

## THE APPLICATION OF BUSINESS ANALYTICS IN PRODUCT CUSTOMIZATION AND PERSONALIZATION

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**Purpose:** The purpose of this publication is to present the applications of usage of business analytics in energy management.

**Design/methodology/approach:** Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

**Findings:** The advantages of using business analytics in energy management are substantial, including cost reduction, enhanced energy efficiency, and sustainability alignment. This approach also provides real-time monitoring and control capabilities, predictive maintenance, and compliance with regulatory requirements. However, it comes with challenges such as data integration complexity, data quality, and security issues, as well as the need to address high implementation costs and talent gaps. Business analytics is a game-changer in energy management within Industry 4.0, offering numerous benefits but also requiring organizations to overcome significant challenges. Embracing these complexities will enable organizations to thrive in this dynamic landscape while contributing to a sustainable and efficient future.

**Keywords:** business analytics, Industry 4.0, digitalization, artificial intelligence, real-time monitoring; customization, personalization.

**Category of the paper:** literature review.

### 1. Introduction

Business analytics plays a pivotal role in the era of modern business, particularly when it comes to product customization and personalization. In an increasingly competitive marketplace where consumers are inundated with choices, tailoring products and services to individual preferences has become a strategic imperative for companies seeking to thrive and grow. In this paper, we delve into how business analytics is leveraged to drive product

customization and personalization, delivering enhanced customer experiences and bolstering bottom lines.

The purpose of this publication is to present the applications of usage of business analytics in energy management.

## **2. Customization and personalization of product – the usage of business analytics**

The role of personalization and customization of products in Industry 4.0 is pivotal and transformative. Industry 4.0, also known as the Fourth Industrial Revolution, represents a paradigm shift in manufacturing and production, characterized by the integration of digital technologies, automation, data analytics, and the Internet of Things (IoT) into industrial processes. Industry 4.0 enables companies to create highly personalized products that cater to individual customer preferences. Customers today expect products that align with their unique needs and tastes. By leveraging advanced technologies, companies can deliver products that resonate with each customer on a personal level, thereby enhancing the overall customer experience (Wolniak, 2016; Czerwińska-Lubszczyk et al., 2022; Drozd, Wolniak, 2021; Gajdzik, Wolniak, 2021, 2022; Gębczyńska, Wolniak, 2018, 2023; Grabowska et al., 2019, 2020, 2021; Wolniak et al., 2023; Wolniak, Grebski, 2023; Wolniak, Skotnicka-Zasadzień, 2023; Jonek-Kowalska, Wolniak, 2023).

Personalization in Industry 4.0 goes beyond simple customization; it involves mass customization, where products can be tailored to suit individual preferences on a large scale. This is achieved by combining automation and digital technologies to efficiently produce customized products at a scale and cost that was previously unattainable. Personalization and customization allow for demand-driven manufacturing (Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022).. Instead of producing items in large quantities and hoping they sell, businesses can produce goods based on actual customer demand. This reduces inventory costs, waste, and the risk of overproduction (Jonek-Kowalska, Wolniak, 2021, 2022; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021, Orzeł, Wolniak, 2021, 2022, 2023; Rosak-Szyrocka et al., 2023; Gajdzik et al., 2023; Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecuła, Wolniak, 2022; Olkiewicz et al., 2021).

Industry 4.0 relies heavily on data collection and analysis. Personalization and customization generate valuable data about customer preferences and behavior. This data can be used not only to tailor products but also to gain insights into market trends, enabling companies to make informed decisions about product development and marketing strategies (Wolniak, Skotnicka-

Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Wolniak, 2011, 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2021, 2022; Gajdzik, Wolniak, 2023; Wolniak, 2013, 2016; Hys, Wolniak, 2018).

Customized products often require stringent quality control measures to ensure they meet the unique specifications of each customer. Industry 4.0 technologies, including sensors and data analytics, enable real-time quality monitoring and rapid adjustments in production to maintain high-quality standards. Personalization can contribute to sustainability efforts by reducing waste. When products are made to order, there is less excess inventory that may go unsold and end up as waste. This aligns with the growing demand for eco-friendly and sustainable practices.

Business analytics starts with data collection and analysis. By mining customer data from various sources such as online behavior, purchase history, and demographic information, companies gain valuable insights into customer preferences, behavior patterns, and desires. These insights serve as the foundation for effective product customization and personalization strategies. Analytics helps in segmenting customers into distinct groups based on shared characteristics or behaviors (Ghibakholl et al., 2022). These segments can range from broad categories to highly specific niches. Once segments are defined, companies can target each group with customized products or offerings that are tailored to their unique needs and preferences. This approach is far more effective than one-size-fits-all marketing strategies (Scappini, 2016).

Product recommendations are one of the most visible forms of personalization. Businesses employ recommendation engines that use complex algorithms, often driven by machine learning, to suggest products or content to customers (Nourani, 2021). These recommendations are based on the customer's past interactions, as well as the behavior of similar customers. Amazon's product recommendation system is a prime example of this in action. Analytics also facilitates dynamic pricing, where prices are adjusted in real-time based on various factors, including demand, competitor pricing, and customer behavior (Charles et al., 2023). Airlines and ride-sharing services like Uber employ this strategy to optimize revenue. It allows businesses to offer personalized pricing to different customer segments, increasing the likelihood of purchase (Bakir, Dahlan, 2022). Analytics is instrumental in conducting A/B tests, where different versions of a product or website are shown to different groups of users, and their interactions are analyzed. This helps in fine-tuning product features or website layouts to maximize user engagement and conversion rates, making the user experience more personal and effective. In manufacturing and e-commerce, analytics plays a crucial role in optimizing supply chains to meet the demands of custom or personalized products efficiently. Predictive analytics can help forecast demand for specific variations of a product, reducing waste and improving inventory management (Greasley, 2019).

