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Big data and IoT adoption in shaping organizational citizenship behavior: The role of innovation organizational predictor in the chemical manufacturing industry

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A B S T R A C T

This research aims to investigate the relationships between Big Data and Internet of Things (IoT) adoption and employee behavior in the chemical manufacturing industry, specifically focusing on the mediating role of organizational innovation. The research methodology employs a quantitative approach that involves employee surveys, statistical analysis, and mediation testing. The primary findings reveal that Big Data adoption significantly enhances Organizational Innovation, contributing positively to Organizational Citizenship Behavior (OCB) among employees. Conversely, IoT adoption has a significant positive impact on Organizational Innovation but does not directly influence OCB. The relationship between IoT adoption and OCB is mediated by Organizational Innovation, highlighting the pivotal role of innovation as an intermediary in influencing employee behavior. The practical implications of this research suggest that organizations in the chemical manufacturing industry should strategically integrate Big Data and IoT technologies to foster innovation and elevate OCB. Leadership support and employee training are crucial. Study limitations include industry specificity, self-reported data, and static analysis. Future research should diversify samples and use longitudinal methods. Recommendations: embrace tech with innovation focus, train leaders, and deepen understanding of tech, innovation, and behavior.

1. Introduction

In the continuously evolving digital era, the integration of Big Data and Internet of Things (IoT) has become a major focal point in shaping various industries (Atzori et al., 2017; Mahdavinejad et al., 2018). The chemical manufacturing industry is one such sector profoundly impacted by these advancements (Pereira & Romero, 2017). The ability to collect, analyze, and process large-scale data (Big Data) and connect devices and systems through networks (IoT) has opened new opportunities and challenges for organizations in the chemical industry (Yang et al., 2017). One crucial aspect to consider in this context is Organizational Citizenship Behavior (OCB) exhibited by employees (Ocampo et al., 2018; Rose et al., 2016). OCB is a significant concept in human resource management, reflecting the extent to which employees contribute to the well-being of an organization beyond their core job duties (Chaudhary, 2020). Employees with high levels of OCB tend to behave more cooperatively, proactively, and innovatively, which can positively contribute to organizational performance (Hernaus et al., 2022; Malik, 2023). However, paradigm shifts in technology such as Big Data and IoT can significantly influence employees' OCB (Shahbaz et al., 2019; Taamneh et al., 2018). Previous research has explored the impact of Big Data and IoT on various business aspects (Jha et al., 2020; Patel et al., 2020; Santoro et al., 2019), including operational efficiency, data analytics, and

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strategic decision-making. However, there remains a gap in understanding how the adoption of Big Data and IoT can shape OCB among employees, especially in the context of the chemical manufacturing industry.

Therefore, this research aims to fill this knowledge gap by investigating the relationship between the adoption of Big Data and IoT and employees' OCB in the chemical manufacturing industry. Additionally, this research will consider the role of organizational innovation as a crucial predictor that may moderate the relationship between the adoption of Big Data and IoT and OCB. By comprehending how Big Data and IoT technologies influence employees' OCB and the role of organizational innovation in this context, this research is expected to provide deeper insights into how organizations in the chemical manufacturing industry can optimize the benefits of adopting these technologies to enhance their performance and competitiveness. Furthermore, this research can contribute both theoretically and practically to the understanding of the role of technology in shaping employee behavior in the workplace.

In addition to the significant potential benefits, the adoption of Big Data and IoT in the chemical manufacturing industry also presents several challenges that need to be addressed. For instance, data security and privacy become primary concerns when highly sensitive and critical data for organizational operations are stored and exchanged digitally. Therefore, in the context of adopting Big Data and IoT, it is crucial to consider adequate security policies and practices to protect the organization's data and systems from potential cyber threats. Furthermore, training and development of employees are also essential factors to ensure that they can understand and effectively utilize Big Data and IoT technologies. Organizations need to invest in upskilling and reskilling their employees to keep them aligned with the advancements in these technologies and enable them to respond appropriately. Apart from the benefits and challenges associated with the adoption of Big Data and IoT, this research will also elucidate the role of organizational innovation as a critical predictor that may influence the extent to which these technologies affect employees' Organizational Citizenship Behavior (OCB). Organizational innovation is a key element in shaping a culture of innovation and progress within a company, and it can moderate the impact of technology on employee behavior.

