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ORIGINAL RESEARCH

Measuring City Brand Authenticity Based on Evidence from Social Networks: Case of Almaty

Aisha Akhmetbayeva[1]*, Guillaume Tiberghien[2], Vladimir Garkavenko[3]

Abstract

The research paper has several objectives including conducting a thorough literature review to outline the existing models for measuring brand authenticity with particular focus on destination branding; selecting a suitable model(s) to be applied to the assessment of city brand authenticity; and performing a case study analysis of the brand of Almaty, Kazakhstan, based on a content analysis of social network(s) dedicated to the city brand. The majority of extant studies on brand authenticity focus on exploring authenticity within particular industries or in relation to products with less attention being devoted to the authenticity of destination brands. This study is unique in its attempt to apply brand authenticity measurement models to the specific context of Almaty as an emerging destination brand. A content analysis was conducted on data from ten Instagram pages dedicated to Almaty, following established theories on brand authenticity. One hundred posts were analyzed from each reviewed account. Each post was studied for the presence of specific cues derived from the selected theoretical models. The analysis showed that the direction on which to build the brand identity of Almaty has not been determined yet. Still, based on the presence of specific cues derived from the selected theoretical models including the four dimensions of brand authenticity proposed by Bruhn et al. and Anholt's City Brand Hexagon model, analysis performed on selected Instagram accounts dedicated to Almaty city shows that Almaty has a potential of building an authentic brand.

Keywords: city brand authenticity, content analysis, emerging destination brand, Almaty, innovation, Instagram.

Introduction

In today's highly commercialized and vastly globalized markets, consumers have started to show more interest in brands which are genuine. Brand authenticity is believed to significantly enhance overall brand experience and tends to generate increased customer satisfaction with the brand (Hernandez-Fernandez & Lewis, 2019; Kim & Bonn, 2016; Tran & Keng, 2018). Indeed, according to the survey conducted by Stackla among almost 1600 consumers from the UK, Australia and the U.S in 2019 (DeGruttola, 2019), 90 % of respondents stated that authenticity is important in decisions which brands support; the rate went up from the previous 2017 result of 86 % (ibid.). Companies are responding by emphasizing authenticity in their brand offerings: organizations are ready to devote effort and resources to ensure they position their brands as authentic in the perception of consumers aiming to strengthen the trust in their brand. The research on brand authenticity remained scarce in the 2010s but increased from 2018. Most recent studies (post 2020) largely investigated the brand authenticity concept in relation to other constructs like brand equity, brand loyalty, brand credibility, and customer satisfaction. However, the majority of extant studies on brand authenticity focus on exploring authenticity within particular industries or in relation to products with less attention being devoted to the authenticity of destination brands. A few recent studies on authenticity of destination connected the authenticity construct with the revisit intention (Shi et al., 2022), explored heritage destination brand's authenticity (Chen et al., 2021) and addressed the notion of brand legitimacy shaping brand authenticity and destination loyalty (Chen & Lee, 2021).

This authors' contribution to the study of destination brand authenticity is in the provision of a comprehensive overview of the existing literature on brand authenticity, identification of the brand authenticity measurement model(s) and the development of an application of the model(s) to the context of the emerging destination brand using the example of Almaty. Thus, the current work is among the first studies on testing the developed brand authenticity measurement model on an emerging destination.

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The following section "literature review" presents a more detailed review of the extant studies on the concept of brand authenticity; next, research questions of this study are defined, and then, the brief context of the Almaty city brand is presented.

Literature review

The definition of authenticity varies across different sources. The concept of authenticity is believed to take its roots from the Greek philosophy (Hernandez-Fernandez & Lewis, 2019), while later the concept had developed into denoting an object which is genuine and not an imitation (ibid.). A number of other academic texts support the characteristic of genuineness associated with authenticity. Thus, according to Grayson and Martinec (cited in Tran & Keng, 2018), authenticity can be related to the qualities of genuineness, truth and reality. Other studies by Boyle and Munoz et al. (cited in Tran & Keng, 2018) define authenticity as something sincere, original, real and natural.

Brand has a standard definition of any distinctive feature which may appear as a name, design, or symbol that aims to identify a good or a service (American Marketing Association). Thus, when applied to a brand, authenticity signifies that consumers perceive it as genuine and trustworthy in fulfilling its promises. Indeed, brand authenticity is closely linked to brand trust: if customers do not find the brand to be authentic, the trust in that brand could be lost. Various studies reflect on the attempts to conceptualize brand authenticity. A study by Morhart et al. discussed the concept of perceived brand authenticity and defined four elements of the concept (Morhart et al., 2015; Fig. 1). According to the model proposed by Morhart et al., the four elements of perceived brand authenticity focus on brand being "timeless" and capable to survive trends ("continuity" element), willing to deliver on its promises ("credibility" element), adhering to loyalty and care about customers ("integrity" element), and reflecting values that customers deem important ("symbolism" element; Morhart et al., 2015).

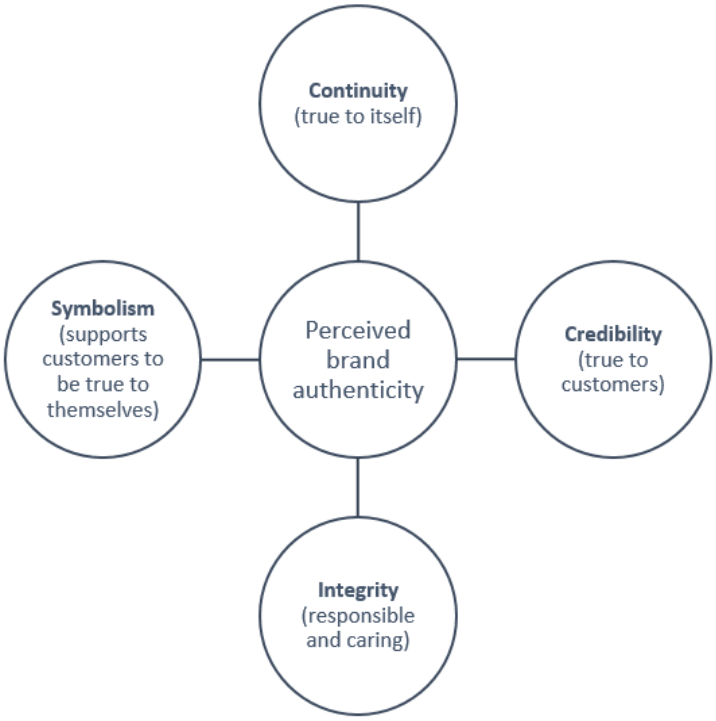

Figure 1. Perceived brand authenticity elements

Note — compiled by the authors based on the source (Morhart et al., 2015)

Another study (cited in Tran & Keng, 2018) led to the identification of six characteristics of brand authenticity, which include originality, commitment to quality, credibility, scarceness, heritage and style persistence, purity, and sacredness. A study by Bruhn et al. (2012) resulted in the creation of a psychometric scale for measuring consumers' perceptions of brand authenticity, wherein brand authenticity was composed of four dimensions depicted in Figure 2.

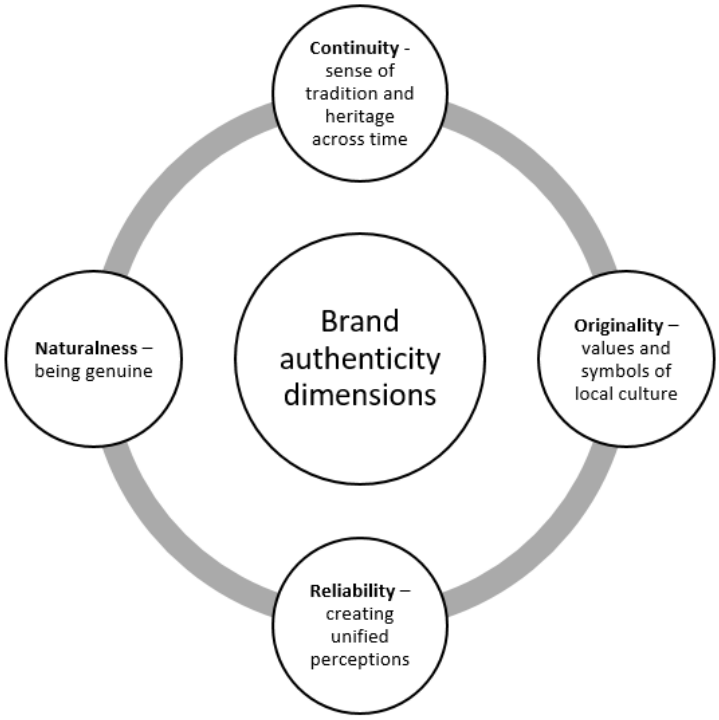

Figure 2. Brand authenticity dimensions

Note — compiled by the authors based on the source (Bruhn et al., 2012)

Hernandez-Fernandez and Lewis (2019) presented an overview of various previous research that aimed to define antecedents of brand authenticity concept starting from 1993 and till 2016. It can be observed that the concept has undergone evolution from being associated with workmanship, cultural and historic integrity (Tiberghien & Garkavenko, 2013; Tiberghien, 2020) in earlier years of its development to gradually shifting towards being associated with brand consistency, brand individuality and brand continuity in later years (starting 2010s; Hernandez-Fernandez and Lewis, 2019). A study by Girardin et al. (2023) built on Entity-Referent Correspondence Framework of Authenticity infers that authenticity implies being true to either an ideal, a fact, or a self. Other studies examined brand authenticity through various dimensions and factors and connected authenticity with different constructs such as brand trust, perceived value, brand individuality, brand consistency, brand equity, brand continuity and customer satisfaction (Hernandez-Fernandez and Lewis, 2019; Tran & Nguyen, 2022). In general, it can be concluded that the concept of brand authenticity is lacking a one defined measuring scale as there are various factors, characteristics and dimensions used in literature to define and measure brand authenticity. Nevertheless, the results of the majority of studies (Hernandez-Fernandez and Lewis, 2019) on brand authenticity prove that the customers' positive perception of brand authenticity leads to increased brand trust and improved perceived value of the brand. Brand authenticity is important as it helps the brand to distinguish itself among other available offerings and helps establish stronger emotional connections with customers (ibid.).

Meanwhile, companies have to stay true on keeping the brand authentic: in the era of social media dominance, customers can easily identify if the brands live up to their promises. A few of the recent studies address the power of social networks in building an image of a tourist destination. A study by Arefieva et al. (2021) discussed how the analysis of symbols through the prism of Instagram photos could be useful for better branding and marketing of a destination. Another study by Tamaki (2021) argues that posting images in social networks tend to affect the tourists' psychological well-being and ultimately influence the branding of tourist destinations. In support of the findings presented in (Arefieva et al., 2021; Gon, 2021), an article by Gon (2021) discusses the user-generated content in social media as a resource for the designing the experience which would in turn enhance the destination marketing and management strategies. Furthermore, McCreary et al. (2020) utilized data from social media to explore tourist destination image of a particular tourist-oriented region. Garay (2019) went further by analyzing a sample of tweets with a hashtag #visitspain to examine the functioning of the image formation process. Villamediana-Pedrosa et al. (2019) also performed a big data analysis of Facebook publications in order to identify message design strategies aimed at generating either a positive or negative engagement with customers.

Destination branding differs from traditional product/service branding in a sense that it takes the concept further than simply embodying brand name, symbol or logo which is used to identify a brand. Additionally, the destination brand must ensure a memorable experience and serve as an umbrella for all the memories, perceptions, and images that will later be associated with the destination in the visitor's mind. (Hashim et al., 2018). Destination brand image has a long history of development starting from the early 1940s (Pike, 2009). Today destination branding is more important than ever as an attractive destination brand leads to the inflow of tourists, which in turn has a positive effect on the destination's economy and development (Shi et al., 2022). At the same time, a destination brand which fails to offer the promised experience may lead to an immediate reaction on tourist numbers and the increase of the expenses to be incurred for reviving the destination's image.

Branding a city has similar challenges to branding a destination: a city's history, culture, people, infrastructure and visual characteristics — all have to be embedded in a successful brand. Measuring city brand is a complicated task: foremost, the decision regarding which criteria to include in the measurement is crucial. In 2006, Anholt developed the City Brand Hexagon model comprised of six distinct elements which aims to determine the city brand equity (Anholt, 2006; Fig. 3).

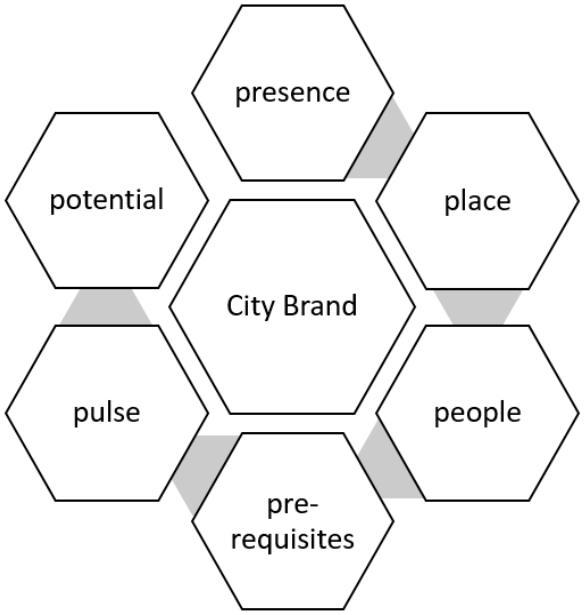

Figure 3. Anholt's City Brand Hexagon model

Note — compiled by the authors based on the source (Anholt, 2006)

The elements refer to the different characteristics of a city brand: thus, "presence" denotes the city's status, both within the region and internationally; "place" embraces the physical image of the city; "people" reflects the inhabitants and their opinion towards the city; "pre-requisites" in essence cover the city services including public transport, hospitals, education institutions, sports facilities and other essential city services; "pulse" reflects whether the city life is considered to be vibrant and interesting; "potential" includes all the possibilities offered by the city both to the locals and to visitors such as education, employment, investments, and so on (Benedek, 2017).

Philip Kotler devoted substantial research to place marketing (Kotler, 2000). According to Kotler, prior to developing a brand of a city, it is important to understand the need behind the branding effort. He stated that the cities nowadays are increasingly under risk due to the heightened competition among cities, urban revolution and decay, rapid changes in global environment, and the limited resources of the cities. Kotler identified the main stages for the successful creation of a marketing strategy for a city brand: initiating place audit, developing vision and goals, formulating strategy, outlining action plan, implementing and controlling the process (ibid.).

When it comes to brand authenticity of a city, it is more often believed to include all the characteristics which make the image of the city stand out. Such features may include city logo or emblem, effective slogan, peculiar associations and accents — all of which intend to make the city memorable in the perception of lo-

cals and tourists alike (Galeyeva, 2022). Some of the best examples of effective city brands are New York with its I LOVE NY signature and the Big Apple symbol; Paris where the Eiffel Tower is used on many promotional materials including the logo of Paris tourist office; Amsterdam which played with its name creating the "I am sterdam" slogan symbolizing the combined heritage of the city and openness to new things; Copenhagen which turned the "open" part of its name into the brand of being open to opportunities, investments, events, etc.; Stockholm which successfully branded itself as the capital of Scandinavia earning the status for being one of the best cities for foreign direct investments and attracting the largest inflow of tourist in the Northern Europe area (Galeyeva, 2022; Vokrugsveta, 2019).

Research questions

The overall aim of this study is to measure the brand authenticity and the brand strength of the city of Almaty. The research objectives of the study are to conduct a thorough literature review aimed at outlining the existing models for measuring brand authenticity with particular focus on destination branding; then, to select a suitable model(s) to be applied to the assessment of city brand authenticity; and to perform a case study analysis of the brand of Almaty, Kazakhstan, based on a content analysis of social networks dedicated to the city brand.

The research questions for the study are:

1. Based on existing literature related to brand authenticity and its measurement, what would be the appropriate measurement model for the city brand authenticity?
2. What is the current brand positioning of Almaty city in the social network(s) dedicated to the city?
3. Is there a potential to build the brand of Almaty city based on authenticity?

Context of the study

Almaty (before — Alma-Ata, Vernyi) is the city of the republican significance of the Republic of Kazakhstan. The city used to be the capital of the Kazakh Autonomous Soviet Socialist Republic till 1936, then became the capital of the Kazakh Soviet Socialist Republic as part of the Union of Soviet Socialist Republics till 1991, and remained the capital of the independent Kazakhstan till 1997. Almaty can be translated from Kazakh as "full of apples". Almaty is the largest city of Kazakhstan by population: as of September 2023, more than 2.2 million people resided in the city (Official statistics of the city of Almaty). Aside from population size, Almaty today remains the most culturally and ethnically diverse city in the Republic, along with maintaining the status of regional financial and business center. The city boasts the significant number of research and education institutions, museums, theaters, parks and gardens, sports arenas, trade areas and industrial enterprises (Guide to Almaty). Almaty and its surrounding area are also attractive for their natural attractions, being home to lakes, canyons, parks and mountains.

Resulting from all the attractions offered by the city, Almaty has traditionally welcomed a notable inflow of tourists. As indicated by the official informational source of the Prime Minister of the country, starting 2021, the tourism industry in the country has started showing signs of recovery from the COVID crisis. During the first months of 2022, Almaty was visited by more than 320 thousand tourists, 55 thousand representing visitors from abroad (Official informational source of the Prime Minister of the Republic of Kazakhstan). Ten destinations of Almaty and its surrounding area, including destinations of the Almaty mountain cluster, were prioritized for development. The efforts to promote the Almaty region as an attractive tourist destination included active advertising work carried out both in the domestic and international markets. Information about tourist sites in the region was updated in Google street, Wikipedia and Yandex services (ibid.). According to the city tourism department, during the first half of 2023, the number of foreign tourists visiting Almaty rose to 261.6 thousand people (Profi Travel). The city Akimat (city council) expects that by the end of 2023, up to 500 thousand foreign tourists will visit Almaty (ibid.). During the latest meeting of the Council of Heads of the Shanghai Cooperation Organization which took place in July 2023, the President of the Republic of Kazakhstan Kassym-Jomart Tokayev proposed to declare the city of Almaty the tourist and cultural capital of the Shanghai Cooperation Organization (SCO) for the period of Kazakhstan's chairmanship in the SCO (Official website of the President of the Republic of Kazakhstan).

Even though the city has the potential to grow and develop its tourism sphere, the branding of Almaty remains to be developed. Throughout the history of independent Kazakhstan, contests were conducted on the branding of some cities in the country. As to Almaty, a logo oriented towards attracting tourists was introduced in 2016 and instantaneously became the object of heated discussions (Galeyeva, 2022; see Figure 4).

Figure 4. Logo of the city of Almaty

Source: Kapital (2016)

According to the Development Center of the city of Almaty, the developer of the logo, the apple in the center of the logo represents the core symbol of the city, while the seven circles around the apple are seven orbits of energy. Number seven has a sacred meaning in Kazakh culture, and symbolizes tribute to the past, traditions, and aspiration towards bright future (Kapital). The color coding stands for the colors of the sky, the flag of Kazakhstan, the sun, freedom, vitality and energy, harmony with nature, inspiration and purity of the creative path (ibid.). Thus, the logo was supposed to represent the sacredness of Almaty heritage, however, some commenters thought that the image failed to live up to its promise. For instance, according to the General Director of the International Foundation "Eurasian Media Forum", the authors failed to convey the main idea in the image of Almaty — that it is "the city of apples" and "the city located at the foothills of the mountains". Zoya Falkova, contemporary artist, adds that the sacredness feature from the explanation is clearly far-fetched (KTK). Other Almaty citizens (Galeyeva, 2022) also stated their concerns about the new logo: when being presented with the logo, some saw a triangle of radioactive/biological/nuclear danger, while the apple in the center was associated with the disappearance of apple orchards in the city (ibid.). Perhaps, as a response to the dissatisfaction with the symbol of Almaty expressed by the residents (Galeyeva, 2022; KTK), in 2022 the city administration announced the plan to develop a new city brand — "Discover Almaty" which would aim to promote Almaty as a tourist destination and accompany the improvement in the quality of tourism services. The administration believed the new brand would support the planned increase in the flow of foreign tourists to 1 million people by 2030 (TengriNews).

Methods

Qualitative research approach was selected for this study as it serves to contribute to achieving research aim and objectives by capturing information which cannot be conveyed in quantitative data and exploring the application of theoretical models to a practical case (Creswell, 2014). In addition, qualitative research approach was better suited for the current study as it allows extracting sufficient volume of data from a relatively small sample size (Bachelor Print). Exploratory research approach was adopted as the addressed research questions have not previously been studied in depth (Creswell, 2014). Methodology of the study employed the content analysis. Content analysis is a research data analysis method which intends to review and assess the communication messages extracted from data sources (Krippendorff, 2019). Content analysis was chosen for the reason that it allows capturing a more insightful sense of researched concepts within the dataset (Vitouladiti, 2014). Content analysis was conducted based on established theories of brand authenticity using data collected from social network pages dedicated to the city of Almaty. For this study, the authors decided to focus on Instagram for the foremost reason that today it is one of the most widely used social media worldwide: according to Statista, in 2021, Instagram boasted 1.21 billion monthly active users which made up 28 percent of the world's internet users while as per Statista's forecast, by 2025, the number of Instagram active users would reach 1.44 billion which would account for over 31 percent of global internet users (Acuti et al., 2018; Statista).

The ten reviewed Instagram accounts dedicated to the city of Almaty were chosen using purposeful sampling method (Palinkas et al., 2015). Thus, the Instagram accounts of official city administration departments were selected first, including "akimat_almaty" account managed by Almaty city Akimat, "openalmaty" account, which is the official public reception service of Almaty city administration,

"almatytourism" account which is managed by Almaty city tourism department, and "almatydc.kz" account, which represents Almaty city development center. The remaining six accounts were selected from a list of accounts dedicated to Almaty on Instagram based on the number of followers and the account dedication to type of activities detailed in the city. The latest one hundred posts from ten selected Instagram accounts dedicated to Almaty city as of November 1, 2023, were reviewed.

Out of the considered models, the following two models were selected for the analysis: the model proposed by Bruhn et al. (2012) and Anholt's City Brand Hexagon model (Anholt, 2006). The reason for choosing the model proposed by Bruhn et al. was that the model offers four distinct dimensions of brand authenticity each detailed in the model (Bruhn et al., 2012). Anholt's City Brand Hexagon model does not explore the brand authenticity; however, it was chosen to be applied in the study for its relevance to evaluate city brand with the assumption that if the city brand shows strong performance under the six elements of the City Brand Hexagon model, it has a distinct potential to build on its authenticity as authenticity has a direct positive link to brand equity (Tran & Nguyen, 2022). The dimensions/elements of each of the two selected models are now presented in detail.