Listening to customer feedback through surveys, reviews, and social media is vital for product improvement and personalization. Advanced sentiment analysis tools can help businesses extract actionable insights from unstructured textual data, enabling them to make

data-driven decisions to enhance their products. With the advancement of technology, real-time personalization is becoming more prevalent (Javaid, Haleem, 2020). Websites and mobile apps can adapt their content and user interfaces on the fly based on a user's behavior and preferences. This level of personalization enhances the user experience and increases engagement (Peter et al., 2023).

Businesses can use predictive analytics to anticipate what features or customizations customers will desire in the future (Di Marino et al., 2023). This foresight informs product development efforts, ensuring that new offerings align with evolving customer needs and preferences. Ultimately, effective product customization and personalization driven by business analytics can provide a significant competitive advantage. Companies that can consistently deliver tailored experiences are more likely to build customer loyalty, increase customer lifetime value, and outperform competitors (Cillo et al., 2022).

The integration of business analytics into product customization and personalization strategies has revolutionized the way companies interact with their customers. By leveraging data-driven insights, businesses can create highly tailored experiences that resonate with individual preferences, resulting in increased customer satisfaction, loyalty, and profitability (Akundi et al., 2022). As technology and analytics continue to advance, the potential for even more sophisticated personalization and customization is bound to grow, reshaping the landscape of business in the process (Adel, 2022).

Table 1 contains descriptions of how business analytics is used in product customization and personalization. This comprehensive table highlights the diverse applications of business analytics in customizing and personalizing products, underlining their importance in improving customer experiences and driving business success in various industries.

**Table 1.**

*The usage of business analytics in product customization and personalization*

<b>Application of Business Analytics</b>	<b>Description</b>	<b>Examples/Use Cases</b>
Customer Segmentation	Utilizes data analysis to categorize customers into groups based on shared characteristics or behaviors.	- Segmenting online shoppers into categories like "frequent buyers," "bargain hunters," or "luxury shoppers." - Tailoring marketing campaigns to specific segments. - Creating personalized product recommendations for each segment.
Recommendation Engines	Employs complex algorithms to suggest products or content to customers based on their past interactions.	- Netflix recommending movies and TV shows based on viewing history. - Amazon suggesting products related to recent purchases. - Spotify curating playlists based on a user's listening habits.
Dynamic Pricing	Adjusts prices in real-time based on factors like demand, competitor pricing, and customer behavior.	- Airlines offering personalized pricing based on factors like travel dates and browsing history. - E-commerce platforms adjusting prices for products based on demand and inventory levels.
A/B Testing	Conducts experiments with different product versions to optimize features and layouts for user engagement.	- Testing two different website layouts to see which one results in more conversions. - Trying out various email subject lines to see which one generates more click-throughs. - Testing different product images to improve click-through rates in an app.

Cont. table 1.

Supply Chain Optimization	Uses predictive analytics to forecast demand for custom or personalized products, reducing waste.	- Fashion retailers using data to predict which clothing items will be popular in different regions and seasons. - Food delivery services optimizing routes and inventory to minimize food waste. - Manufacturing companies producing customized goods based on anticipated demand.
Customer Feedback Analysis	Analyzes feedback through surveys and reviews, extracting insights for data-driven product improvements.	- Analyzing customer reviews to identify common complaints or suggestions for product enhancement. - Conducting sentiment analysis on social media comments to gauge public opinion about a brand or product. - Using chatbot interactions to identify customer pain points and improve service.
Real-time Personalization	Adapts website or app content and interfaces in real-time based on user behavior and preferences.	- E-commerce sites displaying product recommendations as users browse. - Personalized content recommendations on news websites. - Customizing the layout and content of a mobile app's home screen based on user interaction patterns.
Predictive Analytics for Development	Anticipates future customer needs and preferences, guiding the development of new product features.	- Automakers using data to predict consumer preferences for features in future car models. - Tech companies developing AI-powered voice assistants based on an understanding of user needs. - Subscription services adding new content based on predictive analytics of user interests.
Competitive Advantage	Provides a significant edge by enhancing customer satisfaction, loyalty, and profitability through personalization.	- Brands like Starbucks using personalized offers and rewards to build customer loyalty. - E-commerce platforms competing by offering highly customized shopping experiences. - Financial institutions providing tailored investment advice based on individual goals and risk profiles.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz at al., 2015; Nourani, 2021; Peter et al., 2023).

### 3. Software used in customization and personalization of product

In today's highly competitive business landscape, the ability to customize and personalize products has become a strategic imperative. This customization not only caters to individual customer preferences but also creates a unique and engaging experience that can set a company apart from its competitors. To achieve this level of personalization, businesses rely on a range of software and applications designed to tailor products and services to the specific needs and desires of each customer. Here, we explore some notable examples of such software and their applications in the realm of product customization and personalization.

Adobe Photoshop is a venerable image editing software that empowers designers and marketers to create and modify visual elements with precision. Its versatility is evident in its use across various domains. For instance, it is commonly employed in customizing images and graphics on promotional merchandise like T-shirts and coffee mugs. Furthermore, it plays a pivotal role in personalizing digital marketing materials such as banners and advertisements.