Therefore, this research is expected to provide a comprehensive perspective on the role of Big Data and IoT in shaping OCB in the chemical manufacturing industry while also identifying the factors influencing this interaction. The findings of this study can assist managers and organizational leaders in devising more effective strategies for adopting and integrating Big Data and IoT technologies in a broader context, including considerations related to security, employee training, and innovation culture. The research gap in this study lies in the limited understanding of how the adoption of Big Data and IoT influences Organizational Citizenship Behavior (OCB) among employees in the chemical manufacturing industry. While previous research has explored the impact of these technologies on various business aspects, there is a lack of comprehensive examination regarding their effects on employee behavior, particularly in this specific industry context. Additionally, the role of organizational innovation as a predictor and moderator in this relationship has not been extensively studied. Therefore, the research gap centers on the need to bridge this knowledge gap and provide insights into the intricate dynamics between technology adoption, OCB, and organizational innovation in the chemical manufacturing sector. The novelty of this research stems from its unique focus on the intersection of Big Data, IoT adoption, and OCB within the chemical manufacturing industry. By investigating how these technologies influence employee behavior and considering the moderating role of organizational innovation, this study aims to contribute fresh insights to both the fields of technology management and organizational behavior. It seeks to uncover unexplored relationships and dynamics, shedding light on how technological advancements shape employee attitudes and actions in a critical industrial sector.

The significance of this research lies in its potential to inform organizational leaders and managers in the chemical manufacturing industry about the implications of adopting Big Data and IoT technologies. Understanding how these technologies affect OCB can assist organizations in optimizing their technology adoption strategies, enhancing employee engagement, and ultimately improving overall performance. Additionally, the study's focus on the role of organizational innovation adds depth to our comprehension of the organizational factors that influence the impact of technology on employee behavior. The motivation behind this research is to address the evolving landscape of technology adoption and its influence on employee behavior, especially in industries characterized by data-intensive processes like chemical manufacturing. As technology continues to reshape workplaces, it is crucial to gain insights into how these changes impact employees and the organization as a whole. By exploring the motivators and inhibitors of OCB in the context of Big Data and IoT adoption, this research aims to provide actionable recommendations for organizations looking to navigate this digital transformation successfully.

Therefore, research Objectives as following:

1. To investigate the relationship between the adoption of Big Data and IoT technologies and Organizational Citizenship Behavior (OCB) among employees in the chemical manufacturing industry.
2. To assess the role of organizational innovation as a predictor and moderator in the relationship between technology adoption and OCB.
3. To identify the challenges and opportunities associated with the adoption of Big Data and IoT in the chemical manufacturing sector.
4. To provide practical recommendations for organizations in the industry to optimize the benefits of technology adoption and foster a culture of innovation and OCB among employees.

2. Literature Review and Hypothesis Development

2.1 Big data and innovation organizational predictor

Verma and Bhattacharyya (2017) explain that Big Data adoption refers to the organization's integrating Big Data technologies, methodologies, and practices into its operations. It includes collecting, storing, processing, and analyzing large and complex datasets, ultimately leading to data-driven insights and informed decision-making. Ashaari et al. (2021) assert that Big Data adoption empowers organizations with data-driven decision-making capabilities. Data-driven insights can guide innovation strategies, helping organizations identify emerging trends, customer needs, and market gaps, enhancing predictive innovation capabilities (Ghasemaghaei & Calic, 2019). Gepp et al. (2018) assess that Big Data analytics can uncover patterns, anomalies, and opportunities that may not be apparent through traditional methods. It can generate innovative ideas and concepts as organizations gain deeper insights into their operations and markets. Chalvatzis et al. (2019) argue that Big Data can optimize resource allocation by identifying areas with the highest innovation potential. It ensures that resources, including human capital and investments, are directed toward projects and initiatives more likely to yield innovative outcomes (Grover et al., 2018). Based on the notion of Ungureanu et al. (2021) is that Big Data can break down silos within organizations by promoting cross-functional collaboration. When different departments can access the same data-driven insights, they can work together more effectively to drive innovation (McBride et al., 2019). The relationship between Big Data adoption and the Innovation Organizational Predictor is symbiotic. Big Data adoption enhances an organization's predictive capabilities by providing the data and insights necessary to inform innovation processes (Bag et al., 2020). In turn, organizations with a strong Innovation Organizational Predictor are better positioned to leverage Big Data effectively for innovation (Mikalef et al., 2019). Understanding and harnessing this relationship can help organizations navigate the complexities of data-driven innovation and establish a culture and environment conducive to continuous and successful innovation efforts (Rizk et al., 2022). Based on the previous researcher's description, the proposed hypotheses are as follows:

H$_1$: *Big data adoption impacts positively on innovation organizational predictors.*

