was defined that EU does not provide the homogenous conditions to fintech.

3 Fintech financial governance based on KRIs typical for EU

3.1 Fintech operations in smart city: Regional economic aspect

This section of the Thesis is devoted to the connection between financial metrics and compliance risks in the sharing economy (Cernisevs & Popova, 2023). The integration of fintech in smart cities is examined as a convincing example of regional economy. Fintech continues to expand its presence in smart cities and impacts regional economies significantly; technological financial innovation can drive urban development at a regional level.

The introduction of Industry 4.0 is not only transforming production methods but also raising questions about the characteristics of products, especially if distributed ledger technology is integrated into their production (Mayer *et al.*, 2021). Formalisation is very important for the development of digital products and services, and it is necessary to issue crypto assets in order to begin the production of crypto-asset-based products (Pesch *et al.*, 2021). Balancing formalisation with innovation is critical, as the disruptive potential of implementing crypto assets poses challenges to traditional currencies and established businesses (Mäntymäki *et al.*, 2020). To address these gaps, the Thesis defines the sequence of accounting events related to crypto asset issuance, classifying it as part of the manufacturing process. Practically, it contributes to the procedural regulation of the accounting events related to crypto asset issuance within the EU. ICO is considered as a manufacturing process within Industry 4.0 and role smart cities in crypto asset issuance is examined.

The appearance of digitalisation in the economy redefined the product composition, introducing non-digital, digital, and crypto-assets components (Cernisevs & Popova, 2023). While digital manufacturing has been extensively studied (Paritala *et al.*, 2017; Vaidya *et al.*, 2018; Alcácer & Cruz-Machado, 2019; Suleiman *et al.*, 2022), more attention should be given to the

manufacturing and distributing of fully digital and crypto-assets-based products. This study examines challenges arising from crypto assets' conflicting definitions in ICOs. The study classifies ICOs as manufacturing processes within Industry 4.0, exploring their potential impact on traditional manufacturing and the smart city ecosystem. The classification of crypto assets into utility tokens, asset-based tokens, and payment tokens forms an ecosystem within the smart city. Digital supply chains are the fundamental component of digital manufacturing, where the distinction between manufacturers and consumers is blurred, and the participants of smart city are referred to as smart users.

The adoption of IFRS for fintech accounting is obligatory in the EU, ensuring consistency and transparency in financial statements of financial institutions (Cualain & Tawiah, 2023). The case study of Rome as a smart city assessed its development through projects and smart KPIs, which were selected based on digitisation levels and compatibility with crypto-assets-based products. Practical formulas for financial institutions issuing crypto assets were developed based on costs and income functions (Cernisevs & Popova, 2023).

Expanding the traditional concept of a product to include three elements – digital, non-digital, and crypto-assets-related components –, fundamentally transforms the way of risk management.

The Doctoral Thesis research question – 4. *Does the new approach to digital product manufacturing with regional economic aspects affect the risk environment of fintech company?* – **answered.** The research question was answered positively – The new approach to digital product manufacturing involves the risk environment of a fintech company.

3.2 Sharing of financial services in EU economy

This section of Thesis is devoted to the assessment of feasibility and financial costs of integrating fintech into smart city system to improve KPIs and to promote the sharing economy (Popova & Cernisevs, 2023). The study emphasises the significance of open banking as a key aspect of financial institutions involvement in the sharing economy. Based on (O’Leary *et al.*, 2021) research focused on assessing data openness within open banking, the key elements that should be considered when evaluating a third-party's readiness for open banking.

The study includes the analysis of sharing services in smart cities, with a specific focus on open banking services in Rome. The investigation reveals that open banking services significantly contribute to the implementation of the smart economy in smart cities. The open banking within the financial operations in smart city is based on special licensing types and special protocols. Account Information Service (AIS) is the license type for AIS providers, which allows access to the information of payment accounts. Payment Initiations Service (PIS), which allows to initiate payments from the customer’s accounts. The predictability of fixed costs makes integrating shared financial services economically viable within smart city. The study supports the hypothesis that the issuance and distribution of digital financial products can be likened to manufacturing and marketing processes, respectively. The integration of digital financial products into sharing economy increases the complexity of their distribution. Inadequate risk management practices in this area can lead to systemic risks, market downturns, and criminal practices. The proper risk management, effective regulatory control, and consumer protection measures can ensure stability and integrity.

The Doctoral Thesis research question – 5. *Does sharing economy create additional compliance and regulatory risks for fintech company?* – answered. Yes, the sharing economy creates other compliance and regulatory risks for fintech companies.

3.3 KPIs and risk indicators

The ECB, in its supervision newsletter of 15 February 2023 (Annex 1), highlighted certain concerns about KPIs in the financial industry. They pointed out that KPIs are not always transparent and clear, and focus too much on financial performance, neglecting risk and control. The supervisors also identified weaknesses in KPIs consistency with risks.

For fintech a risk-based strategy effectiveness depends on understanding of the risks they face.

The selection criteria for these companies ensured that they were registered in the EU, regulated or supervised by financial authorities, had risk professionals, and were involved in the payment business. Each identified risk represented a threat or a series of threats that could exploit the company's existing vulnerabilities. The data for the model's elements and indicators were collected through semi-structured interviews conducted with the five selected companies in 2017 and 2022. The survey conducted for risk assessment had several stages. The data collected during these phases were useful to understand the risk situation, vulnerabilities and potential threats faced by these companies, contributing to the development of an effective risk-based strategy.

The risks were grouped in the following way:

Governance risks – the risk that the company's rules, processes, and mechanisms function improperly. Governance risks relate to the directors' decisions (Schmid *et al.*, 2011; Asante *et al*, 2014; Elderson, 2022).

Operational risks – the risk that the company experiences a loss due to inadequate or failed internal processes, people, systems, or external events (Wang *et al.*, 2018; Kaddumi & Al-Kilani, 2022; Cristea, 2021; Cole *et al.*, 2001).

Human resources risks – the risks that human resources pose on the company's operations (Ibrahim & Melhem, 2016; Boon *et al.*, 2019; Stahl *et al.*, 2020).

