

THE APPLICATION OF BUSINESS ANALYTICS IN PERSONALIZED CUSTOMER EXPERIENCE

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Purpose: The purpose of this publication is to present the applications of usage of business analytics in personalized customer experience.

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 applications of business analytics in personalized customer experiences span data collection, segmentation, predictive analytics, and multi-channel personalization, delivering greater customer satisfaction, revenue, and competitive advantage. Achieving this transformation requires the use of various software solutions, including CRM systems, marketing automation tools, analytics platforms, predictive analytics software, and recommendation engines. Harnessing the power of data and analytics is the key to gaining a competitive edge in this customer-centric era. Businesses that tailor their offerings to each customer's unique preferences and needs can not only meet but exceed customer expectations, ensuring growth and long-term success. Ultimately, personalized customer experiences, driven by business analytics, are not merely a response to customer demands; they are the path to unlocking the full potential of customer relationships and establishing a strong position in the ever-evolving marketplace.

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

Category of the paper: literature review.

1. Introduction

Business analytics is the systematic use of data, statistical and quantitative analysis, and predictive modeling to drive fact-based decision-making in an organization. This approach involves collecting and analyzing vast amounts of data to extract valuable insights that can be used to enhance various aspects of a business, including customer experience. Personalization

in the customer experience is not merely a buzzword; it's a fundamental aspect of modern marketing and service. Customers today expect businesses to know them, understand their preferences, and offer solutions tailored to their specific needs. When customers feel seen and appreciated, they are more likely to remain loyal, spend more, and recommend the business to others.

Business analytics, often described as the systematic exploration of data using various statistical and quantitative methods, is an indispensable tool for organizations looking to optimize their operations, make informed decisions, and, most importantly, enhance the way they interact with their customers. The focus on personalized customer experience has become a pivotal point of differentiation in the modern marketplace, and here's how business analytics is driving this transformation (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):

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2. Personalized customer experience

Business analytics helps in the collection, integration, and processing of vast amounts of data from various sources. This data can include customer interactions, purchase history, online behavior, and feedback. Through data analysis, businesses can segment their customer base into distinct groups based on behavior, preferences, demographics, and more. These segments can then be targeted with personalized offers and communications. By applying predictive analytics, businesses can forecast customer behavior and preferences. This enables them to proactively meet customer needs, such as suggesting products or services before the customer even realizes they need them (Du et al., 2023; Fjellström, Osarenkhoe, 2023).

E-commerce giants like Amazon have shown how effective recommendation systems can be. These systems use customer data to suggest products or content that the customer is likely to be interested in, thereby enhancing the shopping experience. Through real-time data analysis, businesses can make instant decisions on personalizing the customer experience. This could involve showing tailored content on a website, sending personalized emails, or customizing in-store experiences. Businesses can use analytics to gain insights from customer feedback and reviews. By understanding the sentiment and identifying common issues, they can make improvements to better serve their customers (Castro et al., 2014; Wang et al., 2023).

The application of business analytics in personalized customer experience is not just a trend; it's a strategic imperative in the modern business world. To succeed in a customer-centric marketplace, businesses must harness the power of data and analytics to better understand and cater to the unique needs and preferences of each customer, ultimately driving growth, loyalty, and success (Adel, 2022).

At the heart of personalized customer experiences is data, and lots of it. Business analytics plays a vital role in gathering and integrating data from numerous sources, including CRM systems, e-commerce platforms, social media, point-of-sale systems, and customer feedback channels. This data is then centralized and processed to create a comprehensive customer profile. The key is to obtain a 360-degree view of each customer, capturing their interactions, preferences, behaviors, and transaction history (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).