1) Bruhn et al. (2012) model, Figure 2: four dimensions of brand authenticity — continuity, originality, reliability and naturalness. As mentioned above, the model was selected as it reflects distinct dimensions of brand authenticity, and the proposed dimensions are suited to be applied to the measurement of the city brand authenticity. The dimensions are as follows:

- *Continuity* — the brand fosters a sense of tradition and heritage over time. In the content analysis, cues searched for included visual or textual depictions of images related to the city's traditions, history, and heritage.

- *Originality* — the brand stimulates presentation of symbols and values that represent local culture. Cues included visual or textual reflections of symbols associated with local culture;

- *Reliability* — the brand is able to keep its promises and is reliable. Cues included characteristics of unified perception of the brand, such as consistent use of image and communication styles and fonts within posts, and consistent display of logo of Almaty within posts;

- *Naturalness* — the brand is in general genuine and natural. Cues contained associations of brand showing care and genuine motivation to serve the customers/citizens.

2) Anholt's City Brand Hexagon model (Anholt, 2006), Figure 3: six elements of city brand equity — presence, place, people, pre-requisites, pulse and potential. As stated earlier, even though the model does not directly explore the brand authenticity, it was chosen to be applied in the study for its relevance to evaluate city brand and the elements comprising the city brand equity. The assumption undertaken for selecting this model is that if the city brand shows strong performance under the six elements of the Hexagon model, it has a distinct potential to build on its authenticity as authenticity has a direct positive link to brand equity (Tran & Nguyen, 2022). These six elements relate to the different characteristics of the city brand:

- *Presence* denotes the city's status, both regionally and internationally. For the purpose of this study, the cues which were searched for the content analysis included the city's relations with other cities within the region and the city's prominence in international arena, if applicable;

- *Place* embraces the physical image of the city. Cues included visual and textual information about the city, its architecture, infrastructure, sights and locations;

- *People* reflects the inhabitants and their opinion towards the city. Cues included visual and textual information about the city dwellers;

- *Pre-requisites* in essence cover the city services including public transport, hospitals, education institutions, sports facilities and other city services. Cues depicted visual and textual associations with the city services;

- *Pulse* reflects whether the city life is considered to be vibrant and interesting. Cues included referrals to the city life, visual and textual representations of vibrant city events and people;

- *Potential* includes all the possibilities offered by the city both to the locals and to visitors such as education, employment, investments. Cues included information about the possibilities for employment and education offered by the city.

Table 1 presents an overview of Instagram accounts dedicated to Almaty city used for the content analysis of this study (Table 1).

Table 1. Instagram accounts dedicated to the city of Almaty by the number of followers

No.	Account	Organization (if applicable)	Number of followers	Number of posts	Main language(s)	Orientation
1	almaty.today		836 000	864	Russian	News, short interviews/overviews
2	almaty_city		411 000	22 600	Russian	News, photos/videos, user generated content, ads
3	akimat_almaty	Almaty city akimat (city government body)	333 000	4 554	Kazakh and Russian	Informative (news, events, celebrations)
4	almaty.memories		142 000	2 018	Russian	Historical photos of the city, user generated content, ads
5	almaty_novosti		100 000	6 918	Russian	News, events, ads
6	visitalmatykz		59 200	693	English, Kazakh and Russian	Overview of events, locations, sights
7	openalmaty	Public reception service of the Almaty city akimat	54 200	2 781	Kazakh and Russian	News, responses to citizens' requests/complaints (before/after photos, etc.), ads
8	almatytourism	Almaty city tourism department	14 200	450	Kazakh and Russian	Tourism related activities and events
9	inalmatykz		13 700	8 736	Russian	News, weather forecasts, ads, events
10	almatydc.kz	Almaty city development center	1 401	720	Kazakh and Russian	News, events, plans for development

Note — compiled by the authors based on content analysis (November 1, 2023)

Results

Out of the ten reviewed Instagram accounts dedicated to the city of Almaty, four are supported by official organizations — Almaty city administration ("akimat_almaty" account), public reception service of the Almaty city administration ("openalmaty" account), Almaty city tourism department ("almatytourism" account), and Almaty city development center ("almatydc.kz" account). In terms of the number of followers, the three leading accounts are "almaty.today" with over 836 thousand followers, followed by "almaty_city" with over 411 thousand followers, and "akimat_almaty" followed by more than 333 thousand users. "almaty_city" is the most active account displaying over 22 600 posts in total. The majority of the accounts duplicate the presented information in Kazakh and Russian languages, with the only exception of "visitalmatykz" account, where the posts are mainly written in English with occasional additions in Kazakh and Russian. Most of the accounts are oriented towards delivering news. In addition, half of the accounts have a more specific purpose: "visitalmatykz" and "almatytourism" are targeting tourists, "almaty.memories" is largely devoted to displaying the retro-style photographs of the city, "openalmaty" occasionally deals with complaints/concerns of the city dwellers, and "almatydc.kz" at times posts plans on developing the city. Out of all accounts, only "almaty_novosti" uses the logo of the city of Almaty (Kapital) in its posts, while "almatydc.kz", "akimat_almaty", "openalmaty", and "almatytourism" use the official city coat of arms. Next, analysis is presented of all ten Instagram accounts through the models of perceived brand authenticity dimensions developed by Bruhn et al. and City Brand Hexagon model created by Anholt.

Bruhn et al. developed a psychometric scale for measuring consumers' perceptions of brand authenticity (Bruhn et al., 2012). According to their model, brand authenticity is composed of four distinct dimensions, which were assessed through the content analysis of hundred posts from each of the ten selected Instagram accounts dedicated to Almaty city.

The following table reflects the assessment of city brand authenticity within the posts from the selected Instagram accounts using the measurement model proposed by Bruhn et al. (Table 2).

Table 2. Assessment of 100 posts in Instagram accounts dedicated to the city of Almaty according to the dimensions developed by Bruhn et al.

No.	Dimension / Account	Continuity	Originality	Reliability	Naturalness
1	almaty.today	7	15	97	31
2	almaty_city	12	12	44	8
3	akimat_almaty	15	12	47	40
4	almaty.memories	32	18	70	9
5	almaty_novosti	2	3	72	19
6	visitalmatykz	16	24	57	13
7	openalmaty	7	9	74	50
8	almatytourism	14	21	30	20
9	inalmatykz	2	4	26	22
10	almatydc.kz	6	8	85	24
Note — compiled by the authors based on content analysis (2012)					

- *Continuity* — out of the ten considered Instagram accounts dedicated to Almaty city, the account with the largest number of continuity cues was "almaty.memories", the account which is largely oriented towards reliving history of the city through retro-style photographs. Indeed, the content displayed in the account s reflects the city heritage which in turn appears to attract followers, as the account has the fourth largest number of followers out of the ten reviewed pages. The accounts "visitalmatykz" and "almatytourism" boasting notable number of posts with 'continuity' cues are more often oriented towards attracting tourists which can be explained by the notion of tourists being drawn to the history and heritage of the destination. While the accounts devoted to covering local news and events showed fewer posts with "continuity" cues ("almaty_novosti", "inalmatykz");

- *Originality* — both accounts oriented towards promoting tourism in the city are more often associated with the "originality" cue ("visitalmatykz", "almatytourism"). The posts reflect the connection to local culture intended to inspire tourists to visit Almaty. Once again, the Instagram pages dedicated to covering news are less concerned with displaying "originality" cues ("almaty_novosti", "inalmatykz");

- *Reliability* — most of the reviewed Instagram accounts showed consistency in their posts: the style was similar with the continuous usage of the same fonts, elements and designs. "almaty.today" and "almatydc.kz" displayed the largest number of posts with the consistent use of design and style. Overall, the communication style of posts within all ten accounts was also consistent: the majority of accounts used both Kazakh and Russian languages for covering the information in their posts, and had done it on a consistent basis;

- *Naturalness* — a number of posts reflected the care and the genuine motivation to support and help the readers. Accounts "openalmaty" and "akimat_almaty" displayed the largest number of posts with "naturalness" cues which can be explained by the orientation of these account towards responding to concerns of Almaty citizens and providing overall support and care.

Next, the same posts from Instagram accounts were reviewed using Anholt's City Brand Hexagon model (Anholt, 2006; Benedek, 2017). The following table reflects the assessment of posts within the selected Instagram accounts in terms of City Brand Hexagon model (Table 3). One hundred posts (as of November 1, 2023) were reviewed for each account.

Table 3. Assessment of 100 posts in Instagram accounts dedicated to the city of Almaty according to Anholt's City Brand Hexagon model (compiled by authors based on content analysis)

No.	Element / Account	Presence	Place	People	Pre-requisites	Pulse	Potential
1	almaty.today	5	44	50	42	13	5
2	almaty_city	2	48	33	12	10	3
3	akimat_almaty	3	59	72	32	16	1
4	almaty.memories	-	84	19	14	2	-
5	almaty_novosti	-	35	59	22	2	-
6	visitalmatykz	8	96	50	6	21	-
7	openalmaty	7	67	50	20	8	1
8	almatytourism	11	48	58	14	10	1
9	inalmatykz	9	48	52	24	3	1
10	almatydc.kz	12	78	41	24	3	7
Note — compiled by the authors based on content analysis							

- *Presence* — as it was mentioned earlier, the cues for the "presence" element cover the city's relations with other cities within the region and the city's prominence in the international arena. A few cues related to the city presence were identified within the posts of the Instagram accounts of Almaty city. "Almatydc.kz" and "almatytourism" had more posts with "presence" cues as they promoted the status of Almaty city internationally.

- *Place* element involved cues with visual and textual information about the city, its architecture, infrastructure, sights and locations. All the accounts displayed considerable number of "place" element cues reflected in posts depicting Almaty architecture and infrastructure with "visitalmatykz" leading with place cues appearing in 96 posts out of the reviewed 100;

- *People* — again, all of the accounts dedicated to the city of Almaty displayed cues associated with people with "akimat_almaty" showing the largest number of posts about Almaty citizens. Notably, "almaty.memories" had the smallest number of "people" element cues, as the account is mostly displaying retro photos of Almaty architecture and landscape;

- *Pre-requisites* — most of the accounts expressed concern with the state of city services. In particular, a notable number of posts associated with public transport issues and news was displayed in majority of accounts; the largest number of "pre-requisites" element cues reflected in posts depicting, among others, issues associated with Almaty traffic, state of public transport and city safety conditions was noticed in "almaty.today" and "akimat_almaty" accounts while "visitalmatykz" had the fewest number of posts with "pre-requisites" element cues which can be explained by the account orientation to attract tourists rather than to cover information on public city services.

- *Pulse* — all ten reviewed accounts had some posts reflecting the vibrant life of Almaty city. The account "visitalmatykz" showed the largest number of posts which could be associated with the "pulse" element due to, assumably, the account mainly targeting tourists and, therefore, displaying the attractions of the city life including but not limited to announcements about city festivals and celebrations, concerts and exhibitions, and sports events. Other accounts showed less activity within this element as they more often focused on the routine city news;

- *Potential* — surprisingly, the potential element was the most neglected out of all six elements of the model: only some Instagram accounts had posts reflecting the city potential, and even if present, those posts were quite scarce. "almaty.today" and "almatydc.kz" had 5 and 7 of the posts covering the potential of the city respectively: the focus of the posts often mentioned employment and education opportunities offered by the city.

Discussions

Findings show that the reviewed Instagram accounts fared well in terms of brand authenticity as all four dimensions of continuity, originality, reliability and naturalness proposed by Bruhn et al. were covered to some extent by each of the accounts. However, the distribution of the presence of all four dimensions is uneven with some accounts presenting more cues of some dimensions while no single account embodied consistent number of cues of all four dimensions. This inconsistency in coverage may lead to a fragmented image of the city of Almaty for the citizens and visitors alike as they would need to follow several accounts of the city to get a complete picture and understanding of the city brand. Still, based on the results of this study, the reviewed Instagram accounts displayed posts containing cues reflecting all four dimensions of brand authenticity (continuity, originality, reliability and naturalness). In particular, "continuity" and "originality" were notably displayed in Instagram accounts dedicated to attracting tourists, while cues associated with "reliability" were present in most of the reviewed accounts and "naturalness" was largely presented within accounts run by the city council. Therefore, it could be derived from the performed analysis that Almaty has the potential of building an authentic brand.

Following the analysis based on Anholt's City Brand Hexagon model, all ten Instagram accounts devoted to Almaty city performed strongly within "place", "people" and "pre-requisites" elements. Elements of "presence" and "pulse" received less attention, while "potential" was neglected which conveys an incomplete picture of the overall brand perception of the city of Almaty, especially in the perception of potential visitors and tourists as all six elements of the City Brand Hexagon model are essential to build a successful brand. A similar issue can be observed with the brand authenticity dimensions' model: the elements are covered inconsistently throughout different Instagram accounts with no single account displaying all elements required for an effective account of a city brand. Thus, the citizens and visitors would need to follow several accounts of the city to get a full picture of the city brand.

To summarize, the analysis showed that the efforts to display all dimensions and all elements of the city brand of Almaty are in place. The official organizations such as Almaty city administration, Almaty city tourism department and Almaty city development center attempt to build on Almaty brand by regularly posting and updating their social network accounts. However, it can be observed that there is no unified effort to promote the brand of the city. The adopted logo of Almaty is being used only by only one Instagram account. There are numerous occasions of the same news being displayed within several accounts. Moreover, as the information is fragmented across the reviewed Instagram accounts, and the accounts seem to target different aims, a visitor will have to follow several accounts of the city to get a complete picture of the Almaty brand. Therefore, the main recommendation would be to unify the efforts to promote the brand of Almaty by offering a single main Instagram account for the city which would serve as an umbrella account for supplementary pages; with each page displaying information devoted to one type of activity, whether it is tourism in general, wherein posts could reflect cues from continuity and originality dimensions of brand authenticity measurement model developed by Bruhn et al. along with cues relating to presence, place and people elements which compose Anholt's City Brand Hexagon model; vibrant city life, for which posts could reflect cues from originality dimension and pulse element; retro-style photos with posts depicting cues from continuity dimension along with presence and place elements); complaints/suggestions with posts containing cues from reliability and naturalness dimensions and pre-requisites element); news, where posts may reflect cues from originality and reliability dimensions and all six elements of Anholt's City Brand Hexagon model), etc. The main account could serve as the main source of general city news and events with the list of supplementary accounts displayed in the main information section of the account.

Conclusions

This paper presented an overview of the extant literature about the definition and models for measuring brand authenticity. Several models for measuring brand authenticity were discussed, including the model of perceived brand authenticity elements developed by Morhart et al. (2015) and the model of brand authenticity dimensions proposed by Bruhn et al. (2012). It can be observed, that even though various approaches to measuring brand authenticity had been developed (Hernandez-Fernandez & Lewis, 2019; Morghart et al., 2015; Bruhn et al., 2012), the existing research on the topic does not offer a unified technique for measuring brand authenticity, in particular, relating to the city brands. Two models were selected for measuring brand authenticity of Almaty, Kazakhstan: perceived brand authenticity dimensions developed by Bruhn et al. and City Brand Hexagon model created by Anholt. The model proposed by Bruhn et al. was chosen because it defines four distinct dimensions of brand authenticity, each covered in detail. (Bruhn et al., 2012). Anholt's City Brand Hexagon model does not explore the brand authenticity, however, it was chosen to be applied in the study for its relevance to evaluate city brand with the assumption that if the city brand shows strong performance under the six elements of the City Brand Hexagon model, it has a distinct potential to build on its authenticity as authenticity has a direct positive link to brand equity (Tran & Nguyen, 2022). Content analysis of posts from ten Instagram social network pages dedicated to Almaty city was performed to assess brand authenticity from data collected from the Instagram social network pages dedicated to Almaty city. The analysis showed that for the city of Almaty, the efforts to display the brand authenticity dimensions proposed by Bruhn et al. and City Brand Hexagon model elements created by Anholt are in place. However, the dimensions/elements are covered inconsistently throughout the reviewed Instagram accounts with no single account displaying all dimensions/elements required for effective city brand presentation. Thus, the citizens and visitors alike would need to follow several accounts of the city to get a full picture of the city brand. The main recommendation would be to unify the efforts to promote the brand of Almaty by offering a single main Instagram account for the city which would serve as an umbrella account for supplementary pages each of which would display information within its orientation.

Theoretical implications

This paper presents an analysis of city brand authenticity based on social network analysis for an emerging brand of the city of Almaty. The theoretical models used in this study were adapted to assess both the authenticity of the city brand and the overall city brand strength and could be adopted to assess other city brands in the country. Such analysis could serve as a basis for identifying which brand authenticity dimensions an emerging destination should focus on to develop its brand.

Managerial implications

The analysis of city brand authenticity based on social network analysis performed in this study displays an effective overview of the main existing social network accounts dedicated to the city of Almaty and their authenticity dimensions displayed about the city of Almaty. This study could be useful for the Almaty city destination management organizations and the city tourism department for adapting the strategy of building a successful city brand in the south of Kazakhstan which would enable to attract more tourists into the city. The study could also serve as a guidance for creating a better communication strategy from the Almaty city council, which would particularly address the ways of developing the image of the city and communicating that image for wider tourism development.

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ORIGINAL RESEARCH

China's special economic zones: from traditional labor-intensive industries to eco-industrial park development

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Abstract

Special economic zones (SEZs) development plays a significant role in China`s economic and industrial growth. However, rapid industrialization and increasing number of industrial parks has significantly intensified environmental pollution issues. These facts resulted in an urgent need for effective coordination between further economic growth, industrial expansion, and search for solutions to environmental issues. One of the most effective approaches to implement these concerns is to develop eco-industrial parks (EIPs). The research applied methods: the dialectical method for analyzing models of various SEZ types creation and operation; historical and logical analysis methods for examining the historical stages and processes for SEZ development; comparative analysis methods for studying the prerequisites to modernize and transform certain SEZ types into EIPs; structural analysis methods to evaluate economic performance indicators and identify the structure of EIPs. The primary goal for EIP concept development has been to balance between intensive industrial growth and environmental issues resolution. The EIPs creation can be considered as one of the key instruments in implementing the sustainable development policies, aiming to integrate environmentally friendly technologies into production, reduce CO_2 emissions, and promote efficient resource use. The EIPs operational mechanism is built on circular economy principles, fundamentally modifying production and consumption models within China`s economy. EIPs serve as a key mechanism for transitioning China's economy from extensive to intensive growth model. To achieve sustainable development goals and coordinate the relationship between economic expansion and environmental protection issues, China has been implementing programs for more than two decades aimed at gradually transforming national development zones, ETZs and HTZs into EIPs. The economic performance indicators of EIPs highlight their role as the leading economic and industrial centers in China, driving substantial economic growth due to innovation, sustainability, and international cooperation.

***Keywords**:* China, special economic zones, economic development, Eco-Industrial Parks, environmental technologies, circular economy, sustainable development, innovation.

Introduction

Special economic zones (SEZs) establishment processes in China were initiated in 1979, alongside the government's economic reforms. Over the past 35 years, SEZs have played a significant role in the country's economic development and rapid industrialization. SEZs can be considered as a key instrument of state policy, fulfilling multiple strategic functions:

- SEZs have been used as a tool for industrial development, aiming to drive the country's industrial expansion and technological development;
- SEZs serve as a key instrument of investment policy, aiming to attract foreign capital and stimulate economic growth;
- SEZs have functioned as a regional policy tool, facilitating industrial development in specific areas of the country while solving employment issues.

The first SEZs, in the form of Development Zones (DZs), primarily specialized in labour-intensive production due to the availability of extremely cheap labour at the time. These zones consumed large amounts of resources, promoted rapid industrial capacity expansion, and contributed to extensive economic growth in China. Hundreds of industrial parks were established, serving as hubs for concentrated industrial production. However, this led to severe environmental pollution, particularly air pollution, and high carbon dioxide (CO_2) emissions, especially in major industrial centres. By the 2000s, amidst escalating environmental chal-

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lenges, the need to transition from an extensive growth model to an intensive growth model became evident. China initiated the development of Eco-Industrial Parks (EIPs) within the framework of existing National Economic and Technological Development Zones (ETZs) and National High-Tech Zones (HTZs). The emergence of EIPs reflects a shift in China's economic development strategy. The primary goal behind the EIP concept development was to establish a balance between rapid industrial growth and environmental issues solution. The EIPs creation can serve as a key tool in sustainable development policies implementation. One of the most effective mechanisms for coordinating sustainable economic policies has been the implementation of circular economy principles, including the establishment of Eco-Industrial Parks. EIPs enhance the economic, environmental, and social efficiency of enterprises. The Eco-Industrial Parks have become a central element of China's modern industrial strategy, which seeks to combine intensive industrial development with the advancement of green technologies, minimize environmental impact, and improve resource efficiency. As of 2022 China had already established 109 EIPs.

Literature Review

In scientific literature, numerous scholars have conducted research over different time periods on the mechanisms of Special Economic Zones (SEZs) and their impact on the economy of the host country. Various studies have analysed both positive and negative effects of transnationalization and foreign capital inflows, particularly in developing countries, as these investments have had diverse economic consequences. Global researchers have shown significant interest in China`s experience with establishing different types of SEZs and their role in the country's industrial development. A distinct area of research focuses on the development of Eco-Industrial Parks (EIPs) in China and their role in sustainable development policies. The main thematic areas of research by both domestic and foreign scholars can be outlined as follows:

1) The establishment of SEZs in China and their use as a tool for industrial, investment, and regional policies, as well as their role in economic and industrial development, have been explored in the works of S. Zhang (Zhang, 2019), X. Chen (Chen, 2019), D. Marjanac (Marjanac, 2021), M. Wu, C. Liu, J. Huoang (Wu et al., 2021), X. Lin, C. Yan, K. Zhang (Lin et al., 2022), F. Lu, W. Sun, J. Wu (Lu Fangwen et al., 2022), etc;

2) The creation and development of Eco-Industrial Parks in China as a new model for ecological and innovative development, the transformation of existing industrial clusters into EIPs, and the formation of circular economy models and green production within EIPs have been studied in the works of H. Hong, A. Gaspararatos (Hong, Gaspararatos, 2020); T. Wang, M. Zhang, C.H. Springer, C. Yang (Wang et al., 2021); R. Bleischwitz, M. Yang, B. Huang, X. XU, J. Zhou, W. McDowall (Bleischwitz et al., 2022), A. Coussa (Coussa, 2024), etc;

3) The environmental and economic effects of Eco-Industrial Parks in China, their role in environmental conservation, and their contribution to the implementation of sustainable development policies have been discussed in the research of B. Huang, G. Yong, J. Zhao, T. Domenech, Z. Liu, S.F. Chiu (Huang et al., 2019), K. Cao, l. Jin, Y. Zhu, Z. Ne, H. Li (Cao et al., 2022), X. Liu, J. Zhang, T. Liu, X. Zhang (Liu et al., 2022), Z. Tingting, X. Jiaping, L. Ling, X. Jiqing (Tingting et al., 2024), etc;

4) The statistical and analytical data on the functioning of SEZs in China can be found in the reports and databases of UNCTAD, the World Bank, as well as in databases Ministry of Commerce of the People's Republic of China, Ministry of Science and Technology of the People's Republic of China, Websites of SEZs.