In the world of e-commerce, businesses frequently rely on Adobe Photoshop to edit product images, showcasing custom options to potential buyers (Castro et al., 2014; Wang et al., 2023).

Salesforce Marketing Cloud is a comprehensive marketing automation platform that equips businesses with the tools they need to launch highly personalized marketing campaigns and gain valuable insights through data analysis. This platform is instrumental in personalization efforts. For example, it enables businesses to send precisely targeted email campaigns that contain tailored content and product recommendations. Additionally, it aids in segmenting customer data to create marketing lists that are finely tuned to individual preferences. The platform's analytics capabilities allow companies to gain deeper insights into customer behavior, which can then be leveraged to refine marketing strategies.

Adobe Experience Manager is a content management solution designed to create and deliver personalized digital experiences. It is widely used to customize website content based on user behavior and preferences. For example, a visitor browsing for sports equipment may see sports-related content, while another interested in fashion may encounter fashion-focused content. Adobe Experience Manager also manages and delivers personalized content for e-commerce platforms, ensuring that each user is presented with products and offers tailored to their interests. Furthermore, it facilitates the creation of personalized landing pages for marketing campaigns, optimizing engagement and conversion rates.

Dynamic Yield is a personalization platform powered by artificial intelligence (AI) that specializes in optimizing content and product recommendations across digital channels. Businesses employ Dynamic Yield to provide personalized product recommendations on e-commerce websites. For instance, when a user browses a clothing website, this platform can suggest items based on the user's browsing and purchase history. Dynamic Yield also excels in optimizing website content, images, and messaging for different customer segments, ensuring that the user experience is highly individualized. Furthermore, it plays a significant role in A/B testing, where personalized versus non-personalized experiences are compared to measure their impact and make data-driven decisions for improvements.

Optimizely is an experimentation and personalization platform that enables organizations to test and deliver personalized experiences to their audiences. This platform is highly versatile and finds applications across various industries. For instance, businesses use Optimizely to conduct A/B tests to optimize website and app layouts for different user segments. By doing so, they can identify the most effective designs and interfaces for various customer groups. Additionally, Optimizely facilitates personalization by allowing businesses to tailor user interfaces and content based on user preferences. It can also be employed to implement dynamic pricing experiments, helping companies maximize their revenue by adjusting prices in real-time based on demand and other factors (Du et al., 2023; Fjellström, Osarenkhoe, 2023).

Segment is a customer data platform that plays a crucial role in gathering and integrating customer data from multiple sources. This platform is invaluable for personalization efforts as it enables businesses to consolidate customer data from websites, mobile apps, and third-party

sources. By doing so, it creates unified customer profiles that provide a comprehensive view of individual preferences and behaviors. This unified data can then be harnessed for personalization across various marketing and analytics tools, ensuring a consistent and personalized customer experience.

Algolia is a search and discovery API that enhances search functionality on websites and apps. It is a vital tool for e-commerce and content-based platforms seeking to deliver highly personalized search results and recommendations. For instance, Algolia is used to implement advanced search features on e-commerce websites, such as typo tolerance and synonym support, ensuring that users find what they are looking for quickly and easily. Additionally, Algolia excels in providing personalized product recommendations based on user search queries and browsing behavior. It also enables location-based personalization by displaying nearby stores or services in search results, enhancing the user experience further.

Monetate is a personalization platform that focuses on delivering tailored content and product recommendations to website visitors. This platform is particularly adept at enhancing the user experience on e-commerce websites. For example, it is employed to display personalized banners, product recommendations, and content based on user behavior, creating a more engaging and relevant browsing experience. Monetate is also instrumental in A/B testing, allowing businesses to measure the impact of personalization efforts versus generic website experiences. Furthermore, it aids in personalizing the checkout process, showing relevant upsell and cross-sell products to maximize conversion rates and revenue (Zeng et al., 2022; Pech, Vrchota, 2022).

Table 2 is listing examples of software and applications used in the customization and personalization of products, along with descriptions of their usage. These software and applications represent just a fraction of the diverse tools available to businesses for the customization and personalization of products and services. Their versatility and capabilities empower companies to create memorable and unique customer experiences, leading to increased customer satisfaction, brand loyalty, and ultimately, business success in today's competitive market.

**Table 2.**

*The usage of business analytics in customization and personalization of product*

<b>Software/Application</b>	<b>Description</b>	<b>Usage Examples</b>
Adobe Photoshop	A professional image editing software that allows designers to create and modify visual elements for personalized products.	- Customizing images and graphics on promotional merchandise like T-shirts and mugs. - Personalizing digital marketing materials such as banners and advertisements. - Editing product images for e-commerce websites to showcase custom options.
Salesforce Marketing Cloud	A marketing automation platform that provides tools for creating personalized marketing campaigns and analyzing customer data.	- Sending personalized email campaigns with tailored content and product recommendations. - Segmenting customer data to create targeted marketing lists. - Analyzing customer behavior and engagement to refine marketing strategies.

Cont. table 2.