2.2 Big Data and organizational citizenship behavior

Big Data adoption provides employees access to a wealth of information and insights (Fosso Wamba et al., 2015). This increased access empowers employees to make more informed decisions and contribute to organizational objectives (Martínez-Peláez et al., 2023). Well-informed employees are likely to engage in proactive OCB, such as suggesting process improvements or innovative solutions (Walumbwa et al., 2020). Al-Khatib (2022) argues that organizations that adopt Big Data foster a data-driven culture. In such cultures, employees are encouraged to base their decisions on data and evidence. This culture can promote OCB, as employees may feel more empowered to share ideas, collaborate, and take ownership of organizational challenges. Big Data analytics can provide real-time feedback and performance metrics (Kamble & Gunasekaran, 2020). Recognizing and rewarding employees based on their contributions can motivate them to engage in OCB (Pham et al., 2023). Employees who feel valued for their efforts are likely to go the extra mile to support their colleagues and the organization (Bolino et al., 2013). Chierici et al. (2019) assert that Big Data adoption can facilitate collaboration and knowledge sharing among employees. When employees can access data-driven insights, they are more likely to share information, support their peers, and collectively work toward organizational goals. Therefore, the hypothesis as following:

H$_2$: *Big data adoption impacts positively on organizational citizenship behavior.*

2.3 IoT adoption and innovation organizational predictor

According to Brous et al. (2020), IoT adoption refers to the organization’s process of integrating IoT technologies and practices into its operations. This includes the deployment of IoT devices, sensors, and systems, as well as the collection, transmission, and analysis of data generated by IoT-connected assets. IoT adoption provides organizations with an abundance of real-time data and insights (Sestino et al., 2020). This data-rich environment empowers organizations to make data-driven decisions, identify emerging market trends, and anticipate customer needs, thereby enhancing predictive innovation capabilities (Hossain et al., 2020). IoT facilitates the development of innovative products and services (C. Z. Li et al., 2021). Organizations can create IoT-based solutions that meet evolving customer demands and provide predictive maintenance capabilities, enabling them to stay ahead of competitors in their industry (Manavalan & Jayakrishna, 2019). Leung et al. (2022) argue that IoT adoption can streamline operations and optimize resource allocation. This allows organizations to redirect resources, including human capital and investments, toward innovation initiatives that hold the most promise for success. Based on the notion of Dutta et al. (2020) is that IoT fosters cross-functional collaboration by enabling different departments to access and share real-time data. This collaboration enhances the innovation process, as teams can work together more effectively, leveraging data-driven insights to drive innovation. In conclusion, the relationship between IoT adoption and the Innovation Organizational Predictor is symbiotic. IoT adoption enhances an organization’s predictive capabilities by providing the data and insights necessary to inform innovation processes (Belhadi et al., 2021). Conversely, organizations with a strong Innovation Organizational Predictor are better positioned to leverage IoT effectively for innovation. Recognizing and capitalizing on this relationship can empower organizations to not only harness the potential of IoT for innovation but also cultivate an environment conducive to continuous and successful innovation endeavors (Zheng et al., 2023). Hence, the hypothesis as following:

H3: *IoT adoption impacts positively on innovation organizational predictor.*

2.4 IoT adoption and organizational citizenship behavior

According to Javaid et al. (2021), IoT adoption provides employees with access to real-time data and insights. This increased access can empower employees to make more informed decisions, contribute novel ideas, and proactively engage in problem-solving, all of which are characteristic of OCB. Zhong et al. (2017) in addition that IoT fosters collaboration among employees, as real-time data sharing becomes easier. When employees from different departments have access to the same data-driven insights, they are more likely to collaborate on initiatives, share information, and collectively work toward organizational goals, aligning with OCB (Singh et al., 2021). Organizations that adopt IoT often cultivate a data-driven culture where data-backed decisions are encouraged (Mithas et al., 2020). Such cultures promote innovation and proactivity, as employees feel empowered to propose and test new ideas based on data insights, thereby contributing to OCB (Jeong et al., 2019). IoT-enabled data analytics can provide real-time feedback and recognition for employees' efforts (W. Li et al., 2021). Recognition for their contributions can boost employees' morale and motivation, leading to increased OCB. The integration of IoT technologies and practices can enhance employee access to real-time information, foster a culture of data-driven decision-making, provide recognition for contributions, and facilitate collaboration—all of which are conducive to OCB (Colombari et al., 2023). Recognizing and leveraging this relationship can be beneficial for organizations aiming to maximize the advantages of their IoT investments, not only in terms of data-driven decision-making but also in cultivating a culture of employee engagement and positive organizational citizenship. Thus, the hypothesis as following:

H4: *IoT adoption impacts positively on organizational citizenship behavior.*

2.5 Innovation organizational predictor, organizational citizenship behavior, and its mediation

Botelho (2020) explains that the Innovation Organizational Predictor encompasses a set of factors, conditions, and practices within an organization that influence its capacity to innovate. These factors may include an innovation-oriented culture, leadership support for innovation, well-defined innovation processes, cross-functional collaboration, and the ability to adapt to market changes (Gemünden et al., 2018). Cheema et al. (2020) assess that Organizational Citizenship Behavior (OCB) comprises voluntary, discretionary actions by employees that go beyond their formal job roles and responsibilities. OCB includes behaviors such as helping colleagues, participating in problem-solving, providing innovative suggestions, and promoting a positive organizational culture (Chuang et al., 2019). Organizations fostering a culture of innovation are more likely to encourage employees to engage in behaviors that contribute to OCB (Tran, 2023a). In innovative environments, employees may be more willing to collaborate, share knowledge, and contribute creative solutions to problems, all of which align with OCB (Tran, 2023b). When leaders actively support and champion innovation initiatives, employees are more likely to follow suit by engaging in behaviors that support organizational goals (Dobbins et al., 2018). Leadership that values and promotes innovation sets a tone for OCB by signaling that proactive contributions are valued. Innovations often require cross-functional collaboration (Twemlow et al., 2022). Organizations that facilitate and reward cross-functional teamwork create an environment that encourages employees to engage in collaborative OCB, such as helping colleagues in different departments (Hart et al., 2016). Recognizing and rewarding innovative efforts can motivate employees to continue exhibiting OCB. When employees receive recognition for their contributions to innovation, they are more likely to extend their discretionary efforts toward other pro-organizational behaviors (Wang et al., 2023). Therefore, there is a substantial relationship between the factors associated with the Innovation Organizational Predictor and Organizational Citizenship Behavior. Organizations that prioritize and foster innovation are more likely to create environments where employees willingly engage in behaviors that benefit the organization beyond their formal job roles (Mi et al., 2019). Recognizing and cultivating this relationship can be advantageous for organizations seeking to leverage innovation as a driver of not only business success but also a positive organizational culture characterized by employee engagement in OCB (Khan et al., 2020). Furthermore, understanding the mediation of the Innovation Organizational Predictor is crucial for organizations seeking to optimize their innovation climate and organizational outcomes. By recognizing how certain factors within the Innovation Organizational Predictor mediate relationships between variables, organizations can identify and leverage mechanisms to promote innovation, employee engagement, and positive organizational behavior. In doing so, organizations can create environments that foster innovation and drive overall success. So, the hypothesis as following:

H5: *Innovation organizational predictor impacts positively on organizational citizenship behavior.*

H6: *Innovation organizational predictor mediates the relationship between big data adoption and organizational citizenship behavior.*

H7: *Innovation organizational predictor mediates the relationship between IoT adoption and organizational citizenship behavior.*

3. Method

This empirical study employs a quantitative approach to collect, analyze, and interpret data. The research population consists of employees in the chemical manufacturing industry in Cilegon City, Indonesia, who have adopted Big Data and IoT technologies. Sampling will be conducted using the simple random sampling method from the relevant population. The sample size will be determined based on statistical formulas with predetermined confidence levels and margins of error. This study will utilize a sample of 160 respondents from various chemical industries as follows:

- Petrochemical Industry: A total of 16 respondents working in the petrochemical industry participated in this study. They are professionals involved in producing chemical substances derived from petroleum, such as plastics, polymers, and other petrochemical products.
- **Pharmaceutical Industry:** In the pharmaceutical industry, 16 respondents are employees engaged in the production of pharmaceuticals, healthcare products, and other pharmaceutical chemicals.
- **Agrochemical Industry:** The agrochemical industry is represented by 16 respondents who work on chemical products used in agriculture, including fertilizers, pesticides, and herbicides.
- **Food Chemical Industry:** A group of 16 respondents are employed in the food chemical industry, which produces chemicals used in food processing, such as preservatives, food colorants, and flavorings.
- **Construction Chemical Industry:** In the construction chemical industry, 16 respondents are involved in producing chemicals used in construction, such as cement, paint, and insulation materials.
- **Electronic Chemical Industry:** 16 respondents work in the electronic chemical industry, which manufactures chemicals used in producing electronic components, including semiconductors and microprocessors.
- **Automotive Chemical Industry:** In this sector, 16 respondents are employees producing chemical materials used in vehicle manufacturing, such as coatings, paints, and lubricants.
- **Consumer Chemical Industry:** The consumer chemical industry is represented by 16 respondents who produce chemical products used in everyday consumer goods, such as personal care products, detergents, and cleaning products.
- **Textile Chemical Industry:** A group of 16 respondents are employed in the textile chemical industry, which produces chemicals used in textile processing, including textile dyes and textile processing chemicals.
- **Energy Chemical Industry:** In the energy chemical industry, 16 respondents are involved in producing chemical fuels, batteries, and renewable energy technologies.