At the same time, many aspects of the impact of SEZs and EIPs — such as their temporal, spatial, economic, and environmental effects — on China's economic development, as well as the applicability of China's experience to other developing economies, remain open for further research.

Methods

In conducting this study, the authors used the following research methods: a) dialectical analysis was used to analyze the models for establishing various types of special economic zones (SEZs) (to understand how development zones can be transformed into Eco-Industrial Parks (EIPs), and explore the EIPs operational mechanisms based on circular economy principles, as well as to analyze interactions between various factors such as the geographic concentration of EIPs, their sectoral specialization, resource distribution and circulation, government policies, and social and economic outcomes); b) historical and logical analysis (used to analyze the stages and processes of SEZ creation); c) comparative analysis (used to study the processes of prerequisites formation to modernize and transform the certain types of SEZs into Eco-Industrial Parks); d) structural analysis (used to analyze economic performance indicators and identify the structure of Eco-

Industrial Parks, as well as to determine EIP development trends and assess their role in sustainable development policies implementation); e) systematic approach and empirical research methods (comparison, analysis, and synthesis) to identify the individual components of the object under study and establish cause-and-effect relationships.

Results

Since China initiated its economic reforms and the "open door" policy in 1978, the country has achieved remarkable progress in its economic development, becoming one of the largest economies in the world. A significant role in this phenomenal economic growth has been played by the numerous Special Economic Zones (SEZs). The establishment of SEZs, the first of which emerged nearly 40 years ago, is regarded as one of the most critical factors in China's integration into the global economy. Today, SEZs account for 22 % of China's GDP, 45 % of total foreign direct investment (FDI), and 60 % of the country's exports (The World Bank, database).

As of 2022, China has established numerous 2543 SEZs across the country (Liu Xiao et al., 2022). In 1984, the State Council of China approved the establishment of the first 14 SEZs in the eastern coastal regions, focusing primarily on industrial projects (although the earliest SEZs — Shenzhen, Zhuhai, Xiamen, and Guangdong — had been operating de facto since 1979). The combination of SEZs being supplied with cheap labour from rural areas, essential production resources, and a favourable regime for foreign investments created conditions for scaling up industrial production. From this period onward, China started the large-scale implementation of the SEZ concept, using them as tools for industrial, investment, and regional policies (Marjanac, 2021). The role of SEZs in China's regional development, aimed at smoothing out existing imbalances, is extremely important (Cranea et al., 2018). Since their creation in China, Special Economic Zones (SEZs) have been primarily focused on key objectives such as developing industrial production, particularly manufacturing sector, promoting cutting-edge technologies, generating employment opportunities, fostering human capital development, and attracting foreign investors with all necessary investments to support these processes. It is necessary to separately highlight the importance of zones for the technological development of the country and the introduction of innovations into industrial production (Yeung in et al., 2009). SEZs have played a major role in developing human resources, improving labor productivity and building China's modern human resource potential Lu Fangwen et al., 2022). SEZs are now established in various regions of China, leveraging demographic potential and accessibility to global markets (making them more attractive for foreign investments), administrative centres, seaports, and other strategic advantages. Each SEZ is designed for specific sectors and employs unique approaches to fostering global competitiveness, offering a distinct "value proposition" (UNCTAD,2019).

The key functions that special economic zones (SEZs) were required to fulfill for the national economy include the following:

- Attracting additional financial resources, particularly foreign investments, to accelerate economic growth both at the national level and within specific regions;
- The progressive role of SEZs in driving China's rapid industrialization at the end of the last millennium and fostering extensive diversification of production;
- Developing key sectors of the manufacturing industry to facilitate the transition from labor-intensive specialization to capital-intensive production, and eventually to the emergence of high-tech industries and research centers equipped with modern technologies;
- Promoting export-oriented industries to enhance China's competitive potential and facilitate the country's expansion into international markets;
- Developing domestic research and innovation, establishing research centers, and consequently, developing a highly skilled workforce and creating advanced production facilities;
- Establishing new economic activity centers to ensure balanced development across different regions;
- Implementing a regional development model to promote economic growth, particularly in industry, tourism, and trade.

In China, numerous types of SEZs can be identified (Table 1). The evolution of SEZs in China has taken place in stages, reflecting the country's primary goals and economic development priorities (Zhang, 2019; Chen, 2019). During the initial phase, following the introduction of the "open door" policy, the Chinese government aimed to accelerate industrialization through the attraction of foreign capital. SEZs became a key tool in achieving this goal by providing preferential conditions for foreign investors and stimulating the creation of new production capacities. The next step involved the industrialization of specific regions. The

transition to more complex manufacturing took place within industrial parks and clusters, with a focus on processing final products. Subsequently, the Chinese government shifted its focus to fostering high-value-added production. SEZs became hubs for the development of high-tech industries based on cutting-edge innovations and research (Zeng, 2010; Yeung, 2009). (Examples include SEZs such as Shenzhen, Zhuhai, Xiamen, Hainan (Lin et al, 2022)). The practical results showed that the SEZ's program (2000–2017) significantly promoted the green technology innovation of enterprises. The number of green patents in SEZ's has increased by 17 % (Liu Xiao et al., 2022). A progressive advancement followed with the establishment of eco-industrial parks, designed to adhere to strict environmental standards and principles of a circular economy. Even today, China's practice of establishing eco-industrial parks serves as a model and an example for other countries to follow.

Table 1. Key types of SEZs in China and their strategic focus

Types of economic zones	Targeted focus and periods of establishment
Special Economic Zones (SEZs)	Attracting foreign capital, creating jobs, developing underperforming regions, and promoting export-oriented, labour-intensive industries — Shenzhen, Zhuhai, Xiamen, Guangdong (established in 1979). Over time, a gradual shift occurred toward capital-intensive and technologically advanced production, with examples such as Hainan (1988) and the Pudong New Area in Shanghai (1989).
Development Zones (DZs)	Varying by status (provincial, regional, national), level of autonomy, and territorial size, often created for large-scale investment projects. Facilitating industrialization of specific regions. Initiated in the 1990s. By 2006, 1,568 DZs were operational, serving as a foundation for further development into ETZs and FTZs.
National Economic and Technological Development Zones (ETZs)	These are government-designated areas in China where state development programs are used to encourage foreign investment inflows, promote industrial production (focusing on transition from labor-intensive specialization to capital-intensive production), and encourage cutting-edge technologies development and implementation. ETZs serve as the foundation for the specialized industrial clusters development. The first ETZs were established in 1984 across 14 coastal cities, including Shanghai, Tianjin, Dalian, Qingdao, and Shenzhen. By 1992, 35 ETZs existed, growing to 70 by 2010.
National High-Tech Zones (HTZs):	The establishment of HTZs focuses on high technologies and innovations, the development of green technologies, and the creation of concentrated scientific potential for the commercialization of research and development. These zones aim to facilitate the design, production, and export of advanced technological products and innovations. The first HTZ, Zhongguancun (Beijing), established in 1988. By 2010, 54 HTZs were in operation.
Free Trade Zones (FTZs):	The primary goal of their establishment is to promote international trade and related business activities. Specialization: duty-free zones, export processing, foreign trade, logistics, warehousing, and infrastructure development. One of the first zones, Waigaoqiao, was established in Shanghai in 1992. By 2010, 15 FTZs operated across 13 coastal cities.
Export Processing Zones (EPZs)	EPZs started to be established to promote industrial export production and attract foreign investment. Typically, EPZs involve designated areas within Special Economic Zones (SEZs) designed to facilitate goods production for export. The first EPZ in China was established in 1980 in Shenzhen. One of the largest EPZs was the Waigaoqiao EPZ in Shanghai. Today, China has over 50 EPZs, primarily located in major industrial centers. By 2010, there were 61 EPZs in China (44 in coastal areas and 17 inland).
Industrial Parks	Concentration of industrial activity, creating technologically advanced production facilities, and forming industrial clusters.
Eco-Industrial Parks (EIPs)	EIPs embody China's national development strategy, focusing on environmental conservation and zero-waste production development. The core principles of EIPs are to develop eco-friendly industries and integrate circular economy practices. The first EIP in China was considered to be Suzhou Industrial Park, which started developing in the late 1990s, introducing the closed-loop production concept. The title of China's first national demonstration eco-industrial park was granted to Guangxi Guigang National Demonstration Eco-Industrial (Sugar) Park, established in 2001.
Note — compiled by the authors according to databases of UNCTAD, the World Bank, FDI-China, Websites of SEZs	

After establishing labour-intensive industries within SEZs, the Chinese government laid the foundation for developing capital-intensive and high-tech production. To achieve this, the government implemented a differentiated policy for foreign direct investments (FDIs), offering incentives and preferences to attract FDI into high-tech and innovation-driven industries. This policy became the cornerstone for the establishment of

National Economic and Technological Development Zones (ETZs) and National High-Tech Zones (HTZs). While many of the measures for foreign investors in ETZs and HTZs mirror those in SEZs, ETZs introduced a division between manufacturing and non-manufacturing enterprises, with a tax rate of 15 % for the former and 30 % for the latter (China's Ministry of Commerce, 2024). FDI activities within HTZs are focused on knowledge-intensive projects and exports.

To encourage research and development (R&D) activities within ETZs and HTZs and facilitate their integration into production, as well as to stimulate export-oriented activities (where at least 70 % of production must be exported), China has introduced a preferential tax rate of 15 %. Additionally, this preferential period can be extended for three more years for the companies engaged in advanced technologies development and implementation. To further incentivize reinvestment, China introduced tax refunds for reinvested capital. If profits are reinvested in the enterprise within five years, 40 % of the tax is refunded; if reinvestment targets high-tech or export-oriented enterprises, 100 % of the tax is refunded. Through these measures, the Chinese government successfully specialized ETZs and HTZs for attracting FDI into export-oriented, capital-intensive production (ETZs) and export-driven, high-tech enterprises (HTZs). In contrast, SEZs encouraged FDI more broadly (Kuznietsova, 2024).

Traditional models of industrial parks in China serve as areas of concentrated industrial activity and key drivers of the country's economic development. Industrial parks account for 60 % of China's industrial output, 70 % of energy consumption, and 72 % of greenhouse gas emissions (Bleischwitz et al., 2022). Despite China's impressive achievements through the establishment of industrial parks, rapid industrialization has also brought significant environmental challenges. With growing attention to climate change, ecological issues have become a major concern. Key problems include severe water, air, and soil pollution, as well as large volumes of industrial waste. To preserve the environment and implement sustainable development goals, China is undertaking large-scale efforts to transform industrial clusters established within DZs, ETZs, and HTZs into eco-industrial parks.

In 2001, the Chinese government implemented a large-scale program to establish Eco-Industrial Parks, emphasizing the adoption of resource-efficient and environmentally friendly technologies. This initiative paved the way for the China's gradual transition from extensive to intensive economic growth model. That same year, the construction of China's first national demonstration eco-industrial park — the Guangxi Guigang National Demonstration Eco-industrial (Sugar) Park — was approved (Zhang Ling et al., 2010). The transformation and conversion of Development Zones (DZs) into Eco-Industrial Parks (EIPs) typically occur through specific UpGrade processes in production technologies within individual zones, following this sequence (Cao Kairui et al., 2022): 1) provincial development zones undergo UpGrade processes to achieve the status of national development zones; 2) national development zones, through economic development initiatives, can be transformed into either: a) National Economic and Technological Development Zones (ETZs), or b) National High-Tech Zones (HTZs); 3) modernization and transformation of ETZs and HTZs into Eco-Industrial Parks (EIPs).

The modernization and transformation processes of ETZs and HTZs into EIPs differ significantly due to distinct industrial focus of each zone type, their technological levels, the readiness of enterprises to implement EIP principles, and the varying types of industrial clustering within the zones. The primary characteristic of HTZs is the development of knowledge-intensive and high-tech industries, with a focus on scientific and technological innovations, including information technology, nanotechnology, biotechnology, and more. For this reason, the trends in activities, operational principles, financial preferences and subsidies for National High-Tech Zones (HTZs) were monitored by China's Ministry of Science and Technology, ensuring alignment with the country's overall economic and technological development strategy. In contrast to HTZs, the goals for the National Economic and Technological Development Zones (ETZs) establishment were different. They focus on industrial development based on contemporary technologies within specific regions, emphasizing processing or extractive industries depending on the region's resources (this transition typically involves transitioning from labor-intensive to capital-intensive industries) while actively attracting foreign investors. ETZs actively implement export-oriented programs. Based on ETZs core functions, their activities are monitored by the Ministry of Commerce of China. This Ministry is responsible for shaping ETZ policies while considering China's positioning in primary global commodity markets. The operating mechanism of EIPs is much broader, based on the principles of a circular economy. EIPs encompass a wide range of industries, emphasizing the development of environmentally sustainable technologies. Key industries include electronics, electrical engineering, machinery manufacturing, automotive production, chemical production, energy, healthcare, and food and textile industries.

At the current stage of economic development, both in China and globally, eco-industrial parks represent the highest level of evolution among special economic zones, particularly industrial parks. The concept of EIPs is based on the principles of circular economy and integration of environmentally friendly green technologies into industrial production, complying with sustainable development goals (Coussa, 2024). Primary goal of Eco-Industrial Park is to connect various enterprises through logistics or energy flow transfers, creating a symbiotic combination of industries that share resources and exchange by-products (Wang Tiantian et al., 2021). In this system, by-products or waste from one facility can become raw materials, resources, or energy sources for another. EIP should imitate a "natural system" within the park and establish a "producer-consumer-decomposer" cycle within the industrial ecosystem. Aiming to establish a high-tech, highly efficient, and environmentally friendly park, EIP can also implement closed-loop material cycles, multi-level energy utilization, and waste minimization (Mathews et al., 2018). Depending on the level of production activities diversification, EIPs are divided into three main groups: integrated (with entities/operations from several industries sectors); sectoral (with a dominant industrial sector): venous (dominant industrial sector is waste reuse and recycle) (Hong, Gasparatos, 2020).

The operations of EIPs are based on the principle of "reduce, reuse, and recycle", which encompasses three core components: 1) reduction principle: focuses on minimizing the sources of economic activity by reducing consumption of materials, raw resources, and energy required to meet production and consumption demands through the adoption of advanced technologies; 2) reuse principle: focuses on both production and consumption sectors; 3) recycling principle: requires that products can be turned into usable resources instead of unnecessary waste (Cao Kairui et al., 2022).

The above principles integration into operations represents the practical implementation of the circular economy concept and leads (as a result of EIPs activities), to more efficient use of natural resources and the solution of various environmental issues. Among the top priorities are reducing environmental pollution levels and lowering greenhouse gas emissions. Based on 15 years of research data, it has been established that EIPs significantly reduce the intensity of carbon dioxide (CO_2) and sulphur dioxide (SO_2) emissions; EIPs have been found to reduce sulphur dioxide emissions by 27.8 % and carbon dioxide emissions by 11.2 %. This indicates that the establishment of EIPs can contribute to sustainable development with low carbon emissions (Cao Kairui et al., 2022).

China's current policy on Eco-Industrial Parks creation demonstrates the country's commitment to integrate environmental approaches into industrial growth**. The key features of China's Eco-Industrial Parks include:**

- **Circular Economy: reuse of resources and waste.**
- **Green Energy: utilization of renewable energy sources.**
- **Industrial Symbiosis: resource sharing among enterprises.**
- **International Cooperation: joint projects with other countries (e.g., Germany, Singapore).**

The circular economy (closed-loop economy) represents a system of interconnected enterprises and complementary structures (operating within the framework of EIPs), organized into a unified production system based on closed technological cycles. This approach ensures the complete utilization of raw materials and waste within the system. These systems are built on compatible technological processes and adhere to clearly defined environmental standards and requirements (Liu Changhao, Cote, 2017).

The key objectives of implementing the circular economy, as outlined in China's 14th Five-Year Economic Development Plan, aim to establish the most advanced resource recycling system and enhance resource efficiency. These objectives include (Bleischwitz et al., 2022):

- Achieving a 20 % increase in resource use efficiency compared to 2020;
- Reducing water resource consumption by 13.5 % and energy resource — by 16 % per unit of GDP;
- Achieving waste recycling targets, including 86 % for agricultural residues (e.g., crop stems), 60 % for municipal solid waste, and construction debris;
- Expanding the resource recycling sector to a production value of 5 trillion yuan (approximately $770 billion USD);
- Deepening the development of agricultural circular economy systems and creating closed-loop agricultural production models etc.

The state program for defining environmental requirements and standards for the formation of Eco-Industrial Parks (EIPs) includes a two-tiered procedure: 1) Initial Approval: state authorities issue approval for the creation of the park; 2) Certification Process: the park undergoes certification to verify compliance with established standards and is granted the status of a National Demonstration Eco-Industrial Park (ND-

EIP). Currently, the total number of eco-industrial parks includes both approved EIPs since 2001 and those that have undergone the certification process and received the status of ND-EIPs. In 2022, the total number of (approved and certified) EIPs was 109, of which 79 had the status of ND-EIPs. The first certified ND-EIP was established in 2008, and by the end of that year, there were 2 ND-EIPs (number of approved — 29 EIPs). By 2019, the number of ND-EIPs has already reached 55, and the number of Eco-Industrial Parks at the approval stage (actually at the development stage) was 52. The most significant growth in EIP development occurred between 2008 and 2015, during which the total number of EIPs increased 3.5 times, from 30 to 106 (for example, the Twelfth Five-Year Plan (2011–2015) for China's development included the establishment of 55 EIPs) (Hong, Gasparatos, 2020).

Since EIPs were primarily established based on industrial parks, it is important to note their concentration in economically developed regions of China, particularly in provinces where environmental issues had significantly escalated, necessitating a shift in the government's approach to further economic growth. The transformation of high-tech zones into eco-industrial parks should contribute to increasing ecological productivity (Tingting et al, 2024). Many industrial park locations were characterized by high levels of CO2 emissions and urgently required measures to improve the ecological situation. The concentration of EIPs remains in the industrially advanced provinces, with Jiangsu standing out with 25 EIPs, followed by Shanghai with 9, Shandong with 8, and Zhejiang with 7. However, over the past decade, a trend toward more even distribution of EIPs across China has emerged (Hong, Gasparatos, 2020). Table 2 presents a list of 10 prominent EIPs along with their primary areas of specialization.

Table 2. The largest EIPs in China and their focus sectors

№	EIPs focus sectors
1	**China-Singapore Suzhou Industrial Park** (SIP) — Jiangsu Province **Features**: a joint project between China and Singapore, focused on clean energy and water resource management. It incorporates advanced wastewater treatment technologies and industrial symbiosis practices.
2	**Tianjin Economic-Technological Development Area** (TEDA) — Tianjin **Features**: one of China's first Eco-Industrial Parks, emphasizing industrial waste recycling and resource utilization. The development of renewable energy and emission reduction.
3	**Qingdao Sino-German Ecopark —** Shandong Province **Features**: joint initiative of China and Germany. Utilization of renewable energy sources (solar, wind). Promotion of environmentally friendly construction and sustainable urban planning.
4	**Yixing Environmental Science and Technology Industrial Park —** Jiangsu Province **Features**: specialization in environmental protection technologies, with a primary focus on water treatment and pollution control.
5	**Hangzhou Circular Economy Industrial Park —** Zhejiang Province **Features**: implementation of industrial symbiosis models, waste recycling, and resource reuse. Emphasis on energy efficiency and low-carbon processes.
6	**Guiyang Eco-Industrial Park —** Guizhou Province **Features**: integration of eco-friendly practices into industrial development. Deployment of clean production technologies. Conservation of biodiversity in surrounding areas.
7	**Zhuhai Eco-Industrial Park —** Guangdong Province **Features**: integration of renewable energy into industrial production. Air and water pollution control measures. Development of "smart" manufacturing facilities.
8	**Baotou Rare Earth High-Tech Industrial Development Zone —** Inner Mongolia **Features**: a hub for sustainable mining and processing of rare earth metals. Strict resource management controls.
9	**Chengdu High-Tech Industrial Development Zone —** Sichuan Province **Features**: high-tech manufacturing with environmentally conscious approaches. Application of advanced electronic waste recycling technologies. Focus on ecological innovations and research.
10	**Fuzhou Circular Economy Demonstration Park —** Fujian Province **Features**: implementation of circular economy principles, including waste recycling and material reuse. Integration of green logistics systems.
Note — compiled by the authors according to databases of FDI-China; China Services Info: Industrial Park; Websites of SEZs	

The case of three largest EIPs in China (China-Singapore Suzhou Industrial Park (SIP), Tianjin Economic-Technological Development Area (TEDA), and Qingdao Sino-German Ecopark) and the main indicators of their economic activity are analyzed in detail below.

China-Singapore Suzhou Industrial Park (SIP). Annual GDP exceeds RMB 300 billion, significantly contributing to Suzhou's overall economic development. Land Area covers 288 square kilometres, with over 60 % dedicated to environmentally friendly and high-tech industries. Foreign Direct Investment

(FDI) surpasses USD 40 billion, with more than 5,000 foreign enterprises operating in the park, including Fortune 500 companies such as Bosch, Siemens, and Johnson & Johnson. Industrial Output: annual industrial output exceeds RMB 500 billion. Specializations: key sectors include electronics, biotechnology, automotive manufacturing, and information technology. Export volume: annual exports exceed USD 100 billion**,** making SIP one of China's largest export hubs. High-tech products and services dominate the trade portfolio.

The park has created over 800,000 jobs across various sectors. A high concentration of skilled labour is achieved through partnerships with educational institutions and programs aimed at attracting highly qualified specialists. To promote innovation and research, the park has established and now operates over 30 research institutes and 3,000 high-tech enterprises. Annual investments in research and development exceed 5 % of the Park's GDP**,** fostering continuous innovation (Suzhou Industrial Park, 2024).

Sustainable Development and Environmental Initiatives: SIP is recognized as a model of eco-industrial development. It has implemented advanced waste recycling systems, wastewater treatment, and renewable energy usage. The green coverage exceeds 45 %, with substantial investments directed toward sustainable urban infrastructure development.