Health and safety risks – the risk that the company may be subjected to a health and safety hazard in a specific workplace (Silva & Navarro, 2012; Lai *et al.*, 2020; Mustard & Yanar, 2023).

Financial risks – the risk that a company may face the possibility of losing money on an investment or business project (Syed & Bawazir, 2021; Zhang, 2022).

Cyber risks – this risk includes hardware and software failures, spam, viruses, malicious attacks, and other ICT matters (Scarlat *et al.*, 2011; Khan & Malaika, 2021; Varga *et al.*, 2021).

Capital adequacy risks refer to the risks associated with the firm's capital position, focusing on the sufficiency of capital to support existing and future business activities and the accessibility of additional capital if required. (Dangl & Lehar, 2004; Décamps *et al.*, 2004; Petersen & Mukuddem-Petersen, 2005; Bosch *et al.*, 2008; Fouche *et al.*, 2008) developed continuous-time models to address optimal control problems related to portfolio choice and capital requirements. These studies aim to find solutions to ensure banks' optimal risk management in a stochastic dynamic setting. Specifically, they seek to minimize market risk and capital adequacy risk, which involves ensuring the safety of the assets and stability of capital sources. (Baker & Wurgler, 2015; Giudici, 2018; Nguyen *et al.*, 2019; Jain *et al.*, 2023) consider capital adequacy risk, which relates not only to the capital adequacy ratio but also to the risks associated with a firm's capital position.

Environmental/external risks – the risks arising from economic events that are out of the control of the company (Hummel *et al.*, 2021; Torinelli & Silva Júnior, 2021; Tao *et al.*, 2022).

Law and regulation risks – the risk of financial, reputational or litigation damage to a company if it fails to monitor, control and prevent or significantly reduce regulatory compliance risk. Legal and regulatory risks reduce the risk of regulatory compliance (Laeven and Levine, 2009; Darolles, 2016; Mursalov, 2021; Rastogi *et al.*, 2022).

Strategic risks – the risk of loss arising from bad business decisions that need to be better aligned to strategic goals, failed execution of policies and processes designed to meet those goals, and inability to respond to macroeconomic and industry dynamics. Strategic risks are also those risks associated with operating in a specific industry (Delkhosh & Mousavi, 2016; Dvorský *et al.*, 2020; Kryvych & Goncharenko, 2020; Kunz & Heitz, 2021).

Financial crime risks – the risks arising from failing to prevent financial crime, money laundering, and market abuse (Europarlament, 2018; Al-Suwaidi & Nobanee, 2020; Faccia *et al.*, 2020).

For each type of risk, every threat and vulnerability identified was carefully classified to determine its relevance and relationship with the specific risk. This process aimed to determine whether each threat and vulnerability was directly related to the particular risk.

Five companies were selected (Cernisevs *et al.*, 2023a):

- Credit Institution in Latvia
- Virtual Asset Management company in Finland
- Virtual Asst Management company in Estonia
- Fintech company in Latvia
- Electronic Money Institution in Malta

The selected companies have the following features (Cernisevs et al., 2023a):

- The selected five fintechs represent three of four groups of fintech (Cernisevs et al., 2023a): – financial fintech, payment fintech, and asset management fintech. The fintechs of the fourth existing type do not deal with payments and, consequently, are beyond the scope of this study. Therefore, all areas of fintech functioning according to the set goal are represented in the study.
- All companies are supervised as credit institutions, electronic money institutions, virtual assets management institutions, and PIS providers. Two of them have been passported to provide services in all EU countries. Therefore, the sample is representative (Popova & Cernisevs, 2023).

The information obtained through the semi-structured interviews formed the basis for developing the risk assessment models.

Each participant company was separately assessed by the impact of 217 threats; the likelihood of 217 threats; the impact of 78 vulnerabilities; the likelihood of the 78 vulnerabilities

Five types of financial institutions were interviewed to select the model's components and indicators. Totally there were defined 217 threats and 78 vulnerabilities. Each threat and vulnerability were described by the value of its impact and likelihood. Overall each model was built on $(217 \times 2 + 78 \times 2) \times 5 = 2950$ indicator values (Cernisevs et al., 2023a).

The results of the survey allowed the development of a dynamic risk assessment models that effectively illustrated the risks specific to fintech companies in the EU. Through interviews with five companies, different threats and vulnerabilities were identified, ranked and analysed to show their interactions. Probability and impact of these risks were calculated by averaging likelihood and impact, providing a comprehensive evaluation of severity. The

models considered multiple threats and vulnerabilities for a single risk, offering a holistic view of the interconnected risk.

3.4 Internal processes KPIs of the EU fintech based on KRIs

The Thesis is dedicated to investigating the interaction of manufacturing and distribution risks in financial digital products and their impact on the financial performance of institutions (Cernisevs *et al.*, 2023). The main focus is the importance of efficient risks managing and mitigating in manufacturing and distribution processes of financial digital products.

To confirm Hypotheses 1 and 2, there were developed two models that assess the relationship between various types of financial institution risks and important KPIs of financial management, such as financial and capital adequacy risks. The first model focuses on evaluating the relationship between internal operational risks of a financial institution and the corresponding financial management KPIs.

In conducting the simultaneous analysis of multiple statistical relationships, the partial least squares structural equation modelling (PLS-SEM) was employed (Chin *et al.*, 2020; Dash & Paul, 2021; Hair *et al.*, 2021). The choice of PLS-SEM method was based on its effectiveness in handling any data samples, making it suitable for exploratory research and not requiring data to follow a normal distribution (Popova & Popovs, 2022; Popova & Zagulova, 2022).

The risk groups were determined based on their potential impact. Considering that these risk groups encompass both internal and external processes, the following risk groups chosen for modelling: governance risk; cyber risk; operational risk; financial crime risk; human resources risk

The first set of hypotheses (H1–H5) relates to financial risk:

H1: Governance Risk directly affects company KPI.

H2: ICT Risk directly affects company KPI.

