AJIT-e Academic Journal of Information Technology
10.5824/ajite.2023.04.002.x

2023 . Fall - Güz . Volume – Cilt: 14 . Issue – Sayı: 55

Türkiye Can Leverage the Power of Innovation, Artificial Intelligence, and Fintech to Enhance Productivity

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ABSTRACT

The aim of this study is to reveal what Türkiye should do to increase its economic and social productivity according to the GII, fintech index, and AI index analyses. Based on the total scores of the GII, fintech, and AI indices were analyzed with K-Means clustering algorithm and linear projection methods. Türkiye needs to make a breakthrough in areas such as fintech and artificial intelligence, which are at the beginning of the digital age. In particular, it needs to focus on innovation and imitation, which can be combined into a new term, "imovation." Türkiye needs to increase its production of innovative products on a global scale. Focusing on and improving its competencies in this field is critical for economic and social productivity. Unlike previous studies, this study has been analyzed by selecting 51 countries that include all three of the Global Innovation, Fintech and AI indices. Based on these indices, Türkiye has been compared with other countries and what Türkiye needs to do for economic and social productivity has been revealed.

Keywords **:** Global Innovation Index, Fintech Index, AI Index, Productivity

Türkiye Verimliliği Artırmak için İnovasyon, Yapay Zekâ ve Fintech'in Gücünden Yararlanabilir

ÖZ

Bu çalışmanın amacı, GII, fintek endeksi ve yapay zekâ endeksi analizlerine göre Türkiye'nin ekonomik ve sosyal verimliliğini artırmak için neler yapması gerektiğini ortaya koymaktır. GII, fintek ve yapay zekâ endekslerinin toplam puanları baz alınarak K-Means kümeleme algoritması ve doğrusal projeksiyon yöntemleri ile analiz edilmiştir. Türkiye'nin dijital çağın başlangıcında olan fintek ve yapay zekâ gibi alanlarda atılım yapması gerekmektedir. Özellikle, yeni bir terim olan "imovasyon" ile birleştirilebilecek inovasyon ve taklit üzerine odaklanmalıdır. Türkiye'nin küresel ölçekte yenilikçi ürün üretimini artırması gerekmektedir. Bu alandaki yetkinliklerine odaklanması ve bunları geliştirmesi ekonomik ve sosyal üretkenlik açısından kritik önem taşımaktadır. Bu çalışma, önceki çalışmalardan farklı olarak Küresel İnovasyon, Fintech ve Yapay Zekâ endekslerinin üçünü de içeren 51 ülke seçilerek analiz edilmiştir. Bu endeksler baz alınarak Türkiye diğer ülkelerle karşılaştırılmış ve Türkiye'nin ekonomik ve sosyal üretkenlik için yapması gerekenler ortaya konulmuştur.

Anahtar Kelimeler **:** Küresel İnovasyon Endeksi, Fintech Endeksi, Yapay Zeka Endeksi, Verimlilik, Türkiye

Araştırma Makalesi / Research Article
Date Received: 28.08.2023
Publishing Date: 22.11.2023

AJIT-e Academic Journal of Information Technology
2023 Fall/Güz – Cilt/Vol: 14 - Sayı/Issue: 55
10.5824/ajite.2023.04.002.x

INTRODUCTION

Innovation and Productivity

Innovation boosts productivity by creating efficient products and services, leading to increased output and reduced costs. However, research productivity has been declining, as seen in Moore's Law, where the number of researchers required to double computer chip density has increased by 18 times since the 1970s (Bloom et al., 2017, 2020). The relationship between innovation and productivity is not generally linear. There is an inverted U-shaped relationship between product market competition (PMC) and innovation. High PMC can increase incremental profit from innovation, while excessive competition may reduce incentives. Innovations in materials, software, and technologies like carbon fiber, 3D printing, artificial intelligence, and robots have improved efficiency, output, and customer satisfaction. Empirical evidence supports these predictions, as seen in UK firms' patenting activity.(Aghion et al., 2002). Innovation drives productivity growth through research effort, productivity, and competition. It creates new markets, jobs, and businesses, boosting the economy. The internet has increased e-commerce productivity, and as innovation accelerates, it is expected to have an even greater impact on productivity in the future.

AI and Productivity

AI, a rapidly evolving field, has the potential to revolutionize various industries by automating tasks, making predictions, and improving decision-making in areas like finance, education, cybersecurity, and defense (Raban & Hauptman, 2018), (Pătraşcu, 2021). AI, a rapidly evolving field, has the potential to revolutionize various industries by automating tasks, making predictions, and improving decision-making in areas like finance, education, cybersecurity, and defense (Acemoglu & Restrepo, 2019). AI can automate repetitive tasks, freeing employees to focus on more complex work. It can also automate customer service tasks, allowing representatives to focus on complex cases and customer relationships. AI can analyze large data, identify patterns, and make better decisions in product development, marketing, and pricing. Automation complements labor and increases output, interacting with labor supply adjustments (Autor, 2015). AI technologies may automate jobs; however, employment growth has been observed in industries undergoing rapid technological change. A demand model predicts future job changes (Bessen, 2018). AI technology could potentially worsen income inequality by increasing access to AI technology. It could also provide a competitive advantage for businesses by automating tasks, leading to higher profits and higher prices. AI can also personalize products, increasing customer satisfaction and loyalty. However, it could also lead to job displacement in certain industries and bias in AI systems, potentially causing unfair outcomes. Therefore, it's crucial to weigh the potential benefits and risks before deploying AI technologies.

Fintech and Productivity

Financial Technology (Fintech) can enhance productivity by automating manual tasks like payment processing, account management, and customer service, freeing up employees to focus on more complex, strategic work, despite potential negative effects on efficiency and

productivity. Automation reduces employment and labor share, but encourages new tasks. Fintech can temporarily decrease productivity during transition periods, but the impact varies depending on technology. Fintech can make financial services accessible to underserved groups, increasing economic activity and productivity. The effects of fintech on productivity depend on technology type and workforce skills (Acemoglu & Restrepo, 2019; Bloom et al., 2014). Fintech uses data analytics to provide insights into financial performance, which aids in resource allocation and productivity. It also creates new markets for financial products and services, such as peer-to-peer lending and crowdfunding platforms. These advancements increase economic activity and productivity, automating manual tasks, making financial services more accessible, providing new insights, and fostering efficient operations.

Other Important Fields and Productivity

Internet of Things (IoT): IoT, a network of connected physical objects, is a promising sector for innovation, enhancing infrastructure protection, national security, and environment optimization (Pătraşcu, 2021).

Emerging Educational Technologies (EETs): Early-stage EETs, utilizing technologies like mobile, analytics, VR, AR, gamification, adaptive learning, machine learning, and blockchain, have the potential to revolutionize K-12 education (Dubé & Wen, 2021; Wali & Popal, 2020).

Cybersecurity Technologies: Cyber-attacks are increasing, necessitating technologies like homomorphic encryption, blockchain, and cyber resilience for defense, while emerging IoT and autonomous technologies pose challenges and potentially contribute to attack capabilities (Raban & Hauptman, 2018).

Advanced Manufacturing Technologies (AMTs): Cyber-attacks are increasing, necessitating technologies like homomorphic encryption, blockchain, and cyber resilience for defense, while emerging IoT and autonomous technologies pose challenges and potentially contribute to attack capabilities (Prabhaker et al., 1995).

Computational Technologies: Computational technologies, which utilize computers for problem-solving and task execution, are rapidly evolving due to increased demand and scientific advancements, with the potential to revolutionize various applications and societal aspects (Thampi & Adamuthe, 2015).

The adoption of advanced technologies, which are expected to significantly impact sectors like education, finance, cybersecurity, manufacturing, and national security, presents significant challenges and ethical implications (Onderco & Zutt, 2021; Raban & Hauptman, 2018).

1. LITERATURE REVIEW

The knowledge economy, based on innovation, research and development (R&D), technology, AI, machine learning, and big data analysis, is transforming information into a value-added commodity, impacting the future of the world.

Innovation for Productivity

The authors propose a multidisciplinary definition of organizational innovation, addressing the lack of a common definition and knowledge-based operationalizations. They emphasize the need for a comprehensive and adaptable definition that covers various aspects of innovation, distinguishing between traditional and knowledge management literature (Baregheh et al., 2009; Quintane et al., 2011).

The references emphasize the need for a comprehensive definition of innovation that considers multiple perspectives. Innovation in technology includes new products, new technologies, new business models, teaching methods, and healthcare delivery models. It is essential for economic growth and social progress, helping solve problems, create new products, and improve lives. Technology is the most important innovation tool in a country, whether used for peace or war.

AI for Productivity

AI is the development of computer systems capable of performing tasks requiring human intelligence, such as visual perception, speech recognition, decision-making, and problem-solving. Reinforcement learning, a method combining psychological and neuroscientific perspectives, optimizes control of an environment using high-dimensional sensory inputs. Recent advancements in deep neural networks have enabled artificial agents like deep Q-networks to learn successful policies directly from high-dimensional sensory inputs. AI has applications in healthcare, finance, transportation, and entertainment. Recent research has demonstrated that deep Q-network agents can excel at diverse tasks, bridging the gap between high-dimensional sensory inputs and actions (Mnih et al., 2015).

Silver et al., (2016); introduced a new approach to computer Go using deep neural networks trained from supervised learning from human expert games and reinforcement learning from self-play games. AI, the simulation of human intelligence processes by machines, has been successful in solving various problems, including game playing and medical diagnosis. Machine learning allows computers to learn without explicit programmed, powering recommendation engines and self-driving cars. Natural language processing (NLP) and computer vision techniques extract meaningful information from digital images, used in self-driving cars and medical image analysis. AI has the potential to revolutionize industries and improve our lives, but it's crucial to develop safeguards to mitigate risks.

Fintech for Productivity

Fintech combines financial services and information technology, evolving over different eras. FinTech 1.0, from 1866-1987, supported globalization. FinTech 2.0, 1987-2008, digitizes financial processes. Since 2008, a new era, driven by start-ups, presents challenges for regulators and market participants (Arner et al., 2015). FinTech's rise is a response to the evolving global landscape, posing significant challenges for regulators and banks (Anagnostopoulos, 2018). FinTech 1.0 (1966-1987) marked the beginning of financial globalization, followed by FinTech 2.0 (1987-2008) as financial services firms digitized processes, presenting a new era in both developed and developing nations (Arner et al., 2015).