One-size-fits-all approaches no longer cut it in today's market. With the help of business analytics, organizations can segment their customer base into distinct groups based on demographics, behavior, purchasing history, and other attributes. This segmentation allows businesses to tailor their marketing efforts, product recommendations, and communication to the unique needs and preferences of each segment. In essence, it transforms marketing from a scattershot approach to a highly targeted one. Predictive analytics, a subset of business analytics, leverages historical data to forecast future customer behavior and preferences (Zeng et al., 2022; Pech, Vrchota, 2022). It's like having a crystal ball for understanding what customers might need or want next. With these insights, businesses can anticipate customer needs and proactively offer solutions, making the customer feel seen and valued (Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022).

E-commerce giants like Amazon have shown the immense power of recommendation systems. Using customer data and machine learning algorithms, these systems suggest products or content that align with a customer's past purchases and interests. This not only enhances the shopping experience but also drives additional sales. The power of business analytics isn't just in crunching historical data; it also extends to real-time decision-making. By analyzing customer data in the moment, businesses can make instant decisions on personalization. For example, an e-commerce website can dynamically adjust its homepage content based on a customer's browsing behavior, offering products that are most likely to appeal to that individual (Ghibakholl et al., 2022).

Listening to the voice of the customer has never been more critical. Feedback, whether from surveys, reviews, or social media, provides invaluable insights. Business analytics can be used to extract meaning from this data, identifying sentiment, common issues, and areas for improvement. It's a direct feedback loop to help businesses refine their products and services continually (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).

Table 1 contains descriptions of how business analytics is used in personalized customer experience. This comprehensive table highlights the diverse applications of business analytics in personalizing the customer experience, spanning data collection, segmentation, predictive analytics, and real-time personalization, to name a few. These applications ultimately lead to enhanced customer satisfaction, increased sales, and a significant competitive advantage in the modern business landscape.

Table 1.

The usage of business analytics in personalized customer experience

Aspect of Personalized Customer Experience	Application of Business Analytics
Data Collection and Integration	Aggregating data from various sources such as CRM systems, websites, mobile apps, social media, point-of-sale systems, and customer surveys. Integrating data into a centralized repository to create comprehensive customer profiles. Employing data cleansing and enrichment techniques to ensure data accuracy and completeness. Ensuring compliance with data privacy regulations (e.g., GDPR or CCPA) during data collection and storage. Implementing robust data security measures to protect customer data from breaches and cyber threats.
Customer Segmentation	Utilizing data analytics to classify customers into distinct segments based on demographics, behavior, preferences, and purchase history. Crafting marketing campaigns, product offerings, and content tailored to the unique needs of each segment. Conducting cluster analysis and machine learning algorithms to identify hidden patterns within customer data. Regularly updating customer segments as new data becomes available or customer behavior changes. Conducting in-depth customer journey mapping to understand the end-to-end customer experience.
Predictive Analytics	Applying predictive modeling to forecast customer behavior, purchasing patterns, and future needs. Proactively providing customers with personalized recommendations and solutions based on these predictions. Utilizing machine learning and artificial intelligence for predictive modeling. Refining predictive models over time by incorporating new data and adapting to changing customer preferences. Conducting sensitivity analysis to assess the impact of different variables on predictive outcomes.
Recommendation Systems	Developing recommendation engines that analyze customer behavior and preferences to suggest relevant products, services, or content. Enhancing the customer experience through personalized product recommendations and content delivery. Incorporating collaborative filtering and content-based recommendation algorithms. Continuously improving recommendation algorithms through customer feedback and usage data. Implementing recommendation explainability features to build trust with customers.
Real-time Personalization	Implementing real-time data analysis to make instant decisions on personalization. Customizing website content, email marketing, and in-store experiences based on customers' current interactions, location, and real-time preferences. Leveraging real-time decision engines and adaptive content delivery. Ensuring high system availability and performance to deliver real-time personalization without delays. Monitoring customer behavior during peak traffic hours for accurate real-time personalization.

Cont. table 1.