The Tianjin Economic-Technological Development Area (TEDA) is one of China's most significant economic and industrial zones, driving growth in manufacturing, technology, and international business. TEDA's annual GDP exceeds RMB 400 billion **(**approximately USD 58 billion**)**, contributing significantly to the overall economic development of Tianjin. TEDA covers an area of about 119 square kilometres**,** with well-developed infrastructure supporting industrial, commercial, and residential needs. The industrial output value of TEDA surpasses RMB 600 billion annually. In the high-tech sector, aviation manufacturing and nanomaterials production stand out as key industries. TEDA's industrial base is primarily composed of knowledge-intensive and capital-intensive industries, such as electronics, electrical engineering, electronic technologies, petrochemicals, and machinery manufacturing. TEDA offers a diverse economic structure with a well-balanced mix of traditional industries and emerging sectors.

TEDA has attracted over USD 30 billion in foreign direct investment. The zone hosts more than 5,000 foreign enterprises**,** including leading international corporations like Siemens, GE, Johnson & Johnson, and Volkswagen. TEDA appeals to investors through supportive policies, efficient infrastructure, and its proximity to key trade routes. TEDA employs over 600,000 workers across various industries. The workforce is highly educated, with a significant portion of the population holding higher education degrees and technical training, as core sectors like IT, finance, and advanced manufacturing require skilled and professional personnel.

TEDA is a key trade hub for Tianjin, with an annual export volume exceeding USD 70 billion**.** Its well-developed logistics and transportation infrastructure ensure efficient trade operations. The zone supports a wide range of export activities, including high-quality products such as machinery, electronics, chemicals, and industrial equipment. TEDA is also a major centre for innovation, hosting numerous research institutes and high-tech enterprises. Investments in research and development exceed 5 % of GDP**,** focusing on artificial intelligence, robotics, biomedicine, and environmental technologies (TEDA, 2024).

Sustainable development and environmental initiatives: TEDA's activities are based on the principles and approaches of sustainable development programs. This includes the implementation of safe green technologies, resource conservation and energy efficiency programs (with a strong focus on renewable energy sources), as well as initiatives to combat environmental pollution by reducing industrial CO_2 emissions.

Qingdao Sino-German EcoPark. The EcoPark makes a significant contribution to Qingdao's economic development by focusing on innovation and sustainable industrial practices. The annual GDP of the Qingdao Sino-German EcoPark exceeds RMB 20 billion (approximately USD 2.9 billion**).** Industrial production in the EcoPark surpasses RMB 50 billion annually. Key industries: primary industries include intelligent manufacturing, new energy, environmental technologies, and high-tech sectors such as biomedicine and robotics. The Qingdao Sino-German EcoPark features advanced infrastructure, and its convenient location near Qingdao Port enables efficient trade both domestically and internationally. The park has a well-developed export economy, with an annual export volume exceeding RMB 10 billion. Major export categories include machinery, high-quality electronic components, and environmental technologies.

The EcoPark has attracted over USD 5 billion in foreign direct investment and provides employment for more than 30,000 workers, with an emphasis on a skilled workforce. The park collaborates with leading German corporations such as Bosch, Siemens, Thyssenkrupp, and others, engaging in joint projects in sustainable technologies and advanced manufacturing. Kingdao Xinyo-German Ecopark encourages cooperation between Chinese and German companies, universities and research institutes, which promotes knowl-

edge exchange, joint research projects and technological transfers aimed at developing environmentally sustainable industries. The EcoPark invests a substantial portion of its GDP in innovation and technological development. Over 10 % of GDP is allocated annually to research and development, with a focus on advancements in artificial intelligence, production automation, energy efficiency, and environmental solutions (Qingdao Sino-German Ecopark, 2024).

Sustainable development and environmental initiatives: Qingdao Sino-German Eco-Park actively implements sustainable development with a focus on environmentally safe technologies. It implements programs aimed at reducing industrial CO emissions, waste management, and efficient water use. Additionally, renewable energy initiatives are being widely implemented, including solar energy and industrial waste conversion into an energy source.

Thus, the EIPs reviewed are prime examples of successfully integrating sustainable development and advanced technologies into manufacturing and business. Through significant investments in green technologies and international partnerships, EIPs contribute to sustainable economic growth and innovation, creating a competitive environment for businesses.

The certification of Eco-Industrial Parks (EIPs) in China involves a stringent process requiring compliance with specific sustainable development and environmental standards. Since the constitution of China establishes a three-tier administrative division, a similar three-level system is applied in setting requirements for environmental standards and assessing their impact on the economy and the environment. At both the national and local levels, the primary focus is on reducing CO_2 emissions into the atmosphere, improving water resource management system, and implementing energy-saving programs, particularly the development of renewable energy sources (Huang Beijia et al., 2019). In 2015, the Ministry of Environmental Protection (MEP) introduced a new standard for National Demonstration Eco-Industrial Parks (HJ/T274-2015). Since 2016, new environmental standards for EIPs have been enforced in China to achieve high environmental performance and enhance competitiveness at both domestic and international levels. The economic impact assessment of these standards demonstrates both preliminary improvements in environmental performance and enhanced economic competitiveness of EIPs. However, due to the strict requirements of the Green Manufacturing Standard System, there are certain issues (technical, technological, organizational, and, in many cases, primarily financial) in transforming industrial zones and individual enterprises into fully operational EIPs.

The environmental requirements for EIPs, as defined by standardization procedures established, are based on three main programs: Green Manufacturing Standard System Construction Guide (2016), Industrial Green Development Plan (2016–2020), and Green Factory Evaluation General Rules (GB/T 132-2018). In 2020, based on above documents, the Chinese government adopted the program "Accelerating the Establishment of Green Production and Consumption Regulations and Policy System", which outlines the main directions and priorities for environmental technologies implementation in production processes.

Among the key organizations responsible for certification at the national level, the following should be highlighted: 1) **National Development and Reform Commission (NDRC)**, which plays a crucial role in setting standards and defining development directions for eco-industrial parks. The **NDRC** oversees the supervision and certification of sustainable industrial parks; 2) **Ministry of Ecology and Environment (MEE)**, which is responsible for certifying eco-industrial parks based on established environmental protection requirements, pollution reduction measures, and sustainable development principles; 3) **China Association of Circular Economy (CACE)**, which promotes circular economy principles and provides certification services for parks that meet ecological standards. Additionally, numerous independent organizations accredited by the government conduct certification of eco-industrial parks based on established sustainability criteria. At the regional and local levels, government authorities collaborate with industrial parks to ensure compliance with regional environmental policies and sustainable development goals (Huang Beijia et al., 2019). Thus, the certification of eco-industrial parks in China is a multi-layered process involving national, regional, and local organizations, as well as independent certification bodies. This policy focuses on integrating environmentally friendly technologies into production, promoting efficient resources uses, and in general supporting sustainable development policy. EIPs successfully integrate economic growth with environmental responsibility through the adoption of green technologies and sustainable practices (Table 3).

Table 3. EIPs' Performance Efficiency

Objectives of EIPs	Result of EIPs' activities
Environmental Efficiency: Emission reduction Efficient use of water and energy	Reduction of greenhouse gas emissions and pollutants through the implementation of cleaner production methods, energy-efficient technologies, and sustainable waste management practices. Significant improvements in water conservation and energy efficiency, leading to reduced overall resource consumption per unit of production.
Circular Economy and Waste Management: Increase in recycling rates Efficient resource utilization	EIPs have achieved higher waste recycling and resource reuse rates, minimizing landfill waste. Implementation of systems for more efficient use of secondary materials reduces waste and ensures a sustainable approach to production processes.
Technological Development and Innovation: Implementation of green technologies Research and development	EIPs have successfully integrated innovative solutions in renewable energy, water purification, pollution reduction, and other environmental areas. Significant efforts are dedicated to developing eco-friendly solutions that contribute to sustainable development.
Economic and Social Impact: Attracting investments Regional development Job creation	Enterprises within EIPs attract both domestic and international investments, focusing on sustainable development. EIPs contribute to job creation in the green industrial sector, emphasizing environmentally responsible production.
Improvement of Government Policy in Management and Monitoring	Certified EIPs adhere to stricter environmental standards, ensuring greater transparency, accountability, and regulatory compliance. Enhanced collaboration between government agencies, businesses, and local communities promotes sustainable development.
Alignment with Global Sustainable Development Goals	Among the primary goals of EIPs complying with sustainable development goals are environmental conservation (by reducing overall consumption and production costs), mitigation of negative climatic change effects (by implementing green production standards), and in general promotion of environmental responsibility at both the state and individual enterprise levels.

Note — compiled by the authors based on the databases of the World Bank; China Services Info: Industrial Park; Websites of EIPs

Thus, EIPs in China demonstrate positive results in reducing environmental impact, stimulating sustainable economic growth, and fostering technological advancements. These parks play a pivotal role in achieving the country's environmental and socio-economic goals, contributing to a more sustainable future.

Conclusions

At the initial stage of the open-door policy, the government of the People's Republic of China (PRC) sought to accelerate the industrialization of the economy by attracting foreign capital. Special Economic Zones (SEZs) became a key instrument in achieving this goal, providing preferential conditions for foreign investors and stimulating the creation of new production capacities. Currently, China has developed multiple types of SEZs. The evolution of SEZs in China has proceeded in stages, reflecting the primary goals and priorities of the country's economic development. The transformation of SEZ types illustrates China's shift from specializing in labor-intensive manufacturing to more complex production processes within industrial parks. Over time, the Chinese government shifted its focus toward promoting high-value-added production, and SEZs became hubs for the development of high-tech industries. A progressive step in this transition was the establishment of eco-industrial parks, based on strict environmental standards and principles of the circular economy.

The Chinese government actively promotes the creation and development of Eco-Industrial Parks (EIPs) through the implementation of comprehensive policies, financial incentives, and the encouragement of sustainable technologies. China has integrated the concept of ecological civilization into its national strategy, which focuses on sustainable development and environmental conservation. This strategy is practically implemented through the establishment of eco-industrial parks.

To achieve sustainable development goals and ensure coordination between economic expansion and environmental protection, China has been implementing programs for over two decades to gradually transform National Development Zones, National Economic and Technological Development Zones (ETZs), and National High-Tech Zones (HTZs) into Eco-Industrial Parks. The models for transforming economic devel-

opment zones into EIPs, as outlined in this study, constitute a central element of China's modern economic strategy. This strategy aims to integrate intensive industrial development with the advancement of green technologies, achieving high environmental efficiency while reducing the burden on the environment. Since the early 2000s, EIP development programs have been incorporated into China's five-year economic plans, demonstrating a phased, strategic, and justified approach to this process. China's national policy defines economic development goals and directions, promoting the reduction of environmental pollution, improvement of energy efficiency in production, implementation of circular economy principles, and the green development of industrial parks. Eco-industrial parks play a central role in these processes, contributing to sustainable economic development. They also serve as a key instrument for transitioning China's economy from an extensive to an intensive growth model. The emergence of EIPs signifies a shift in China's economic development trajectory, manifesting in a combination of continued active industrial growth, a focus on high-tech industries, and environmental conservation policies. A key mechanism for integrating these directions is the implementation of circular economy principles, including the establishment of EIPs.

The foundation of EIP operations lies in the implementation of a closed-loop economic strategy. The principles and mechanisms of the circular economy within EIPs are aimed at minimizing waste, promoting reuse, recycling materials and waste, utilizing all types of resources efficiently, restoring resources, and establishing sustainable interconnections along production-consumption processes between individual enterprises within EIPs. EIP development programs place significant emphasis on introducing green and clean technologies to enhance energy efficiency, including multi-level energy utilization, the creation of closed energy cycles, and the use of renewable energy sources. EIPs serve as hubs for high-tech industries, as demonstrated by the case studies of three parks: China-Singapore Suzhou Industrial Park (SIP), Tianjin Economic-Technological Development Area (TEDA), and Qingdao Sino-German Ecopark.

Thus, the primary functions of EIPs include: a) Combining the development of the circular economy with enhanced market competitiveness through the use of innovative technologies; b) Facilitating fundamental transformations in industrial production and consumption models within China's economy; c) Supporting the transition toward intensive economic growth.

The Chinese government provides substantial financial incentives for Eco-Industrial Parks in the form of grants and subsidies for projects that promote sustainable development, particularly those focused on waste recycling and green technology advancement. EIPs benefit from tax incentives and preferential loan conditions for enterprises implementing environmental initiatives. On the other hand, EIP standards emphasize improved environmental management, with comprehensive ecological indicators defining the framework for sustainable operations. Strict environmental requirements for EIP establishment, along with an existing certification system, aim to balance ecological responsibility with intensive economic growth based on circular economy principles and green standards. China's experience in establishing EIP standards and performance indicators can serve as a model for other countries seeking to develop industrial benchmarks aligned with sustainable development goals.

The economic performance of EIPs reflects their role as leading economic and industrial centers in China, significantly contributing to economic growth through innovation, sustainability, and international cooperation. Observing China's experience in EIP development demonstrates their effectiveness in social, economic, and environmental aspects, underscoring the importance of promoting such industrial zones on a global scale.

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ORIGINAL RESEARCH

What household structure encourages innovation? Comparative analysis of a case study of female labor in Kyrgyzstan and Kazakhstan

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Abstract

This study examines the impact of patrilocality on women's work in Kyrgyzstan and Kazakhstan. It demonstrates how the dominance of the husband in decision-making affects women's activity in the labor market. This hinders the innovative development of the country and limits the country's entrepreneurial potential. The authors use Life in Kyrgyzstan 2019 data in econometric analysis, with OLS and Tobit models. This statistical analysis focuses on the relationship between household structure and labor force participation of married women in Kyrgyzstan. Since similar data is not available for Kazakhstan, the comparative analysis is based on a review of the literature. The authors assume that the patriarchal structure of families has become widespread in both neighboring countries due to the similar mentality, traditions, and history of the Kyrgyz and Kazakhs. The authors find that women in patrilocal households spend more hours at home compared to women in households with other family structures. Moreover, the husband's dominance in family decision-making correlates positively with the number of hours the wife works outside the home. This demonstrates a positive effect of intrahousehold income distribution mechanisms. The findings highlight the need for policies to support women's economic activity in both countries. The authors conclude that addressing barriers created by traditional male-headed households can increase women's contributions to innovation and entrepreneurship, thereby contributing to economic growth and development in Central Asia.

Keywords: Patrilocality hypothesis; Innovation; Entrepreneurship; Household work allocation; Kyrgyzstan; Kazakhstan, Econometric analysis; Female labor supply; Marriage arrangements.

Introduction

In many developing countries, women are much more likely than men to perform domestic chores due to traditional family structures. This in turn limits their participation in economic activity, especially their chances of fully participating in the labor market and of becoming entrepreneurs. Such gender inequality is particularly evident in patrilocal households, where women are forced to live with their husband's family after marriage. Findings from other countries indicate that such family living arrangements make women care for the household and children, thus subjugating their career and education goals. This excludes more than half of the country's workforce from contributing to innovation and entrepreneurship (Chen & Mace, 2023; Jayachandran, 2015). This is in line with the patrilocality hypothesis which posits that such cultural setups reduce the supply of female labor in the market. This reduces actual and potential economic growth.

Patrilocality is a common cultural practice in Central Asian countries. It is linked with cultural practices concerning child care and family loyalty. The embedding of such practices blocks the integration of women in economies of developing countries. This is documented by the OECD (2019) and Jayachandran (2020). They find that unpaid care work is largely shouldered by women, worsening their chances of a career. The problems that are associated with patrilocality are most pronounced in two Central Asian states, Kyrgyzstan and Kazakhstan, which have much in common in their historical and cultural traditions that shape today's gender roles and family structure.

The current study focuses on these two Muslim-majority nations of the former Soviet Union. They are highly patrilocal and thus offer a unique opportunity for comparative studies of gender equality. In Kyrgyzstan, data from the Life in Kyrgyzstan Panel Study 2019 reveal how living conditions affect women's participation in the labor market. The findings are consistent with an earlier study by Landmann et al. (2018), which shows that patrilocal households often increase women's care responsibilities and reduce their oppor-

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tunities for outside employment. There has not been much research on similar quantitative data for Kazakhstan, but the 2018 data of the Bureau of National Statistics provide strong evidence that women in Kazakhstan are also affected by the same challenges. The gender division in domestic work is evident in all regions of Kazakhstan with women having the responsibility of household chores to a greater extent as compared to men.

This paper also examines an alternative household structure where gender equality dominates and where both spouses jointly make such economic decisions as where the woman will work. The authors believe that this type of household is the most preferable for modern society, as it empowers women and stimulates their entrepreneurial activity. This leads to innovation in all spheres of society. For example, according to the OECD (2019), infrastructure investments, namely improving access to childcare, were identified as critical public interventions to ease the burden of unpaid care work for women and increase their participation in the labor force. In Kazakhstan, policies aimed at reducing gender inequality should focus on specific assistance to rural women. They must take on more domestic work than urban women.

This paper makes several contributions. First, it fills a gap in the existing literature by empirically testing the patrilocality hypothesis in the context of labor and innovation economics. Such research has not been conducted before with a large database. Second, it demonstrates that gender-equal family structures can mitigate the damage done by traditional norms and religion in Central Asian countries. Third, it provides actionable policy recommendations for promoting gender equality in Central Asia.

Literature review

Global Perspectives on Patrilocality and Gender Dynamics

Patrilocality is a common household structure in most parts of the world. Using cross-cultural data from South Asia, Sub-Saharan Africa, and East Asia, studies find that patrilocality subordinates women, enhances women's burden of unpaid domestic work, and constrains their access to education and employment (Landmann et al., 2018; Meseguer-Sánchez et al., 2020).

For instance, Ebenstein (2014) connects patrilocality with the durability of gender inequality. He explains that norms that compel women to live with their in-laws oppress daughters-in-law. Such customs define gender roles at the economic expense of women. Likewise, in China, Chen and Mace (2023) find that women living in patrilocal households do significantly more physical work than men. This trend is also observed in rural India (Dhanaraj et al., 2019).

Women's family care and other roles in household economies are also not given the attention they deserve and in some cases are not recognized at all, especially in the context of poverty. Okeyo (1979) points out that women are vital in the subsistence economy of rural Kenya. Their responsibilities include agricultural production, income earning, and caregiving. The same pattern is seen across the world, as Antonopoulos (2008) found in studying the relationship between care work and formal labor markets. The care work done by women supports economic structures but is not accounted for in standard economic measures.

The role of women in households affects both paid and the unpaid work. Riggio et al. (2010) found a significant link between household duties and the level of self-efficacy of young women. The more experience young women had with household chores, the better prepared they were for the labor market. In the same manner, Zunaidi and Maghfiroh (2021) studied the women's roles in Indonesia and the economic pressures that forced them to work in the formal sector while taking care of domestic responsibilities in rather adverse conditions.

This dual burden, called the "second shift," is a common concept in global studies. The World Survey on the Role of Women in Development (United Nations, 2019) highlights that poverty of income and time prevents women from breaking free from poverty and achieving their economic potential.

While patrilocality is more common in Central Asia, findings from egalitarian societies show that gender equitable policies can bring about positive change. Grönlund et al. (2017) concluded that policies supporting the sharing of household responsibilities increased the attachment of women to the labor market in the Scandinavian countries. The above findings are in line with the bibliometric analysis of family economies in poverty contexts by Meseguer-Sánchez et al. (2020). They support the need for incorporating Sustainable Development Goals into gender-specific policies.

In Central Asia, Landmann et al. (2018) examined the effects of patrilocal residence on women's labor market participation in Kyrgyzstan and found that women's work participation is diminished by care-giving responsibilities. The quantitative data on Kazakhstan is quite limited and therefore it is impossible to directly compare it with the data of Kyrgyzstan, but it is necessary to mention that the two post-Soviet countries are

very similar in terms of context and cultural beliefs that keep women from engaging fully in innovation and entrepreneurship as noted by Okeyo in 1979 and Zunaidi and Maghfiroh in 2021.

Developing Economies and Central Asia

The role played by household structures in determining women's labor force participation, and the consequent effects on innovation and entrepreneurship, is one of the most important issues in development economics. This section reviews current research, analyzing the influence of patrilocality, care work, and sociocultural standards that restrict women's economic participation in Central Asia, and specifically Kyrgyzstan and Kazakhstan.

In Central Asia, patrilocality has a significant impact on women's participation in labor markets and their ability to promote and develop goods and services. In addition, according to Jayachandran (2015), patrilocality worsens gender inequality by perpetuating conventional family structures that prevent women from exercising control over their lives and from engaging in outside home work (farming). In patrilocal households' women are expected to spend a lot of time in unpaid domestic work. This leaves them with little time and energy to engage in professional and business activities (Urbaeva & Lee, 2018). This hurdle thus prevents women from being more entrepreneurial as this entails many hours of one's time.

Urbaeva and Lee (2018) studied patrilocal households in post-Soviet countries. Women's household status was a key factor in their use of maternal health care services. The implications were extensive: The structure of patrilocal households and the lack of authority that women have in them hamper women's autonomy, which is necessary to their economic participation and creativity.

Unpaid care work is still a major obstacle to women's economic empowerment. The OECD (2019) pointed out that women still take on most of the responsibility of unpaid domestic work such as childcare, caregiving, and household work. These tasks are labor-intensive and often go unrecognized by families. Consequently, they hamper women's employment opportunities in the formal sector. It has been suggested that improvements in infrastructure like childcare and clean energy can alleviate these burdens and allow women to participate more actively in the economy.

Jayachandran (2020) also examines how social norms reinforce gender divisions of labor. To redistribute duties within households, and therefore throughout the wider economy, policy and community-based interventions must address the cultural norms that define women as the caregivers. Persistence of such norms underlines the importance of developing context-appropriate approaches to encourage more equal gender norms.

Cultural norms affect the level of economic agency that women exhibit. Jayachandran (2020) notes that such norms change with economic growth. However, such change is not consistent; strict norms are common in rural and conventional communities. In Kyrgyzstan and Kazakhstan, where patrilocality is practiced with other patriarchal norms, women are restricted from the labor market. These restrictions are not just social but structural, since they concern caregiving, family work, and women's purity.

Studying West Africa, Ogundana et al. (2021) build a growth model based on gender that focuses on the need for financial inclusion, market information and management education for women entrepreneurs. The implications vary with the region. For instance, in Central Asia, banks should not compel the husband or his parents to co-sign the wife's application for a loan.

The Central Asian context is unique for the way that urbanization and Soviet social reforms, which encouraged the education of women and their involvement in the labor market, have brought the influences of modernity to cultural capitals such as Almaty in Kazakhstan and Bishkek in Kyrgyzstan. But rural culture remains traditional. Thus, urban women are more liberated than rural women (OECD, 2019).