The financial sector is undergoing significant transformation due to financial innovation, introducing new products, services, output processes, and business models to drive future growth (Anagnostopoulos, 2018).

Fintech refers to the use of technology to automate financial services, offering more convenient, efficient, and affordable alternatives. It includes mobile banking apps, peer-to-peer lending platforms, robot advisors, cryptocurrencies, insurtech, regtech, blockchain, crowdfunding platforms, and stock trading apps. These technologies enable users to check balances, transfer money, and pay bills from their smartphones. They also enable peer-to-peer lending, automate investment portfolio management, and ensure regulatory compliance. Fintech is a growing industry that aims to make financial services more accessible, affordable, and efficient for everyone, particularly those unfamiliar with money management due to asymmetric information.

What Is the Relationship Between Innovation, Fintech and AI?

Innovation, fintech, and AI are interconnected and mutually influential. Fintech combines financial services and technology, using AI for advanced data analysis, automation, and personalized services. AI techniques like machine learning and deep learning improve fraud detection, risk assessment, and credit scoring. Innovation drives fintech and AI, creating new business models and enhancing productivity in many industry areas such as fintech (Cao et al., 2021; Donepudi, 2017; Shin & Choi, 2019). AI is a technological innovation enhancing fintech's capabilities, enabling the development of novel solutions and services, driving further industry innovation (Jiang et al., 2022; Li et al., 2021). Innovation, fintech, and AI are interconnected and mutually reinforcing. Fintech uses AI to drive financial services innovation, while AI enhances fintech's capabilities, driving further industry growth. This combination makes financial services more accessible, efficient, and personalized, shaping the future of money management. AI and fintech have significantly impacted financial services, automation, and customer experiences. AI technologies like machine learning and big data analytics have developed intelligent solutions, enhancing banking industry competitiveness (Dwivedi et al., 2021). Fintech adoption promotes corporate innovation, but AI automation raises concerns about job displacement and inequality (Acemoglu & Restrepo, 2019; Li et al., 2021).

The impact of AI, innovation, and fintech on employment and sustainable development is expected to continue, with the integration of blockchain and AI potentially humanizing the AI economy. However, challenges like job displacement and resistance to innovation need to be addressed. The future of AI and fintech will depend on factors like demand dynamics, sustainable development goals, and the integration of emerging technologies (Bessen, 2018; Farahani et al., 2022; Jiang et al., 2022; Kazachenok et al., 2023; Sun et al., 2022).

Innovation, AI, and fintech are rapidly changing the world, transforming our lives, work, and business. Innovation drives economic growth and social progress, while AI automates tasks and improves decision-making in finance, healthcare, and transportation. Fintech, using AI, blockchain, and other technologies, improves financial services by making them more accessible, efficient, and personalized. These advancements disrupt traditional industries and significantly impact money management.

10.5824/ajite.2023.04.002.x

2. METHOD

The data includes the Global Innovation Index (GII), Fintech Index, and AI Index. Countries with data in these indexes were compared, while those without data were not (AI Index Steering Committee, 2023; Hussein Kassim et al., 2021; WIPO, 2022). Orange and Quasar data mining analysis tools were used to compare 51 countries meeting these conditions, ensuring comprehensive analysis of innovation, fintech, and AI (Demšar et al., 2013; Hartigan & Wong, 1979; Lloyd, 1982; Steinley, 2006; Toplak et al., 2017, 2021).

Table 1: Countries' index scores

Countries	Innovation Score	Fintech Score	AI Score
Argentina	28,60	2,69	17,50
Australia	47,10	13,73	30,90
Austria	50,20	5,25	27,70
Belgium	46,90	4,61	26,60
Brazil	32,50	8,16	22,10
Canada	50,80	10,26	40,30
Chile	34,00	2,93	20,20
China	55,30	8,07	61,50
Colombia	29,20	3,07	17,80
Denmark	55,90	6,08	30,50
Egypt	22,70	0,67	16,90
Estonia	50,20	10,45	26,00
Finland	56,90	8,30	34,90
France	55,00	5,93	32,80
Germany	57,20	11,12	39,20
Greece	34,50	1,42	18,30
Hungary	39,80	2,53	20,70
India	36,60	5,90	31,40
Indonesia	27,90	3,13	18,20
Ireland	48,50	6,36	28,80
Israel	50,20	19,41	40,00
Italy	46,10	4,15	26,50
Japan	53,60	6,05	33,90
Kenya	22,80	4,48	8,30
Lithuania	37,40	11,11	19,70
Luxembourg	49,80	5,33	29,20
Malaysia	38,70	3,04	19,60
Malta	49,10	3,39	22,40
Mexico	31,00	4,44	16,90
New Zealand	47,20	4,52	21,60
Nigeria	16,90	1,46	9,30
Norway	48,80	5,64	26,40
Pakistan	23,00	0,32	10,10
Poland	37,50	4,17	24,80
Portugal	42,10	4,33	23,70
Russia	34,30	6,13	23,70
Saudi Arabia	33,40	0,87	23,30
Singapore	57,30	15,83	49,70
Slovakia	34,30	1,24	17,10
Slovenia	40,60	2,53	21,50
South Africa	29,80	3,13	14,10
South Korea	57,80	5,28	40,30
Spain	44,60	7,67	27,70
Sweden	61,60	13,14	30,30
Switzerland	64,60	14,95	37,70
Tunisia	27,90	0,81	13,70
Türkiye	38,10	3,64	20,60
United Kingdom	59,70	38,71	41,80
Uruguay	29,20	6,58	16,30
United States	61,80	69,15	100,00
Vietnam	34,30	0,69	18,00

The study analyzes the effects of innovation, AI, and fintech on each other using the k-Means clustering algorithm, focusing on the GII, AI, and fintech indexes in selected countries, based on their total score data and their impact on each other.

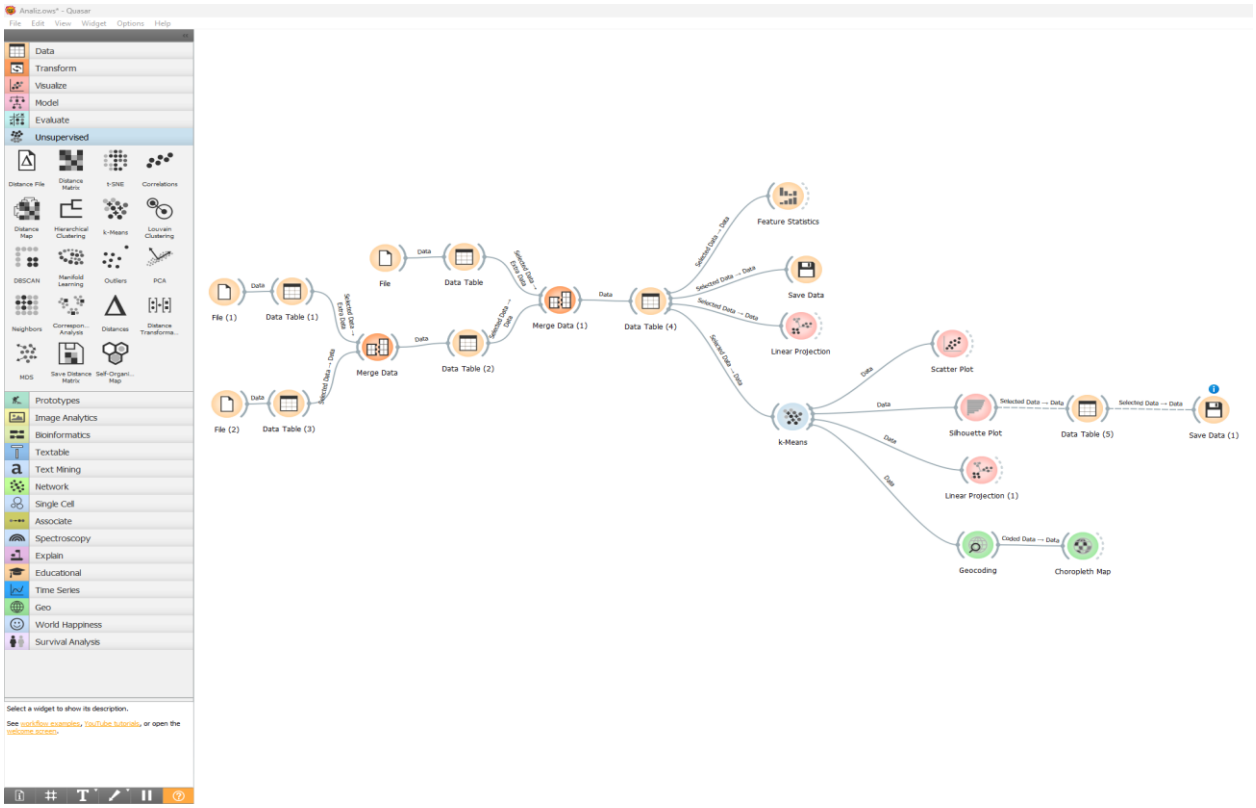

Figure 1: Analysis workflow

The k-Means clustering algorithm is a widely used method for partitioning data into clusters, developed over the past fifty years. It aims to minimize variance within each cluster by assigning data points to the nearest centroid and updating the centroids based on newly assigned points. The algorithm has been extensively studied and has applications in computer science and computer vision. It is an iterative algorithm that repeats steps until it converges to a solution. The best way to choose the number of clusters is experiment with different values (Demšar et al., 2013; Hartigan & Wong, 1979; Lloyd, 1982; Steinley, 2006; Toplak et al., 2017, 2021).

3. FINDINGS

The analysis of index-based data results are detailed below.

Feature Statistics

Feature statistics offer a swift method to analyze and discover intriguing aspects within a particular data set (Demšar et al., 2013; Toplak et al., 2017, 2021).

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Table 2: Feature statistics of the indexes

Index Score	Distribution	Mean	Mode	Median	Dispersion	Min.	Max.	Türkiye
GII Score		42.42	34.3	42.1	0.28	16.9	64.60	38.1
AI Score		27.3	16.9	23.7	0.53	8.3	100.0	20.6
Fintech Score		7.7	0.32	5.25	1.38	0.32	69.15	3.64

According to the GII, Türkiye ranks 37th among 128 countries with a score of 38.1. The highest score in this index is 64.60 for Switzerland and the lowest score is 11.60 for Guinea. According to the Fintech Index, Türkiye ranks 40th among 83 countries with a score of 3.64. The highest score is 69.15 for the United States and the lowest score is 0.12 for Ethiopia. According to the AI index, Türkiye ranks 40th out of 62 countries with a score of 20.6. The highest score is 100 for the United States and the lowest score is 8.3 for Kenya (AI Index Steering Committee, 2023; Hussein Kassim et al., 2021; WIPO, 2022).

k-Means Clustering Algorithm Results

The analysis visualization analysis is based on the three clusters, as the highest cluster analysis score is based on these clusters.