Adobe Experience Manager	A content management solution that enables the creation and delivery of personalized digital experiences.	- Customizing website content based on user behavior and preferences. - Managing and delivering personalized content for e-commerce platforms. - Creating personalized landing pages for marketing campaigns.
Dynamic Yield	A personalization platform that uses AI to optimize content and product recommendations across digital channels.	- Providing personalized product recommendations on e-commerce websites. - Optimizing website content, images, and messaging for different customer segments. - A/B testing personalized versus non-personalized experiences to improve conversion rates.
Optimizely	An experimentation and personalization platform that allows businesses to test and deliver personalized experiences.	- Conducting A/B tests to optimize website and app layouts for different user segments. - Personalizing the user interface and content based on user preferences. - Implementing dynamic pricing experiments to maximize revenue.
Segment	A customer data platform that collects and integrates customer data from various sources for better personalization.	- Consolidating customer data from websites, mobile apps, and third-party sources. - Creating a unified customer profile to deliver consistent, personalized experiences. - Enabling the use of customer data for personalization across various marketing and analytics tools.
Algolia	A search and discovery API that helps businesses deliver fast and relevant search results and recommendations.	- Implementing advanced search functionality with typo tolerance and synonym support on e-commerce websites. - Providing personalized product recommendations based on user search queries and browsing behavior. - Enabling location-based personalization by showing nearby stores or services in search results.
Monetate (now part of Kibo)	A personalization platform that delivers tailored content and product recommendations to website visitors.	- Displaying personalized banners, product recommendations, and content based on user behavior. - A/B testing personalized versus generic website experiences to measure impact. - Personalizing the checkout process by showing relevant upsell and cross-sell products.
Qlik Sense	A business intelligence and data visualization tool that helps organizations analyze and visualize customer data.	- Creating interactive dashboards to explore customer behavior and preferences. - Generating data-driven insights into customer segments for personalized marketing campaigns. - Analyzing historical sales data to forecast future product customization trends.
SmarterHQ	A customer data and personalization platform that enables brands to personalize marketing communications.	- Sending personalized email recommendations for products based on customer browsing and purchase history. - Creating triggered marketing campaigns based on real-time customer behavior. - Personalizing website content and promotions in real-time to increase engagement.

Source: (Adel, 2022; Akundi et al., 2022; Olsen, 2023; Aslam et al., 2020; Bakir, Dahlan, 2022; Cillo et al., 2022; Ghibakholl et al., 2022, Javaid, Haleem, 2020, Javaid et al., 2020; Cam et al., 2021; Charles et al., 2023; Greasley, 2019; Hurwitz et al., 2015; Nourani, 2021; Peter et al., 2023; Castro et al., 2014; Wang et al., 2023; Du et al., 2023; Fjellström, Osarenkhoe, 2023; Zeng et al., 2022; Pech, Vrchota, 2022).



## 4. Conclusion

In the rapidly evolving landscape of modern business, the role of business analytics is paramount, especially concerning the customization and personalization of products. In an era where consumers are bombarded with choices, tailoring products and services to individual preferences has become not only a strategic move but a necessity for companies striving to excel in a competitive market. This article has delved into how business analytics serves as the driving force behind product customization and personalization, ultimately leading to enhanced customer experiences and bolstered bottom lines.

The primary objective of this publication has been to shed light on the diverse applications of business analytics in energy management. However, the focus has been on how business analytics transforms the realm of product customization and personalization, offering insights into customer behavior, preferences, and desires, which serve as the foundation for effective strategies. Through segmentation, companies can divide their customer base into distinct groups, allowing them to offer customized products and services tailored to each group's unique needs and preferences, thus transcending the limitations of one-size-fits-all marketing.

Recommendation engines, powered by complex algorithms and machine learning, stand as visible examples of personalization in action. These engines suggest products and content based on a customer's past interactions and the behavior of similar customers, as seen in Amazon's product recommendation system. Dynamic pricing, real-time personalization, A/B testing, and supply chain optimization are other areas where business analytics plays a pivotal role, ensuring that products are not only personalized but also efficiently delivered to meet specific demands.

Customer feedback analysis through surveys, reviews, and sentiment analysis tools is vital for product improvement and personalization, allowing businesses to make data-driven decisions. Predictive analytics anticipates future customer needs, guiding product development efforts to ensure alignment with evolving preferences. In essence, effective product customization and personalization driven by business analytics confer a significant competitive advantage, enhancing customer satisfaction, loyalty, and profitability, ultimately outperforming competitors.

The integration of business analytics into product customization and personalization strategies has revolutionized the way companies engage with their customers. By leveraging data-driven insights, businesses can craft highly tailored experiences that resonate with individual preferences, resulting in increased customer satisfaction, brand loyalty, and profitability. As technology and analytics continue to advance, the potential for even more sophisticated personalization and customization is bound to grow, reshaping the landscape of business in the process.

Moreover, this article has provided a comprehensive overview of the software and applications that are instrumental in the customization and personalization of products. From Adobe Photoshop's image editing capabilities to Salesforce Marketing Cloud's marketing automation prowess, these tools empower businesses to create unique and engaging experiences. Adobe Experience Manager streamlines content personalization, while Dynamic Yield and Optimizely utilize cutting-edge technologies to optimize content and personalize user interfaces. Segment facilitates the consolidation of customer data, Algolia enhances search functionality, and Monetate focuses on delivering tailored content and recommendations.

In conclusion, business analytics has evolved into a crucial driver of innovation and customer-centricity in modern business. Its applications in product customization and personalization are not only transforming industries but also redefining the relationship between businesses and their customers. As companies continue to harness the power of data and analytics, the future holds the promise of even more personalized and customized experiences, further solidifying the pivotal role of business analytics in the ever-changing landscape of commerce.