H3: Operational Risk directly affects company KPI.

H4: Financial Crime Risk directly affects company KPI.

H5: Human Resource Risk directly affects company KPI.

The second set of hypotheses (H6-H10) relates to capital adequacy risk:

H6: Governance Risk directly affects company KPI.

H7: ICT Risk directly affects company KPI.

H8: Operational Risk directly affects company KPI.

H9: Financial Crime Risk directly affects company KPI.

H10: Human Resource Risk directly affects company KPI.

Using own methodology, the author calculated the average risk associated with each respondent of semi-structured interviews for each risk group. These outcomes served as the data source for the subsequent PLS-SEM modelling. The use of standardised criteria and data from multiple companies allowed risk assessment in the payments industry.

PLS-SEM analysis in SmartPLS was conducted comprising three stages aimed at evaluating the model quality:

- Outer Indicators Validation: the loadings of indicator of the identified constructs and assessment of the model's reliability and validity.
- Inner (Structural) Model Evaluation: the relationships between the different groups in the model were assessed.
- Overall Model Evaluation: the standard path analysis was applied.
- The model's validity, reliability, and accuracy were assessed. They satisfy all the requirements.

The resulting model was built based on the established relationships derived from the hypotheses. In the exploratory study, indicators of latent variables with loadings greater than 0.60 were initially selected, as this threshold is considered appropriate. All latent variable values exceeding 0.60 were included in the model.

The construct validity metrics of the outer model, such as composite reliability (CR) and average variance extracted (AVE), were within the required limits. Each construct demonstrated high dependability and internal consistency. The composite reliability was > 0.984, and the average variance extracted was > 0.942, indicating that the selected variables accurately represented the latent constructs intended for measurement. To assess multicollinearity, VIF values are examined, and ideally should not exceed 3.3 (Petter *et al.*, 2007; Hair *et al.*, 2010; Hair *et al.*, 2011). In this model the highest VIF value was 2.665 (see Figure 3.1).

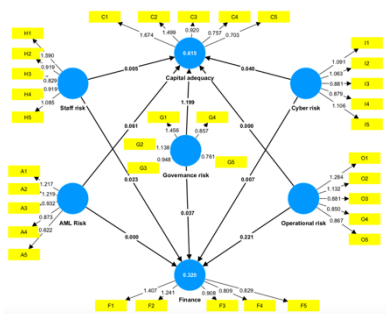


Figure Error! No text of specified style in document..1 Operational risks model for internal processes

Source: generated by the author (Cernisevs et al., 2023a)

The inner model evaluates the relationships between constructs using three key metrics: the coefficient of determination (R^2), standardised path coefficients (β), and impact size (f^2). The study was done in seven iterations, which is within the permitted limit (Hair *et al.*, 2011).

Of particular interest were the R^2 values for the constructs "Capital adequacy risk" and "Financial risk," as they are the target variables of the model. The results indicated that approximately 61.5 % of the other risks significantly impact the capital adequacy risk, while 32.0 % of the other risks significantly influence the financial risk. These R^2 values are relatively high, suggesting that the research successfully identified the key factors influencing financial and

capital adequacy for fintech companies and potentially for businesses of similar size and infrastructure.

Out of the ten hypotheses studied, only five were confirmed, indicating that there are specific relationships between risks and other factors. In particular, governance risk was found to have the most significant effect on capital adequacy risk ($\beta = 0.742$), while cyber risk had the smallest impact ($\beta = 0.119$) (See Table 3.1).

Table 3.1

Result of hypotheses testing

	Hypotheses	Result of Checking
H1	AML Risk - > Capital adequacy	Confirmed
H2	AML Risk - > Finance	Not Confirmed
H3	Cyber risk - > Capital adequacy	Confirmed
H4	Cyber risk - > Finance	Not Confirmed
H5	Governance risk - > Capital adequacy	Confirmed
H6	Governance risk - > Finance	Confirmed
H7	Operational risk -> Capital adequacy	Not Confirmed
H8	Operational risk - > Finance	Confirmed
H9	Staff risk - > Capital adequacy	Not Confirmed
H10	Staff risk - > Finance	Not Confirmed

Source: generated by the author based on SmartPLS 4.0 (Olegs Cernisevs, Yelena Popova and Dmitrijs Cernisevs, 2023)

The Doctoral Thesis research question – 6. Do Key Risk Indicators of the Fintech determine Key Performance Indicators related to financial management? – answered. The current assessment confirms that risk indicators of the fintech have relationship with its KPIs. This fact prove that Key Risk Indicators determine Fintech’s KPIs.

3.5 Fintech compliance with regional EU legislation: KPIs and KRIs

Compliance is very important in the financial market, since regulations, policies and legislation must be followed to ensure compliance with industry regulations (Cernisevs *et al.*, 2023b). Human resource management in

compliance is also developing. Sustainable event planning became increasingly popular to reduce environmental impact. Strategic planning integrates compliance into a financial institution's forecasting and considers the necessary compliance resources (Boon *et al.*, 2019; Jatobá *et al.*, 2019; Garengo *et al.*, 2022).

To analyse compliance-related processes, PLS-SEM analysis was applied. The reasons for using it are same as for internal processes analysis. The author used the same approach for performance indicators as for financial and capital adequacy risks. Consequently, other groups of risks were identified based on their potential impact.

A set of hypotheses (H1–H5) was formulated to examine the direct impact of each risk group on company compliance-related KPIs.

H1: Governance risk has a direct impact on company compliance-related KPI.

H2: Health /safety risk has a direct impact on company compliance-related KPI.

H3: Environmental/External risk has a direct impact on company compliance-related KPI.

H4: Legal/ Compliance risk has a direct impact on company compliance-related KPI

H5: Strategic risk has a direct impact on company compliance-related KPI.

Similarly, for risks of internal processes, another set of hypotheses (H6–H10) was designed to explore the direct effects of each risk group on company compliance-related KPIs specifically related to capital adequacy.

H6: Governance risk has a direct impact on company compliance-related KPI.

H7: Health /safety risk has a direct impact on company compliance-related KPI.