Kyrgyzstan, with the data from the Life in Kyrgyzstan survey (2019), offered empirical evidence on these processes. Women in patrilocal households had a lower probability of being employed in the external labor market. This finding was consistent with regional studies that identified the social norms regarding caregiving and family obligations as barriers to women's labor force participation. In the case of Kazakhstan, although the same type of data was not available, qualitative research also indicated the need for research that was comprehensive and yet specific to the region for policy.

The analysis of Kyrgyzstan and Kazakhstan shows both the similarities and differences of the position of women in these societies. Although the data for Kazakhstan is lacking in the form of the Life in Kyrgyzstan survey (2019), the cultural and historical similarities between the two countries suggest that the findings from Kyrgyzstan may also be relevant to Kazakhstan. Especially in rural areas, patrilocal family arrangements prevent women from fully pursuing careers.

Innovation is a function of diversity and inclusiveness. By identifying structural obstacles posed by patrilocality and unpaid care work, policymakers can harness the dormant potential of women in Central Asia. Incorporating gender policies into national development plans would promote justice, innovation, and economic development.

This literature review focuses on the relationships between the household structure, socio-cultural norms and women's labor participation in Central Asia. By analyzing these factors, this study expands the understanding of how cultural norms influence the economic well-being of women. It provides a solid base for policies that target enhancing women's position and supporting innovation in economies making the transition to markets.

Kyrgyzstan

Traditional norms of Kyrgyzstan greatly affect the socio-cultural development of the country, especially the patrilocality that shapes the economic activities of women. According to Landmann, Seitz and Steiner (2018) patrilocal residence in Kyrgyzstan increases women's domestic work, particularly caring for the elderly, while limiting their employment opportunities. This is because, in Kyrgyzstan, women receive less support from their in-laws in household duties and childcare compared to women in less patrilocal societies (Landmann et al., 2018).

The bias against careers for women is also seen in marriage practices. Bride kidnapping, or *ala kachuu*, remains a pervasive tradition, accounting for up to 30 % of marriages (Borbieva, 2012; Hofmann & Chi, 2022). These forced unions often lead to highly patriarchal household dynamics, restricting women's autonomy. However, Hofmann and Chi (2022) suggest that women in these households sometimes leverage labor migration as a means to escape patriarchal constraints, while others conform to traditional roles to maintain family unity.

Migration shapes gender dynamics. Economic pressures have driven significant male out-migration, leaving women to manage multi-generational households. Ismailbekova (2013, 2014) highlights the role of grandmothers and mothers-in-law in preserving patrilineal traditions, including the transmission of genealogies and the orchestration of marriages. This dynamic maintains the cultural norms of kinship but at the same time offers chances for women to shape the family.

Kyrgyzstan has not shaken off the influence of the traditional norms. Nedoluzhko and Agadjanian (2015) noted the changes in the society including the reduced practice of arranged marriages and the bride kidnapping which they attributed to changes in the socio-demographic environment after the breakup of Soviet Union. Women in Bishkek have higher chances of obtaining an education and finding employment. This increases women's autonomy and decreases dependence on traditional customs.

Integration of economic and family roles is difficult for women. Thieme (2008) states that opening up of new opportunities for migration and economic development has created more work for women and especially those who are left to take care of families. This "multi-local" livelihood makes women navigate between conventional roles and new possibilities.

Kazakhstan

In Kazakhstan, the relation of traditional gender roles to modernization is visible. The gender roles in Kazakh society were influenced by the nomadic culture of the Kazakh tribe where women helped to manage the household and other public functions, including combat and governance (Abdikadyrova et al., 2018). However, the Soviet period made a rather counter-intuitive change: women were provided with education and jobs but were expected to also become wives and mothers (Kuzhabekova et al., 2018).

Kazakhstan shows wide differences between the participation of men and women in the labor market. This shows that women are still making 21.7 % less than their male counterparts partly because of systematic occupational segregation and gender-based discrimination in hiring and promotion (Kabylova, 2022). Although women are well-represented in the educational and health sectors, they are under-represented in management positions, and the issues they encounter are compounded by the cultural expectations of the family (Alpysbayev et al., 2024; Kuzhabekova et al., 2018).

Despite improvement in the public aspect of gender equality, the private aspect of gender roles is still conservative. The role of women has not changed much. They are still mainly responsible for unpaid care work while cultural norms and lack of state policy support only exacerbate the issue (Kabylova, 2022). Efforts to achieve an equal sharing of domestic responsibilities between men and women have been slow, largely due to the challenge of changing deep-rooted cultural beliefs (Kan, 2023).

But post-Soviet economic reforms have led to the increase of women's participation in the informal rural economy. According to Werner (2024), women traders along the New Silk Road navigate patriarchal structures to support their families. These traders fulfill their conventional gender roles while expanding their economic roles, thus withstanding the pressures of Kazakhstan's market system.

The discrepancy between the gender equality of public and private domains affects fertility plans. Gender-sensitive attitudes are more common in urban areas while traditional family culture still dominates rural areas. This conflict has resulted to low fertility desires among women who seek to work and care for their families (Kan, 2023; Kabylova, 2022).

Kazakhstan has adopted many legal measures on gender equality, signing and approving numerous international agreements and creating national councils on gender issues, according to Kuzhabekova et al. (2018). But the measures are mostly declarative and not effectively implemented. Other obstacles include cultural norms as well as geographical differences that block gender equality (Kan, 2023).

Kyrgyzstan and Kazakhstan: Comparative Dynamics

The culture of patrilocality in Kyrgyzstan presents a clear example of how household structures shape women's economic activities. About 60 % of married women in the rural areas of Kyrgyzstan live with the husband's family and are likely to take on the responsibilities of a housewife raising children, which hampers her employment prospects (Kyrgyzstan National Statistics Committee, 2021). This is in harmony with the nationalist rhetoric which strengthens the patriarchal ideology in rural society (Belafatti, 2019). Furthermore, economic insecurity in Kyrgyzstan enhances these limitations, as families react to socio-economic pressures by subscribing to conventional gender roles (Junisbai, 2010).

While Kyrgyzstan has seen some benefits from its integration into the global economy, particularly in terms of women's labor force participation, Kazakhstan has experienced a much deeper level of integration. About 75 % of women in Kazakhstan are either working or looking for a job. This can be attributed to the efforts made in the areas of education and labor market (World Bank, 2022). Nevertheless, patrilocality and traditional gender norms still prevail in rural areas (Zadayev, 2024). These rural-urban differences reflect how and to what extent globalization and economic modernization affect gender relations in these two countries (Sadykova et al., 2022).

While both Kyrgyzstan and Kazakhstan feel the effects of patrilocality, the resulting difference in their economic development provide valuable insights. On the one hand, urbanization and more modern policy have led to higher economic activity of women in Kazakhstan in the two largest cities, such as Almaty and Astana. On the other hand, Kyrgyzstan is mainly rural, with a culture that still favors traditional gender roles hence a greater gender inequality (Junisbai et al., 2017). These challenges are further aggravated by the cultural globalization that influences the two societies (Sadykova et al., 2022).

These differences can be mitigated by such new strategies as improving education and enterprise for women in remote areas. Regional cooperation can also help achieve these goals. Kazakhstan's experience with advanced policy can pave a way for a brighter future for Kyrgyzstan. All in all, these initiatives can sustain development of the region and enhance its gender equality.

Methods

The authors' analysis of patrilocality includes Ordinary Least Squares and Tobit models of the impact of household structure on the labor supply of married women in Kyrgyzstan. Kovaleva and Taylor (2023) provide the theoretical mathematical model for this broad line of research. It assumes that the husband determines the amount of housework his wife will do in order to maximize his own utility by avoiding household chores. This utility is offset by the loss of outside income that his wife could have worked as well as his loss of her affection. The husband balances these factors in deciding how much housework his wife should do.

Here is a model more specific to this note. Let us denote the wife's earned income as Y. This is the product of her wage w and the number of hours X that she works outside of the home. Thus Y = wX. In turn, X is a positive function of the share A of the wife's labor time that she spends outside of the home, that is, on her career, 0 <= A <= 1. In turn, A is a positive but diminishing function of the wealth W of the husband and wife. Greater wealth endows the wife with more education and entrepreneurial opportunities. These factors increase the amount of time that she can spend on her career. In short, the wife's earned income is Y = w * X[A(W)].

We assume that initially the wife lives with her husband's family, which compels her to work fully at home. To have a career, she and her husband must move to a residence of their own. The cost of this move is

TC, a function of location is L. The husband and wife will relocate if her career income exceeds the cost of the move. In sum, the wife's earned income is Y = w * X[A(W)] — TC[L].

The model implies that the wife's earned income is higher when wealth is higher and when potential residences for the couple are nearer the home of the husband's family. Thus, the wife earns more in high-income urban economies than in other regions. Additionally, since she engages in more entrepreneurial activity in these economies, they also experience higher levels of innovation and economic growth.

The dataset for Kyrgyzstan comprises 11,913 observations from the Life in Kyrgyzstan (LIK) panel survey (2019), focusing on 3,063 married women. For Kazakhstan, we use the data collected by the Bureau of National Statistics in 2018 with a gender breakdown of the distribution of unpaid work by region and type of settlement (urban and rural). These data are incorporated into the comparative framework.

The Life in Kyrgyzstan (LIK) panel survey is a rich source of longitudinal data collected annually from households across Kyrgyzstan. The survey covers various socio-economic dimensions, including employment, education, household decision-making, and regional disparities. For Kazakhstan, while comparable panel survey data is unavailable, existing studies and reports suggest similar socio-economic patterns, particularly in urban-rural divides, educational attainment, and labor market participation.

We use both Ordinary Least Squares (OLS) and Tobit regression models to analyze the Kyrgyzstan data. The OLS model provides baseline estimates of the relationship between the dependent and independent variables. Given the substantial proportion of zero values in the *Hourstotal* variable — representing women who do not engage in outside work — the Tobit model is employed to address this truncation. For Kazakhstan, the findings from Kyrgyzstani data serve as a reference point, since the two countries are comparable in the labor market.

Variable Definitions:

– *Hourstotal*: The number of hours that women work per week outside the home. This measures their engagement in the labor market.

– *Move*: A binary variable that is 1 if the woman moved in with her husband's family and 0 otherwise to show patrilocal residence.

– *Decision*: A binary variable that denotes the husband as the head of the household making economic decisions for the woman.

– *Schooling*: Woman's years of schooling as a control variable for human capital endowment.

– *East*: A binary variable that classifies households as living in urban and high-income areas (for instance, Bishkek in Kyrgyzstan and Almaty or Astana in Kazakhstan).

This analysis assumes that the variable ***Move*** adequately captures patrilocality, which is common in both countries, although nuances such as the size and composition of extended families could further refine this measure. Additionally, while direct measures of innovation or entrepreneurial activity are unavailable, outside work hours and education serve as proxies for labor dynamics. For Kazakhstan, the comparative analysis is based on secondary sources, which may lack the granularity of primary data.

To ensure the validity of findings for Kyrgyzstan, we conducted several robustness checks, including:

– *Testing for multicollinearity among independent variables using variance inflation factors (VIFs).*

– *Comparing results across different model specifications, including interactions between schooling and decision-making variables.*

– *Examining regional sub-samples to explore geographic variations in the effects of patrilocality.*

In the case of Kazakhstan, Bureau of National Statistics data are analyzed descriptively for patterns of unpaid domestic work by gender and settlement type. The findings are expanded, using regional analysis to examine differences and their effects on the labor force participation of women.

Our choice of regression models reflects both theoretical and practical considerations. OLS offers simplicity and interpretability for baseline analyses, while Tobit regression addresses the limitations of censored data. The comparative framework emphasizes the socio-cultural and economic parallels between Kyrgyzstan and Kazakhstan, leveraging shared historical contexts to extend insights across both nations. This dual-country approach enriches our understanding of how household structures influence female labor supply and, by extension, the potential for innovation in Central Asia.

Results

According to descriptive statistics (Table 1), the average married woman in Kyrgyzstan works 14.3 hours per week outside the home, has nearly 11 years of education, and is unlikely to have moved to her husband's family (Move = 0.013).

Table 1. Descriptive statistics

Variable	Observations	Mean	Standard deviation	Min	Max
Hourstotal	3,055	14.285	20.514	0	70
Move (=1)	3,055	0.013	0.112	0	1
Decision (=1)	2,785	0.198	0.399	0	1
Schooling	2,916	10.602	2.115	0	15
East (=1)	3,055	0.327	0.469	0	1
Note — compiled by the authors based on 2019 LIK data.					

For instance, in Kazakhstan (Fig. 1), data from the Bureau of National Statistics (2018) show that women are engaged in unpaid domestic work on average for 13.4 % of their time while men are involved for 4.9 %. This indicates the gender gap. This is consistent with Kyrgyzstan where conventional extended-family systems still dominate in rural areas. Both countries are characterized by patrilocality and by male-headed households and by male decision-making, hampering economic activities of rural women.

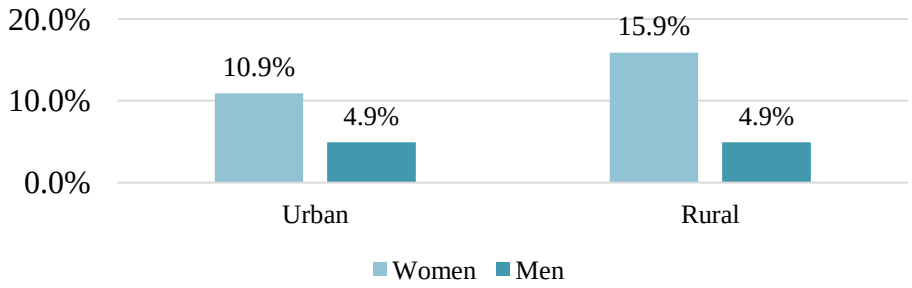

Figure 1. Unpaid domestic work in Kazakhstan by gender and region (2018)
Note — compiled by the authors

In urban Kyrgyzstan, such as Bishkek, women report higher education levels and greater labor force participation than in rural areas (Fig. 1). Likewise, as indicated in Figure 1, the data from Kazakhstan's Bureau of Statistics demonstrates that urban women were engaged in unpaid domestic work for 10.9 % of their time, while their rural counterparts were involved for 15.9 %. Urban Kazakhstani cities, such as Almaty and Astana, also reflect progressive trends, with urbanization driving higher female engagement in the workforce. Conversely, rural areas in both countries maintain stronger adherence to traditional family arrangements, demonstrating limited economic participation by women. These geographic and cultural similarities highlight the regional factors shaping women's economic opportunities across Central Asia.

Table 2 for Kyrgyzstan shows correlation matrix. Low correlations among independent variables, indicating minimal multicollinearity. The highest correlation (–0.225) is between Decision and East, which is highly significant (the t-statistic is –11.351). The general lack of simple collinearity suggests regional variation in cultural attitudes toward male decision-making: In the sample, husbands are more likely to determine the wife's work allocation in rural areas than in urban ones. Similarly, in Kazakhstan, urban-rural divides should influence intra-household decision-making dynamics, with urban households more likely to adopt egalitarian approaches. These patterns reinforce the regional similarities between the two countries.

Table 2. Correlation matrix

	Hourstotal	Move	Decision	Schooling	East
Hourstotal	1.0000				
Move	–0.062	1.000			
Decision	–0.002	–0.044	1.000		
Schooling	0.182	0.015	–0.067	1.000	
East	0.151	0.061	–0.225	0.125	1.000
Notes — compiled by the authors based on 2019 LIK data.					

According to the Table 3 OLS regression, in Kyrgyzstan, the coefficient on Move is –12.62 ($p < 0.001$), indicating that women in patrilocal households experience a significant reduction in outside work hours. Similar dynamics are anticipated in Kazakhstan, where patrilocal traditions persist, especially in rural areas. Decision positively affects outside work hours (+2.02, $p = 0.045$) in Kyrgyzstan, suggesting that supportive husbands enable greater female economic participation.

Table 3. OLS and Tobit regressions for working hours

	OLS		Tobit	
Move	–12.623***	(0.000)	–48.290***	(0.000)
Decision	2.017**	(0.045)	5.942**	(0.026)
Schooling	1.664***	(0.000)	4.238***	(0.000)
East	6.278***	(0.000)	15.975***	(0.000)
Sigma			46.192	
Constant	–4.348**	(0.032)	–62.051***	(0.000)
N	2738		2738	
Left-centered			1718	
R^2	0.0562			
Pseudo R^2			0.0122	
Log likelihood			–6352.523	
Note — compiled by the authors based on 2019 LIK data.				

This effect is likely mirrored in Kazakhstan, given its shared cultural backdrop. Furthermore, the regional analysis of Kazakhstan (Fig. 2) shows that women in certain regions such as South Kazakhstan (15.6 %), Kyzylorda (16.1 %), and North Kazakhstan (15.8 %) shouldered the greatest domestic responsibilities. This in turn reduced their ability to engage in paid work or start their own business.

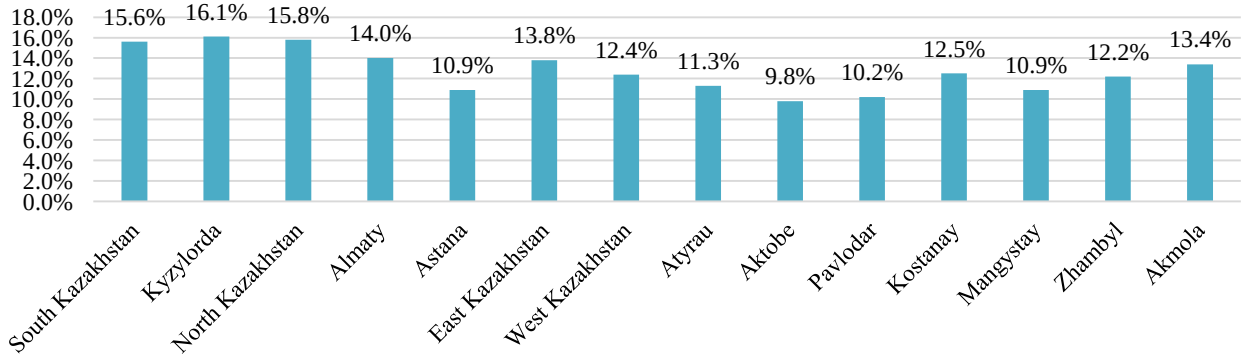

Figure 2. Regional domestic burdens for women in Kazakhstan (2018)

Note — compiled by the authors

Education emerges as a transformative factor in Kyrgyzstan, with each additional year of schooling increasing outside work hours by 1.66. Urban residence (East in Kyrgyzstan) also shows a positive effect on outside work hours. In Kazakhstan, the more educated regions, which are the urban areas including Almaty and Astana, have reduced gender gaps. Education enhances the employment prospects of women and increases their status in households, enabling them to spend less time on domestic chores and more on their careers (Fig. 2). Figure 2 also depicts the changes in social relations in urban settings where education changes the gender norms of division of labor within the household.

The Tobit model (Table 3) for Kyrgyzstan confirms the OLS findings, with Move reducing outside work hours by 48.29 ($p < 0.001$) and Decision increasing them by 5.94 ($p = 0.026$). The same trend can be observed in Kazakhstan where urbanization lightens the burden of domestic work on women, and urban women contribute less time to unpaid chores than their rural counterparts (Table 3). This highlights the importance of structural factors and policies that mitigate gender inequality. The results indicate that wives in patrilocal households spend little time working in the labor market. The Left-centered statistic shows that 1,718 observations reported no work hours outside of the home. The negative and significant intercept, -62.05 in the Tobit model, and the low R-squared or pseudo-R-squared values of the model, indicate that some factors reduce the woman's outside labor beyond those controlled for in the models. This is consistent with the large share of observations (62.7 %) that report no outside labor for the woman.

In Kyrgyzstan, urban women work 15.98 more hours per week outside the home compared to rural counterparts. Kazakhstan's urban centers similarly offer greater economic opportunities, with regional disparities playing a critical role in shaping labor market outcomes. Policymakers in both countries must address these divides to foster equitable labor force participation.

Interaction terms in Kyrgyzstan's analysis reveal that higher education levels mitigate the negative effects of patrilocal living arrangements. The authors argue, that these findings also apply to Kazakhstan, where education similarly provides women with the freedom to choose their household structure and moderates the influence of religion and tradition on the degree of patriarchy. For example, Women with a university education in patrilocal households have higher labor force participation rates than less educated women. The authors believe that such differences in labor force participation demonstrate the importance of women's attainment in both countries, particularly in rural areas.

In addition, the authors found that urban residence significantly increased the number of hours that married women worked outside the home in Kyrgyzstan. This reflects greater access to employment opportunities due to a larger labor market supply and better infrastructure. Similar patterns occur in urban Kazakhstan, where urbanization is known to facilitate economic participation in the labor market. However, cultural traditions and behavioral norms persist in both countries, limiting women's opportunities to participate in the labor market even in cities. The authors therefore conclude that policymakers should help address these cultural barriers through targeted interventions and social assistance.

Performed robustness checks for LIK 2019 data confirm the stability of the regression results. Alternative model specifications, which include lagged variables and sub-sample analyses, yield consistent findings. The inclusion of interaction terms between Decision and East highlights the progressive influence of urbanization on household dynamics. Similar robustness is expected in Kazakhstan, given the comparable socioeconomic and cultural contexts.

This comparative analysis underscores the similarities between Kyrgyzstan and Kazakhstan in terms of household structures, education, and regional disparities affecting the participation of women in the labor force. While both countries exhibit traditional norms that hinder women's economic opportunities, urbanization and education emerge as critical levers for change. Future research should focus on collecting comparable data for Kazakhstan to deepen the comparative insights and inform policy interventions aimed at reducing gender inequities in labor markets.

Discussions

The statistical analysis confirms the patrilocality hypothesis. Women's working hours decrease significantly when they are in patrilocal households as compared to non-patrilocal households. This implies that patrilocal changes in the family structure reduce the labor force participation of women and aggravate the gender gap. This reflects that women in patrilocal households work longer hours at home than their counterparts in non-patrilocal households. Moreover, Kazakhstan data show that rural women do more unpaid care work than their urban counterparts; this is also seen in Kyrgyzstan. Apparently, cultural standards such as patrilocality and male-headed decision-making hinder women's employment, especially when compounded by gender bias. Cultural standards that deny women equal opportunities for paid employment and instead encourage them to become caregivers are especially evident in rural areas of Kazakhstan and Kyrgyzstan. The consequences are social as well as economic.