## References

1. Adel, A. (2022). Future of industry 5.0 in society: human-centric solutions, challenges and prospective research areas. *Journal of Cloud Computing*, 11(1), 40.
2. Akundi, A., Euresti, D., Luna, S., Ankobiah, W., Lopes, A., Edinbarough, I. (2022). State of Industry 5.0-Analysis and Identification of Current Research Trends. *Applied System Innovation*, 5(1), DOI: 10.3390/asi5010027.
3. Aslam, F., Wang, A.M., Li, M.Z., Rehman, K.U. (2020). Innovation in the Era of IoT and Industry 5.0: Absolute Innovation Management (AIM) Framework. *Information*, 11(2), doi:10.3390/info11020124
4. Bakir, A., Dahlan, M. (2022). Higher education leadership and curricular design in industry 5.0 environment: a cursory glance. *Development and Learning in Organizations*.
5. Cam, J.D., Cochran, J.J., Ohlmann, M.J.F. (2021). *Business analytics: descriptive, predictive, prescriptive*. Boston: Cengage.
6. Castro, H., Câmara, F., Câmara, E., Ávila, P. (2024). Digital Factory for Product Customization: A Proposal for a Decentralized Production System. *Lecture Notes in Mechanical Engineering*, pp. 879-886.
7. Charles, V., Garg, P., Gupta, N., Agrawal, M. (2023). *Data Analytics and Business Intelligence: Computational Frameworks, Practices, and Applications*. New York: CRS Press.

8. Cillo, V., Gregori, G.L., Daniele, L.M., Caputo, F., Bitbol-Saba, N. (2022). Rethinking companies' culture through knowledge management lens during Industry 5.0 transition. *Journal of Knowledge Management*, 26(10), 2485-2498.
9. Dameri, R.P. (2016). Smart City and ICT. Shaping Urban Space for Better Quality of Life. In: *Information and Communication Technologies in Organizations and Society*. Cham, Switzerland: Springer International Publishing.
10. Di Marino, C., Rega, A., Vitolo, F., Patalano, S. (2023). Enhancing Human-Robot Collaboration in the Industry 5.0 Context: Workplace Layout Prototyping. *Lecture Notes in Mechanical Engineering*, 454-465.
11. Drozd, R., Wolniak, R. (2021). Metrisable assessment of the course of stream-systemic processes in vector form in industry 4.0. *Quality and Quantity*, 1-16, DOI: 10.1007/s11135-021-01106-w.
12. Drozd, R., Wolniak, R. (2021). Systematic assessment of product quality. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(4), 1-12.
13. Du, B., Yuan, J., Shu, W., Shen, Y. (2023). Optimal product customization and cooperative advertising strategies in supply chain with social influence. *Procedia Computer Science*, 221, pp. 992-999.
14. Dutta, J., Roy, S., Chowdhury, C. (2019). Unified framework for IoT and smartphone based different smart city related applications. *Microsystem Technologies*, 25(1), 83-96.
15. Fjellström, D., Osarenkhoe, A., Roe, T. (2023). Enablers of international product customisation strategy – a Swedish case. *International Journal of Business Environment*, 14(2), pp. 240-276.
16. Gajdzik, B., Grebski, M., Grebski, W., Wolniak, R. (2022). *Human factor activity in lean management and quality management*. Toruń: Towarzystwo Naukowe Organizacji i Kierownictwa. Dom Organizatora.
17. Gajdzik, B., Jaciow, M., Wolniak, R., Wolny R., Grebski, W.W. (2023). Energy Behaviors of Prosumers in Example of Polish Households. *Energies*, 16(7), 3186; <https://doi.org/10.3390/en16073186>.
18. Gajdzik, B., Wolniak, R. (2021). Digitalisation and innovation in the steel industry in Poland - selected tools of ICT in an analysis of statistical data and a case study. *Energies*, 14(11), 1-25.
19. Gajdzik, B., Wolniak, R. (2021). Influence of the COVID-19 crisis on steel production in Poland compared to the financial crisis of 2009 and to boom periods in the market. *Resources*, 10(1), 1-17.
20. Gajdzik, B., Wolniak, R. (2021). Transitioning of steel producers to the steelworks 4.0 - literature review with case studies. *Energies*, 14(14), 1-22.
21. Gajdzik, B., Wolniak, R. (2022). Framework for R&D&I Activities in the Steel Industry in Popularizing the Idea of Industry 4.0. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(3), 133.