3.1. Data Collection and research variables

Data collected using questionnaires specifically designed to measure variables refers to Big Data adoption, IoT adoption, Innovation Organizational Predictor, and Organizational Citizenship Behavior. Research Variables include independent variables: Big Data adoption, IoT adoption, Innovation Organizational Predictor. Mediating variable: Organizational innovation. Dependent variable: Organizational Citizenship Behavior (OCB).

3.2. Data processing and research process

Statistical analyses that will be used include regression analysis to test relationships between variables and mediation analysis to test the mediating role of Organizational innovation (Soenyono & Basrowi, 2020). In addition, research process including Identification of the research population and sample selection: In this phase, the target population, which consists of employees within the chemical manufacturing industry who have adopted Big Data and IoT technologies, will be identified. A systematic sample selection process will be employed to ensure representative sampling (Marwanto et al., 2020). Data collection through questionnaires and secondary data: To gather comprehensive insights, data will be collected through the administration of carefully designed questionnaires (Soenyono & Basrowi, 2020). Additionally, relevant secondary data from reputable sources will be incorporated to enrich the research dataset. Data analysis using appropriate statistical techniques: The collected data will undergo rigorous analysis utilizing advanced Smart PLS statistical software (Suwarno et al., 2020). This analysis will encompass a diverse array of statistical techniques, such as regression analysis, which will be employed to assess relationships between variables (Marwanto et al., 2020). Furthermore, mediation analysis will be conducted to scrutinize the mediating role of Organizational innovation in the context of the study. Interpretation of results and drawing conclusions: The outcomes of the data analysis will be meticulously interpreted to draw meaningful conclusions (Basrowi & Maunnah, 2019). This phase is pivotal in extracting insights regarding the relationships between technology adoption, innovation predictors, and Organizational Citizenship Behavior (OCB) (Basrowi & Utami, 2020). It will also provide a nuanced understanding of the mediating role played by Organizational innovation. Preparation of the research report: The findings, interpretations, and conclusions of the study will be documented in a comprehensive research report. This report will adhere to academic standards and guidelines, presenting the research process, methodology, results, and implications for further research or practical applications (Suseno et al., 2018). This structured research process ensures that the study is conducted systematically, data is analyzed rigorously, and the results are effectively communicated to contribute valuable insights to the field of organizational behavior and technology adoption in the chemical manufacturing industry.

3.3. Expected outcomes and significance

Expectations for positive relationships between Big Data adoption, IoT adoption, and Innovation Organizational Predictor with Organizational Citizenship Behavior (OCB) form a fundamental aspect of this research.

