

Changes in the real estate office market in the face of the Fourth Industrial Revolution: A case study of Krakow

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ABSTRACT

Objective: This article examines the impact of the Fourth Industrial Revolution on the office real estate market, focusing on Kraków, Poland.

Material and methods: The study employs in-depth interviews, targeting two experienced office managers specialising in lease management in Kraków, the largest regional office market in Poland. While qualitative research is inherently non-representative, this approach was chosen to gain a deeper understanding of the context of the studied phenomena.

Findings: The study reveals that technological advancements significantly influence market dynamics. Office buildings equipped with the latest technologies are more likely to achieve quick commercialisation. In the context of remote work, tenants demand highly optimised and eco-friendly office solutions to attract and retain employees.

Research limitations: The study's focus on Kraków presents a limitation, as market conditions may vary in other regions. Additionally, the research is constrained by the availability of data and the uneven distribution of market knowledge.

Research implications: The findings highlight the necessity for continuous technological adaptation in the office real estate market. Further research involving diverse market participants from various locations would enhance understanding. This study emphasises the profound effects of the Fourth Industrial Revolution on shaping tenant expectations and office market trends.

Keywords: Fourth Industrial Revolution; Commercial Real Estate; Office buildings; ESG; Remote work

JEL codes: R3, M1, M2

Article type: research article

DOI: 10.15678/worej.2450-534X.18948

Received: 26 July 2024 **Revised:** 19 November 2024 **Accepted:** 10 January 2025

INTRODUCTION

The purpose of this article is to present the changes in the real estate office market in the face of the Fourth Industrial Revolution. This revolution, also known as Industry 4.0, introduces advanced digital technologies that impact various sectors of the economy, including the real estate market. In the context of these transformations, the key research questions to be addressed include:

- How does the Fourth Industrial Revolution and proptech influence (or will influence) the real estate market?
- How have tenant expectations regarding office space, its usage, and amenities changed?
- Has the aspect of sustainable buildings, ESG, and green certifications become particularly important in recent years?
- What does the future hold for the office market in Krakow?

To answer these questions in our study, we employed the method of in-depth interviews, targeting two experienced office managers specialising in lease management in Kraków, the largest regional office market in Poland. While qualitative research is inherently non-representative, this approach was chosen to gain a deeper understanding of the context of the studied phenomena.

The selection of Kraków as the focus of our research was deliberate, as it is the largest regional real estate market in Poland, hosting a diverse range of companies from various sectors of the economy. This characteristic makes it a particularly rich environment for examining trends and dynamics in the office rental market.

Additionally, we selected managers from two distinct property management companies with differing scales of operation. This choice was made to enhance their roles as key informants, providing diverse perspectives on market trends and ensuring a more comprehensive understanding of the subject matter.

This methodological approach allowed us to capture nuanced insights into the phenomena under investigation, offering valuable contributions to the discourse on office market dynamics in the context of the Fourth Industrial Revolution.

The study's findings will provide insights into how modern technologies and changing tenant needs are shaping the office real estate market, as well as how Krakow is coping with the challenges and opportunities associated with Industry 4.0.

LITERATURE REVIEW

The scientific literature describing the impact of the Fourth Industrial Revolution (also known as Revolution 4.0 and Industry 4.0 (Schwab, 2018) on the office real estate market is limited, but a few valuable studies in this area can be highlighted. Furmanek (2018) explains the main ideas of the Fourth Industrial Revolution, defining it as a general concept based on ubiquitous digitisation, information technologies (noticeable in every aspect of life), virtual simulations in decision-making processes, reliance on real-time data processing, the Internet of Things, and the widespread dissemination of new manufacturing technologies.

Bartkowiak, Górską, Koszel, Mazurczak, Strączkowski, and Kinelski (2023) describe new technologies in the real estate market, with particular emphasis on proptech (property technology). This term encompasses processes, products, and business ideas utilising the latest resources in information and communication technologies. They also identify the main goal of proptech: increasing efficiency and optimising construction technology, development activities, the investment process, and property management. Their research confirms that modern technologies play an important role in the choice of premises for most future tenants.

In the book by Belniak, Głuszak, and Zięba (2013), information can be found about popular certification systems for green (mainly office) buildings and the benefits of investing in sustainable real estate. However, the research also highlights current barriers of green constructions in Poland: a lack of adequate awareness and conviction among users regarding its advantages, financing issues and a superficial understanding of the concept of sustainable development.

One of the most well-known certification systems, LEED, is also described in an article by Głuszak, Małkowska and Marona (2021). Their research indicates that decision-making factors regarding green certifications depend on location, policies, environmental regulations, and socioeconomic conditions. They also vary over time. The adoption level of certifications is correlated with the overall level of innovation in the economy.