H8: Environmental/External risk has a direct impact on company compliance-related KPI

H9: Legal/ Compliance risk has a direct impact on company compliance-related KPI.

H10: Strategic risk has a direct impact on company compliance-related KPI.

The list of threats and vulnerabilities applicable to all companies described in the section devoted to the conducted survey was created.

The same procedure of the model estimation described above was applied

All latent variable loading values exceeding 0.60 were included in the model (See Figure 3.2).



Figure **Error! No text of specified style in document..2** Compliance-related risks model

Source: generated by the author (Cernisevs et al., 2023b)

All outer model's quality indicators, including composite reliability (CR) and average variance extracted (AVE), meet the required thresholds. Each construct showed high levels of reliability and internal consistency. The average variance extracted was > 1.007 , and the composite reliability was > 0.992 , indicating that the variables accurately represented the latent constructs intended for measurement. The highest VIF value observed was 2.685. The study was completed in seven out of ten allowed iterations (Hair *et al.*, 2017; Chin *et al.*, 2020).

The latent variables of the model demonstrated that approximately 66.7 % of the other types of risk affect the capital adequacy risk, while 36.9 % of the other types of risk affect the financial risk. These relatively high R^2 values indicate that the key factors influencing the target variables of the model were identified successfully, namely capital adequacy risk and financial risk.

Regarding the precise relationship between risks and other factors, only five out of ten hypotheses were confirmed. The study revealed that environmental risk has the least effect ($\beta = 0.574$), whereas strategy risk has the most significant impact on financial risk ($\beta = 0.074$).

The investigation into the relationship between internal process risks and KPIs indicates that staff risk does not correlate with finance and capital sufficiency risk (Cernisevs et al., 2023b). However, the study of compliance-related KRIs reveals that adherence to worker health and safety standards is correlated with capital adequacy and financial risk. Compliance with legal requirements for employee working conditions falls under the within the scope of human resource management, thereby influencing company KPIs.

This study demonstrates a clear connection between KPIs and KRIs in compliance area. The research reveals correlations between each risk factor in the model and financial or capital adequacy risks. Compliance-related risks account for 66.7 % of capital adequacy risks and 36.9 % of financial risks. This study identifies key variables influencing various risk types that impact financial and capital adequacy risks.

Hypothesis 1 of the Doctoral Thesis *Key Performance Indicators (KPI) based on the Key Risk Indicators (KRI) can be used by the financial governance of Financial Institutions across the European region. - CONFIRMED*

Hypothesis 2 of the Doctoral Thesis *The European Financial Institutions of different types can use the same KPIs in their financial governance. - CONFIRMED*

Conclusions

On the basis of the study results the following conclusions were done:

1. The systematic literature review demonstrated that the topic of KPIs formation for financial institutions is not covered sufficiently in the scientific publications. The issues of cybersecurity and liquidity referring to risks are discussed, but they do not focus on selecting KPIs based on these risks. The Thesis proves that the traditional KPIs for measuring financial success, for example, ROE, can be used for fintech, but they do not cover the needs of fintech. The research offers the way of choosing the risk indicators suitable for the financial institution on the basis of Delphi survey results. The selected risk indicators become the basis for developing the KPIs. The offered statistical model allows checking the relevance of the chosen risks for this institution.
2. The author developed the detailed classification of types of fintech and segmentation of the digital products in accordance with the type of fintech, which can be used by the financial institutions, producing the digital products. The analysis of fintech licensing can support the producers of digital products and decrease the compliance-related risks.
3. The author has developed the taxonomy of digital products. It allows connecting the production of various digital products and facilitating the activities of financial institutions.
4. The author provided a legal classification for electronic money and crypto assets, as well as a life-cycle classification based on the EU regulations, important for issuing these assets. A token classification algorithm was also developed.
5. The author suggests the pricing strategies for the digital products. These strategies are based on the EU regulatory acts and Fama's theory. The risks inherent in the price formation methods were identified and analysed.

6. The factors of regional dimension which affect the fintech operations were identified. It is shown that the traditional resource theories are not applicable for the operations with digital products. Information and telecommunication development are the key factors for the digital economy.
7. The implementation of the EU regional policy at the EU member states level create different conditions for functioning of the financial institutions and can impact their functioning not only via regional policy, but also via legislative acts and national regulation. Therefore, the financial institution can choose the location within the EU, where the conditions are especially favourable for the operations of the exact financial institution.
8. The author analyses the requirements of the ECB to the financial institutions to select the KPIs on the basis of risk indicators and offers the ways how they can adopt these requirements for the operations of fintech in the EU.
9. The Thesis demonstrates the life-cycle and stages of producing of the digital assets in the EU, which determine their associated risks. It is simultaneously proven that digital assets production should be reflected in inventories but not in capital section in financial reporting, which contradicts the numerous scientific publications but supported by the approach of IFRS. This fact changes not only accounting practices of the EU financial institutions but also allows them to change the financial governance including risk management.
10. The author proves that fintech is one of the most important factors of smart city development. The Thesis demonstrates that smart city authorities can actively use fintech for providing the financial services with the division of costs on the basis of the offered costs function; it is shown that smart city administration can efficiently use the operations of fintech for the city development.

11. The distribution of costs between financial institutions and smart city administration allows implementation of shared financial services in smart city. The developed cost functions can facilitate introduction of financial products in smart city. However, these operations also produce specific compliance and regulatory risks, which were identified.
12. The survey of experts in risk management of financial institutions using Delphi method allowed identifying the specific risk indicators for financial institutions relating financial stability and capital adequacy risks in internal and compliance-related processes. The criteria for their assessment were developed. The identified risks evaluated in accordance with the developed criteria and were included in the data sets, used for constructing the statistical models. The identified risks were used as latent variables in the developed statistical models.
13. Two statistical models were developed with application of PLS-SEM method for internal and compliance-related processes. The models examined the relationship between KPIs and KRIs in the fintech industry. The significant dependence between the majority of internal operational risks and financial/capital adequacy risk were determined. All of the analysed risks except staff risk show the relationships with financial results; however, staff risk, as well as other risks, is significant for compliance-related processes.
14. The quality of the developed models was estimated in accordance with the world-accepted methodology for estimating SEM. The quality of models is high. As a result, the Hypotheses of the Thesis are supported. Hypothesis 1 was confirmed through internal models' analysis, showing the links between financial metrics and risk categories. The development of accurate and relevant KPIs on the basis of KRIs improves financial governance of financial institutions and financial stability across Europe. Hypothesis 2

was confirmed by the analysis of outer models' indicators, where the indicator loadings for latent variables show minimal variation, despite representing different types of financial institutions. The proximity in values suggests that these different institutions may employ similar KPIs for evaluating performance.