Table 3: k-Means Clustering Algorithm Results Table

Countries	Cluster	Silhouette	Silhouette (Cluster)	Innovation Score	Fintech Score	AI Score
Portugal	C1	0.578926	0.261295	42.1	4.3266	23.7
Slovenia	C1	0.633511	0.457302	40.6	2.5344	21.5
Hungary	C1	0.648972	0.517547	39.8	2.5335	20.7
Malaysia	C1	0.664567	0.580557	38.7	3.0442	19.6
Turkey	C1	0.667312	0.587789	38.1	3.6397	20.6
Poland	C1	0.65017	0.486343	37.5	4.1687	24.8
Lithuania	C1	0.625582	0.4692	37.4	11.1071	19.7
India	C1	0.591907	0.208858	36.6	5.8972	31.4
Greece	C1	0.69367	0.700759	34.5	1.4150	18.3
Russia	C1	0.672419	0.591187	34.3	6.1321	23.7
Slovakia	C1	0.693853	0.701674	34.3	1.2353	17.1
Vietnam	C1	0.692688	0.698004	34.3	0.6931	18.0
Chile	C1	0.694028	0.696908	34.0	2.9256	20.2
Saudi Arabia	C1	0.683041	0.632816	33.4	0.8670	23.3
Brazil	C1	0.673727	0.61618	32.5	8.1635	22.1
Mexico	C1	0.699906	0.728954	31.0	4.4369	16.9
South Africa	C1	0.698583	0.716187	29.8	3.1264	14.1
Colombia	C1	0.701506	0.734159	29.2	3.0666	17.8
Uruguay	C1	0.692769	0.702144	29.2	6.5785	16.3
Argentina	C1	0.700963	0.731648	28.6	2.6924	17.5
Indonesia	C1	0.699269	0.72315	27.9	3.1308	18.2
Tunisia	C1	0.694999	0.701845	27.9	0.8136	13.7
Pakistan	C1	0.681017	0.635856	23.0	0.3242	10.1
Kenya	C1	0.677039	0.615172	22.8	4.4753	8.3
Egypt	C1	0.684894	0.65983	22.7	0.6688	16.9
Nigeria	C1	0.665437	0.573132	16.9	1.4600	9.3
Switzerland	C2	0.656042	0.539717	64.6	14.9513	37.7
Sweden	C2	0.657345	0.534085	61.6	13.1409	30.3
United Kingdom	C2	0.593488	0.335833	59.7	38.7072	41.8
South Korea	C2	0.660449	0.555149	57.8	5.2833	40.3
Singapore	C2	0.646885	0.489107	57.3	15.8284	49.7
Germany	C2	0.669416	0.587541	57.2	11.1183	39.2
Finland	C2	0.671482	0.597261	56.9	8.3042	34.9
Denmark	C2	0.662159	0.554342	55.9	6.0787	30.5
China	C2	0.618092	0.373877	55.3	8.0719	61.5
France	C2	0.665598	0.574335	55.0	5.9266	32.8
Japan	C2	0.664441	0.570863	53.6	6.0547	33.9
Canada	C2	0.655319	0.532557	50.8	10.2642	40.3
Austria	C2	0.631747	0.428918	50.2	5.2474	27.7
Estonia	C2	0.628538	0.397421	50.2	10.4462	26.0
Israel	C2	0.634171	0.470346	50.2	19.4050	40.0
Luxembourg	C2	0.635633	0.452731	49.8	5.3288	29.2
Malta	C2	0.560432	0.138459	49.1	3.3850	22.4
Norway	C2	0.612117	0.347424	48.8	5.6358	26.4
Ireland	C2	0.626066	0.415053	48.5	6.3565	28.8
New Zealand	C2	0.52273	-0.00292644	47.2	4.5163	21.6
Australia	C2	0.617892	0.395545	47.1	13.7292	30.9
Belgium	C2	0.576354	0.238898	46.9	4.6149	26.6
Italy	C2	0.552852	0.168591	46.1	4.1538	26.5
Spain	C2	0.552284	0.168996	44.6	7.6700	27.7
United States	C3	0.5	0	61.8	69.1513	100.0

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The Silhouette Plot widget provides a visual representation of data consistency within clusters, assessing cluster quality using a silhouette score. A score close to 1 indicates the data's center, while scores close to 0 indicate the border between clusters. Euclidean formula was used.

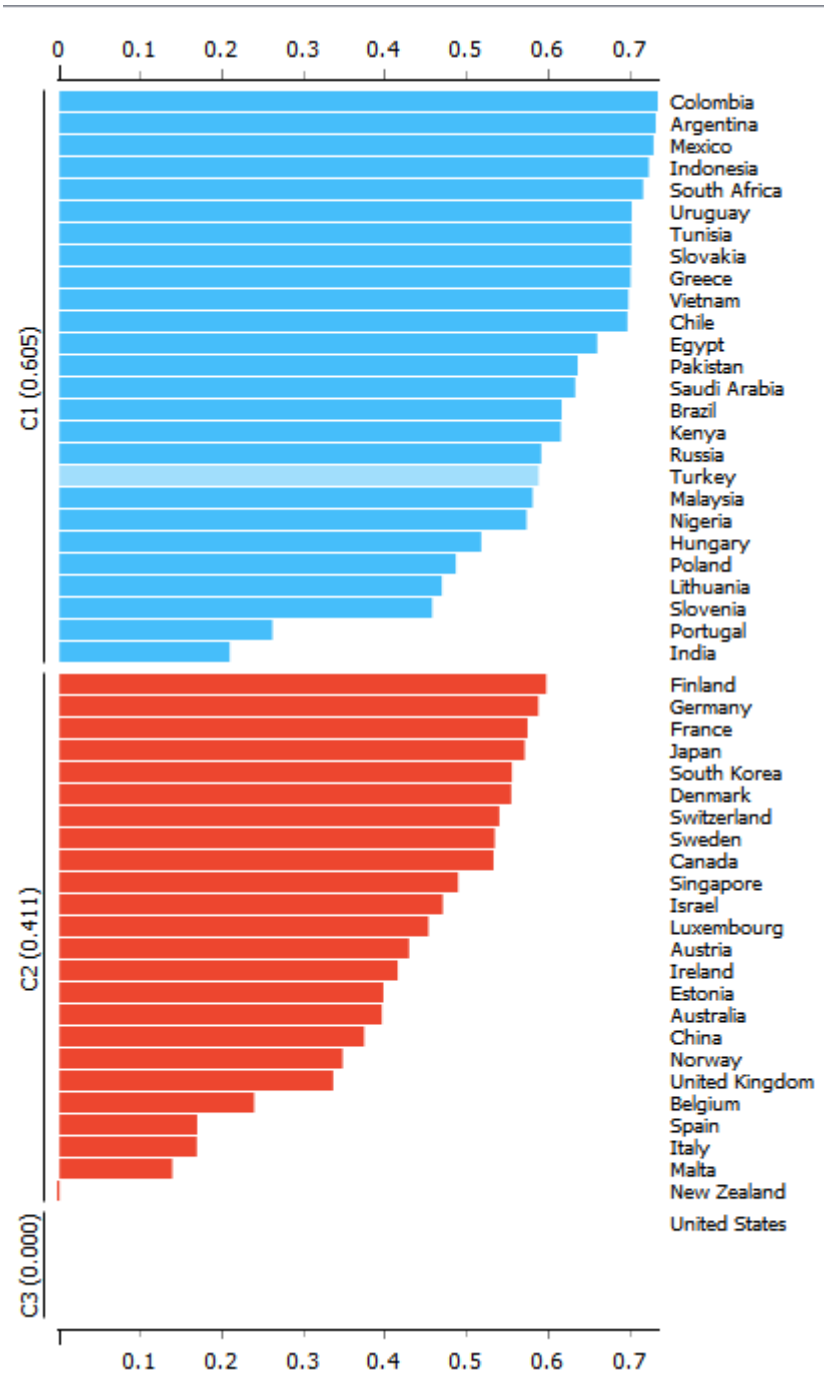

Figure 2: k-Means Clustering Algorithm Results (3 clusters)

According to the k-Means best clustering result, 51 countries are divided into 3 clusters. America is a cluster on its own. The second cluster is dominated by European countries.

Countries such as Türkiye, Russia, Poland, Kenya, Kenya, Malaysia, Nigeria and Hungary form the third cluster group.