Feedback Analysis	Mining customer feedback, reviews, surveys, and social media comments for valuable insights and sentiment analysis. Identifying recurring issues, complaints, and compliments to drive continuous improvement in products and services. Employing natural language processing (NLP) and sentiment analysis techniques. Monitoring and addressing negative feedback promptly to mitigate reputational damage. Conducting root cause analysis for recurring issues identified through feedback analysis.
Enhanced Customer Satisfaction	Offering personalized recommendations and support based on individual customer profiles. Tailoring communication to convey appreciation, understanding, and acknowledgment of customer needs, preferences, and feedback. Implementing chatbots and AI-driven customer service for real-time personalized support. Continuously training customer service agents on personalized communication and conflict resolution. Monitoring customer satisfaction metrics and Net Promoter Score (NPS) to measure the impact of personalized customer service.
Increased Sales and Revenue	-Suggesting products or services that align with a customer's purchase history, interests, and browsing behavior. Implementing cross-selling and upselling strategies that leverage data-driven insights to increase customer spending and boost revenue. Tracking and analyzing conversion funnels for optimization. Monitoring the impact of personalized offers on sales and making adjustments as needed. Implementing dynamic pricing strategies based on customer behavior and market conditions.
Improved Customer Retention	Using analytics to identify customers at risk of churn or dissatisfaction and proactively addressing their concerns. Implementing loyalty programs, personalized offers, and retention strategies to reduce churn rates and improve customer retention. Developing customer lifetime value (CLV) models for retention strategies. Conducting post-churn analysis to identify reasons for customer attrition and address root causes. Measuring customer lifetime value (CLV) regularly and using it as a key performance indicator (KPI) for retention efforts.
Competitive Advantage	Leveraging data and analytics to stay ahead of competitors by providing more personalized and relevant experiences. Gaining an edge in the market through data-driven decision-making, product innovation, and exceptional customer service. Continuously monitoring the competitive landscape and adapting strategies accordingly. Benchmarking against industry leaders and innovators to identify areas for improvement. Collaborating with cross-functional teams to ensure a unified approach to maintaining a competitive advantage.
Efficient Marketing Spend	-Optimizing marketing campaigns by targeting the right audience with highly personalized messages and content. Reducing wasteful spending on generic marketing efforts by analyzing customer preferences, engagement data, and marketing ROI to improve campaign effectiveness. A/B testing and attribution modeling for marketing optimization. Adhering to a strict budget allocation strategy that balances customer acquisition and retention. Monitoring and adjusting the marketing mix in response to shifts in customer behavior and market trends.
Multi-Channel Personalization	Ensuring consistent and personalized customer experiences across various touchpoints, including websites, mobile apps, social media, email, in-store interactions, and call centers. Utilizing analytics to track and analyze customer behavior and preferences across multiple channels. Implementing cross-channel integration to provide a seamless and coherent personalized experience regardless of the customer's chosen interaction point. Customizing content and recommendations based on the specific channel and device, recognizing that customer expectations may vary.
Geo-Location Based Personalization	Utilizing geolocation data from customers' mobile devices to personalize content, offers, and recommendations based on their current physical location. Leveraging geo-fencing technology to trigger location-specific notifications and promotions when customers are near physical stores or specific geographic points of interest. Analyzing location data to understand regional preferences and behaviors, allowing for tailored regional marketing campaigns. Ensuring data privacy and consent management when collecting and using location data to personalize the customer experience.

Cont. table 1.

Custom Product and Service Bundles	Analyzing customer purchase history and preferences to create custom bundles of products or services that align with individual customer needs. Implementing dynamic pricing for bundled offerings, taking into account customer willingness to pay and historical purchase patterns. Offering personalized package recommendations that cater to both cost-conscious and premium customers. Monitoring the success of personalized bundles through conversion rates and customer feedback to fine-tune offerings over time.
Loyalty Program Personalization	Utilizing customer loyalty program data to personalize rewards, incentives, and offers based on individual customer behavior and engagement with the loyalty program. Creating personalized tiers or segments within the loyalty program to provide exclusive benefits and incentives to high-value customers. Analyzing the impact of personalized loyalty program offers on customer retention and repeat purchases.

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).