15. The recommendations for the financial institutions, regulatory bodies at the EU level (European Commission, the ECB and European supervisors) and at national level (National/Central banks and national supervisors) were developed. The recommendations relate only to the function of supervision of financial institutions. This function is implemented by all the above-mentioned bodies, and the recommendations were developed to all of them as supervisors.

Recommendations

On the basis of provided study the following recommendations for fintech and for regulatory and supervising authorities were formulated.

For the financial management of financial institutions operating in EU

1. *Implement a Dual Indicator System.* Financial institutions should adopt a dual indicator system that incorporates both Key Risk Indicators (KRIs) and Key Performance Indicators (KPIs) to ensure a comprehensive performance measurement that aligns with company objectives and complies with all legal regulations.
2. *Adopt the Statistical KPI Selection Models.* Utilise the tailored statistical models to analyse KPIs and risk factor correlations, allowing for precise determination of crucial relationships for each financial institution based on its unique operations, regional presence, goals, and risk profiles.
3. *Prioritise High-Risk Indicators.* Establish a process for identifying high-risk indicators relevant to the business and prioritise these as KPIs. These risk-based KPIs should be equally important to traditional performance metrics in strategic decision-making.
4. *Regularly Update KPIs.* Schedule consistent evaluations of KPIs relevance to adapt to evolving conditions within the digital finance sector, ensuring that metrics remain aligned with current business and regulatory landscapes.
5. *Enhance Risk Prediction Processes.* When assessing potential risks, include considerations of average risk probabilities prevalent in the wider market, not solely based on the institution's past negative experiences, to form a more comprehensive risk assessment.
6. *Optimise KPI Reporting Mechanisms.* Develop an in-depth reporting framework for communicating KPIs and risk factors to all stakeholders, such

as investors, board members, regulatory bodies, and employees, enhancing transparency and accountability.

7. *Expand Training and Knowledge Sharing.* Offer dedicated training for management and employees to deepen their understanding of the interplay between KPIs and KRIs, fostering a culture of informed risk management and performance assessment.
8. *Conduct Regular Benchmarking.* Perform regular benchmarking against industry standards to pinpoint areas of improvement, stay abreast of market developments, and proactively adjust strategic directions.
9. *Invest in KPI Tracking Technology.* Allocate resources to advanced technological systems that enable sophisticated tracking, analysis, and reporting of KPIs, thereby elevating decision-making processes and strategic planning capabilities.
10. *Systematise Feedback Loops for KPI and KRI Analysis.* Establish a structured feedback system that periodically reviews the dynamics between the company's KRIs and KPIs, facilitating continuous improvement and strategic refinement.

For EU financial regulators and lawmakers (ECB, European Commission and European Supervisors)

1. *Publish Integrated KPI and KRI Guidelines.* Issue comprehensive guidelines that detail the incorporation of Key Performance Indicators (KPIs) with Key Risk Indicators (KRIs), ensuring that both are given equal importance in the performance assessments of fintech entities.
2. *Mandate KPI and KRI Disclosure.* Amend financial reporting regulations to mandate the disclosure of both KPIs and KRIs, offering a clearer understanding of the risk profile and performance metrics of fintech companies.

3. *Develop Standardised Risk-Performance Metrics.* Initiate the creation of a standardised set of risk-performance metrics, drawing on the results of recent studies to ensure industry-wide applicability and comparability.
4. *Encourage Risk-Based Performance Measurement.* Promote policies that incentivise fintech firms to develop financial KPIs that reflect their specific operational risks, encouraging more tailored risk management practices.
5. *Support Cross-Sector KPI and KRI Model Development.* Foster collaboration across fintech firms, traditional financial institutions, academia, and regulatory bodies to tailor KPI and KRI models to each financial entity's needs.
6. *Advocate for RegTech Adoption.* Encourage the implementation of Regulatory Technology (RegTech) to enhance the accuracy and efficiency of KPI and KRI management, tracking, and reporting, thereby improving regulatory oversight.
7. *Institute Periodic Industry Reviews.* Schedule regular industry assessments to ensure KPIs remain aligned with the evolving risk landscape of the fintech sector.
8. *Monitor KPI and KRI Evolution.* Continuously monitor fintech industry KPI and KRI changes to adjust regulatory requirements accordingly, maintaining their effectiveness and relevance.
9. *Create Adaptive Regulatory Frameworks.* Establish dynamic regulatory frameworks capable of quick adaptation to changes in fintech, ensuring KPIs and KRIs are updated in response to emerging risks.
10. *Offer KPI and KRI Integration Training.* Develop training programs for fintech professionals on creating and implementing an integrated approach to selecting and utilizing KPIs and KRIs. This could involve specific modules or certifications, potentially in collaboration with European financial educational institutions.

In implementing these recommendations, policymakers should consider revising key legislative documents such as the Markets in Financial Instruments Directive (MiFID II), the Capital Requirements Regulation (CRR), and the Payment Services Directive (PSD2), to incorporate the necessary provisions for KPI and KRI integration and reporting. Additionally, white papers and best practices manuals could be developed to guide the industry in these new standards.