Table 1
Research instrument

Variable	Indicators	Source
Big Data	1. Usage of Big Data Platforms: The organization has implemented a Big Data platform for managing and analyzing large datasets. 2. Availability of Big Data Infrastructure: The organization has established infrastructure supporting the storage and processing of big data, such as data lakes or data warehouses. 3. Employee Involvement: Employees within the organization have received training or advanced training related to the use of Big Data technology. 4. Use of Big Data Analysis Tools: "The organization utilizes Big Data analysis tools such as Hadoop, Spark, or similar solutions for data processing. 5. Utilization of External Data: The organization integrates external data into their analysis, including data from external sources such as social networks or industry data. 6. Data-Driven Decision-Making: The organization frequently makes strategic decisions based on the results of Big Data analysis. 7. Data Security Systems: The organization has implemented robust data security systems to protect their Big Data from cyber threats. 8. Infrastructure Scalability: The Big Data infrastructure within the organization can easily be scaled to handle growing data volumes. 9. Performance Metrics: The organization measures performance and operational efficiency through metrics derived from Big Data analysis. 10. Innovation in Products or Services: The use of Big Data has led to innovation in the products or services offered by the organization.	Ashaari et al. (2021); Chalvatzis et al. (2019); Gepp et al. (2018); Ungureanu et al. (2021)
IoT	1. Deployment of IoT Devices: The organization has deployed IoT devices and sensors to collect data from various assets and environments. 2. IoT Data Integration: Data generated by IoT devices is integrated into the organization's data ecosystem and used for analysis. 3. IoT Infrastructure: The organization has established the necessary infrastructure to support the connectivity and management of IoT devices. 4. IoT Analytics Tools: IoT analytics tools and platforms, such as IoT-specific analytics software, are used to process and gain insights from IoT data. 5. Real-Time IoT Data Usage: Real-time data from IoT devices is actively used for monitoring and decision-making processes. 6. IoT Data Security Measures: Robust security measures are in place to safeguard IoT data and devices from potential cybersecurity threats. 7. Scalability of IoT Infrastructure: The organization's IoT infrastructure is designed to scale seamlessly to accommodate growing numbers of IoT devices and data. 8. IoT-Driven Process Improvements: IoT technology has led to process improvements and efficiencies within the organization. 9. IoT-Enabled Services: The organization offers IoT-enabled products or services to customers or clients. 10. IoT-Related Skill Development: Employees receive training and skill development opportunities related to IoT technologies and applications. 11. IoT for Predictive Maintenance: IoT data is used for predictive maintenance, helping to prevent equipment failures and downtime. 12. IoT-Enhanced Customer Experiences: IoT is leveraged to enhance customer experiences through personalized services and insights.	Brous et al. (2020); Leung et al. (2022); C. Z. Li et al. (2021); Sestino et al. (2020)
Innovation Organizational Predictor	1. Leadership Support for Innovation: The organization's leadership actively supports and promotes innovation as a core value. 2. Innovation-Oriented Mission and Vision: The organization's mission and vision statements reflect a commitment to innovation and continuous improvement. 3. Innovation Training and Development: Employees are provided with training and development opportunities focused on fostering innovation skills and mindsets. 4. Cross-Functional Collaboration: Cross-functional teams are encouraged to collaborate on innovative projects and initiatives. 5. Resource Allocation for Innovation: The organization allocates dedicated resources (financial, human, and technological) for innovation projects. 6. Experimentation and Risk-Taking: The organization encourages experimentation and is willing to take calculated risks to drive innovation. 7. Recognition of Innovative Efforts: Innovative contributions by employees are recognized and rewarded within the organization. 8. Innovation Metrics and KPIs: Key performance indicators (KPIs) related to innovation are established and tracked regularly. 9. Open Communication Channels: Open communication channels exist, allowing employees to share ideas and feedback regarding innovation. 10. Innovation Culture Assessment: Periodic assessments or surveys are conducted to gauge the organization's innovation culture and identify areas for improvement. 11. Integration of Customer Feedback: Customer feedback and insights are actively integrated into the innovation process to meet customer needs. 12. Innovation Strategy Alignment: The organization's innovation strategy is aligned with its overall business strategy and goals.	Botelho (2020); Gemünden et al. (2018)
Organizational Citizenship Behavior	1. Helping Colleagues: Employees willingly assist their colleagues with work-related tasks or challenges. 2. Initiative and Problem-Solving: Employees take the initiative to identify and solve organizational problems without being prompted. 3. Teamwork and Collaboration: Employees actively participate in team projects and collaborate effectively with coworkers. 4. Support for Organizational Values: Employees consistently demonstrate behaviors that align with the organization's core values. 5. Positive Workplace Atmosphere: Employees contribute to creating a positive and inclusive workplace atmosphere. 6. Adherence to Organizational Policies: Employees follow organizational policies and procedures, even when not closely supervised. 7. Continuous Learning and Development: Employees proactively seek opportunities for learning and skill development to benefit the organization. 8. Promoting Organizational Reputation: Employees engage in actions that enhance the organization's reputation and image in the industry or community. 9. Resource Conservation: Employees make efforts to conserve resources, reduce waste, and improve sustainability within the organization. 10. Customer-Focused Service: Employees provide exceptional service to customers, exceeding minimum service requirements. 11. Conflict Resolution: Employees engage in constructive conflict resolution to maintain a harmonious work environment. 12. Volunteering for Additional Tasks: Employees volunteer for tasks or responsibilities beyond their job descriptions to support the organization's goals.	(Colombari et al., 2023; Tran, 2023a, 2023b)

The anticipated outcomes encompass a multifaceted understanding of how technological advancements and innovation-related factors interrelate with employee behavior within the complex landscape of the chemical manufacturing industry. It is expected that a positive association will be uncovered between the adoption of Big Data and IoT technologies and the propensity of employees to engage in Organizational Citizenship Behavior (OCB). This suggests that as organizations embrace Big Data and IoT, employees are likely to exhibit behaviors that go beyond their formal job roles, such as assisting colleagues, offering innovative solutions, and actively participating in initiatives that contribute to the overall well-being of the organization. Furthermore, the research anticipates that the relationship between technology adoption and OCB will be mediated by Organizational innovation. In other words, the adoption of Big Data and IoT alone may not fully explain variations in OCB; rather, it is expected that the mediating role of Organizational innovation will elucidate the underlying mechanisms through which these technologies influence employee behavior. This mediation effect underscores the importance of fostering an innovative organizational culture and practices to unlock the full potential of technology adoption.