Research by C. W. Starr, J. Saginor and E. Worzala (2021) shows Industry 4.0's impact on real estate. It includes smart building solutions such as minimising energy costs, measuring air quality and building capacity regarding spacing. The goal of smart buildings is to implement sustainable technologies

and improving users experience. During the COVID-19 pandemic, Industry 4.0 findings especially helped to create healthy workplaces. Authors particularly mention the Building Information Modelling (BIM) concept. It provides a digital representation of both functional and physical characteristics of the property. Also financial aspects of buildings and the real estate sector employees' daily tasks are widely influenced by Industry 4.0.

Z. Tan and N. G. Miller (2023) provided insights on sustainability-focused proptech startups in the article. After interviewing several commercial office buildings, it turned out that all of them were using tools like customised platform systems for asset management and operation. Real estate owners highlight that digitalisation plays a significant role in their sustainability initiative on net-zero operation, energy efficiency and healthy building attributes. The consolidation of the proptech industry through the standardisation and acquisition of startups by established firms will address integration challenges for these companies.

Another article written by P. Ross and K. Maynard (2021) highlights the role of the Fourth Industrial Revolution in creating modern workplaces. The advent of autonomous, intelligent, and sentient urban infrastructure will propel the next industrial revolution beyond 'smart buildings' and 'smart cities'. Although this period presents its fair share of challenges, it also offers a chance and an obligation to shape our desired lifestyles and work environments within our cities. Additionally, it enables us to bring global communities together and foster the development of sustainable economies.

R. Oosthuizen (2022) indicates that the risk of the Fourth Industrial Revolution is the cause of replacing a third of the jobs that exist today. It will also influence how the commercial real estate operates and may reduce its actual users and demand. The STARA (smart technology, artificial intelligence, robotics, and algorithms) concept will be the reason for eliminating occupations. Robotic dexterity and intelligence continue to advance, and the innovation of affordable autonomous units progresses; there is the potential for these machines to outperform humans in a multitude of work settings and dynamic activities.

Many researchers note a growing role of smart buildings in their environment, and already a relatively large and still growing number of so-called smart technologies are present in the real estate sector. The technologies can be grouped into the following nine categories: drones, UAVs, the internet of things (IoT), clouds, software as a service, big data, 3D scanning, wearable

technologies, virtual and augmented realities (VR and AR), and artificial intelligence (AI) and robotics (Ullah, Sepasgozar and Wang, 2018).

Rymarzak and Madera (2020) analysed the Tri-City office space market in sustainable buildings in terms of supply and demand. In recent years, there has been a noticeable trend in constructing office buildings according to sustainable construction standards. Ecological certification requires meeting numerous criteria, including indoor environmental quality, energy efficiency, and transport accessibility. Proper water and waste management, as well as the use of natural building materials, are also important. Meeting these requirements confirms the building's ecological character and its compliance with sustainable development principles.

Janicka (2014) discusses the development of the green office building market in Poland. She presents the main ecological certification systems for buildings, such as BREEAM and LEED, and their growing popularity among developers and investors. The benefits of constructing sustainable office buildings include lower operating costs, higher rents and sale prices, and better working conditions for employees. At the same time, she points out challenges such as higher construction and certification costs. Although green buildings currently constitute a small part of the Polish office market, their share is growing rapidly, mainly due to foreign tenants and investors. The author predicts that in the future, ecological certification may replace the traditional classification of office buildings.

Strumiłło (2023) analyses the importance of sustainable work environments in modern office buildings as an element of ecological urban development. The study covers aspects ranging from building construction to interior design. The author emphasises the need to adapt spaces to the changing requirements of employees, especially after the experiences of remote work during the COVID-19 pandemic. The author indicates that well-designed, sustainable offices can improve work quality, increase productivity, and positively impact employees' health and well-being, making them a key element in urban planning. Furthermore, the author draws attention to the growing role of areas conducive to human interactions and collaboration in office spaces. Investments in sustainable work environments can bring long-term benefits for both employers and employees, while also contributing to the overall improvement of quality of life in cities.

Considering the cited research, it is important to emphasise the significant impact of the Fourth Industrial Revolution on the office real estate

market and the ongoing adaptation process. New technologies and the concept of sustainable development impose specific actions on all participants in the real estate market. The fourth industrial revolution and sustainable development are closely linked in real estate. Advanced technologies like Internet of Things, Artificial Intelligence, and big data enable efficient resource management in buildings, contributing to sustainability goals. These technologies optimise indoor conditions, reduce energy consumption, and facilitate data-driven decision-making in property management. Consequently, the fourth industrial revolution is transforming real estate practices while supporting sustainable development objectives.