For national financial regulators (National (Central) Banks and National Supervisors)

1. *Institutionalise Risk-Based Performance Metrics.* National (Central) Banks and National Supervisors should promote the integration of KRIs into the performance metrics (KPIs) for domestic financial institutions. This could involve drafting and adopting new regulations or amendments to existing financial oversight frameworks that require financial institutions to adopt KPIs that reflect their risk exposure.
2. *Develop National KPI Training Programs.* Organise and facilitate training programs tailored to the national context for financial institutions, focusing on the adoption of an integrated risk-based approach to KPI selection. This training could be made a part of mandatory continuing professional development for finance professionals and could involve the creation of detailed instructional materials, online courses, or workshops.
3. *Harmonise Implementation Strategies.* Establish a uniform set of implementation strategies for risk-based performance metrics that align with those recommended by EU-level regulators. This would require the creation or update of national regulatory guidelines, potentially including a national version of the EU's guidelines. These guidelines would ensure consistency in the application of the integrated KPI and KRI approach across all member states.

To facilitate these recommendations, it would be prudent for national authorities to review and revise national financial oversight acts and guidelines. They might consider producing a national handbook or circular that translates EU-level recommendations into the specific legal and regulatory context of their country. Additionally, they should ensure that these national documents are in harmony with EU directives like the Fourth Anti-Money Laundering Directive or the Digital Finance Strategy for the EU, thereby ensuring a cohesive regulatory environment across both national and European landscapes.

For Smart City's administration

1. AIS and PIS Integration for Smart Economies:
 - 1.1. Smart cities should actively pursue the integration of Account Information Services (AIS) and Payment Initiation Services (PIS) into their financial frameworks. This should include creating secure digital infrastructure to support these services, which will improve payment efficiencies for residents and businesses.
 - 1.2. Develop a strategic plan of the smart city, outlining the steps for integration, such as partnering with fintech firms, ensuring data protection, and setting clear benchmarks for success.
 - 1.3. Conduct pilot programs in select districts or sectors to measure the impact of AIS and PIS on the local economy and mobility, adjusting the approach as necessary before a wider rollout.
2. Strategic KPI Assessment for Shared Financial Services:
 - 2.1. Establish a task force to conduct a comprehensive analysis of how shared financial services can enhance the performance of the city's economy and mobility sectors.
 - 2.2. Update existing Smart City KPI frameworks to include metrics that specifically measure the impact of shared financial services. These metrics

should assess improvements in transaction times, cost savings for the city administration and users, and user satisfaction levels.

2.3. Document best practices and lessons learned from other smart cities that have successfully implemented shared financial services, and adapt these insights to the local context.

3. Engaging entities under PSD2:

3.1. Smart cities should create a policy framework that encourages collaboration with entities under PSD2 directive to broaden the financial service offerings within the city.

3.2. Initiate a regulatory sandbox that allows entities to test innovative financial solutions in a controlled environment, ensuring these services meet regulatory standards and address the needs of the city.

3.3. Set up a Smart City fintech hub that serves as an incubator for entities collaborations, offering support and resources for the development of tailored AIS and PIS solutions for residents and businesses.

To implement these recommendations, Smart Cities governance should develop the detailed guidelines and action plans that outline the phased integration of AIS and PIS, identify clear objectives and milestones for shared financial services, and create a supportive environment for entities. These documents should align with the broader strategic goals of the smart city and include collaboration frameworks, data privacy and security protocols, and an evaluation mechanism to track progress and impact.

List of publications, reports on the topic of the Thesis

Publications:

1. Cernisevs, O. (2021). Analysis of the factors influencing the formation of the transaction price in the blockchain. *Financial and credit systems: prospects for development*. 3(3), 36–47. <https://doi.org/10.26565/2786-4995-2021-3-04> [COPERNICUS]
2. Cernisevs, O., Surmach, A., & Buka, S. (2022). View More Analysis of Aspects of the Regional Economy in the Digital Economy, Using the Example of Financial Services. *Review of Economics and Finance*. 20(1), 203–207. <https://doi.org/10.55365/1923.x2022.20.24> [SCOPUS Q4]
3. Cernisevs, O., & Popova, Y. (2022). Smart City: Sharing of Financial Services. *Social Sciences*. 12(1), 8. <https://doi.org/10.3390/socsci12010008> [SCOPUS Q1; Web of Science]
4. Cernisevs, O., & Popova, Y. (2022). ICO as Crypto-Assets Manufacturing within a Smart City. *Smart Cities*. 6(1), 40-56. <https://doi.org/10.3390/smartcities6010003> [SCOPUS Q1; Web of Science]
5. Cernisevs, O., Popova, Y., & Cernisevs, D. (2023, June). Risk-Based Approach for Selecting Company Key Performance Indicators in an Example of Financial Services. *In Informatics* (Vol. 10, No. 2, p. 54). MDPI. <https://doi.org/10.3390/informatics10020054> [SCOPUS Q1; Web of Science]
6. Cernisevs, O., Popova, Y., & Cernisevs, D. (2023). Business KPIs Based on Compliance Risk Estimation. *Journal of Tourism and Services*. 14(27), 222–248. <https://doi.org/10.29036/jots.v14i27.636> [SCOPUS Q1; Web of Science]
7. Cernisevs, O., Popovs, S. Financial Institutions Sustainable Growth: Delivering Green Fintech Solutions to Smart City Stakeholders. *Cities* (Elsevier), *The International Journal of Urban Policy and Planning* [SCOPUS Q1, Web of Science] Article will be published in year 2024.
8. Cernisevs, O. KPI Selection for Fintech Companies: A Systematic Review of Literature. *American Research Journal of Humanities Social Science* (ARJHSS). 7(1), 50–63. <https://www.arjhss.com/wp-content/uploads/2024/01/D715063.pdf> [COPERNICUS]

Reports and theses at international congresses and conferences:

1. Cernisevs, O., Zvirgzdina, R., Skadina, H., Linina, I. 2019. How to Define the Current Price of The Cryptocurrencies by Crypto Exchange? *IBIMA* 13–14 November 2019, Madrid, Spain. 1646–1653. [Web of Science]