3. Software used in personalized customer experience

The evolution of customer expectations and the increasing competition in today's business landscape have made personalized customer experiences a paramount differentiator. To meet this demand, companies employ various software solutions to collect, analyze, and act on customer data in ways that enhance the overall customer journey.

CRM software is the foundation of personalized customer experiences. It stores and manages customer data, including contact information, purchase history, and interactions. CRM systems enable businesses to create comprehensive customer profiles and deliver tailored experiences based on this information. Popular CRM software includes Salesforce, HubSpot, and Microsoft Dynamics. Marketing automation tools help businesses automate and personalize their marketing efforts. They use customer data to segment audiences and deliver personalized content, emails, and campaigns. Software like HubSpot, Marketo, and Pardot allows for dynamic content, email personalization, and customer journey mapping (Scappini, 2016).

Analytics platforms like Google Analytics and Adobe Analytics provide insights into customer behavior, preferences, and interactions with your digital properties. Business intelligence tools like Tableau and Power BI help organizations make data-driven decisions by visualizing and analyzing customer data. Predictive analytics tools, such as IBM SPSS and RapidMiner, use historical data to predict future customer behavior. This enables businesses to anticipate customer needs, offer tailored product recommendations, and take proactive measures to enhance the customer experience (Nourani, 2021).

Recommendation engines are integral for e-commerce and content-based platforms. Solutions like Amazon Personalize and Adobe Target use algorithms to analyze user behavior and make real-time product or content recommendations, increasing engagement and conversions. A CMS (Content Management Systems) like WordPress, Drupal, or Joomla is crucial for personalized content delivery. They enable businesses to dynamically customize website content, landing pages, and blogs based on user behavior and preferences Charles et al., 2023).

Email marketing platforms like MailChimp and SendinBlue allow businesses to send personalized emails. They use customer data to create segmented email lists and tailor content to individual interests, thereby increasing email open rates and engagement. Customer service software, such as Zendesk and Freshdesk, integrates customer data to provide personalized support. Agents can access customer histories, preferences, and issues, offering tailored solutions and enhancing customer satisfaction. Personalization engines like Dynamic Yield and Evergage specialize in creating unique, individualized experiences across various channels. They offer dynamic content, product recommendations, and real-time personalization capabilities (Bakir, Dahlan, 2022).

Software such as SurveyMonkey and Qualtrics enables companies to collect feedback from customers and analyze sentiment. These insights help identify areas for improvement and tailor responses to customer suggestions and concerns. Tools like Hootsuite and Sprout Social allow companies to track and engage with customers on social media. By understanding customer sentiment and responding to personalized inquiries, businesses can build stronger relationships (Greasley, 2019).

CDPs, (Customer Data Platform) including Segment and Tealium, centralize customer data from various sources. They unify data to create a single customer view, facilitating more accurate and personalized experiences (Javaid, Haleem, 2020).

AI and machine learning platforms such as TensorFlow and PyTorch are crucial for building custom recommendation engines and predictive models. They enable the development of advanced personalization algorithms. Tools like Optimizely and Google Optimize allow businesses to conduct A/B tests on personalized content and features to determine their impact on user engagement and conversions (Cillo et al., 2022).

Table 2 is listing examples of software and applications used in the case of personalized customer experience. These software examples represent key categories within personalized customer experience, ranging from CRM systems that store customer data to marketing automation platforms, analytics tools, and business intelligence solutions that enable personalization at various touchpoints in the customer journey (Akundi et al., 2022).