Kazakhstani data show that women spend 2 hours and 16 minutes on unpaid domestic work in urban areas and a tenth more time, 2 hours and 29 minutes, in rural areas. This supports existing findings of a significant difference between urban and rural areas in labor market participation; which is also seen in Kyrgyzstan.

Women in Kazakhstan spend more than three times as many hours that men do on unpaid domestic labor (3 hours 36 minutes vs. 1 hour 9 minutes). This gap is even bigger in the rural setting due to the cultural norms of households. These findings are consistent with those findings from Kyrgyzstan.

A vital point is that male-headed households correlate with women working more hours, holding constant the family arrangement. This result shows that intra-household factors affect labor market outcomes. For example, in urban settings, policies that support joint decision-making role by both spouses, as well as flexible working arrangements, can increase women's employment rates. New evidence reveals that in Kazakhstan, the decision-making role of husbands in running a household is related to higher levels of women's economic activities in urban areas.

Education turns out to be a powerful tool. Higher education counteracts the adverse impact of patrilocal living standards. In Kazakhstan, urban women with higher education spend an average of 2 hours and 7 minutes per day on unpaid domestic work, while for rural women with a similar level of education, this increases to 2 hours and 29 minutes. This is evidence of the importance of education and urbanization in the economic development of women and reduction of gender inequality.

The interaction terms in the Kyrgyzstan analysis show that education reduces the adverse impact of patrilocal living arrangements. These findings also pertain to Kazakhstan, where education enables women to have more choices in the choice of household structure and partially liberates them from religion and tradition. University-educated women who belong to patrilocal households in Kazakhstan are more likely to be involved in labor market activities than other women.

Kyrgyzstan and Kazakhstan are quite similar in household structure, education and regional traits that affect women's employment. Although both countries have preserved many archaic attitudes towards women's working rights, urbanization and education are drivers of change.

Graphical data for Kazakhstan show how women's unpaid domestic labor is unevenly distributed across regions. They perform the most unpaid work in the rural provinces of South Kazakhstan, Kyzylorda, and North Kazakhstan.

Policy implications

Kyrgyzstan and Kazakhstan have deep cultural and historical similarities from Soviet times, including intra-family norms, religion and a dominant patriarchal social structure. We believe that Kyrgyzstan and Kazakhstan can work together to develop policies that leverage their shared history and cultural similarities to empower women, stimulating economic transformation and innovation.

First, we would emphasize that Kazakhstan and Kyrgyzstan face challenges in providing decent education to rural women. The share of women with higher education in rural areas is significantly lower than in urban areas. The two countries should prioritize scholarships, accessible educational centers, and online learning platforms to expand opportunities for rural women. Or the government could expand access to quality education for rural women through scholarships and vocational training tailored specifically for patrilocal households as targeted social assistance.

Second, special programs aimed at informing families about the benefits of gender equality can change social attitudes over time. Such educational campaigns and actions should encourage joint decision-making by spouses, such as income management. These methods can enable women to participate more intensively in the labor market and in entrepreneurship, promoting innovation.

Third, encouraging women's participation in science, technology, engineering, and mathematics (STEM) fields is vital to advancing innovation. For example, according to a study in the United States by Hanushek (2001), changes in per-student spending, teacher salaries, and class size do not significantly impact student achievement; however, innovations in teaching methods play a crucial role. Similarly, we argue that in Kazakhstan, gender equality and role programs do not have to be expensive to succeed. The key factor is to engage students' critical thinking.

Fourth, economic reforms can increase gender equality. Tax credits to the wife's earned income can encourage joint responsibility for income. Flexible working arrangements, such as remote work and part-time work, can help women balance household responsibilities and professional aspirations, allowing them to start their own businesses. Enforcing anti-discrimination laws and providing legal aid services can protect women from workplace bias.

Furthermore, we advocate for the implementation of microloan programs, grants, mentorship initiatives, and networking opportunities to foster women's entrepreneurship in Kazakhstan and Kyrgyzstan. While early research on microfinance suggested that repayment rates were higher when borrowers' relatives acted as guarantors, more recent studies indicate that joint liability is not a prerequisite for the success of microloans. High repayment rates can also be achieved when borrowers' access to future loans is contingent upon the timely repayment of existing ones, as well as when lenders demonstrate flexibility by extending repayment periods during periods of financial hardship. (Cai et al., 2023; Meki & Quinn, 2024). But "microfinance loans are subject to intra-household dynamics," write Cai et al. (2023), "and interventions targeting women specifically need to be sensitive to gender norms and inequalities that favor aggregation of resources into male hands".

Kyrgyzstan's success with microfinance initiatives targeting women in rural and patrilocal households serves as a model for Kazakhstan. Adapting these programs to Kazakhstan's financial framework could empower women entrepreneurs in underserved regions, facilitating economic diversification and innovation.

Setting an example can succeed. Mentorship programs address skill gaps for women entrepreneurs in both countries. Kazakhstan's larger economy and infrastructure provide an opportunity to develop regional training hubs. Publicizing success stories of households where husband and wife have equal power avoid adverse patrilocality.

In addition, reorganizing infrastructure in favor of rural settlements can have positive effects. While urban centers such as Bishkek and Almaty have the most modern and comfortable infrastructure, rural areas require comfortable public transport and night lighting that enable women to commute and work safely. To overcome inequality between cities and villages, governments can improve high-speed internet coverage for remote education and develop mobile financial services specifically for rural areas.

In sum, transformation of household structures and promotion of gender equality within families are the key factors for unlocking female potential in Kazakhstan, Kyrgyzstan, and throughout Central Asia.

Conclusions

This study concerns how the patriarchal structure of families in Kazakhstan and Kyrgyzstan affects women. Through econometric testing of the patrilocality hypothesis, we find that traditional households' structures and norms affect women by increasing the domestic burden. This also limits their access to education and consequently their employment in the labor market, inhibiting entrepreneurial activity and innovation.

In addition, we conclude that women in patrilocal households work fewer hours outside the home. On the other hand, when spouses jointly decide income distribution, this enhances women's potential by promoting their greater participation in the labor market. This loosens restrictions of traditional patriarchal households. To empower women, education and urbanization are the most important levers. Urban women and women with higher levels of education demonstrate significantly higher labor force participation.

Our comparative analysis of Kyrgyzstan and Kazakhstan also applies to other post-Soviet Central Asian countries. Both countries face similar challenges related to patriarchal and religious traditions, but they also demonstrate how to address these challenges through targeted government interventions. Policies that promote gender equality in the labor market and at home will expand access for women to education and entrepreneurship. They will also create an environment conducive to innovation and economic growth.

However, interventions must be appropriate and consistent with local norms, traditions and customs to ensure public understanding and effective policies. Only then can deeply rooted gender roles be gradually transformed through targeted programs aimed at reforming traditional household education, along with financial incentives that promote an equitable division of labor between the sexes. Urbanization's role in providing access to resources and opportunities further emphasizes the need for bridging urban-rural divides.

The data presented by the Bureau of Statistics of Kazakhstan support these findings and show a large gap between the rates of engagement in the unpaid domestic work by individuals in urban and rural areas as well as by gender. In Kazakhstan, rural women spend more time on unpaid domestic work than urban women. This indicates that cultural norms are still a barrier to women's economic participation.

Future research should aim to collect and analyze comparable data for Kazakhstan to deepen the understanding of regional dynamics. Expanding this research to include other Central Asian nations could provide broader insights into the interplay between household structures, gender roles, and economic innovation. Additionally, longitudinal studies on policy impacts could offer valuable guidance for designing scalable interventions.

Also important is to identify factors affecting the woman's labor supply beyond the social and economic ones specified by the models. One possibility is that the woman's labor supply also depends on Kyrgyzstani or Central Asian culture. Because these two cultures affect all observations in our dataset, they would influence the intercept rather than the other coefficients. Adding Kazakhstani observations to the dataset could clear up this issue. Our work on other papers in this line of research indicates that significant factors include whether the locale is regional, whether the woman is willing to accept risk at work, whether the marriage is on the basis of love or instead is a bridal kidnapping, and whether there are small children, as well as the woman's age and Kyrgyz culture. In short, a woman's labor supply is influenced by geographical, psychological, demographic, marital, and national cultural factors, as well as by social and economic variables accounted for in the models. Nevertheless, the clear impact of social and economic factors is a valuable contribution of this paper. True, the uncontrolled factors such as the basis of the marriage probably correlate with independent variables in our models, potentially influencing their coefficients to some extent. But binary variables often do correlate, and for mathematical rather than social or economic reasons. So, the correlation of our independent variables with the omitted variables would not affect our basic conclusion that social and economic factors affect the woman's labor supply.

In conclusion, addressing the barriers posed by patrilocality is not only a matter of gender equity but a strategic imperative for unlocking untapped potential in Central Asia. Empowering women through equitable

household dynamics, education, and supportive policies can drive innovation, foster economic development, and create a more inclusive society across the region. By leveraging shared cultural and historical contexts, Kyrgyzstan and Kazakhstan can lead the way in fostering gender-inclusive growth and setting an example for neighboring countries.

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ORIGINAL RESEARCH

Human capital in the field of commercialization: assessment of the competencies of technology transfer specialists

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Abstract

This research article examines the crucial role of human capital in the commercialization of scientific research. It highlights the "Valley of Death", the gap between scientific innovations and their market application, especially in countries moving from planned economies to market-oriented structures. The study highlights the need for trained Technology Transfer Specialists (TTP) who serve as intermediaries between academia and industry, facilitating the transformation of research results into commercially viable products and services. These specialists should have a wide range of qualities. The authors analyze the competencies required for TTP, dividing them into basic skills such as technical understanding and intellectual property management, and soft skills including communication and strategic thinking. The study has identified significant gaps in the current TTP competencies in Kazakhstan and highlights the urgent need for specialized training programs. The recommendations include the creation of targeted educational initiatives, reviewing university hiring practices to attract professionals with business acumen, and creating opportunities for continuous professional development. The aim of the study is to increase the efficiency of commercialization offices and, ultimately, contribute to the development of Kazakhstan's innovation ecosystem and economic growth. This study provides a methodological framework for further educational initiatives in the field of technology transfer.

Keywords: human capital, competencies of specialists, hard skills, soft skills, innovation, interrelation between industry and universities.

Introduction

In the scientific literature, the term “Valley of Death” is often used to denote the existence of a huge gap between new scientific discoveries and their introduction to the market (Dean & others, 2022) (Moradlou & others., 2023) (Calza & others., 2020). This gap is even more pronounced in countries with a history of planned economies and a science-push innovation model (Inzelt A., 2015), where scientific discoveries are implemented through a vertical system, moving from scientific institutes to design bureaus and then to factories, all guided by central planning and government orders. After the transition to a market economy, the previous links between science and business were lost, and new mechanisms of interaction are in the nascent stage. For example, in the international ranking of the Global Innovation Index, Kazakhstan ranks 81st and despite its good position in the ratio of patents for inventions (39th place) and utility models (10th place) to GDP, in terms of collaboration between industry and universities, the country ranks 117th (WIPO, 2023).

At this stage, it is necessary to develop horizontal links between stakeholders according to the Triple Helix model and open innovation model (de las Heras-Rosas & Herrera, 2021) (Ferdinands & others, 2023). In this context, along with the need to develop human capital in the field of science, there is an urgent need to cultivate human capital in the field of commercialization and technology transfer.

Commercialization specialists (term used in Kazakhstan) or Technology Transfer Professionals (TTPs) are an important link in bridging the gap between innovative research and its practical application in industry. Their experience and skills play a key role in ensuring the transition of new technologies from the laboratory to the market (Takata & others, 2022) (Gao & Haworth, 2016). The skills needed by TTPs can be divided into two main categories: technical skills (hard skills) and soft skills.

The review of literature shows that hard skills include technical understanding of products or processes developed by scientists (Mom & others, 2012); skills in the field of intellectual property rights management (IPO) and licensing (Mom & others, 2012) (Takata & others, 2022) (Gao & Haworth, 2016); and project

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management skills (Takata & others, 2022). Among soft skills, the most notable are: communication skills with various stakeholders; networking to establish and maintain relationships with partners; negotiation skills to establish mutually beneficial cooperation (Mom & others, 2012) (Sapir, 2021).

In addition to the above, TTPs need such skills as understanding of market trends, business strategies, marketing and skills to create and develop new enterprises, including startups (Mom & others, 2012). Entrepreneurial skills are also important in supporting the commercialization process (Takata & others, 2022).

Effective commercialization necessitates the active engagement of management and the participation of employees, underscoring the critical role of collective team involvement (Cerpentier & others, 2024). Specialists in the commercialization of scientific outcomes must not only possess domain-specific expertise but also demonstrate the ability to establish effective linkages between the academic and industrial sectors. The successful commercialization of research findings requires specific managerial competencies, including the capacity to construct a compelling narrative on the integration of novel technologies into future business ecosystems, as well as the ability to analyze potential networking scenarios to achieve commercialization objectives (Kenzhaliyev & others, 2021; Medlin & Törnroos, 2015).

When systematizing the key competencies of professionals involved in the commercialization of national technologies, the following attributes can be identified:

1. *Commercial Alertness* — the ability to recognize market opportunities and anticipate potential threats.

2. *Market Context Learning* — an in-depth understanding of customer needs and proactive engagement with stakeholders.

3. *Organizational Agility and Alignment* — ensuring that a firm's structure remains flexible and adaptable to dynamic market conditions.

4. *Credibility Building* — fostering trust and establishing a strong reputation within the market and among key stakeholders (Munoz-Penas & others, 2024).

These competencies are particularly relevant to employees of Technology Transfer Offices (TTOs). However, some researchers attempt to commercialize their scientific discoveries independently, circumventing TTOs. Several factors motivate this decision, including confidence in their own entrepreneurial skills, previous negative experiences with TTOs, peer influence, and challenges in establishing collaborations with external partners. Many academic entrepreneurs perceive TTOs as lacking the necessary expertise to provide effective commercialization support (Halilem & Diop, 2025; Nieto Cubero & others, 2021).

The motivations driving scientists to commercialize their research vary widely. While financial incentives serve as a significant factor, intrinsic motivation to develop practical applications for scientific discoveries also plays a crucial role (Huegel, 2024; Sohail & others, 2023). Nonetheless, a common barrier to successful commercialization is researchers' limited awareness of the importance of intellectual property protection, which can hinder the effective transition of innovations from academia to industry (K. Ismail & others, 2012).

Technology Transfer Office personnel serve as intermediaries between academia and industry, facilitating the commercialization of university inventions. Their responsibilities encompass managing technology transfer processes, overseeing licensing agreements, and fostering industry collaborations (Modic & Suklan, 2022). Despite the pivotal role of these coordinators, there remains a notable gap in the scientific literature concerning their characteristics and impact on the commercialization process (N. Ismail & others, 2015).

Table 1– Competencies of Technology Transfer Professionals

Competencies	Definition
1	2
Entrepreneurial skills	The ability to develop and implement business strategies, including understanding the market, analyzing competition, and customer needs.
Managerial skills	The ability to manage projects and teams, set goals, and monitor progress, which is especially important in complex product development processes.
Communication skills	The ability to communicate effectively in both written and oral form, which includes the presentation of ideas and the establishment of partnerships.
Decision-making ability	The ability to make informed decisions based on the analysis of various factors and risks.
Adaptability and flexibility	Willingness to change in the process of commercialization, as well as the ability to quickly respond to new opportunities and challenges in the market.
Commitment to learning	The desire to continuously develop one's skills and knowledge, including aspects related to business and commercialization.

Competencies	Definition
1	2
Technical knowledge	A deep understanding of your field of research, which allows you to evaluate the commercial potential of scientific results and make informed decisions.
Experience and knowledge	It is important that technology transfer specialists have significant experience and knowledge in the field of technology commercialization and intellectual property. This includes understanding licensing processes, patent management, and industry engagement.
Strategic thinking	The ability to strategically plan and understand the long-term goals of both the university and the business helps to navigate the complex interests of both sides.
Note — created by the authors based on (Cerpentier & others., 2024; K. Ismail & others, 2012; N. Ismail & others, 2015; Kenzhaliyev & others, 2021; Modic & Suklan, 2022) *sources*	

Considering that in Kazakhstan, commercialization or technology transfer offices in most universities, with the exception of national research universities and Nazarbayev University, began to form relatively recently, it can be assumed that there are gaps in the competencies of TTPs. With the growth of government funding for science and the introduction of tax incentives for businesses that invest in scientific research, the profession of technology commercialization is becoming relevant and assessing the current situation is of great importance for formulating strategies for the development of human capital in this area.

The purpose of this study is to analyze the competencies of employees of commercialization offices in universities of Kazakhstan and develop recommendations for the development of human capital in the field of technology transfer.

The primary research components of this section, including the methodology, results, and discussion, were prepared by senior researcher Mr.S. Kozhakhmet. The abstract, introduction, and conclusion were authored by Turdalina Sh.K., who also contributed her perspective to the discussion section. The survey and data analysis were conducted by Mr.S. Kozhakhmet, while the article formatting and submission to the editorial board were carried out by Turdalina Sh.K.

Methodology

To understand and develop the interaction between stakeholders in technology transfer, it is important to study the individual characteristics that form the human capital necessary for a strategic partnership (Albats и др., 2020). As TTPs play key role in connecting science and industry, we used parallel mixed method approach to explore competencies and skills of TTPs in universities in Kazakhstan. Using both qualitative and quantitative method simultaneously helped us to complement and enhance results from each approach (Schoonenboom & Johnson, 2017).

To quantitively assess the competences of TTPs, we adopted the scale from Report for Knowledge Commercialisation Australasia “Knowledge Transfer in Australia: Is there a Route to Professionalisation?”. This TTP assessment scale consists of 18 indicators such as entrepreneurship development, legal knowledge, marketing and promotion, intellectual property and compliance, social networks, business knowledge, knowledge transfer administration, development and mentoring, qualifications and experience, knowledge and information flow, information technology, administration and management, influence and networking, strategic thinking, knowledge management, culture, beliefs and values, collaboration (teamwork) and communication.

The respondents assessed each competence (see Table 1) at four levels: Level 4 — Expert, this is a clear strength of mine; Level 3 — Proficient, I am capable and effective in this area; Level 2 — Intermediate, some development in this area would be beneficial; Level 1 — Needs Improvement, I require significant development in this area.

In addition, two more answers were presented: N1 and N2, where N1 is unrelated to my position and N2 is unrelated to the profession of technology transfer.

The study adopted convenience sampling. The online questionnaire was compiled in SurveyMonkey and data was collected in February and March of 2024. The link to the questionnaire with a description, as well as an invitation letter indicating the voluntary and anonymous participation in the study, was sent directly to the heads of the commercialization offices and vice-rectors for science by mail. Additionally, to attract more respondents, the link was also sent to Whatsapp groups on science and commercialization.

Qualitative data was collected through semi-structured interviews with employees of commercialization offices in universities in Kazakhstan and scholars who had direct contact with these offices in implementing

commercialization projects. Nine interviews were conducted in February and March of 2024. Table 2 contains information on participants.

Table 2. Information on participants

#	Status	Position	Organization
1	TTO	Deputy Director of the Commercialization Office	State University
2	TTO	Head of the Commercialization Office	State University
3	TTO	Deputy Director of the Commercialization Office	State University
4	TTO	Vice-Rector for Commercialization	Private University
5	SCI	Scientist-Entrepreneur	Own Company
6	TTO	Director of the Commercialization Office	State University
7	TTO	Vice-Rector for Science	State University
8	SCI	Scientist, Project Leader	State University
9	SCI	Scientist, Project Leader	State University
Note — created by the authors			

Out of nine participants, six were employees of Commercialization or Technology Transfer Offices (TTO) and three were scholars engaged in commercialization projects. All participants provided informed consent and agreed for the interviews to be recorded. The recording was transcribed and analyzed in Dedoose software.

Results

The survey involved 25 managers/employees of commercialization offices in Kazakhstan. 8 of these work at public universities, 10 at private universities, 4 at public research institutes and 1 respondent at a private research institute. The distribution of respondents is shown in Figure 1.

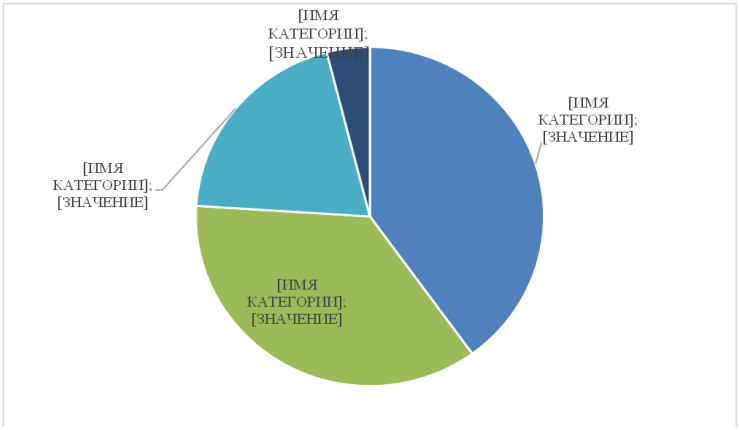

Figure 1. Organizations of respondents

Note — compiled by the authors

Participants of the survey had different backgrounds and various experience levels. The mean experience of respondents in the field of commercialization is 9.6 years, the median is 6.5 years. The respondents had education and work experience in the following fields:

1. Technical and IT areas:
- Petroleum engineering
- Engineering (including engineering, electrical engineer and technical)
- Computer Science
- IT
- Construction
- Transportation services

2. Economic and business directions:
- Economics
- Business & marketing
- International relations, economics

3. Natural Sciences:

- PhD chemistry science
- Biology
- Physics

4. Educational and humanitarian directions:
- Pedagogy and methods of primary education
- Jurisprudence

The majority of respondents are mid-career specialists (48 %), the proportion of novice specialists and senior specialists was 26 %. Figure 2 shows data on the level of respondents.

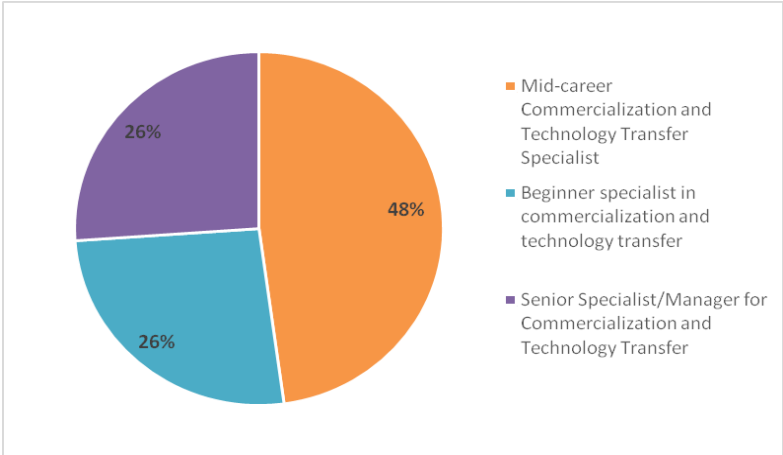

Figure 2. The level of respondents

Note — compiled by the authors

Competencies of employees of the commercialization offices

The aggregated results of the competence assessment are shown in Figure 3 and reflect the current level of competencies in the commercialization. A score of 2 indicates an average level of competence, 3 indicates an above-average level, and 4 indicates a high level of competence.