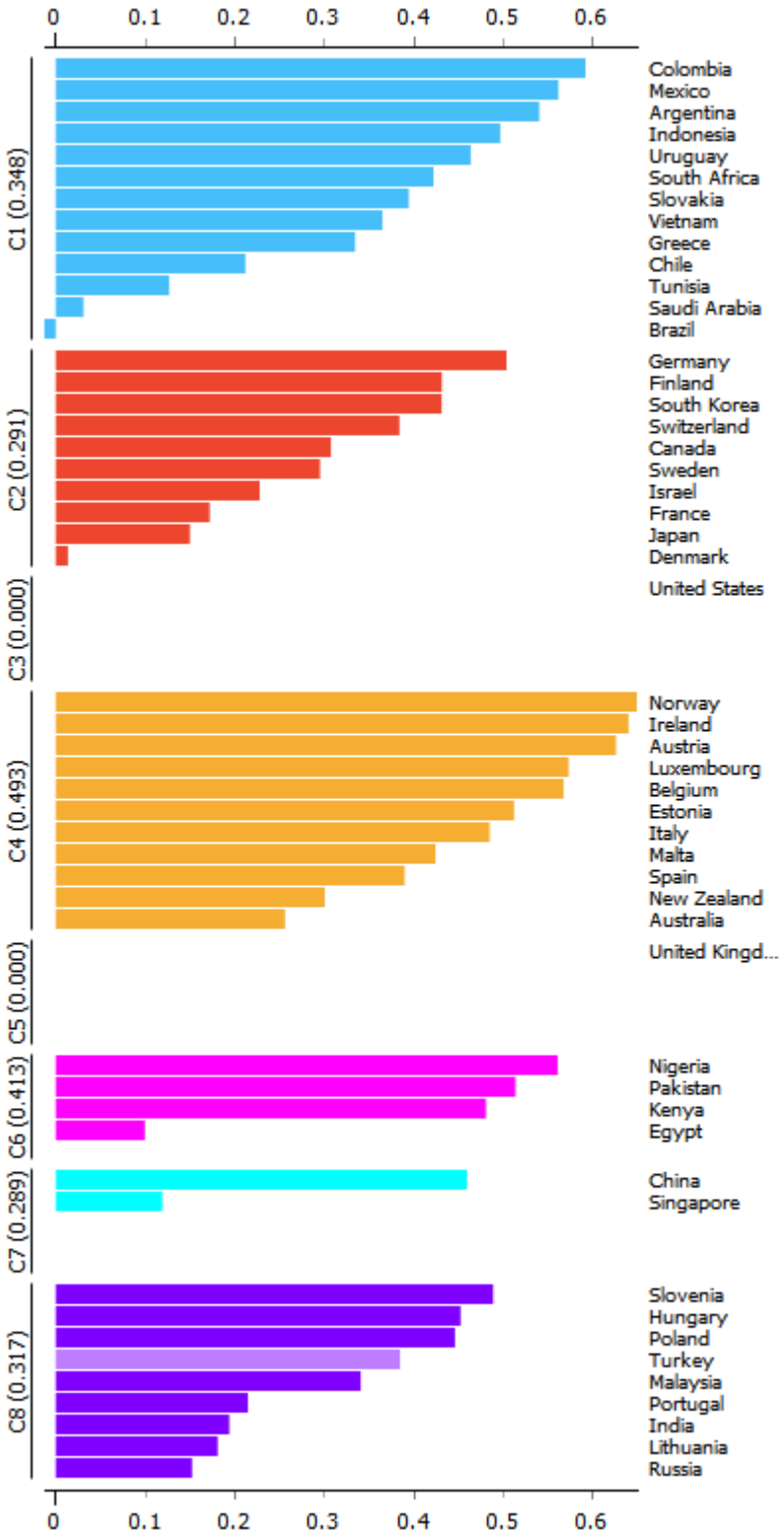

Figure 3: k-Means Clustering Algorithm Results (8 clusters)

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8 clusters were formed by manually directing the k-Means clustering algorithm. According to this clustering result, Türkiye is in the same cluster with Slovenia, Hungary, Malaysia, Portugal, India, Lithuania and Russia. Again, America is a cluster on its own. While China and Singapore are separated as another cluster, two different clusters emerge from European countries. South America forms a cluster on its own.

Linear Projection Method

A linear projection method with explorative data analysis. The linear projection method is a technique used for dimensionality reduction, which aims to discover compact representations of high-dimensional data. Unlike clustering methods, the linear projection method maps the input data into a single global coordinate system of lower dimensionality. This method, specifically the locally linear embedding (LLE) algorithm, is able to learn the global structure of nonlinear manifolds by exploiting the local symmetries of linear reconstructions. LLE computes low-dimensional embeddings that preserve the neighborhood relationships of the high-dimensional inputs (Roweis & Saul, 2000). It is capable of discovering the nonlinear degrees of freedom underlying complex observations, such as images of faces or human handwriting. The linear projection method efficiently computes a globally optimal solution and is guaranteed to converge asymptotically to the true structure for certain data manifolds. This technique has applications in various fields, including data analysis, visualization, and perception (Tenenbaum et al., 2000). The linear projection method can be a useful tool for dimensionality reduction, but it is important to note that it can also introduce some bias into the data set. It displays linear projections of class-labeled data. It supports various types of projections such as circular, linear discriminant analysis, and principal component analysis (Boulesteix & Strimmer, 2006; Koren & Carmel, 2003; Leban et al., 2006).

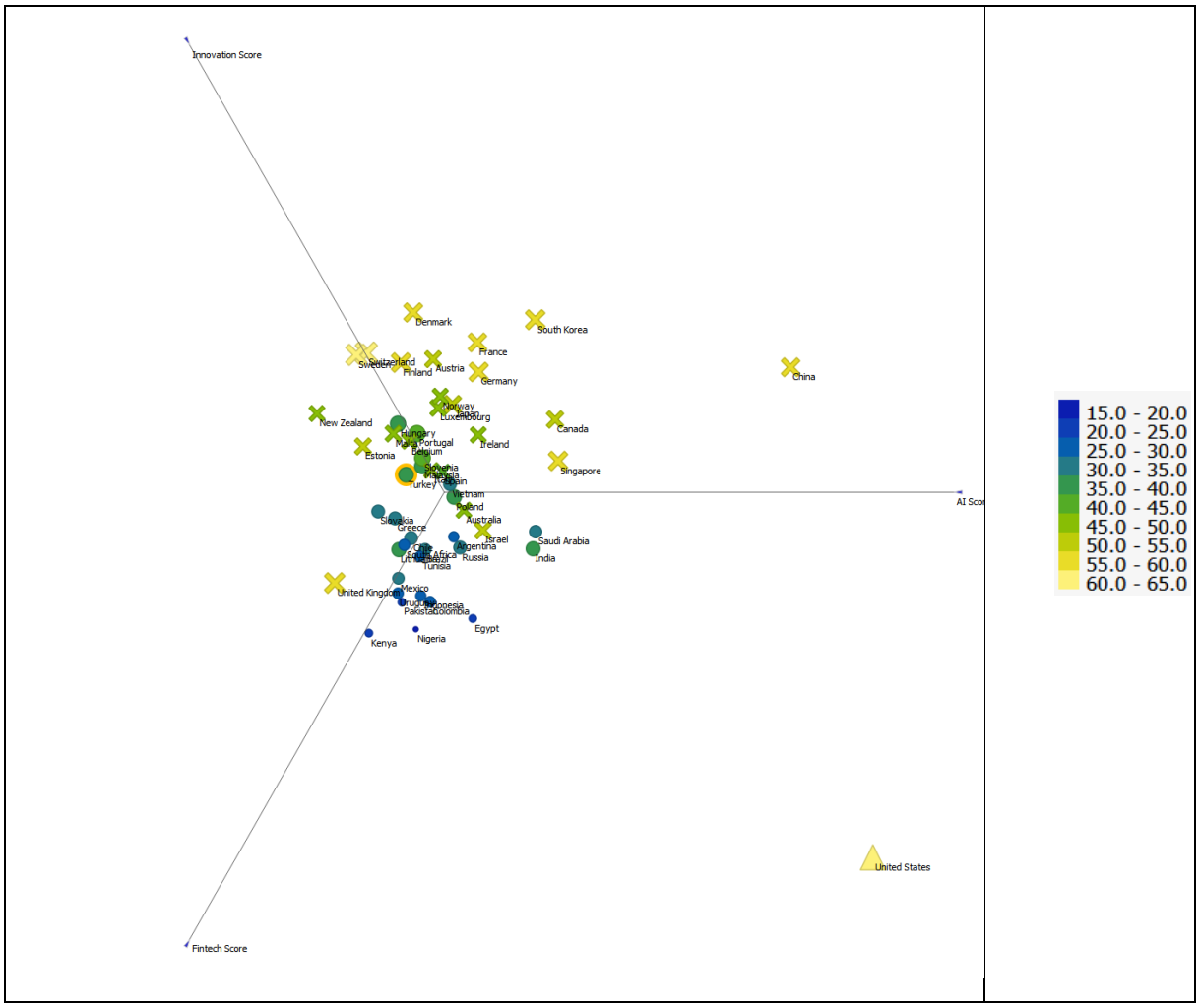

Figure 4: Linear projection of countries clustered according to the GII index

When linear projection analysis is performed according to the GII index, Türkiye is located in the cluster shown in green color and round shape. Türkiye has an average linear projection in this analysis. Countries such as the United States, the United Kingdom, China, Korea, France, Denmark, Singapore and Canada are at important points in this analysis.

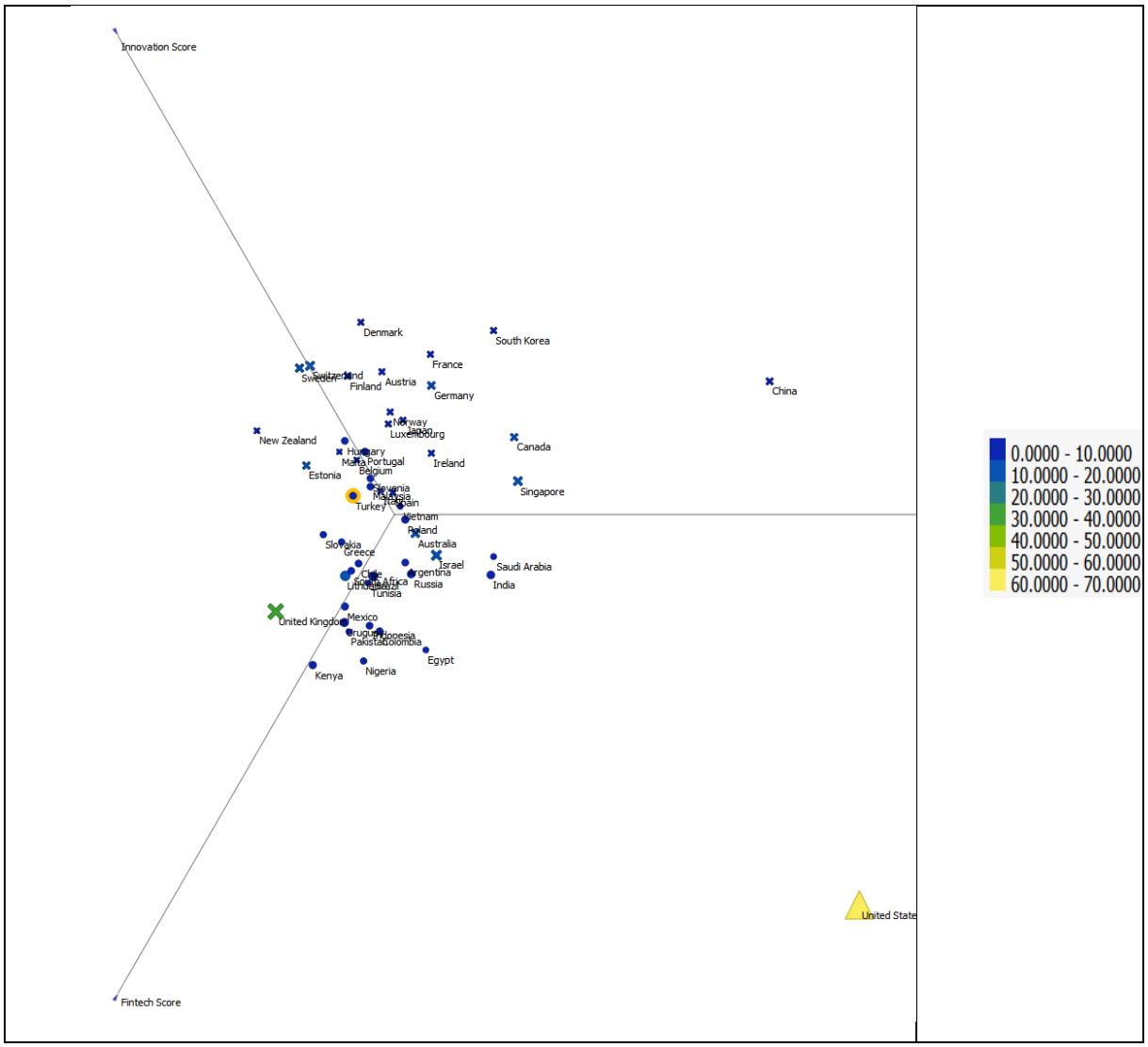

Figure 5: Linear projection of countries clustered according to the Fintech index