2. Cernisevs, O. 2021. Crypto Compliance: Adopting a Risk-based Approach to Crypto assets exchange within Crypto currency exchange company licensed in EU, *IBIMA* 23–24 November 2021, Seville, Spain. 6573–6584
3. Cernisevs, O. 2021. Agile approach in modern banking and financial system regulation, *RaTSiF-2021* 3 December 2021, Riga, Latvia: Transport and Telecommunication Institute
4. Cernisevs, O. 2021 Regtech – the answer for the Financial regulatory challenges. *10th International Research-to-Practice Conference “Society Transformations in Social and Human Sciences”*. 11–12 December 2021, Riga, Latvia: Baltic International Academy.
5. Cernisevs, O., Zemcova, A., Sannikova, L., Danileiko, D. 2022. Globalization and cross-industrial risks framework. *XII International Scientific Conference “Time of challenges and opportunities: challenges, solutions, perspectives”* 13–14 May 2022, Riga, Latvia: Baltic International Academy.
6. Cernisevs, O. 2022. Initial Coin Offering assessment analysing accounting approach in EEA *Round Table Program on the theme of: “European Union (EU) for Smart and Sustainable Growth. European Union for Georgia” Dedicated to the 90th anniversary of the University*, 11 July 2022, Tbilisi, Georgia: Sokhumi State University.
7. Cernisevs, O. 2022. Crypto-Assets. Smart City Production in the Form of an Initial Coin Offering. *8th International Scientific Symposium “Economics, Business & Finance”* 26–30 July 2022, Jurmala, Latvia.
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9. Cernisevs, O. 2022. Aspects of Digital Manufacturing for Smart city *RelStat-2022* October 19–22, 2022, Riga, Latvia: Transport and Telecommunication Institute
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11. Cernisevs, O., Popovs, S. 2023 Smart city Green fintech: impact of the EU policies on Sustainable Urban Development and Financial innovations VI *Iberoamerican Congress on Smart Cities* November 13–17, 2023, Mexico City and Cuernavaca
12. Cernisevs, O. 2023. Divergent Paradigms of Capital Adequacy: A Comparative Theoretical Analysis between Banks and Non-Bank Financial Institutions IX *International Scientific and Practical Conference “Quality management: research and solutions”* Dallas, USA, November 22–24, 2023

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Annexes

ECB SUPERVISION NEWSLETTER

Strong risk culture — sound banks

15 February 2023

Risk culture is a set of norms, attitudes, and behaviours related to awareness, management, and control of risks in a bank. It shapes managements and employees' day-to-day decisions and has an impact on the risks they take.

Weaknesses in risk culture may signal problems in the future, such as financial losses or misconduct. Conversely, a bank's strong financial position could be misleading if there is an underlying problem with culture and conduct. Therefore, even in periods of solid financial health, strong risk culture can be essential in preventing future losses which could damage the reputation of a bank.

This is why supervisors thoroughly examine this risk area based on the European Banking Authority's guidelines on governance. Each bank's responsible for defining and shaping risk culture. In turn, it is the supervisor's role to assess the dimensions of this risk culture.

Tone from the top & communication

- Composition of management bodies
- Functioning of management bodies
- Inclusion of risk and compliance perspectives throughout the bank (e.g. code of ethics)
- Speak-up culture, including whistleblowing mechanism

Incentives

- Incentives schemes (including remuneration and promotion)
- Consequence management to sanction misconduct behaviours

Accountability & ownership of risk

- Effectiveness of the three lines defence
- Risk-based decisions, in line with risk appetite framework
- Strength and stature of risk management and internal control functions
- Escalation in case key risk metrics are breached
- Oversight appropriate to group's structural complexity (e.g. over entities and business lines)

It is challenging to observe and measure risk culture is challenge because it comprises many qualitative elements. However, supervisors have specific tools to examine underlying and more salient factors which may contribute to risk culture. These tools include interviews with board members and business line representatives, sitting in on board meetings, fit and proper assessments, examining documentation like policies, minutes or reports and on-site inspections.

While there are many components of risk culture, this article focusses on three key dimensions: the tone from the top, incentive policies, and risk accountability and ownership.

The observations and sound practices identified here are based on extensive supervisory reviews over the past few years, including bank-specific deep-dives and horizontal analyses.

One of the main duties of banks' management bodies is to establish an appropriate "tone from the top", as this plays a crucial role in holding individuals accountable for prudent risk-taking. To set the right tone, the management body needs to collectively possess the relevant skills and expertise, be of good repute, consider diverse viewpoints in discussions and be able to challenge senior management constructively.

Evidence shows that banks need to improve the capacity to challenge board members on their decisions in risk culture areas. A limited challenging capacity may also hinder follow-up on findings flagged by control functions and supervisors. Moreover, several banks' management bodies do not explicitly oversee culture or effectively cascade culture and ethical standards to all levels throughout the bank. However, some banks have developed good practices to strengthen the effectiveness of oversight. One such example is firms that have established a rigorous framework for monitoring internal culture and conduct, including full transparency through a dashboard. This allows monitoring of how risk culture is embedded within the bank through indicators to gauge how the code of conduct is implemented across the organisation.

Remuneration schemes are another key dimension of risk culture. These are often based on key performance indicators (KPIs) that determine variable remuneration and should ensure behaviours are properly aligned with prudent risk-taking. However, KPIs

are not always clear and transparent. In many instances, they rely excessively on financial performance compared to risk, control, and critical cultural and behavioural aspects. Surprisingly, this also holds for employees in internal control functions and even for chief risk officers. Supervisors have also observed weaknesses in KPIs' alignment with risk appetite, in processes and controls around variable remuneration, and in applying malus and clawback clauses in case of excessive risk-taking or misconduct. There is room for improvement in this area, which calls for supervisory attention.

Risk accountability and ownership are a third dimension of sound governance and risk culture. Some banks need to allocate roles and responsibilities for risk and control-related tasks clearly. Others have risk management and compliance functions, which need to challenge business lines sufficiently or are at times overruled by them. These functions may also need more resources, stature, and practical impact which therefore calls into question their standing within the organisation.