This research is poised to deliver a profound comprehension of the nuanced dynamics within the chemical manufacturing industry. It aspires to transcend the surface-level examination of technology adoption and delve into the depths of how these innovations, coupled with innovation-related predictors, intricately shape the conduct of employees, particularly their engagement in OCB (Basrowi & Utami, 2023). This deeper understanding is essential for organizations seeking to thrive in a rapidly evolving landscape. The significance of this research extends to academia, where it contributes empirical evidence to the existing body of knowledge on technology adoption, innovation, and employee behavior. Such contributions enrich the theoretical framework in organizational behavior studies, advancing the understanding of these critical dynamics. For organizations in the chemical manufacturing sector, this research offers actionable insights that can inform strategic decisions. It underscores the pivotal role of innovation and technology adoption in fostering a positive workplace environment, driving innovation, and enhancing employee engagement (Suseno & Basrowi, 2023). By recognizing these relationships, organizations can develop strategies to remain competitive and adaptive. In essence, this meticulously structured methodology serves as a robust foundation for conducting the research and scrutinizing the hypotheses put forth. It ensures that the research process is conducted with precision and that each step is meticulously detailed, paving the way for a comprehensive examination of technology adoption, innovation, and employee behavior in the chemical manufacturing industry (Mustofa et al., 2023).

4. Results

4.1 Validity and reliability

The data analysis results presented depict the quality of measurement instruments utilized in the study to be of exceptionally high standards. Specifically, this research showcases that all observed constructs—namely, Big Data adoption, Internet of Things (IoT) adoption, Innovation Organizational Predictor, and Organizational Citizenship Behavior (OCB)—have been meticulously measured. Each item within these constructs exerts a profound influence on its respective construct, as evidenced by the high outer loading values. Furthermore, the level of consistency among the items within each construct has been substantiated to be remarkably strong, as indicated by the highly convincing values of Cronbach's Alpha, rho_A, and Composite Reliability (CR). Construct validity is also unequivocally established, as all constructs boast a high Average Variance Extracted (AVE), signifying that the variance explained by the items within the constructs surpasses error variance. These analytical outcomes provide confidence that the measurement instruments employed in this research have met the requisite standards for data reliability and validity. Consequently, the findings of this study can be regarded as a robust foundation for further analysis and credible research discoveries (see Table 2 and Fig. 1).

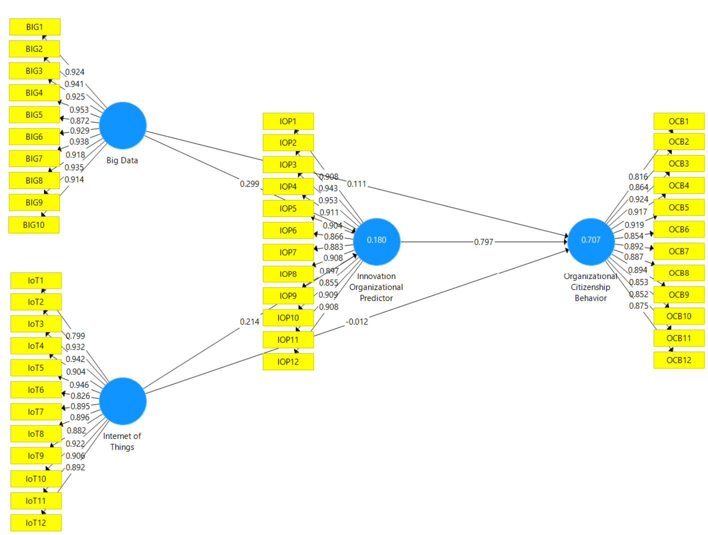

Fig. 1. PLS algorithm result

Table 2
Validity and reliability

Construct	Items	Outer Loading	Cronbach's Alpha	rho_A	CR	AVE
Big Data	BIG1	0.924	0.981	0.985	0.983	0.856
	BIG2	0.941				
	BIG3	0.925				
	BIG4	0.953				
	BIG5	0.872				
	BIG6	0.929				
	BIG7	0.938				
	BIG8	0.918				
	BIG9	0.935				
	BIG10	0.914				
Internet of Things	IoT1	0.799	0.978	0.983	0.980	0.803
	IoT2	0.932				
	IoT3	0.942				
	IoT4	0.904				
	IoT5	0.946				
	IoT6	0.826				
	IoT7	0.895				
	IoT8	0.896				
	IoT9	0.882				
	IoT10	0.922				
	IoT11	0.906				
	IoT12	0.892				
Innovation Organizational Predictor	IOP1	0.908	0.980	0.981	0.982	0.817
	IOP2	0.943				
	IOP3	0.953				
	IOP4	0.911				
	IOP5	0.904				
	IOP6	0.866				
	IOP7	0.883				
	IOP8	0.908				
	IOP9	0.897				
	IOP10	0.855				
	IOP11	0.909				
	IOP12	0.908				
Organizational Citizenship Behavior	OCB1	0.816	0.973	0.975	0.976	0.774
	OCB2	0.864				
	OCB3	0.924				
	OCB4	0.917				
	OCB5	0.919				
	OCB6	0.854				
	OCB7	0.892				
	OCB8	0.887				
	OCB9	0.894				
	OCB10	0.853				
	OCB11	0.852				
	OCB12	0.875				