When linear projection analysis is performed according to the Fintech index, Türkiye ranks at the lower levels, while the UK and the US are far ahead of other countries in this field.

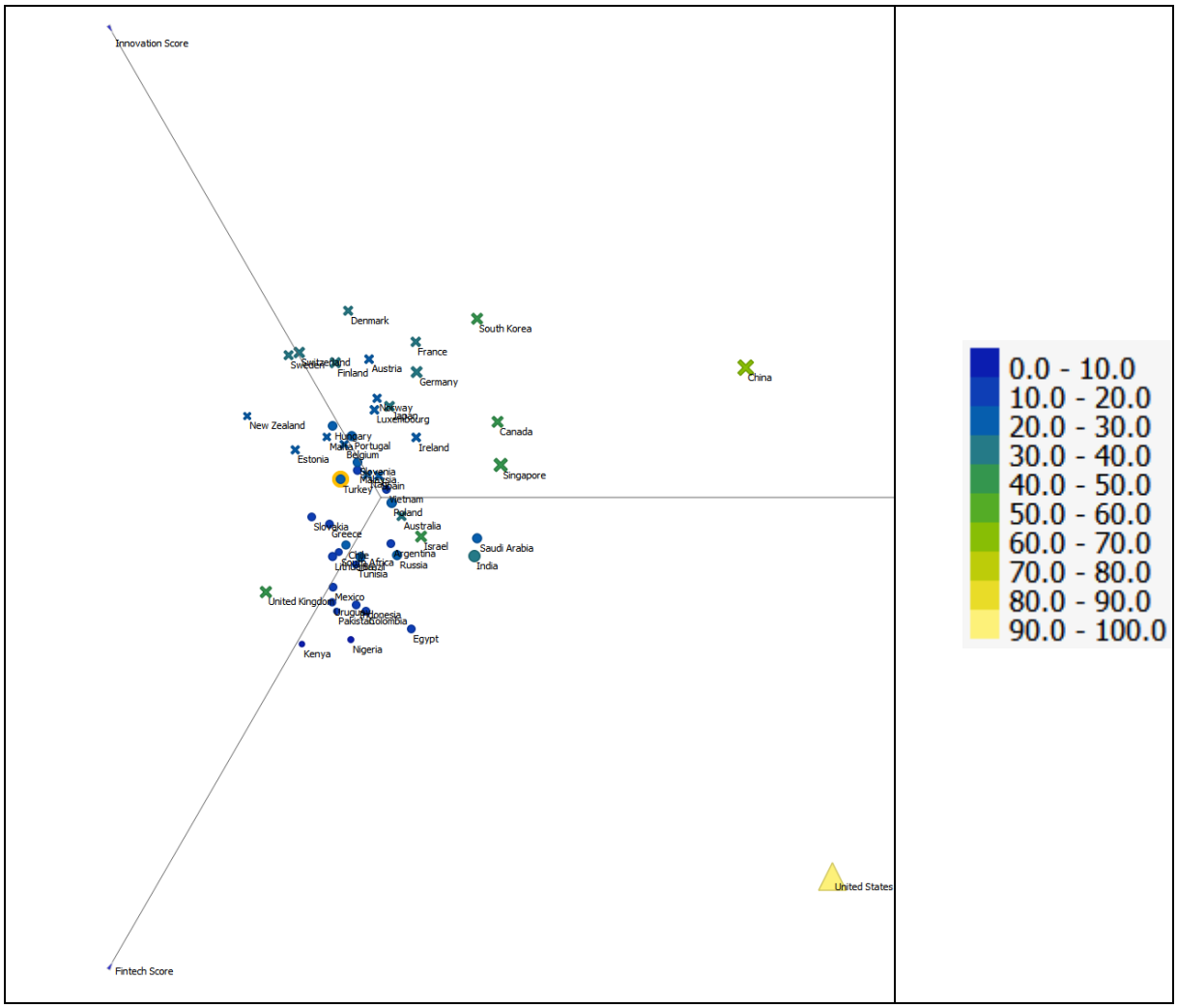

Figure 6: Linear projection of countries clustered according to the AI index

When linear projection analysis is made according to the AI index, Türkiye is at the lower levels, while China and the United States are ahead of other countries in this field. These countries are followed by Singapore, Canada, the UK, and Korea.

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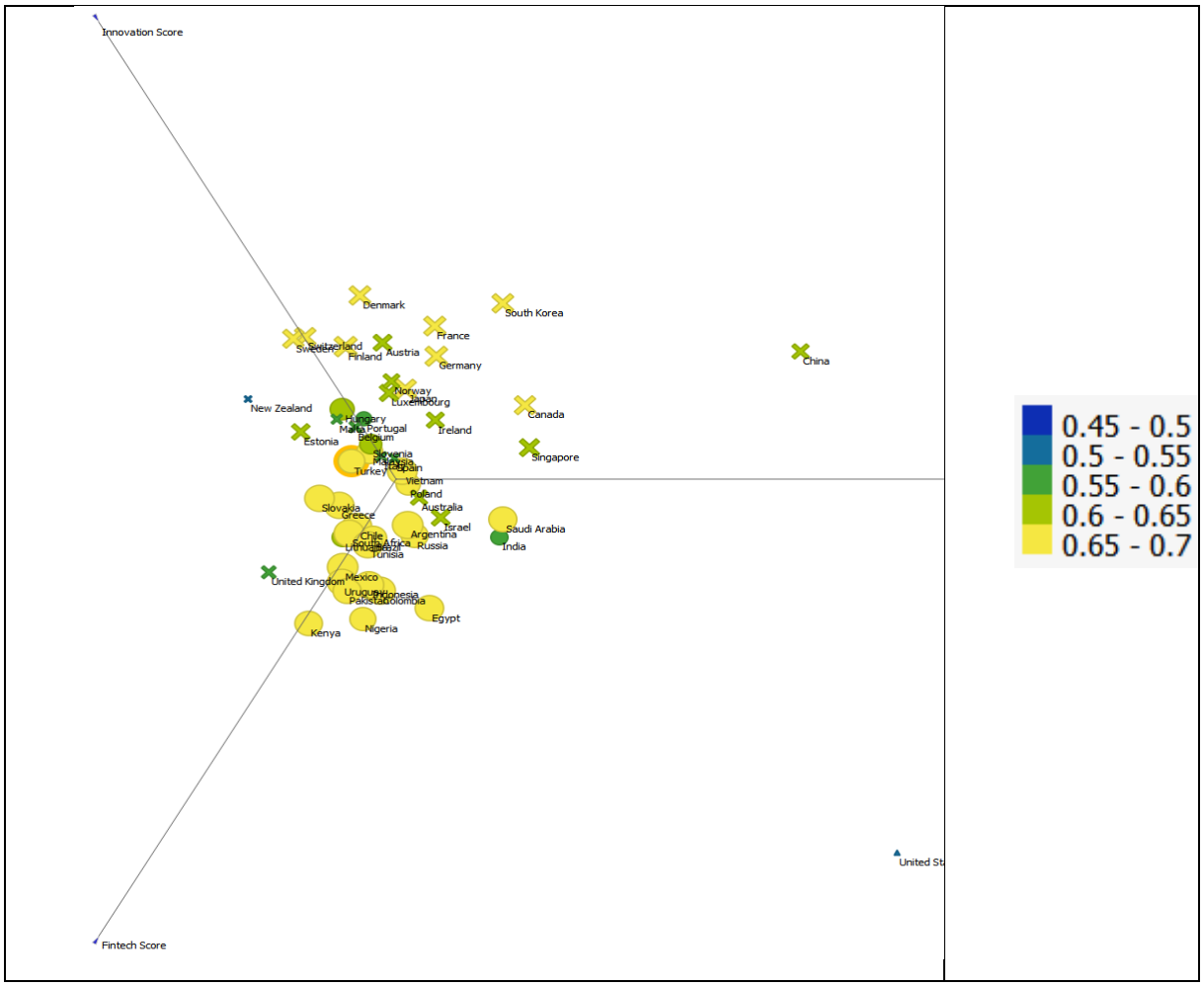

Figure 7: Linear projection of countries clustered according to three indexes

According to the 3 indexes, when linear projection analysis is performed, Türkiye is located in the middle and in the fintech and innovation zone. New Zealand, the UK, and Estonia stand out in this region. America is a cluster that differs from all other countries by being in the AI and fintech region. In the AI and innovation region, countries such as China, Singapore, Korea, Canada, Germany, Denmark, and France stand out.

Geocoding and Choropleth Visualization

The study utilized two geographic information systems from orange data mining tools: Geocoding and Choropleth. Geocoding extracts latitude/longitude pairs from region names or synthesizes them to return region names. Choropleth visualizes measurement variability across a geographic area or within a region, with various levels of granularity available. These tools classify and display color-coded clusters of countries compared in indexes, allowing for better understanding and comparison of different regions (Demšar et al., 2013; Toplak et al., 2017, 2021).