22. Gajdzik, B., Wolniak, R. (2022). Influence of Industry 4.0 Projects on Business Operations: literature and empirical pilot studies based on case studies in Poland. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(1), 1-20.
23. Gajdzik, B., Wolniak, R. (2022). Smart Production Workers in Terms of Creativity and Innovation: The Implication for Open Innovation. *Journal of Open Innovations: Technology, Market and Complexity*, 8(1), 68.
24. Gajdzik, B., Wolniak, R., Grebski, W. (2023). Process of Transformation to Net Zero Steelmaking: Decarbonisation Scenarios Based on the Analysis of the Polish Steel Industry. *Energies*, 16(8), 3384, <https://doi.org/10.3390/en16083384>.
25. Gajdzik, B., Wolniak, R., Grebski W.W. (2023). Electricity and heat demand in steel industry technological processes in Industry 4.0 conditions. *Energies*, 16(2), 1-29.
26. Gajdzik, B., Wolniak, R., Grebski, W.W. (2022). An econometric model of the operation of the steel industry in Poland in the context of process heat and energy consumption. *Energies*, 15(21), 1-26, 7909.
27. Gębczyńska, A., Wolniak, R. (2018). *Process management level in local government*. Philadelphia: CreativeSpace.
28. Ghibakholl, M., Iranmanesh, M., Mubarak, M.F., Mubarik, M., Rejeb, A. Nilashi, M. (2022). Identifying industry 5.0 contributions to sustainable development: A strategy roadmap for delivering sustainability values. *Sustainable Production and Consumption*, 33, 716-737.
29. Grabowska, S., Saniuk, S., Gajdzik, B. (2022). Industry 5.0: improving humanization and sustainability of Industry 4.0. *Scientometrics*, 127(6), 3117-3144, <https://doi.org/10.1007/s11192-022-04370-1>.
30. Grabowska, S., Grebski, M., Grebski, W., Saniuk, S., Wolniak, R. (2021). *Inżynier w gospodarce 4.0*. Toruń: Towarzystwo Naukowe Organizacji i Kierownictwa – Stowarzyszenie Wyższej Użyteczności "Dom Organizatora".
31. Grabowska, S., Grebski, M., Grebski, W., Wolniak, R. (2019). *Introduction to engineering concepts from a creativity and innovativeness perspective*. New York: KDP Publishing.
32. Grabowska, S., Grebski, M., Grebski, W., Wolniak, R. (2020). *Inżynier – zawód przyszłości. Umiejętności i kompetencje inżynierskie w erze Przemysłu 4.0*. Warszawa: CeDeWu.
33. Greasley, A. (2019). *Simulating Business Processes for Descriptive, Predictive, and Prescriptive Analytics*. Boston: deGruyter.
34. Hąbek, P., Wolniak, R. (2013). Analysis of approaches to CSR reporting in selected European Union countries. *International Journal of Economics and Research*, 4(6), 79-95.
35. Hąbek, P., Wolniak, R. (2016). Assessing the quality of corporate social responsibility reports: the case of reporting practices in selected European Union member states. *Quality & Quantity*, 50(1), 339-420.

36. Hąbek, P., Wolniak, R. (2016). Factors influencing the development of CSR reporting practices: experts' versus preparers' points of view. *Engineering Economy*, 26(5), 560-570.
37. Hąbek, P., Wolniak, R. (2016). Relationship between management practices and quality of CSR reports. *Procedia – Social and Behavioral Sciences*, 220, 115-123.
38. Herdiansyah, H. (2023). Smart city based on community empowerment, social capital, and public trust in urban areas. *Glob. J. Environ. Sci. Manag.*, 9, 113-128.
39. Hurwitz, J., Kaufman, M., Bowles, A. (2015). *Cognitive Computing and Big Data Analytics*. New York: Wiley.
40. Hys, K., Wolniak, R. (2018). Praktyki przedsiębiorstw przemysłu chemicznego w Polsce w zakresie CSR. *Przemysł Chemiczny*, 9, 1000-1002.
41. Javaid M., Haleem A. (2020). Critical Components of Industry 5.0 Towards a Successful Adoption in the Field of Manufacturing. *Journal of Industrial Integration and Management-Innovation and Entrepreneurship*, 5(2), 327-348, doi: 10.1142/S2424862220500141.
42. Javaid, M., Haleem, A., Singh, R.P., Haq, M.I.U., Raina, A., Suman, R. (2020). Industry 5.0: Potential Applications in COVID-19, *Journal of Industrial Integration and Management-Innovation and Entrepreneurship*, 5(4), 507-530, doi: 10.1142/S2424862220500220.
43. Jonek-Kowalska, I., Wolniak, R. (2021). Economic opportunities for creating smart cities in Poland. Does wealth matter? *Cities*, 114, 1-6.
44. Jonek-Kowalska, I., Wolniak, R. (2021). The influence of local economic conditions on start-ups and local open innovation system. *Journal of Open Innovations: Technology, Market and Complexity*, 7(2), 1-19.
45. Jonek-Kowalska, I., Wolniak, R. (2022). Sharing economies' initiatives in municipal authorities' perspective: research evidence from Poland in the context of smart cities' development. *Sustainability*, 14(4), 1-23.
46. Jonek-Kowalska, I., Wolniak, R., Marinina, O.A., Ponomarenko, T.V. (2022). *Stakeholders, Sustainable Development Policies and the Coal Mining Industry. Perspectives from Europe and the Commonwealth of Independent States*. London: Routledge
47. Kordel, P., Wolniak, R. (2021). Technology entrepreneurship and the performance of enterprises in the conditions of Covid-19 pandemic: the fuzzy set analysis of waste to energy enterprises in Poland. *Energies*, 14(13), 1-22.
48. Kwiotkowska, A., Gajdzik, B., Wolniak, R., Vveinhardt, J., Gębczyńska, M. (2021). Leadership competencies in making Industry 4.0 effective: the case of Polish heat and power industry. *Energies*, 14(14), 1-22.
49. Kwiotkowska, A., Wolniak, R., Gajdzik, B., Gębczyńska, M. (2022). Configurational paths of leadership competency shortages and 4.0 leadership effectiveness: an fs/QCA study. *Sustainability*, 14(5), 1-21.