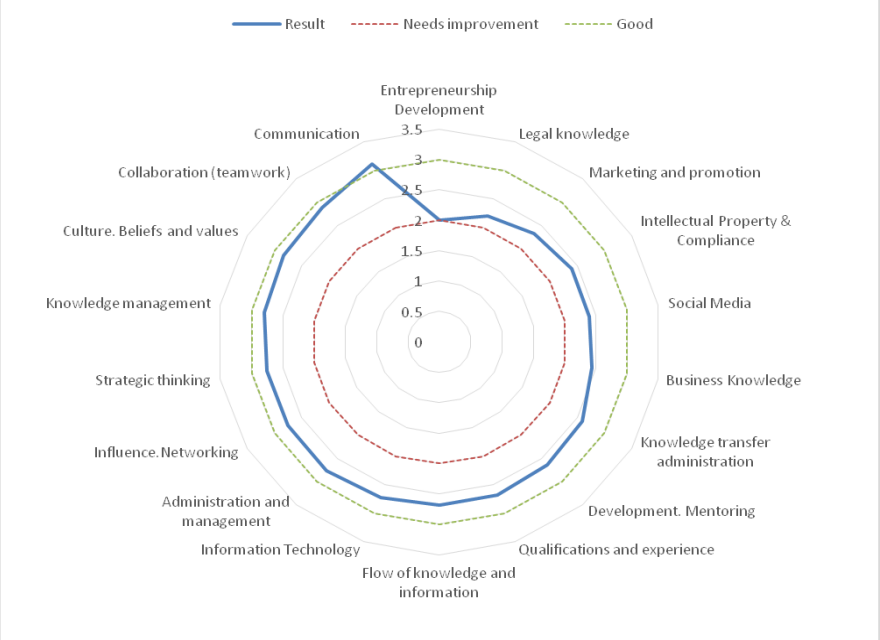

Figure 3. Competencies of employees of commercialization offices

Note — compiled by the authors

The figure shows that the most developed competence is “Communication” with a score of 3.12, which indicates an above-average level. This highlights that the commercialization offices have effective communi-

cation and interaction skills, which are critical for successful knowledge transfer and research commercialization.

Competencies such as "Collaboration" and "Knowledge Management" are also rated above average (2.88 and 2.80, respectively), indicating a good level of teamwork and knowledge management in the organization.

On the other hand, "Entrepreneurship Development" has a score of 2.00, which indicates the average level of this competence. This may indicate that although commercialization offices are able to support entrepreneurial initiatives, there is potential for further development in this area.

Other competencies such as "Marketing and Promotion", "Business Knowledge", and "Knowledge Transfer Administration" are also rated closer to the average level (in the range from 2.32 to 2.60), which may indicate opportunities for improvement in these areas.

Overall, the data show that the commercialization offices have above-average competencies in the areas of communication, collaboration and knowledge management, but there is potential for improvement in the areas of entrepreneurship development, marketing and promotion, as well as business knowledge. The values and distribution of the respondents' responses are shown in Table 3.

Table 3. Competencies of employees of commercialization offices

Competencies	1	2	3	4	N1	N2	The average value
The development of entrepreneurship. Encouraging and supporting the development of entrepreneurial abilities among researchers, administrators and students.	6	7	6	3	2	1	2,00
Culture, beliefs and values. To share the culture, beliefs and values of the unit (for example, a culture of action and willingness to commercialize, the ability to adapt to change, behave honestly, ethically and respectfully).	1	7	8	8	1	0	2,84
Cooperation (teamwork). Work in collaboration with other people to achieve common goals.	1	10	5	9	0	0	2,88
Strategic thinking. Conducting analysis, developing a strategy and transforming a strategy into actions and results.	2	9	7	7	0	0	2,76
Marketing and promotion. Converting market knowledge into commercial opportunities and promotion management.	5	10	7	3	0	0	2,32
Business knowledge. Budget management, decision-making and information management.	5	8	8	4	0	0	2,44
Administration of knowledge transfer. Effective management of knowledge collection, storage and dissemination.	2	10	9	4	0	0	2,60
The flow of knowledge and information. Ensuring an effective flow of information, taking into account the objectives of knowledge transfer.	1	10	10	4	0	0	2,68
Knowledge management. Knowledge management from its creation or collection to the achievement of goals.	1	9	9	6	0	0	2,80
Communication. Communication and interaction with other people to ensure the transfer of knowledge.	0	7	8	10	0	0	3,12
Influence. Networking, negotiation, persuasion and establishing mutual understanding.	1	12	4	8	0	0	2,76
Social network. Using and supporting the use of social media for interaction.	3	11	9	2	0	0	2,40
Intellectual property (IP) and compliance. Management of the creation, protection, assignment and protection of IP rights.	4	9	6	5	1	0	2,40
Legal knowledge. Management of intellectual property licenses and other legal knowledge transfer agreements.	6	12	3	4	0	0	2,20
Administration and management. Managing the effectiveness and improvement of an Organizational Unit and its work.	4	7	5	9	0	0	2,76
Development. Conducting professional development, mentoring and coaching.	4	7	8	6	0	0	2,64
Information technology. The use and support of information and communication technologies.	2	8	10	5	0	0	2,72
Qualifications and experience. The presence of an academic degree or work experience in the industry in the field of technology transfer.	6	5	5	9	0	0	2,68
Note — compiled by the authors							

The absolute majority of respondents agree that specialists in the field of commercialization need business development skills, but unlike other competencies, two respondents indicated that it is not related to their position and one respondent indicated that it is not related to a profession related to technology transfer.

The interviews confirmed the results of survey and showed a significant deficiency in the competencies of the directors and staff of commercialization offices, especially in terms of market knowledge and business skills. Many employees previously held administrative positions at universities and lack experience working in corporate settings. As indicated by one of the participants:

"There are few technology commercialization specialists in Kazakhstan because these are people who know two languages. People who know the language of science and the language of business. They speak both languages. Such people exist, but they are few" (Participant 5).

While there is an agreement that TTPs are doing well in communication and administration, general concern was about the lack of business acumen and any market experience.

"Mainly, this is a function of technology transfer, and people working in technology transfer offices may possess these administrative skills. These could be people from university administration who understand business to some extent, they know the university very well, but they lack investment experience" (Participant 4).

Employees of commercialization offices mention that they lack sufficient skills and have to learn on the job while implementing projects:

"We lack commercialization skills. We have the theory but not the skills for practical application, no competencies. We learn from cases ourselves" (Participant 6).

At the same time, there are almost no special courses or programs for the professional development of commercialization office staff.

"The commercialization office has 4 people, and we also bring in external experts to help us. There was an external expert who helped develop competencies. I think it's necessary to train and develop these competencies. They don't have specialized education. For example, the director is a physicist, a candidate of mathematical sciences, and it's difficult for him because of this" (Participant 7).

"...and there are no projects or programs for improving the qualifications of the existing specialists" (Participant 3).

"We don't have a specific university or even mini-courses on commercialization where our employees could improve their qualifications and work effectively" (Participant 2).

These results indicate the need for professional development for existing staff of commercialization offices in Kazakhstan. Given the lack of specialists in the labor market the bachelor level minor program or master level tracks can be introduced in order to ensure the supply of graduates with necessary skills.

Discussion

The evaluation of employees' skills in Kazakhstani commercialization offices reveals important advantages and disadvantages for these offices. Their exceptional proficiency in knowledge management, collaboration, and communication is a valuable asset. Proficiency in this area is essential for successful information transfer and research commercialization, as it promotes strong relationships between stakeholders. The respondents' prior administrative positions at academic institutions, where these abilities are highly regarded, are probably the source of this competency level.

However, our research also shown some deficiencies in areas such as entrepreneurship development, marketing, promotion, and business knowledge. These gaps are particularly concerning given the critical role these competencies play in successful technology commercialization. The results suggest that while current TTO have administrative and communication skills, they often lack practical business and market experience. This is a significant barrier to effective commercialization, as highlighted by the participants' feedback during interviews.

The analysis of competencies among specialists in the field of commercialization in Kazakhstan has not been previously explored, highlighting the significant scientific novelty of this research. The authors propose the establishment of specialized programs and courses aimed at training professionals in technology transfer. This study can serve as a methodological foundation for the development of similar educational initiatives.

The findings of this study may serve as a foundation for reassessing the personnel policies of universities and research institutions, facilitating the recruitment of specialists with expertise in investment and entrepreneurship. Furthermore, the study suggests developing a system to incentivize the active participation of such professionals in innovation commercialization. Ultimately, the adoption of these recommendations has

the potential to enhance the effectiveness of commercialization offices, thereby contributing to economic growth and the advancement of Kazakhstan's innovation ecosystem.

Kazakhstan can be characterized as transition to a market economy which requires the development of horizontal links between stakeholders, according to models like the Triple Helix and open innovation. This shift underscores the urgent need for specialized training and professional development programs for commercialization specialists. The current educational and professional training infrastructure does not fully support the development of these essential skills.

Conclusion

The survey results, along with qualitative insights from interviews, shows that professionals involved in commercialization have a strong need to enhance their business acumen. Participants pointed out that there is a severe lack of experts who can successfully close the knowledge gap between commercial demands and scientific research. This scarcity highlights the need for focused educational initiatives, such as professional MBA, mini-MBA and certification programs.

The overall shortage of human capital in the field of knowledge translation necessitates the development of bachelor's-level minors and master's-level tracks to equip graduates with skills in technical evaluation of research results and business acumen for assessing commercial value. Universities and research organization may also reevaluate their hiring and renumeration policies to bring in people with investment and entrepreneurial experience to commercialization offices and provide them with additional bonuses or profit-sharing arrangements.

The practical significance of this research lies in formulating specific recommendations for enhancing personnel training in the commercialization of scientific research. Based on the identified deficiencies in entrepreneurial, marketing, and business competencies among specialists, it is recommended to design and implement targeted educational programs, such as professional MBA programs, mini-MBA courses, and certification programs. Additionally, it is proposed to revise undergraduate and graduate curricula to integrate skills necessary for assessing the commercial potential of research outcomes.

In summary, addressing these competency gaps is crucial for fostering a robust ecosystem for innovation and commercialization in Kazakhstan. By investing in comprehensive training and development programs, the country can enhance the effectiveness of its commercialization offices, thereby driving economic growth and innovation.

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ORIGINAL RESEARCH

The evolution of business ecosystems: A text mining-based analysis of innovation and competition (1993–2023)

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Abstract

Discussions about ecosystems are mostly relevant in current time, due to the fact that ecosystem approach is becoming more recognized and more applied in the modern world. In this article the attempt was made to identify the basic directions of ecosystem development in the context of business, innovation and competition. The main trends of this phenomena by time intervals were determined. As an analytical tool the authors' application called "Friendly text mining" which is based on the "NLTK" package of programming language python was put into service. From the Scopus database journals 600 articles for the period from 1993 to 2023 were selected and processed. These findings have shown a significant increase in ecosystem related research, especially since 2014, digitalization, platform-based professional models and variations have been associated with the growing renowned strategy. Analysis also highlights the reduction of traditional cluster-based research, indicating that ecosystems are gradually changing clusters as an impressive structure to understand inter-firm cooperation and competition. In addition, this study recognizes statistically significant relationships between key words such as "ecosystem", "platform", "digitalization", "digitalization", and "innovation", which underscores each other's interconnected nature in contemporary business research. This study contributes to literature by showing the effectiveness of text mining methods, providing a scalable and systematic approach to the evolution of the educational discourse. Future research should find the structural mobility of ecosystems, their impact on industry change, and the role of emerging technologies in their evolution.

Keywords: ecosystem, business, digitalization, diversification, text mining, innovation, python.

Introduction

In this article, we intend to explore the genesis of ecosystems in the context of business and competition through bibliographic analysis, namely using text mining technology, since this technology is relatively recent and, at the time of writing, the ecosystem phenomenon has not been investigated in this way. To do this, the authors want to find out which topics have been most relevant in the above context over the past 30 years, as well as to identify how and which of them have changed their relevance with the advent of ecosystems in the economic scientific works.

Text mining has emerged as a valuable tool in scientific research (Fluck, 2005). It enables the automatic retrieval and extraction of information from scientific articles, which is crucial given the vast volume of literature in these fields. This is particularly evident in the field of mobile learning, where text mining techniques have been used to analyze and extract information from a large number of research articles (Salloum, 2018). The potential of text mining in science and technology research is further underscored by the development of a text mining tool to support complex tasks (Korhonen, 2012; Cockburn, 2018). However, there is a need for further integration and refinement of text mining technology to fully realize its potential in scientific research (Losiewicz, 2003; Chesbrough, 2003).

Since the word "ecosystem" has roots in biological sciences, studying the genesis of ecosystems in a business context may lead to irrelevant articles. To avoid this risk, we decided to use "business", "competition", and "innovation" as keywords instead of "ecosystem" during the article search. To conduct the study, 600 articles published from the journals of the Scopus database were analyzed, according to the keywords mentioned above. The selection of articles covered a fairly large period from 1993 to 2023. Using bibliographic analysis, the authors examined the state and evolution of business processes, competition in innovative research, and the role of ecosystems within them.

The goal of the article is to identify the main directions of ecosystem development in scientists' research, through the prism of business, innovation and competition, in order to determine the trends of these

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phenomena in time intervals, as well as to find anomalous values, which can provide a prerequisite for further research of these values and connections. Additionally, the authors aim to explore the relationship between clusters and ecosystems in the context of competition and test the hypothesis that as interest in ecosystem studies grows, the focus on clusters declines. The authors have contributed to the improvement of text mining technology by combining the most important functions from the NLTK python package, as well as by adding their own lines of code, which are presented later in the article. For their own convenience, as well as possibly for other interested researchers, the above functions were combined into one user-friendly web interface program, which the authors called "Friendly text mining". With the help of "Friendly text mining", the user, having no programming knowledge, will be able to perform various operations (lemmatization, removal of stop words, search for the most used words in the context of periods, etc.) with a large volume of text.

This study showed that in a competitive business environment, the popularity of ecosystem research is growing. Jacobites et al. support the conclusions of this study in the context of creating ecosystems as a mechanism for sustainable competitive advantage of companies. The authors use an ecosystem approach to strategic management and analyze the mechanisms of building an ecosystem of partners and clients (Jacobides et al., 2018).

We agree with scientists (Boschma, 2015; Andersson et al., 2010; Lakhani, 2007) in the opinion that an ecosystem approach can stimulate innovation and entrepreneurship development. The authors explore the roles of various ecosystem participants, including startups, venture investors, accelerators and educational institutions, and analyze the relationship between them to create a favorable environment for innovation.

The results of our research coincide with the analytical approaches of West and Boyers, in the context of business process diversification. Scientists have presented an overview of research related to open innovation and the use of external sources to stimulate innovation in ecosystems that transform traditional business models. They also consider the challenges that organizations face when working in ecosystems (West and Boyers, 2014).

Also, the results of our study coincide with the results of Parker et al., who study the role of the digital platform in building an ecosystem in the modern economy. The authors analyze how platforms are changing business models and how companies can use an ecosystem approach to achieve success (Parker et al., 2016).

We disagree with Ketels in the opinion that clusters are becoming more relevant in current world, and we argue that ecosystems are more preferable form of interactions organization compared to a cluster. In his researches, the author discusses various strategies and tools of industrial policy that can be used for the development of clusters and their benefits (Ketels, 2008; Ketels, 2013; Bresnahan, 2001).

Methodology

To achieve the goal of this article, a special application "Friendly text mining" was developed in the python programming language, using the NLTK package. The NLTK library assists the computer in analyzing, preprocessing and comprehending the written text. We have implemented the concepts of text mining using this library. The main function of the "Friendly text mining" is to analyze a large number of thematic articles and identify trends by finding and comparing the most used words in each period, illustrating all the results in the form of figures and tables. For completeness of the analysis, it also allows searching for words and phrases separately.

To develop this application, the authors took the following libraries in the python programming language as a basis:

NLTK is one of the most popular NLP libraries in Python (Field, 2017). Allows to perform operations on the text such as tokenization, lemmatization, removal of stop words and others.

EEL is a small library for creating interactive web applications, with full access to Python features and libraries. It is thanks to EEL that the authors managed to automate the entire process and make the program more understandable for users who are not familiar with programming.

Matplotlib is a Python library for plotting graphs, which allows the creation of a variety of graphs, with their subsequent customization.

Results

Loading the corpus.

We begin by uploading the files, that is, the "corpus" that we have prepared in advance. These are 600 articles in total from the "Scopus" database with keywords "business", "competition" and "innovation". To

investigate the indicative dynamic of changes we chose 100 articles in any period from 1993–1998, 1999–2003, 2004–2008, 2009–2013, 2014–2018, 2019–2023.

```
@eel.expose
def extract(quantity, periods):
    periods = int(periods) + 1
    quantity = int(quantity) + 1
    data = ""
    if os.path.isfile('./txt/1.txt'):
        for k in range(1, periods):
            f = open(f'./txt/{k}.txt', 'r', encoding="utf-8")
            text = f.read()
            data = str(data) + str(text) + "/n"
            f.close()
            print(f"{k}/6 files are reloading")
            storage[k] = data
            data = ""
    else:
        for k in range(1, periods):
            for i in range(1, quantity):
                text = extract_text(f"./web/corpus/{k}/{i}.pdf")
                print(f"{i}\{quantity-1} in period {k}")
                data = str(data) + str(text) + "/n"
                f = open(f'./txt/{k}.txt', 'w', encoding="utf-8")
                f.write(data)
                f.close()
                storage[k] = data
                data = ""
    return "Uploading has been completed!"
```

Figure 1. Code for loading of the corpus into the program.

Note — compiled by the authors in the programming language "Python"

Figure 1 reports the lines of code for executing the first step of the program. The data on the number of periods and articles are calculated by this function. The corpus is loaded by extracting all text content from PDFs and saving it in TXT format and in the variable "storage". To do this, we used the ready-made extract function from the PDFminer library.

Cleaning the data and finding the frequency.

In Figure 2, the main lines of code for text analysis are provided. Feature of this function is that it's made up from various mathematical and scientific analysis python libraries such as "FreqDist", "WordNetLemmatizer", "MatPlotLib" and etc. All these libraries can be used at the same time with the help of authors' codes, which make text mining more comprehensive and comfortable.

```
1   @eel.expose
2   def creation_table(i):
3       found_words = []
4       lem = WordNetLemmatizer()
5       stop_words = set(stopwords.words("english"))
6       all_stop_words = stop_words.union(additional_stop_words)
7       filtered_words = []
8       lemmed_words = []
9       text = storage[i]
10      # remove numbers
11      text_nonum = re.sub(r'\d+', '', text)
12      # remove punctuations and convert characters to lowercase
13      text_nopunct = "".join([char.lower() for char in text_nonum if char not in string.punctuation])
14      # substitute multiple whitespace with single whitespace
15      text_no_doublespace = re.sub('\s+', ' ', text_nopunct).strip()
16      cleaned_text = text_no_doublespace
17      tokenized_text = word_tokenize(cleaned_text)
18      for w in tokenized_text:
19          if w not in all_stop_words:
20              filtered_words.append(w)
21          for w in filtered_words:
22              lemmed_words.append(lem.lemmatize(w))
23      frequency = FreqDist(lemmed_words)
24      frequency.plot(30, cumulative=False)
25      frequency_words = frequency.most_common(30)
26      a = frequency.most_common(30)
27      x = ' '
28      common_words_local = []
29      for w in range(30):
30          x = x +  f' {w+1}. {a[w][0]} : {a[w][1]} <br>'
31          common_words_local.append(a[w][0])
32      plt.show()
33      common_words[i] = common_words_local
34      print("common_words were added successfully")
```

Figure 2. Code for preparing the corpus and finding the frequency.

Note — compiled by the authors in the programming language "Python"

The first function is called "Remove numbers". The name of this function speaks for itself. The program removes all the numbers that are present in the corpus, since we seek for the most popular words but not the numbers.

The next function "Remove punctuation" removes punctuation marks, symbols, double spaces and other signs that do not contain semantic load.

The "Convert to Words" function splits the text into word tokens. This can be done by the function word_tokenize which is included in the NLTK package. This was made in row 17. Once the tokenization is completed, we will be able to learn valuable and useful information from the tokens. Frequency distribution is one of them. However, before that we need to find and delete stop words. Stop words are words and sentences that do not play any role in the intellectual analysis of the text. Usually "am, is, are, this, a, an" are treated as stop words. However, depending on the purpose of text mining, different words can be considered as stop words. Stop words in NLTK are the most common words in the data. These are words that you don't want to use to describe the topic of your content. They are pre-defined and cannot be deleted. This function removes the basic stop words that are written in the program code. After this process, all punctuation and non-informative stop words will be removed. This operation is done from row 18 to 20.

The lexicon normalization process takes into account another form of text noise. For example, the words "connection", "connected" and "connecting" can be combined into one word "connect". It does this by reducing all derivative-related variants of a word to their common base term. There are usually two ways to normalize the lexicon. These are stemming and lemmatization. Stemming is a method of linguistic nor-

malization that either reduces words to their root word, or cuts out word-forming affixes. This process lowers the meaning of words to their root word. Lemmatization is the process of bringing words to their root word, which are lemmas that are linguistically correct. It does this by using techniques such as vocabulary and morphological analysis to change the base term. In most cases, lemmatization is considered as a more advanced process than stemming. Stemmer analyzes each word independently, without taking into account the surrounding text. For example, the word "better" comes from the word "good", which serves as its lemma. This object will not go through the process of creating the basis for lemmatization, because this requires a preliminary search in the dictionary. NLTK has built-in function to make this procedure called lemmatize. In row 21-22 we use this function to all filtered words from previous steps. Since the corpus is ready, the text has passed all stages of processing and text analysis operations can be performed.