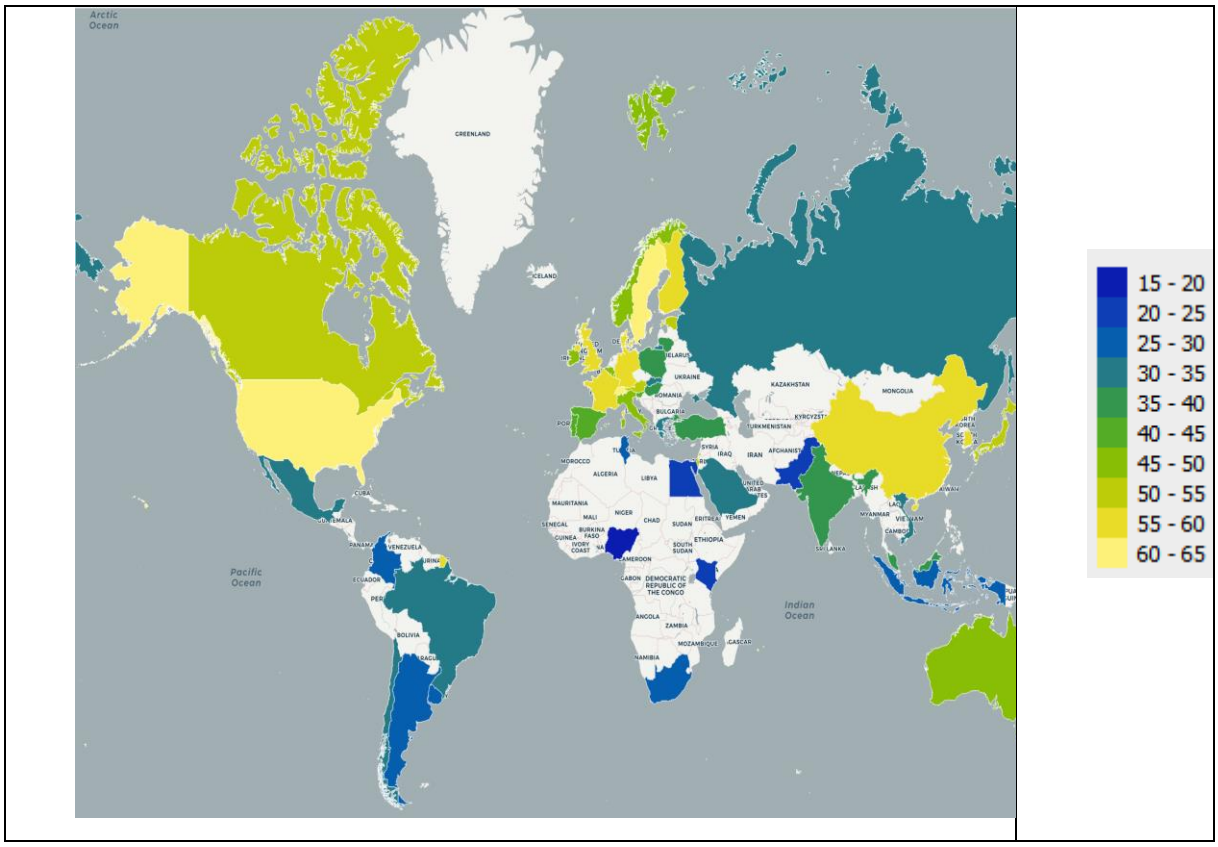

Figure 8: Clustered countries on a world map according to the GII index

The map displays countries grouped by the GII index, with Türkiye being among the dark green clusters, ranging from 35-40 points.

Türkiye's place in the GII is a topic of interest in academic research. Several studies have examined the innovation performance of Türkiye in comparison to other countries. (Kaynak et al., 2017) compared the innovation performance of four EU candidate countries, including Türkiye, using the entropy-based Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) approach. They found that Türkiye's innovation performance was comparable to other candidate countries (Kaynak et al., 2017). Additionally, (Çınar et al., 2020) conducted empirical research on Turkish export companies and found that innovation activities had a positive effect on firm performance (Çınar et al., 2020). These studies suggest that Türkiye has made efforts to improve its innovation performance and that innovation activities have a positive impact on the country's firms. However, further research is needed to provide a comprehensive ranking of Türkiye's place in the GII. Türkiye's ranking in the GII has improved significantly in recent years. In 2022, Türkiye ranked 37th out of 132 countries, up from 49th in 2016. This is the highest-ranking Türkiye has ever achieved in the GII.

Türkiye's innovation ranking improved in 2022 due to increased government investment in R&D, a growing number of startups, a strong education system, a favorable business environment, low taxes, and a supportive government. However, challenges include a high brain drain, lack of access to finance, and weak intellectual property protection. Despite these obstacles, Türkiye is well-positioned to continue improving its ranking in the GII, with continued investment, strong startup ecosystem, and supportive government.

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Figure 9: Clustered countries on a world map according to the fintech index

The Fintech index shows Türkiye in a dark blue country cluster, with America at the top and the UK in a remarkable position.

Türkiye holds a significant position in the fintech index due to its strong banking system and high adoption of technology. The country has made remarkable progress in increasing financial inclusivity through fintech solutions, particularly in providing contactless payment and contract systems, microfinance, and improving payment systems with educational content on responsible consumption (Bayram et al., 2022). Türkiye's potential for fintech growth is further highlighted by its role as a hub for Islamic fintech (Ahmad & Mamun, 2020) The country's collaboration between the banking and fintech sectors, as well as regulatory institutions, has facilitated the emergence of fintech solutions utilizing technologies such as Big Data, AI, and blockchain. With upcoming developments like the sandbox environment in Istanbul Financial Center, Türkiye is poised to further accelerate fintech innovation and address climate-related financial risks (Bayram et al., 2022). Overall, Türkiye's position in the fintech index is characterized by its potential for sustainable finance, financial inclusivity, and Islamic fintech growth.

Türkiye has been ranked 16th in the 2023 Global Fintech Index, up from 20th in 2022. The index is compiled by the Global Fintech Index Foundation and ranks countries on a number of factors, including the size of their fintech ecosystem, the number of fintech startups, the level of government support for fintech, and the regulatory environment for fintech. Türkiye's improved ranking is a reflection of the growing importance of fintech in the Turkish economy.

The Turkish fintech ecosystem is home to over 1,000 startups, and the government has been supportive of fintech development, providing tax breaks and other incentives to startups. The regulatory environment for fintech in Türkiye is also becoming more favorable, with the government recently passing legislation that is designed to make it easier for fintech companies to operate in the country (Hussein Kassim et al., 2021).

The growth of fintech in Türkiye is being driven by a number of factors, including the country's young and tech-savvy population, its growing middle class, and its high demand for financial services. Fintech companies in Türkiye are developing a variety of innovative products and services that are tailored to the needs of Turkish consumers, such as mobile payment apps, peer-to-peer lending platforms, and online investment platforms. The growth of fintech in Türkiye is expected to continue in the coming years. The Turkish government has set a goal of becoming a regional fintech hub, and the country has the potential to become a major player in the global fintech industry.

Türkiye's young, tech-savvy population and growing middle class make it an ideal market for fintech innovation. The government supports fintech development with tax breaks and incentives. The favorable regulatory environment is making it easier for fintech companies to operate. This growth positively impacts the Turkish economy, creating jobs, driving innovation, and positioning Türkiye as a regional fintech hub.

Figure 10: Clustered countries on a world map according to the AI index

The AI index shows Türkiye among light blue countries with scores 20-30, with the United States and China at the top.

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Türkiye ranked 43rd in the 2023 Global AI Index, which is a ranking of 62 countries based on their investment, innovation, and implementation of AI. Türkiye's ranking improved from 48th in 2022, which is a sign that the country is making progress in the field of AI (AI Index Steering Committee, 2023).

Türkiye's strengths in AI include a strong academic base, growing AI startups, a supportive government policy environment, a shortage of skilled AI talent, lack of large datasets, and a regulatory environment that is not yet fully supportive. However, challenges such as a lack of skilled talent, data, and a regulatory framework need to be addressed to become a leading AI hub in the region.

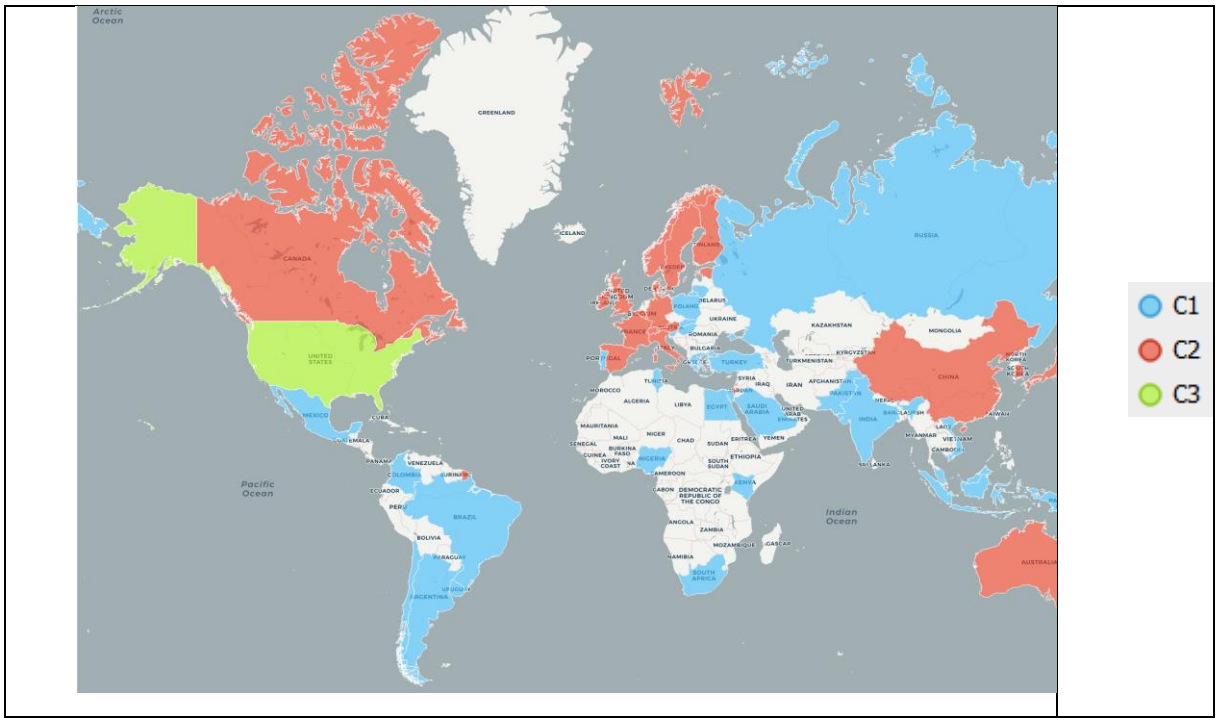

Figure 11: Clustered countries on a world map according to three indexes

As a result of the clustering analysis, the group of countries including Türkiye is shown in the same color in the map above. Türkiye is in the light blue cluster group, followed by America in the green group, followed by European countries, Japan, and China in the red group.