50. Michalak A., Wolniak, R. (2023). The innovativeness of the country and the renewables and non-renewables in the energy mix on the example of European Union. *Journal of Open Innovation: Technology, Market, and Complexity*, 9(2), <https://doi.org/10.1016/j.joitmc.2023.100061>.
51. Nourani, C.F. (2021). *Artificial Intelligence and Computing Logic: Cognitive Technology for AI Business Analytics (Innovation Management and Computing)*. New York: CRC Press.
52. Olkiewicz, M., Olkiewicz, A., Wolniak, R., Wyszomirski, A. (2021). Effects of pro-ecological investments on an example of the heating industry - case study. *Energies*, 14(18), 1-24, 5959.
53. Olsen, C. (2023). Toward a Digital Sustainability Reporting Framework in Organizations in the Industry 5.0 Era: An Accounting Perspective. *Lecture Notes in Networks and Systems*, 557, 463-473.
54. Orzeł, B., Wolniak, R. (2021). Clusters of elements for quality assurance of health worker protection measures in times of COVID-19 pandemic. *Administrative Science*, 11(2), 1-14, 46.
55. Orzeł, B., Wolniak, R. (2022). Digitization in the design and construction industry - remote work in the context of sustainability: a study from Poland. *Sustainability*, 14(3), 1-25.
56. Pech, M., Vrchota, J. (2022). The Product Customization Process in Relation to Industry 4.0 and Digitalization. *Processes*, 10(3), 539.
57. Peter, G.S., Amit, C.B., Deokar, V., Patel, N.R. (2023). *Machine Learning for Business Analytics: Concepts, Techniques and Applications in RapidMiner*. New York: Wiley.
58. Ponomarenko, T.V., Wolniak, R., Marinina, O.A. (2016). Corporate Social responsibility in coal industry (Practices of russian and european companies). *Journal of Mining Institute*, 222, 882-891.
59. Rosak-Szyrocka, J., Żywiołek J., Wolniak, R. (2023). Main reasons for religious tourism - from a quantitative analysis to a model. *International Journal for Quality Research*, 1(17), 109-120.
60. Scappini, A. (2016). *80 Fundamental Models for Business Analysts: Descriptive, Predictive, and Prescriptive Analytics Models with Ready-to-Use Excel Templates*. New York: Create Space.
61. Stawiarska, E., Szwajca, D., Matusek, M., Wolniak, R. (2020). *Wdrażanie rozwiązań przemysłu 4.0 w wybranych funkcjonalnych obszarach zarządzania przedsiębiorstw branży motoryzacyjnej: próba diagnozy*. Warszawa: CeDeWu.
62. Stawiarska, E., Szwajca, D., Matusek, M., Wolniak, R. (2021). Diagnosis of the maturity level of implementing Industry 4.0 solutions in selected functional areas of management of automotive companies in Poland. *Sustainability*, 13(9), 1-38.

63. Stecuła, K., Wolniak, R. (2022). Advantages and Disadvantages of E-Learning Innovations during COVID-19 Pandemic in Higher Education in Poland. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(3), 159.
64. Stecuła, K., Wolniak, R. (2022). Influence of COVID-19 Pandemic on Dissemination of Innovative E-Learning Tools in Higher Education in Poland. *Journal of Open Innovations: Technology, Market and Complexity*, 8(1), 89.
65. Wang, Y., Mo, D.Y., Ma, H.L. (2023). Perception of time in the online product customization process. *Industrial Management and Data Systems*, 123(2), pp. 369-385.
66. Wolniak, R., Skotnicka-Zasadzień, B. (2014). The use of value stream mapping to introduction of organizational innovation in industry. *Metalurgija*, 53(4), 709-713.
67. Wolniak, R. (2011). *Parametryzacja kryteriów oceny poziomu dojrzałości systemu zarządzania jakością*. Gliwice: Wydawnictwo Politechniki Śląskiej.
68. Wolniak, R. (2013). Projakościowa typologia kultur organizacyjnych. *Przegląd Organizacji*, 3, 13-17.
69. Wolniak, R. (2014). Korzyści doskonalenia systemów zarządzania jakością opartych o wymagania normy ISO 9001:2009. *Problemy Jakości*, 3, 20-25.
70. Wolniak, R. (2016). Kulturowe aspekty zarządzania jakością. *Etyka biznesu i zrównoważony rozwój. Interdyscyplinarne studia teoretyczno-empiryczne*, 1, 109-122.
71. Wolniak, R. (2016). *Metoda QFD w zarządzaniu jakością. Teoria i praktyka*. Gliwice: Wydawnictwo Politechniki Śląskiej.
72. Wolniak, R. (2016). Relations between corporate social responsibility reporting and the concept of greenwashing. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacji i Zarządzanie*, 87, 443-453.
73. Wolniak, R. (2016). The role of QFD method in creating innovation. *Systemy Wspomagania Inżynierii Produkcji*, 3, 127-134.
74. Wolniak, R. (2017). Analiza relacji pomiędzy wskaźnikiem innowacyjności a nasyceniem kraju certyfikatami ISO 9001, ISO 14001 oraz ISO/TS 16949. *Kwartalnik Organizacja i Kierowanie*, 2, 139-150.
75. Wolniak, R. (2017). Analiza wskaźników nasycenia certyfikatami ISO 9001, ISO 14001 oraz ISO/TS 16949 oraz zależności pomiędzy nimi. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacji i Zarządzanie*, 108, 421-430.
76. Wolniak, R. (2017). The Corporate Social Responsibility practices in mining sector in Spain and in Poland – similarities and differences. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacji i Zarządzanie*, 111, 111-120.
77. Wolniak, R. (2017). The Design Thinking method and its stages. *Systemy Wspomagania Inżynierii Produkcji*, 6, 247-255.
78. Wolniak, R. (2017). The use of constraint theory to improve organization of work. 4th International Multidisciplinary Scientific Conference on Social Sciences and Arts. SGEM 2017, 24-30 August 2017, Albena, Bulgaria. *Conference proceedings. Book 1*,