We have studied the ready-made vocabulary units and can find the distribution of the 30 most popular words in all periods. To find the most popular words in our word units we use another python library called "FreqDist". From row 23 to 31 the function most_common of this library is implemented. Moreover, one more library called "matplotlib" was included into current research. This library helps to visualize textual information into the graphs and figures. We can get useful and sometimes unexpected information that would be difficult to notice without the use of text mining technology.

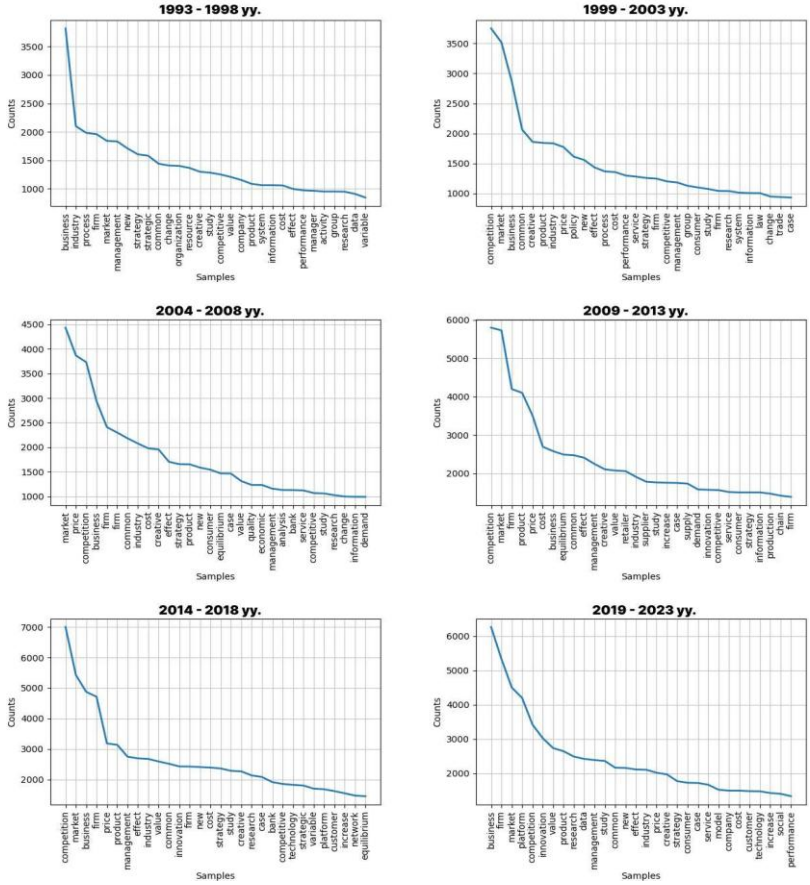

Figure 3. Distribution of the 30 most popular words in all periods.

Note — compiled by the authors in application "Friendly Text Mining"

We can see that all graphs have signs of hyperbole. This means that the words standing closer to the axis of the abscissa coordinates have the greatest number of repetitions and, accordingly, vice versa.

For example, in Figure 3, in the period from 1993 to 1998 we can observe that the word business is the most popular and occurs 3821 times, surpassing the next most frequent word industry (2100) almost by 2 times. The words process, market, management, new, strategy, strategic are also quite common. These words met in this period from 1500 to 2000 times. The last seven positions were occupied by the following words: performance, manager, activity, group, research, data, analysis and competition, which met less than 1000

times. Over the course of 30 years, the frequency of use of these words has varied from graph to graph. Later in the article, we will combine all the data from these graphs into one table for a more visual comparison.

Comparing the results

We have identified the top 30 popular words of each period and now we can observe the trend of changing words in all periods (Table 1). In this table, we have added all the words that were in the top 30 popular words in at least one of the periods. Comparing the absolute meanings of these words in each of the periods would not be entirely correct, since their general meanings differ. Therefore, the authors decided to change the values as a percentage relative to the total number of each word. For example, the word bank appeared only 4,913 times in all periods, and 7.47% of that number, or 367 words, were used between 1993 and 1998. Further, to make the table more visual, conditional formatting of the table was applied in a gradient from red (lowest values) to green (higher values).

If a word is monotonously colored in all periods, then it is equally distributed between periods. We should pay special attention to those words where there is a sharp change in the gradient. In this case, we are talking about the following words: bank, chain, data, innovation, law, manager, model, network, organization, platform, retailer, social network, supplier, supply, technology.

Table 1. The list of all popular words among 6 periods.

Words	**1993–1998**	**1999–2003**	**2004–2008**	**2009–2013**	**2014–2018**	**2019–2023**	**Total words**
1	2	3	4	5	6	7	8
Activity	24,39 %	16,48 %	9,24 %	9,60 %	22,05 %	18,23 %	3895
Analysis	13,21 %	11,50 %	17,72 %	18,38 %	20,06 %	19,13 %	6372
Bank	7,47 %	2,32 %	22,94 %	24,38 %	38,90 %	3,99 %	4913
Business	16,37 %	12,28 %	12,58 %	11,06 %	20,88 %	26,84 %	23341
Case	9,24 %	10,62 %	16,70 %	20,02 %	23,75 %	19,67 %	8758
Chain	10,66 %	5,75 %	12,85 %	39,45 %	14,94 %	16,35 %	3602
Change	20,71 %	13,93 %	14,65 %	14,56 %	18,93 %	17,21 %	6798
Common	11,21 %	16,07 %	16,99 %	19,28 %	19,58 %	16,88 %	12840
Company	20,68 %	11,31 %	17,40 %	10,11 %	13,57 %	26,93 %	5570
Competition	3,32 %	15,30 %	15,21 %	23,66 %	28,55 %	13,96 %	24523
Competitive	15,87 %	15,24 %	13,55 %	19,89 %	23,52 %	11,94 %	7875
Consumer	2,06 %	14,97 %	21,03 %	20,54 %	17,83 %	23,57 %	7336
Cost	9,63 %	12,34 %	18,02 %	24,57 %	21,77 %	13,66 %	10972
Creative	11,33 %	16,23 %	17,06 %	18,40 %	19,76 %	17,22 %	11457
Customer	11,25 %	9,86 %	12,28 %	15,84 %	26,47 %	24,30 %	6106
Data	12,42 %	11,77 %	10,73 %	12,98 %	18,95 %	33,15 %	7313
Demand	4,64 %	12,26 %	17,65 %	28,28 %	20,72 %	16,45 %	5604
Economic	10,73 %	15,39 %	21,00 %	15,00 %	18,10 %	19,77 %	5861
Effect	8,78 %	12,62 %	15,00 %	21,23 %	23,72 %	18,65 %	11350
Equilibrium	0,44 %	4,96 %	21,73 %	36,93 %	21,48 %	14,46 %	6751
Firm	11,57 %	7,35 %	13,57 %	8,21 %	27,83 %	31,48 %	16937
Group	15,19 %	18,00 %	9,19 %	19,74 %	16,69 %	21,20 %	6256
Increase	6,42 %	9,05 %	14,51 %	26,01 %	22,86 %	21,15 %	6762
Industry	16,53 %	14,45 %	16,34 %	15,06 %	21,03 %	16,59 %	12703
Information	15,68 %	14,85 %	14,63 %	22,27 %	14,98 %	17,59 %	6767
Innovation	2,64 %	7,69 %	4,61 %	19,06 %	29,38 %	36,62 %	8260
Law	11,33 %	44,09 %	12,30 %	10,98 %	12,65 %	8,65 %	2277
Management	15,86 %	10,22 %	10,01 %	19,46 %	23,75 %	20,70 %	11552
Manager	32,25 %	15,34 %	11,65 %	9,58 %	16,58 %	14,60 %	2986
Market	7,23 %	13,82 %	17,42 %	22,52 %	21,32 %	17,69 %	25453
Model	8,64 %	7,78 %	10,01 %	13,74 %	28,89 %	30,93 %	4933
Network	12,51 %	13,31 %	11,86 %	9,30 %	34,15 %	18,86 %	4299
New	15,84 %	14,45 %	14,71 %	12,62 %	22,33 %	20,05 %	10776
Organization	30,89 %	15,14 %	11,74 %	11,61 %	17,52 %	13,11 %	4532
Performance	14,24 %	19,04 %	13,17 %	13,77 %	20,16 %	19,62 %	6819
Platform	0,17 %	0,17 %	1,33 %	5,32 %	26,55 %	66,45 %	6319
Policy	13,15 %	29,05 %	13,53 %	13,51 %	15,46 %	15,31 %	5545

Words	1993–1998	1999–2003	2004–2008	2009–2013	2014–2018	2019–2023	Total words
1	2	3	4	5	6	7	8
Price	4,93 %	11,73 %	25,62 %	23,27 %	21,06 %	13,38 %	15102
Process	27,62 %	19,04 %	10,91 %	10,72 %	16,90 %	14,81 %	7176
Product	7,50 %	12,73 %	11,42 %	28,36 %	21,68 %	18,31 %	14464
Production	6,89 %	7,94 %	15,23 %	31,42 %	21,10 %	17,43 %	4688
Quality	8,52 %	11,93 %	25,12 %	16,95 %	15,52 %	21,96 %	4904
Research	10,55 %	11,56 %	11,41 %	14,99 %	23,74 %	27,76 %	8978
Resource	23,80 %	14,57 %	14,05 %	10,24 %	19,07 %	18,27 %	5731
Retailer	2,18 %	4,94 %	11,15 %	54,73 %	7,67 %	19,33 %	3766
Service	9,54 %	16,54 %	14,48 %	19,60 %	18,24 %	21,60 %	7735
Social	5,99 %	12,12 %	14,25 %	12,83 %	22,53 %	32,29 %	4358
Strategic	21,52 %	11,27 %	9,75 %	18,77 %	24,52 %	14,17 %	7341
Strategy	15,79 %	12,37 %	16,29 %	14,83 %	23,23 %	17,48 %	10159
Study	13,04 %	10,92 %	10,77 %	17,98 %	23,23 %	24,06 %	9824
Supplier	7,15 %	5,47 %	15,97 %	42,86 %	17,58 %	10,97 %	4165
Supply	3,04 %	7,98 %	14,75 %	47,15 %	13,63 %	13,44 %	3682
System	17,07 %	16,26 %	12,85 %	18,97 %	16,22 %	18,63 %	6216
Technology	9,55 %	10,84 %	14,64 %	8,16 %	31,35 %	25,46 %	5812
Trade	11,82 %	28,95 %	16,85 %	14,81 %	12,84 %	14,72 %	3240
Value	11,17 %	8,07 %	12,14 %	19,24 %	24,00 %	25,38 %	10789
Variable	12,53 %	11,66 %	12,71 %	20,60 %	25,20 %	17,30 %	6734
Firm	5,94 %	9,32 %	21,59 %	37,66 %	21,71 %	3,77 %	11156
Note — compiled by the authors in application "Friendly text mining"							

From Table 1, we can easily see the spread of words in each period, and coloring helps to better notice how evenly words were used in all periods. If the color shades of a certain word differ slightly from each other from period to period and have a red shade, this indicates that this word was equally relevant throughout the entire period under study and has a high probability of continuing this trend. In contrast, if the colors in the periods differ, and some periods have a more yellow or green hue, it shows that these words were most relevant in these years, unlike others.

Of the total number of activity words used in all periods, which amounted to 3,895, approximately 24,4% of this number was used in the period from 1993–1998, that is, in the first period under consideration. The distinctive periods are periods 2004–2008 and 2009–2013, where there is a significant decrease in the frequency of this word.

The word bank was used in approximately 86% of cases in the 3rd, 4th and 5th periods and about 14% in the rest, with the highest value of 38.9% in the 2013–2018. In this period, the following words also showed the greatest importance: network — 34.15%, competition — 28.55%, technology — 31.35%.

The word chain showed the greatest relevance in the period from 2009–2013, scoring slightly less than 40%. The following words had the similar trend: cost — 24.57%, demand — 28.28%, equilibrium — 36.93, product — 28.36%. production — 31.42, retailer — 54.73, supplier — 42.86. supply — 47.15, firm — 37.66%. Most of the above words are related to each other. For example, the words product, production and chain are related to production topics. At the same time, demand, supply, supplier, retailer, equilibrium, firm describe market participants and market relationships. Therefore, the main object of research in the period from 2013 to 2018 can be suggested as market, as well as industrial production.

The word data was used approximately the same way from the 1st to the 4th periods, slightly increasing the frequency in the 5th period, increasing almost twice to the value of 33.15%. The words firm, innovation, model, research, social, study, value had a similar tendency. The data from the table shows that the study of the above concepts over time becomes more interesting for the authors of publications. It becomes clear that the authors are starting to mention more about research and models, pay more attention to social issues, and there is also a constant increase in interest in innovation.

The word platform had the same tendency. However, its uniqueness lies in the fact that it showed the greatest growth among the words under consideration in the entire study. Approximately 26% of this word was used in the period from 2014–2018 and about 66% in the period from 2019–2023. This suggests that research on platforms is just beginning to gain momentum in scientific circles. This can be caused for several reasons. One of them is that large enterprises are increasingly realizing the importance of building their own

ecosystem for their further growth (Asheim, 2011). In this regard, there is a growing interest in the platforms on the basis of which these ecosystems are being built. Later in the article, we will use the word search function to confirm or refute this assumption.

There is also a relationship between the words law, policy, trade. All of them were most relevant in the period from 1999–2003.

The words manager, organization, process tend to decrease. In the first period, all had the highest values (approximately 30%) and after a while they began to occur less frequently, up to about 14% in the last interval. This may indicate that the study of management and operational activities of the enterprise interested researchers in the early 1990s. However, this interest slowly waned throughout the rest of the period.

Studying the genesis of ecosystem.

In this part, we want to check when, in the context of business, innovation and competition, scientists' interest in ecosystem research began, and how this interest changed during the period from 1993 to 2023. Having determined this trend, we want to compare it with the distributions of words that were studied by the authors in previous steps and, possibly, identify statistically interrelated groups of words that in a certain way affect the growth or decline of each other's relevance.

Up to this stage, we have determined that the word ecosystem has not been used often enough to enter the top 30 from any period. However, we have noticed the rapid growth of the word platform, and as we found out from the works of Isckia's and others (Isckia, 2014), the ecosystem is built on the basis of a specific platform. These results are encouraging and give us a reason to continue the study. As a continuation, the authors decided to determine the exact number of occurrences of the word "ecosystem" in each period and compare it with the words of interest — those that show a sharp contrast from period to period — in Table 1. Additionally, in this step we also investigated words "diversification", "digital" and "cluster" to find out their correlation with the word "ecosystem", and to check these results with the conclusions of other scientists.

We can see how our assumption about the relationship between platforms and ecosystems has been confirmed. Both of these words in percentage terms were used in the first period less than 0.5 percent and remained approximately at this level until the third period. A significant increase was noticeable in the fourth period, where the values sharply exceeded the mark of 25–30 percent, and in the sixth period were approximately equal to 65 percent. This proves that ecosystems and platforms have become one of the main topics of researchers and this interest began to appear from 2014–2018. In the theoretical part, we mentioned that platforms are the basis for creating ecosystems, and the relationship of these words is obvious.

However, what really deserves attention is that the word digital has almost the same tendency of use in percentage and absolute terms. The sharp increase in the study of digitalization has also dramatically increased the relevance in the study of ecosystems. This may indicate that digitalization has a positive impact on the emergence and development of ecosystems. In the future, you can review articles from the sixth period and draw more accurate conclusions using the manual method of text processing.

Table 2. The spread of the word ecosystem and related words among 6 periods.

Words	1993–1998	1999–2003	2004–2008	2009–2013	2014–2018	2019–2023	All words
Cluster	8,95 %	5,42 %	29,00 %	23,83 %	9,08 %	23,71 %	793
Data	12,42 %	11,77 %	10,73 %	12,98 %	18,95 %	33,15 %	7313
Digital	2,21 %	1,39 %	0,74 %	1,39 %	22,93 %	71,33 %	1221
Diversification	5,03 %	2,17 %	3,09 %	7,55 %	15,56 %	66,59 %	874
Ecosystem	0,40 %	0,48 %	0,48 %	2,15 %	31,92 %	64,57 %	1253
Firm	11,57 %	7,35 %	13,57 %	8,21 %	27,83 %	31,48 %	16937
Innovation	2,64 %	7,69 %	4,61 %	19,06 %	29,38 %	36,62 %	8260
Model	8,64 %	7,78 %	10,01 %	13,74 %	28,89 %	30,93 %	4933
Network	12,51 %	13,31 %	11,86 %	9,30 %	34,15 %	18,86 %	4299
Platform	0,17 %	0,17 %	1,33 %	5,32 %	26,55 %	66,45 %	6319
Research	10,55 %	11,56 %	11,41 %	14,99 %	23,74 %	27,76 %	8978
Study	13,04 %	10,92 %	10,77 %	17,98 %	23,23 %	24,06 %	9824
Technology	9,55 %	10,84 %	14,64 %	8,16 %	31,35 %	25,46 %	5812
Value	11,17 %	8,07 %	12,14 %	19,24 %	24,00 %	25,38 %	10789

Note — compiled by the authors in application "Friendly text mining"

The word diversification has a similar connection. Despite the fact that this term appeared in the circles of scientists studying economics much earlier than our studied periods, it began to gain the greatest popularity

ty only in the last two periods. This suggests that the creation and development of ecosystems along with digitalization makes it easier for companies to diversify their activities.

You can also observe the relationship between the words "ecosystem" and "cluster". Based on the bibliographic analysis, it can be noted that scientists recognize that in many respects the terms "ecosystem" and "cluster" have common characteristic features (Adner, 2017). However, in determining the differences between these terms from each other, the opinions of economists differ. There is a point of view in the scientific literature that an ecosystem is a more perfect form of interaction organization compared to a cluster (Moore, 2006; Sherwani, 2018; Autio, 2021; Arthur, 2021). Moreover, scientists emphasize that the ecosystem is the next stage in the evolutionary development of cluster models in the context of digitalization. This fact is confirmed by the results of the study. Table 2 shows that clusters began to become relevant for researchers in periods three and four (29% and 24%, respectively, in percentage terms of universal use for the entire period), before the beginning of mass interest of scientists in the topic of ecosystems. In the fifth period, the popularity of the use of the word cluster decreased to 9%, at the same time, the use of the concept of ecosystems increased from 2% to 32%. In the final period, interest in the research of clusters increased again — about 24%, however, this does not compare with the increase in relevance for ecosystems. In the sixth period, the word "ecosystem" accounted for 65% of occurrences, which is three times more frequent than the use of word clusters.

We can also build a correlation table from this data to quantify the relationship. So, using the Microsoft Excel program, and based on the following formula for calculating the Pearson correlation coefficient, we can get Table 3.

Table 3. A table of correlation coefficients.

	cluster	***data***	***digital***	***diversification***	***ecosystem***	***firm***	***innovation***	***model***	***network***	***platform***	***research***	***study***	***technology***	***value***
Cluster	1,00													
Data	0,95	1,00												
Digital	0,78	0,90	1,00											
Diversification	0,83	0,93	0,99	1,00										
Ecosystem	0,79	0,91	0,99	0,98	1,00									
Firm	0,93	0,99	0,90	0,91	0,92	1,00								
innovation	0,91	0,98	0,92	0,93	0,94	0,98	1,00							
Model	0,93	0,99	0,90	0,91	0,92	1,00	0,99	1,00						
Network	0,90	0,96	0,82	0,83	0,85	0,98	0,95	0,98	1,00					
Platform	0,80	0,92	1,00	0,99	1,00	0,92	0,94	0,92	0,84	1,00				
Research	0,95	1,00	0,88	0,90	0,90	0,99	0,98	1,00	0,98	0,90	1,00			
Study	0,95	0,99	0,85	0,87	0,87	0,98	0,97	0,99	0,98	0,87	1,00	1,00		
technology	0,92	0,98	0,86	0,87	0,89	0,99	0,97	0,99	0,99	0,88	0,99	0,98	1,00	
Value	0,96	0,99	0,86	0,88	0,88	0,99	0,98	0,99	0,98	0,88	1,00	1,00	0,98	1,00

Note — compiled by the authors in application Microsoft Excel

Table 3 shows that the word "ecosystem" has a strong connection with the words digital, diversification and platform, since in all cases the correlation coefficient is higher or equal to 0.98 and their relationship is statistically significant. The word platform can be especially noted. Their correlation coefficient is equal to the maximum value of 1.

Summarizing the results obtained from Tables 1 and 2, we can conclude that in the context of business, competition and innovation, ecosystems were not particularly popular among scientists until 2014. As interest in topics such as innovation, digitalization, diversification, and platforms has developed, there has also been an increase in interest in ecosystems. You can also see how the word cluster is noticeably different from all the words. It has the most minimal correlation in comparison with others. It can be concluded that as diversification and digitalization grow, the cluster approach is giving way to the ecosystem approach. These connections serve as a prerequisite for further in-depth analysis of their causes and potential consequences. However, within the scope of this study, we will limit our discussion to these results.

Conclusions

The study confirmed the hypothesis that interest in ecosystem research is growing in scientific circles and the number of articles studying the cluster approach is decreasing. This is primarily due to the develop-

ment of digital platforms that contribute to the evolution of the organization of business processes from clusters to ecosystems. In the context of digitalization, enterprises are striving to introduce innovative business methods. Ecosystems are priority areas of business development and promotion.

Statistically interrelated groups of words have been identified. These are words related to the topic of ecosystems, such as diversification, digital, cluster. (which in a certain way affect the development of ecosystems).

The development of digital platforms and networks creates new opportunities for businesses and consumers, accelerates the processes of interaction between all participants, and most importantly changes traditional business models. The diversification of enterprises' activities is accompanied by the creation, implementation and development of ecosystems.

The assumption about the relationship between platforms and ecosystems was confirmed. This proves that ecosystems and platforms have become one of the main topics of researchers. The development of digitalization processes has also influenced the increasing relevance of ecosystem research. This may indicate that digitalization has a positive impact on the emergence and development of ecosystems.

As a recommendation for future research, we suggest studying the content and composition of ecosystems as a means of enhancing business process efficiency. Additionally, increasing the state's role in ecosystem management could foster ecosystem growth and development. This could involve measures such as establishing innovation parks, providing tax incentives, financing and supporting startups, and other strategic initiatives.

The review of the articles demonstrates the trend of changing the focus of scientific research of scientists and shows how, as time passed, some words began to lose relevance and be replaced by others. Identifying these changes, especially those that have a sharp rise or decline, as well as further studying their causes, can help advance research in the field of business, innovation and competition. This review and recommendations can enrich the methodological landscape of innovative research and allow the community to use the opportunities provided by digital technologies.

Text mining applications provide access to the processing of a large amount of information and allow you to identify the main trends in research. Therefore, the role of text mining technology in scientific research is quite high.

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