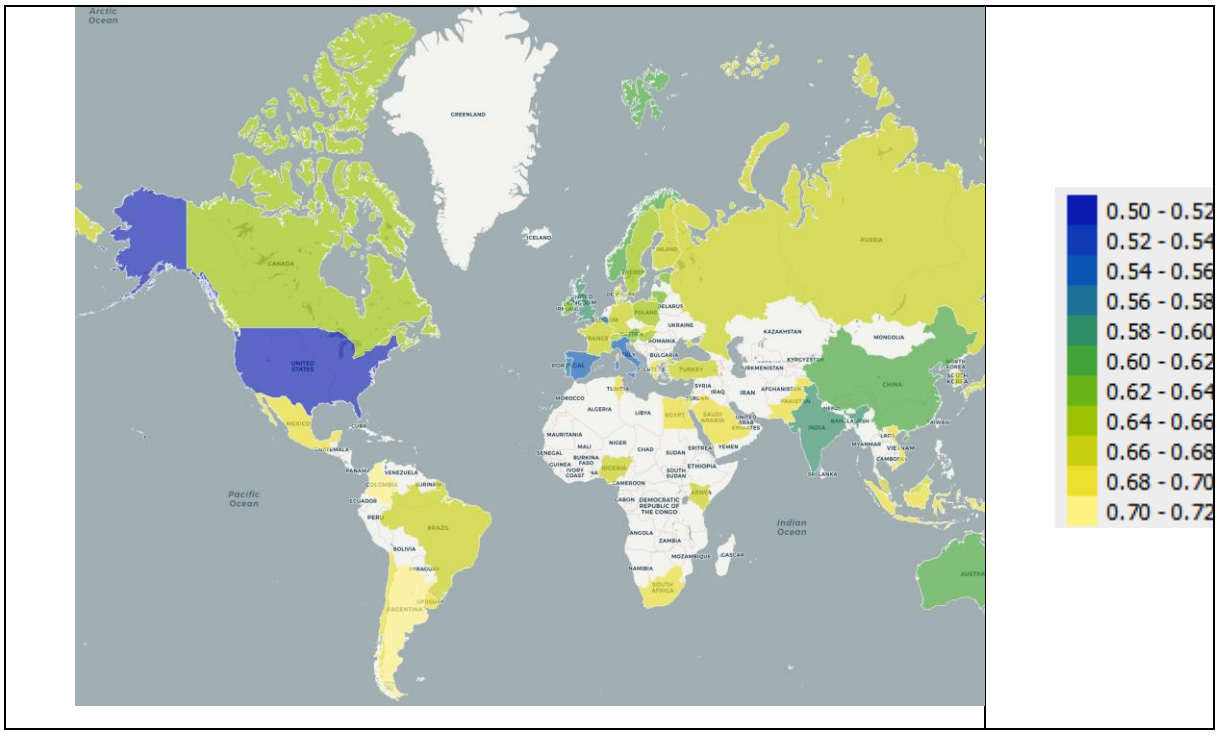

Figure 12: Clustered countries on a world map according to three indexes (Silhouette)

As a result of the clustering analysis, the group of countries including Türkiye is shown in the same color in the map above. The map displays countries clustered based on silhouette clustering scores, with Türkiye, in the 0.66- 0.70. range, America is in the range of 0.50-0.52 and Portugal, Spain and Italy are in the range of 0.56-0.58.

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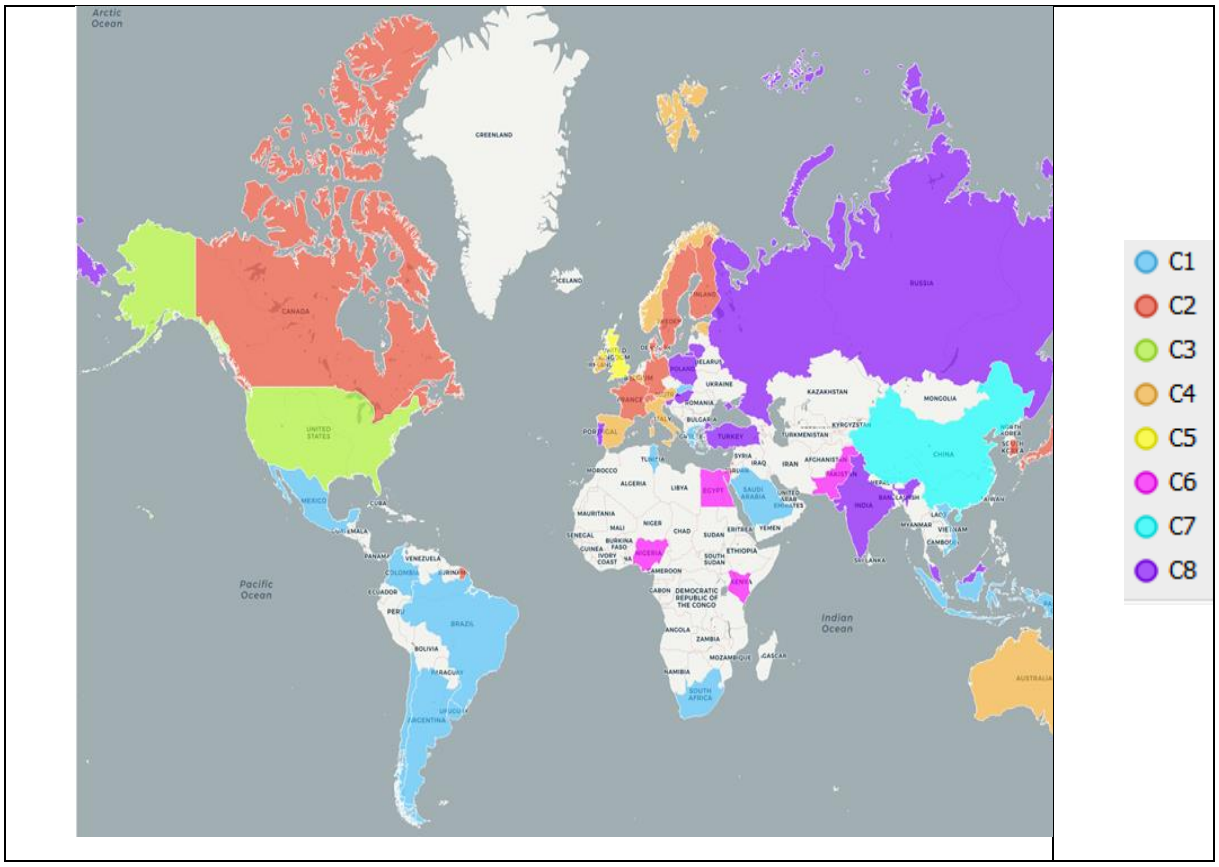

Figure 13: Clustered countries on a world map according to eight indexes

As a result of the clustering analysis, the group of countries including Türkiye is shown in the same color in the map above. The map displays countries grouped by eight indexes, with Türkiye in the purple cluster alongside Poland, Russia, Hungary, and India.

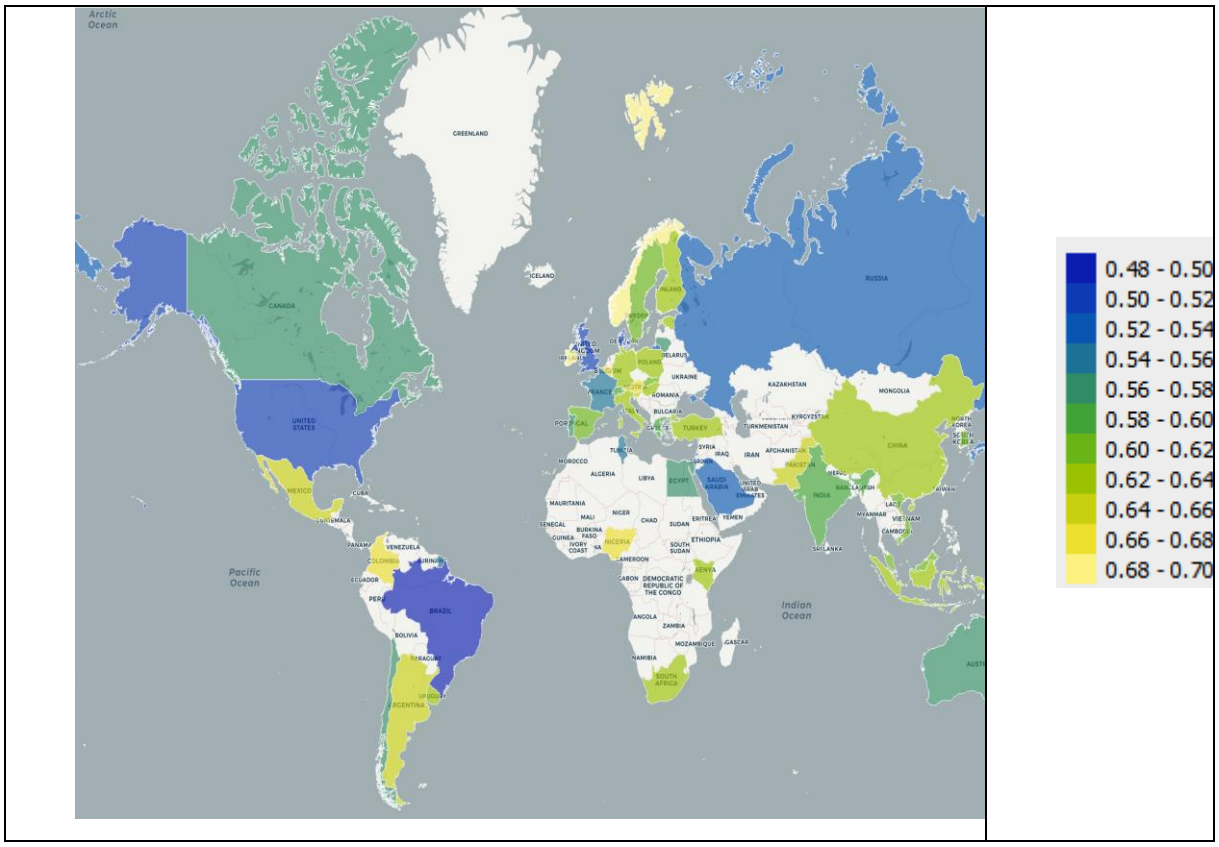

Figure 14: Clustered countries on a world map according to eight indexes (Silhouette)

As a result of the clustering analysis, the group of countries including Türkiye is shown in the same color in the map above. Türkiye is part of a cluster with countries like Poland, Finland, Spain, Italy, and the Philippines, based on silhouette clustering scores ranging from 0.62 to 0.64.