A well-developed risk appetite framework, supported by effective processes deployed across the bank is the cornerstone of a sound risk culture, because it ensures that the risks taken are within a set of acceptable boundaries.

That is why ECB Banking Supervision will continue to assess banks' progress in improving risk culture through peer benchmarking, sharing good practices and ongoing industry dialogue, with appropriate supervisory escalation where key weaknesses are identified. Additionally, as part of the supervisory priorities for 2023-25, a targeted analysis will assess the tone from the top as well as the quality of banks' nomination processes and will feed into the Supervisory Review and Evaluation Process (SREP).

Evaluation of the study by the Czech Association of Payment Institutions



Asociace poskytovatelů platebních
služeb České Republiky, z.s.

23.08.2023
№: 23-08-01

To,
Mr. Olegs Cernisevs
Doctoral Student,
Baltic International Academy
Riga, Latvia

Subject: Appreciation and Recommendation of Your Research Presentation on KPI-based Financial Management System

Dear Mr. Cernisevs,

On behalf of the Czech Payment Companies' Association, I wish to extend our heartfelt gratitude for your insightful presentation on the 5th of June 2023. Your detailed research results concerning the KPI-based financial management system and its relation to Key Risk Indicators (KRI) were both illuminating and timely. The methodology for the KRI evaluation that you showcased was particularly captivating and resonated well with our association's ethos of staying at the forefront of innovative financial practices.

The dialogue that ensued post your presentation, involving the intricate mechanics of selecting KPIs based on KRIs, offered our members a fresh perspective. It sparked a much-needed discussion on enhancing our current systems and methodologies, making us reconsider the structural alignment of our practices.

Considering the relevance and potential impact of your research, the Czech Payment Companies' Association is pleased to inform you that we will be wholeheartedly recommending your proposed approach for practical use to our member companies. We believe that by adopting your methodology, our member companies can pave the way for more transparent, efficient, and risk-aware financial management within the Czech Republic's payment landscape.

Your dedication to this research and the manner in which you presented complex concepts with clarity is commendable. We are confident that your approach, if adopted widely, will bring substantial benefits to our industry.

We look forward to possible future collaborations and wish you continued success in your academic and professional endeavors.

Thank you once again for sharing your expertise and vision with us.

Warm regards,
Sergej Jurlov / President

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Evaluation of the study by the Bank of Latvia



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Rīga; **FOR THE DATE, SEE THE TIMESTAMP OF THE DOCUMENT SIGNATURE**
Our ref.: 22-08.1.1/2023/14141

To whom it may concern

It is to certify that Mr Olegs Cerņisevs submitted his doctoral thesis "NEW APPROACH FOR FINTECH FINANCIAL MANAGEMENT IN THE EUROPEAN ECONOMIC AREA" to the Latvian Bank with the purpose of obtaining an expert opinion regarding his thesis.

The submitted thesis offers a high-quality and versatile analysis of the current challenges in the fintech sector within the European economic area. The narrative of the thesis is logical and allows to follow the development path of the "Fintech" sector from economic and technological aspects.

A special focus shall be dedicated to the 2nd chapter of the thesis where the author analyses the nature of a "digital financial product" and the market of the "digital financial products". The raised question of an appropriate selection of the KPIs for the evaluation of a fintech project is highly relevant in today's reality and deserves special attention.

The practical analysis of the key risk indicators in the 3rd chapter of the thesis and the subsequent conclusions (i.e., "the sharing economy creates additional compliance and regulatory risks for fintech company") may serve as a knowledge basis for policy making and oversight institutions like Latvian Bank in order to increase the efficiency of a risk-based approach to supervision.

The implementation of financial management practices for fintech companies based on key risk indicators represents an innovative and sophisticated approach to financial management in today's "digital economy". The mentioned approach has a practical application, and we are keen to see further adoption of such techniques by local fintech companies as this will support an integrity and sustainable development of the local fintech sector.

Yours sincerely,

**THIS DOCUMENT HAS BEEN DIGITALLY SIGNED WITH A SECURE
DIGITAL SIGNATURE CONTAINING A TIMESTAMP**

Evija Dundure
Head of Insurance and Pension Supervision Department

The logo for Papaya, featuring the word "PAPAYA" in a bold, teal, sans-serif font. The background is a dark teal with a pattern of lighter teal diagonal lines.**Olegs Cernisevs**

Via delle fornaci 139,
Roma (RM), 00165
Italia

November 15, 2023

Dear Mr. Cernisevs,

On behalf of Papaya Ltd, a renowned Maltese Electronic Money Institution, I am writing to extend our deepest gratitude and commendation for your invaluable contribution to developing our company's risk framework. Your expertise and innovative approach have significantly enhanced our risk management strategies and processes. We are delighted to inform you that the risk framework you developed has been thoroughly reviewed and unanimously approved by our Board of Directors. It is a testament to the robustness, relevance, and efficiency of the framework you crafted. Following this approval, we have seamlessly integrated the framework into all operational processes of Papaya Ltd, ensuring a comprehensive and effective risk management system throughout our organization.

Moreover, your pioneering approach to selecting Key Performance Indicators (KPIs) based on the specific risks facing Papaya Ltd has revolutionized our financial governance. This methodology has enabled us to monitor our performance more accurately and significantly enhanced our ability to anticipate and mitigate potential risks proactively. Your work has laid a solid foundation for our continuous growth and stability in the dynamic electronic money sector. Your collaboration with us under the company's risk framework elements has been instrumental in achieving these milestones. The insights and expertise you brought to this project have been invaluable, and the impact of your contributions will be felt for many years to come.

We look forward to possibly collaborating with you again in the future and wish you all the best in your doctoral studies and subsequent endeavors. Please do not hesitate to contact us should you need any further information or wish to discuss potential opportunities for collaboration. Once again, thank you for your outstanding contribution to Papaya Ltd. Your dedication and hard work have been crucial to our ongoing success and development.

Warm regards,

Igor Tsybolyuk
CEO
Papaya Ltd

A handwritten signature in black ink, appearing to read "Igor Tsybolyuk". The signature is stylized and fluid, with a large loop at the end.