Table 2.*The usage of business analytics in customization and personalization of product*

Category	Software	Description
Customer Relationship Management	Salesforce	Salesforce is a widely used CRM platform that allows businesses to manage customer data, interactions, and relationships, enabling personalized engagement.
	HubSpot	HubSpot's CRM provides tools for customer data management and marketing automation, helping businesses tailor marketing efforts based on customer data.
	Microsoft Dynamics	Microsoft Dynamics CRM offers comprehensive customer data management and sales automation capabilities, enabling personalized sales and customer service.
Marketing Automation	Marketo	Marketo is a marketing automation platform that helps businesses create personalized marketing campaigns and nurture leads based on customer behavior.
	Pardot	Pardot, by Salesforce, is a marketing automation tool that assists in personalizing email marketing, lead scoring, and nurturing campaigns.
	Eloqua	Oracle Eloqua offers marketing automation solutions, allowing businesses to create personalized marketing campaigns, track customer interactions, and segment audiences.
Analytics and Business Intelligence	Google Analytics	Google Analytics provides insights into website and app traffic, user behavior, and audience segmentation, enabling data-driven decisions and personalized content.
	Adobe Analytics	Adobe Analytics offers robust analytics and reporting tools, helping businesses understand customer interactions and personalize digital experiences.
	Tableau	Tableau is a data visualization platform that enables businesses to analyze customer data and create interactive dashboards for personalized decision-making.
Predictive Analytics	IBM SPSS	IBM SPSS is a predictive analytics software that uses historical data to forecast customer behavior and preferences, enabling personalized recommendations and proactive measures.
	RapidMiner	RapidMiner is a data science platform that allows businesses to build predictive models for personalized customer experiences, such as dynamic product recommendations.
	SAS Analytics	SAS Analytics offers advanced analytics tools that enable businesses to create predictive models, segment customers, and deliver personalized marketing campaigns.
Recommendation Engines	Amazon Personalize	Amazon Personalize is a machine learning service that allows businesses to create personalized product recommendations for their customers in real-time.
	Adobe Target	Adobe Target is a personalization and A/B testing tool that helps businesses deliver personalized content, offers, and experiences based on customer segments and behavior.
	Dynamic Yield	Dynamic Yield is a personalization platform that offers tools for e-commerce companies to customize content, product recommendations, and messaging for individual customers.

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

Business analytics is not just a tool for data analysis; it's a strategic imperative for organizations looking to excel in the modern business landscape. Personalized customer experience has evolved from a trend to a pivotal point of differentiation. Customers expect businesses to know them intimately, understand their preferences, and offer tailored solutions to meet their unique needs. This expectation is the driving force behind the transformation of how businesses interact with their customers.

The heart of personalized customer experiences is data. Business analytics plays a central role in collecting, integrating, and processing vast amounts of data from various sources, creating comprehensive customer profiles. These profiles are the foundation for understanding and addressing the unique needs and preferences of each customer.

Segmentation, predictive analytics, recommendation engines, and real-time personalization are the pillars of personalized customer experiences. Businesses leverage these analytics tools to anticipate customer needs and proactively offer solutions. By doing so, they create an atmosphere where customers feel seen, valued, and appreciated. Moreover, feedback analysis, enhanced customer satisfaction, increased sales, and improved customer retention are outcomes of employing business analytics in the pursuit of personalized customer experiences. By mining customer feedback and reviews, businesses refine their products and services continuously, leading to higher customer satisfaction, increased sales, and customer loyalty.

The applications of business analytics in personalized customer experiences are diverse and extend across various aspects, from data collection and segmentation to predictive analytics and multi-channel personalization. This comprehensive table provides a clear overview of how business analytics drives the enhancement of customer satisfaction, revenue, and competitive advantage. To achieve this transformation, businesses rely on an array of software solutions, including CRM systems, marketing automation tools, analytics platforms, predictive analytics software, and recommendation engines. These software applications help collect, process, and act on customer data to deliver personalized experiences across various channels.

In this age of customer-centricity, businesses that harness the power of data and analytics gain a significant competitive edge. To succeed, they must tailor their marketing, products, and services to the unique needs and preferences of each customer. With the right software and analytics in place, businesses can not only meet but exceed customer expectations, ultimately driving growth and success. In the end, personalized customer experiences driven by business analytics are not just a response to customer demands; they are the key to unlocking the full potential of customer relationships and securing a strong foothold in the ever-evolving marketplace.

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., Matuszek, 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., Matuszek, 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.