- Modern science. Vol. 5, Business and management.* Sofia: STEF92 Technology, 1093-1100.
79. Wolniak, R. (2018). Functioning of social welfare on the example of the city of Łazy. *Zeszyty Naukowe Wyższej Szkoły, Humanitas. Zarządzanie*, 3, 159-176.
  80. Wolniak, R. (2018). Methods of recruitment and selection of employees on the example of the automotive industry. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacja i Zarządzanie*, 128, 475-483.
  81. Wolniak, R. (2019). Context of the organization in ISO 9001:2015. *Silesian University of Technology Scientific Papers. Organization and Management Series*, 133, 121-136.
  82. Wolniak, R. (2019). Downtime in the automotive industry production process - cause analysis. *Quality, Innovation, Prosperity*, 2, 101-118.
  83. Wolniak, R. (2021). Performance evaluation in ISO 9001:2015. *Silesian University of Technology Scientific Papers. Organization and Management Series*, 151, 725-734.
  84. Wolniak, R. (2022). Engineering ethics – main principles. *Silesian University of Technology Scientific Papers. Organization and Management Series*, 155, 579-594.
  85. Wolniak, R. (2023). Analiza danych w czasie rzeczywistym. *Zarządzanie i Jakość*, 2(5), 291-312.
  86. Wolniak, R. (2023). Analysis of the Bicycle Roads System as an Element of a Smart Mobility on the Example of Poland Provinces. *Smart Cities*, 6(1), 368-391; <https://doi.org/10.3390/smartcities6010018>.
  87. Wolniak, R. (2023). Design thinking and its use to boost innovativeness. *Silesian University of Technology Scientific Papers. Organization and Management Series*, 170, 647-662.
  88. Wolniak, R., Grebski, M.E. (2018). Innovativeness and creativity as factors in workforce development – perspective of psychology. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacja i Zarządzanie*, 116, 203-214.
  89. Wolniak, R., Grebski, M.E. (2018). Innovativeness and creativity as nature and nurture. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacja i Zarządzanie*, 116, 215-226.
  90. Wolniak, R., Grebski, M.E. (2018). Innovativeness and Creativity of the Workforce as Factors Stimulating Economic Growth in Modern Economies. *Zeszyty Naukowe Politechniki Śląskiej. Seria Organizacja i Zarządzanie*, 116, 227-240.
  91. Wolniak, R., Grebski, M.E., Skotnicka-Zasadzień, B. (2019). Comparative analysis of the level of satisfaction with the services received at the business incubators (Hazleton, PA, USA and Gliwice, Poland). *Sustainability*, 10, 1-22.
  92. Wolniak, R., Hąbek, P. (2015). Quality management and corporate social responsibility. *Systemy Wspomagania w Inżynierii Produkcji*, 1, 139-149.
  93. Wolniak, R., Hąbek, P. (2016). Quality assessment of CSR reports – factor analysis. *Procedia – Social and Behavioral Sciences*, 220, 541-547.



94. Wolniak, R., Jonek-Kowalska, I. (2021). The level of the quality of life in the city and its monitoring. *Innovation (Abingdon)*, 34(3), 376-398.
95. Wolniak, R., Jonek-Kowalska, I. (2021). The quality of service to residents by public administration on the example of municipal offices in Poland. *Administration Management Public*, 37, 132-150.
96. Wolniak, R., Jonek-Kowalska, I. (2022). The creative services sector in Polish cities. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(1), 1-23.
97. Wolniak, R., Saniuk, S., Grabowska, S., Gajdzik, B. (2020). Identification of energy efficiency trends in the context of the development of industry 4.0 using the Polish steel sector as an example. *Energies*, 13(11), 1-16.
98. Wolniak, R., Skotnicka, B. (2011):. *Metody i narzędzia zarządzania jakością – Teoria i praktyka, cz. 1*. Gliwice: Wydawnictwo Naukowe Politechniki Śląskiej.
99. Wolniak, R., Skotnicka-Zasadzień, B. (2008). *Wybrane metody badania satysfakcji klienta i oceny dostawców w organizacjach*. Gliwice: Wydawnictwo Politechniki Śląskiej.
100. Wolniak, R., Skotnicka-Zasadzień, B. (2010). *Zarządzanie jakością dla inżynierów*. Gliwice: Wydawnictwo Politechniki Śląskiej.
101. Wolniak, R., Skotnicka-Zasadzień, B. (2018). Developing a model of factors influencing the quality of service for disabled customers in the conditions of sustainable development, illustrated by an example of the Silesian Voivodeship public administration. *Sustainability*, 7, 1-17.
102. Wolniak, R., Skotnicka-Zasadzień, B. (2022). Development of photovoltaic energy in EU countries as an alternative to fossil fuels. *Energies*, 15(2), 1-23.
103. Wolniak, R., Skotnicka-Zasadzień, B., Zasadzień, M. (2019). Problems of the functioning of e-administration in the Silesian region of Poland from the perspective of a person with disabilities. *Transylvanian Review of Public Administration*, 57E, 137-155.
104. Wolniak, R., Wyszomirski, A., Olkiewicz, M., Olkiewicz, A. (2021). Environmental corporate social responsibility activities in heating industry - case study. *Energies*, 14(7), 1-19, 1930.
105. Zeng, D., Guan, M., He, M., Tian, Z. (2022). An Interactive Evolutionary Design Method for Mobile Product Customization and Validation of Its Application. *International Journal of Computational Intelligence Systems*, 15(1), 16.