RESEARCH METHODOLOGY

To carry out the research process, in-depth interviews with 2 respondents were conducted. Each interview lasted approximately 1.5 hours, providing ample time for a comprehensive exploration of the research topic. The interviews took place in June 2023, specifically in Kraków, Poland. A total of 11 questions were utilised to guide the interviews and gather valuable insights from the participants. 4 of them were related to Industry 4.0. The interview respondents included the head of one of the leading commercial real estate office agencies and the leasing director of one of the biggest due to the space office complexes in Kraków. The scope of the study involves gathering information from the respondents regarding the current situation of the office real estate market in Kraków, as well as their opinions and forecasts. The primary objective of the research was to identify the impact of the Fourth Industrial Revolution and the changes it has brought about in the office real estate market.

The selection of respondents was based on their professional positions and the nature of their work. The first respondent is responsible for selecting suitable office spaces for specific clients, while the second is in charge of the commercialisation of a particular property. This allowed obtaining a broader perspective on the current situation of the office real estate market. To achieve the research objective, the following questions were posed to the respondents :

Q1: How does the Fourth Industrial Revolution and proptech influence (or will influence) the real estate market?

Q2: How have tenant expectations regarding office space, its usage and amenities changed?

Q3: Has the aspect of sustainable buildings, ESG, and green certifications become particularly important in recent years?

Q4: What does the future hold for the office market in Krakow?

RESULTS & DISCUSSION

Respondents agreed that the Fourth Industrial Revolution has had a significant impact on the office real estate market. They acknowledged that this impact is not only noticeable but also brings numerous benefits for all market participants. In particular, they highlighted the importance of integrating various systems with building applications, which have been made possible due to advanced technology. These integrated applications have revolutionised building and office space management, leading to notable optimisation benefits. The integration of smart technologies goes beyond basic building management. Internet of Things (IoT) devices and AI-powered analytics are being deployed to gather and analyse data on space utilisation, energy consumption, and occupant behaviour. This data-driven approach allows for predictive maintenance, optimised resource allocation, and improved decision-making for both building managers and tenants. However, the increased reliance on interconnected systems also raises cybersecurity concerns, necessitating robust security measures to protect sensitive data and building operations.

One of the key advantages is the ability to reserve workstations or parking spaces, streamlining the process and ensuring that employees have access to the necessary resources when they need them. Additionally, these applications provide real-time information about events within the office complex or building, allowing for improved communication and coordination among users. Moreover, they also play a crucial role in registering employee attendance, offering insights into office utilisation and productivity, especially in an era where remote work is prevalent.

Among the revolutionary proptech solutions, the respondents identified the Building Management System (BMS). The BMS aids in resource control and savings by preventing failures or identifying instances of excessive electricity consumption in specific workstations or other office areas. This level of advanced monitoring and optimisation not only promotes greater efficiency but also contributes to cost reduction and sustainability efforts, aligning with the rising popularity of eco-friendly solutions in the industry.

The rise of remote and hybrid work models, accelerated by recent global events, has further complicated the office real estate landscape. Technologies enabling hot desking and activity-based working are becoming increasingly prevalent. These systems not only facilitate flexible work arrangements but also provide valuable data on space utilisation. Moreover, office designs are evolving to support seamless collaboration between on-site and remote workers, incorporating advanced audiovisual equipment and virtual meeting spaces.

Looking ahead, the respondents anticipate that the impact of the Fourth Industrial Revolution will become even more pronounced. They predict an increasing demand for control over individual building elements, such as lighting, HVAC systems, and security, as tenants prioritise customisation and personalisation of their office spaces. Moreover, the respondents highlighted the growing expectations for eco-friendly features and sustainability initiatives, as tenants place greater emphasis on environmentally responsible practices.

The respondents have similar observations regarding new tenant expectations for office space. Respondent I, a broker in the office real estate market, noted the trend of *"flight to quality, flight to centre."* *"When tenants decide to rent office space, they expect the highest quality in the best location (city centre)."* This is closely linked to the application of modern building technologies. Respondent II, responsible for the commercialisation of a large office complex, believes that *"Today's office and its design should positively impact employees' well-being. Currently, many new functions and spaces are emerging that differ from the typical office. The coworking function of the office is very important today, where employees should integrate and spend time pleasantly rather than just working at their desks."* In this case as well, it can be stated that modern technologies and continuous optimisation of space according to prevailing trends are currently very important aspects in choosing a workplace.

The growing significance of sustainable buildings, environmental, social, and governance (ESG) principles and green certifications in the real estate industry is widely visible (as mentioned in Tomasik & Marona, 2024). Participants in the office real estate market are becoming increasingly aware of the importance of these factors. Green certifications, such as BREEAM or LEED, have become the benchmark that tenants expect and that investors and developers must adhere to.