CONCLUSION AND DISCUSSION

To enhance productivity for innovation in Türkiye, several factors can be considered. Firstly, fostering a learning orientation within companies can have a positive impact on product innovation performance (Calisir et al., 2013). This includes promoting commitment to learning, shared vision, and open-mindedness. Secondly, the effects of social ties on innovation behavior and new product performance should be taken into account (Yeniaras et al., 2020). Building strong interpersonal ties and leveraging political ties can influence the direction and success of innovation efforts. Additionally, organizational culture plays a crucial role in facilitating radical product innovation (Naranjo-Valencia et al., 2017). Cultivating an adhocracy culture, characterized by flexibility, risk-taking, creativity, and external orientation, can foster innovation. These factors should be considered in the context of Türkiye's emerging economy and the unique challenges it presents (Yeniaras et al., 2020). By addressing these aspects, Türkiye can create an environment conducive to productivity and innovation. To harness the power of innovation, Türkiye can focus on several key strategies. Firstly, fostering a culture of innovation within small and medium-sized enterprises (SMEs) is crucial. Research has shown that organizational culture and empowerment positively impact innovation capability. By promoting collectivism and uncertainty avoidance while reducing power

distance, SMEs can create an empowering work environment that encourages innovation. Secondly, Türkiye should prioritize investment in research, technological development, and innovation in SMEs. The SME Strategy and Action Plan of Türkiye emphasizes the importance of raising awareness about these areas and encouraging SMEs to invest in technology for a sustainable competitive edge. Furthermore, Türkiye can play a central role in the entrepreneurship ecosystem of the Balkan countries, particularly in terms of product innovation, risk capital, and high-growth enterprises. By fostering collaboration and cooperation with other Balkan countries, Türkiye can create opportunities for mutual growth and innovation. In summary, Türkiye can harness the power of innovation by promoting a culture of innovation within SMEs, investing in research and technology, and fostering collaboration with other countries in the region (Çakar & Ertürk, 2010; Tekin et al., 2021).

Türkiye, a country with a rich history of innovation dating back to the Ottoman Empire, has been falling behind in innovation in recent years. To catch up, Türkiye needs to harness the power of innovation in several ways. Firstly, it should increase its investment in R&D to attract and retain talented scientists and engineers. Secondly, it should create a supportive environment for startups, offering tax breaks and incentives to encourage entrepreneurs to start new businesses and develop innovative products and services. Thirdly, Türkiye should promote entrepreneurship in schools and universities to foster a culture of innovation and risk-taking. Lastly, Türkiye should open up to foreign investment, which can bring new ideas and technologies to the country. Lastly, the country should improve its education system to produce a more skilled workforce. Lastly, Türkiye should create a culture of innovation that encourages creativity and risk-taking, ensuring that the country remains a leader in the global economy. Türkiye can boost its technology sector by developing AI, robotics, and the Internet of Things, attracting foreign investment through a favorable regulatory environment and tax breaks. In the agriculture sector, Türkiye can improve crop yields and reduce water consumption by promoting sustainable practices. The tourism sector can also be improved by creating new products and services, improving infrastructure, and building new airports and hotels. To foster innovation, Türkiye should create a favorable regulatory environment by providing tax breaks and incentives to startups and businesses. Additionally, Türkiye can support innovation clusters by providing funding and resources to groups of businesses and organizations working together to develop new technologies. Türkiye can boost its technology sector by developing AI, robotics, and the Internet of Things, attracting foreign investment through a favorable regulatory environment and tax breaks. In the agriculture sector, Türkiye can improve crop yields and reduce water consumption by promoting sustainable practices. The tourism sector can also be improved by creating new products and services, improving infrastructure, and building new airports and hotels. To foster innovation, Türkiye should create a favorable regulatory environment by providing tax breaks and incentives to startups and businesses. Additionally, Türkiye can support innovation clusters by providing funding and resources to groups of businesses and organizations working together to develop new technologies.

Türkiye has the potential to harness the power of fintech to promote sustainable finance and financial inclusivity. According to (Bayram et al., 2022) Türkiye, as one of the largest emerging market economies with a strong banking system and high technology adoption, can

benefit from fintech solutions to boost sustainable finance. The country has made progress in increasing financial inclusivity through contactless payment systems, microfinance, and educational content on responsible consumption (Bayram et al., 2022).Additionally, Türkiye has emerged as a hub for Islamic fintech, with the rise of shariah-compliant Islamic fintech applications. The use of fintech has significantly benefited Islamic finance based on Islamic Shariah (Ahmad & Mamun, 2020).To further harness the power of fintech, a collaboration between the banking and fintech sectors, regulatory institutions, and the development of a sandbox environment can facilitate the emergence of fintech solutions using technologies like Big Data, AI, and blockchain (Bayram et al., 2022). Türkiye has the potential to leverage fintech to boost productivity and economic growth. With a young, growing population, high education level, a large middle class, and a supportive government, Türkiye can invest in infrastructure to support fintech development. This will make it easier for fintech companies to operate and consumers to access fintech products and services. A favorable regulatory environment is also crucial, ensuring clear, predictable, and easy-to-come-by regulations. Supporting fintech education and training will create a skilled workforce and raise awareness of fintech among consumers and businesses. Türkiye can promote fintech innovation by providing funding for startups, hosting fintech events, and connecting fintech companies with potential partners and investors. By implementing these strategies, Türkiye can harness the power of fintech to boost productivity and economic growth. The Turkish government can collaborate with fintech companies to create tailored financial products and services for Turkish businesses and consumers. For instance, a mobile payment app could be developed for all merchants in Türkiye. Tax breaks and incentives for fintech startups can attract investment and create jobs. A regulatory sandbox could be created for fintech companies to test new products in a controlled environment, reducing risk and speeding up development. This move could position Türkiye as a leader in fintech and reap the benefits of innovative technology.

Türkiye has the potential to harness the power of AI by adopting and implementing AI technologies in various sectors. The banking sector in Türkiye has effectively utilized AI to improve their overall services. Additionally, AI has been successfully applied in fields such as neuropsychiatry, ophthalmology, dairy farming, furniture design retailing and water quality assessment (Öztürk & Kula, 2021)in Türkiye. By embracing AI, Türkiye can benefit from increased productivity and efficiency in these sectors. Furthermore, the displacement effect caused by automation and AI can be counteracted by the productivity effect, which increases the demand for labor in non-automated tasks. This suggests that while AI may replace certain tasks, it can also create new labor-intensive tasks, thereby increasing the labor share and countering the impact of automation (Acemoglu & Restrepo, 2019).In conclusion, Türkiye can harness the power of AI by adopting AI technologies in various sectors, such as banking, healthcare, agriculture, and retail. This can lead to improved services, increased productivity, and the creation of new labor-intensive tasks.

Türkiye can leverage AI to boost its economy, enhance productivity, and create new jobs. To achieve this, the country should invest in R&D, including funding universities and research institutions, and provide incentives for businesses developing AI products and services. Educating the workforce in AI is crucial for creating a skilled workforce capable of working in AI-related jobs. This can be achieved through teaching AI in schools and universities, as well

as providing training programs for businesses and individuals. Creating a favorable regulatory environment, including laws protecting privacy and data security, and promoting innovation, is also essential. Partnering with AI-leading foreign companies can help Türkiye learn from their expertise and access their technology, accelerating the development of its own AI capabilities. AI can revolutionize various industries, including agriculture, healthcare, education, and manufacturing. It can automate tasks like planting, harvesting, and pest control, allowing farmers to focus on strategic work like marketing and sales. AI can also analyze data to improve crop yields and reduce costs. In healthcare, AI can diagnose diseases, develop new treatments, and provide personalized care. It can also schedule appointments and manage medical records, freeing doctors and nurses to focus on patient-facing tasks. In education, AI can personalize learning, provide feedback, and automate tasks, enhancing efficiency and effectiveness. In manufacturing, AI can automate tasks like quality control and assembly, allowing workers to focus on complex tasks like problem-solving and innovation. It can also optimize production processes and reduce costs. AI can revolutionize various industries, including agriculture, healthcare, education, and manufacturing. It can automate tasks like planting, harvesting, and pest control, allowing farmers to focus on strategic work like marketing and sales. AI can also analyze data to improve crop yields and reduce costs. In healthcare, AI can diagnose diseases, develop new treatments, and provide personalized care. It can also schedule appointments and manage medical records, freeing doctors and nurses to focus on patient-facing tasks. In education, AI can personalize learning, provide feedback, and automate tasks, enhancing efficiency and effectiveness. In manufacturing, AI can automate tasks like quality control and assembly, allowing workers to focus on more complex tasks like problem-solving and innovation. It can also optimize production processes and reduce costs.

Türkiye can leverage AI to enhance its economy, boost productivity, and create new jobs. By synchronizing innovation, fintech, and AI, the Turkish economy can adapt to the digital age effectively. Financial assets are more valuable than real assets, and fintech can help Türkiye access these assets. AI is a highly effective technology, and focusing on these areas will enable rapid progress in social and economic areas. To become a global power, Türkiye must focus on fintech, AI, and strong innovation. Effective innovation, strong financial markets, and a strong technological infrastructure are essential. China's transition from an imitation economy to an innovation economy has made it a world giant. Türkiye should imitate and then innovate, particularly in fintech and AI, while synchronizing these sectors. This will increase economic and social productivity, leading to Türkiye becoming a global power.

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