The push for sustainability extends beyond certifications. Modern office buildings are incorporating features such as solar panels, green roofs, and advanced waste management systems. From a financial perspective, while these

green initiatives often require higher upfront investments, they can lead to significant long-term cost savings and increased property values. Additionally, many governments are implementing regulations and offering incentives to promote sustainable building practices, further driving the adoption of eco-friendly solutions in the office real estate sector.

One of the core priorities within the context of sustainable buildings is energy consumption. The focus is on reducing energy requirements through efficient design and technology integration. The aim is to create buildings that minimise energy consumption and promote a more sustainable future. Additionally, there is a growing emphasis on zero-emission buildings, which entails the adoption of renewable energy sources and the elimination of carbon emissions.

Another critical consideration is the carbon footprint of the construction sector. The construction industry has a substantial environmental impact, mainly due to the energy-intensive nature of building activities. As a result, reducing the carbon footprint of the construction sector has become a key objective for stakeholders. This involves implementing construction practices that minimise greenhouse gas emissions, optimising materials and waste management, and integrating sustainable design principles from the outset.

These findings regarding the importance of sustainable buildings and green certifications align with previous research in the field. Previously mentioned literature review (Głuszak, Małkowska and Marona 2021 and Janicka 2014) consistently emphasises the significance of certifications in demonstrating environmental commitment, as well as their positive effects on the values and market appeal of properties. Furthermore, the integration of ESG principles and the adoption of sustainable practices are increasingly seen as a competitive advantage, attracting both tenants and investors who prioritise environmental responsibility.

The future of the office real estate market is closely tied to the Fourth Industrial Revolution and its solutions. Respondent I believes that *"modern buildings that meet the current standards of green buildings and have green certifications, as well as being at least aligned with the concept of zero emissions, will have a viable existence. We will also observe a significant focus on the relocation of companies that entered Krakow between 2005 and 2010. These properties have aged somewhat and no longer meet the standards and expectations of today's employees."* Respondent II agrees on this matter, stating, *"The next few*

years will be a huge challenge for the office market in terms of attracting clients, defining the functions of offices, and revitalising existing projects."

In conclusion, the Fourth Industrial Revolution is profoundly reshaping the office real estate market. The integration of advanced technologies, the emphasis on sustainability, and the shifting expectations of tenants are creating both opportunities and challenges for stakeholders. As the industry continues to evolve, adaptability and innovation will be key to success. The future of office real estate lies in creating flexible, sustainable, and technologically advanced spaces that can meet the diverse and changing needs of businesses and their employees.

CONCLUSIONS

The research findings and literature review provide solid evidence of the impact of the Fourth Industrial Revolution on the office real estate market. Moreover, the integration of the latest technologies in buildings significantly enhances their likelihood of achieving swift commercialisation. Tenant expectations have also evolved in this regard, especially in the era of remote work, where offices featuring optimised and eco-friendly solutions are particularly attractive to employees. As the influence of the Fourth Industrial Revolution in this sector continues to grow, it becomes imperative to adapt planned office projects and revitalise existing ones.

In this context, green certifications for office projects play a crucial role in attracting future tenants. Such certifications serve as decisive factors in their selection, emphasising the increasing importance placed on sustainability and environmental responsibility. However, it is important to note that this research topic requires further exploration from both theoretical and practical perspectives. Multiple facets exist through which the impact of the Fourth Industrial Revolution on the office real estate market can be analysed, and broader investigations are needed to comprehend the phenomenon comprehensively. Although the study focuses primarily on Kraków, Poland, it is worth acknowledging that the situation may vary across different locations. Therefore, it is essential to recognise the limitations of such research, including the availability of credible sources and the varying levels of knowledge and information asymmetry prevalent in the market. Engaging with other participants in the office real estate market from diverse areas and gathering their opinions can provide valuable insights. These opinions, often shaped by

individual experiences, can guide future research directions and contribute to a more comprehensive understanding of the subject matter.

It is worth considering that predictions for the office real estate market may not always align perfectly with actual outcomes. Therefore, analysing the discrepancies between projected outcomes and real-world results from specific years can offer a valuable perspective for advancing this research. By exploring these discrepancies, researchers can gain a deeper understanding of the factors that influence market dynamics and improve the accuracy of future forecasts.

ACKNOWLEDGEMENTS AND FINANCIAL DISCLOSURE

The publication presents the result of the Project no PRW/WPOT/2024/0038 financed from the subsidy granted to the Krakow University of Economics. Contribution share of authors is as follows: Paulina Stachura – 70%, Bartłomiej Marona – 30%.

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