4.2 Hypothesis testing

The data analysis presented Table 3 and Fig. 2 revolves around the hypotheses testing concerning the interrelationships among the constructs of Big Data (BIG), Internet of Things (IoT), Innovation Organizational Predictor (IOP), and Organizational Citizenship Behavior (OCB). The following analysis summarizes the outcomes:

In testing the first hypothesis (H1), which examines the connection between Big Data adoption (BIG) and the Innovation Organizational Predictor (IOP), the results firmly support this hypothesis. The analysis yields a t-statistic of 3.860 and an associated p-value of 0.000, signifying a substantial and positive relationship between Big Data adoption and IOP. Moving to the second hypothesis (H2), which explores the relationship between Big Data adoption (BIG) and Organizational Citizenship Behavior (OCB), the findings similarly align with this hypothesis. With a t-statistic of 2.001 and a p-value of 0.046, the results indicate a statistically significant positive association between Big Data adoption and OCB. Shifting to the third hypothesis (H3), which investigates the association between Internet of Things adoption (IoT) and Innovation Organizational Predictor (IOP), the analysis corroborates this hypothesis. The t-statistic of 3.605 and a p-value of 0.000 suggest a meaningful and positive relationship between IoT adoption and IOP. However, the fourth hypothesis (H4), examining the link between IoT adoption (IoT) and Organizational Citizenship Behavior (OCB), stands in contrast. The results reject this hypothesis, with a t-statistic of 0.311 and a p-value of 0.756, indicating a lack of a statistically significant relationship between IoT adoption and OCB. Proceeding to the fifth hypothesis (H5), which delves into the connection between Innovation Organizational Predictor

(IOP) and Organizational Citizenship Behavior (OCB), the outcomes resoundingly support this hypothesis. With a t-statistic of 11.757 and a p-value of 0.000, the analysis reveals a highly significant and positive relationship between IOP and OCB. The sixth hypothesis (H6), which explores a mediation relationship between Big Data adoption (BIG), Innovation Organizational Predictor (IOP), and Organizational Citizenship Behavior (OCB). Specifically, it suggests that the impact of Big Data adoption on OCB is mediated by Innovation Organizational Predictor. The results support this hypothesis, with a t-statistic of 3.546 and a p-value of 0.000, indicating that Big Data adoption has a significant positive relationship with IOP, which, in turn, exhibits a significant positive relationship with OCB. This mediation pathway suggests that Big Data adoption indirectly influences OCB through its impact on IOP. Lastly, the seventh hypothesis (H7), Similar to H6, this hypothesis also examines a mediation relationship, but it involves Internet of Things adoption (IoT), Innovation Organizational Predictor (IOP), and Organizational Citizenship Behavior (OCB). The results support H7, with a t-statistic of 3.428 and a p-value of 0.001, indicating that IoT adoption has a significant positive relationship with IOP, which subsequently demonstrates a significant positive relationship with OCB. This mediation pathway implies that IoT adoption indirectly influences OCB through its impact on IOP.

These analytical findings confirm that adopting Big Data and IoT can positively impact innovation within organizations (IOP) and organizational citizenship behavior (OCB). However, it is noteworthy that IoT adoption does not directly impact OCB (H4) but contributes to OCB through its influence on IOP (H7). It implies that IoT adoption may play a more substantial role in enhancing innovation rather than directly affecting organizational citizenship behavior.

Table 3
Hypothesis result

Hypothesis	Construct*)	Original Sample	STDEV	T Statistics	P Values	Result
H1	BIG → IOP	0.299	0.077	3.860	0.000	Accepted
H2	BIG → OCB	0.111	0.056	2.001	0.046	Accepted
H3	IoT → IOP	0.214	0.059	3.605	0.000	Accepted
H4	IoT → OCB	-0.012	0.039	0.311	0.756	Rejected
H5	IOP → OCB	0.797	0.068	11.757	0.000	Accepted
H6	BIG→ IOP → OCB	0.238	0.067	3.546	0.000	Accepted
H7	IoT→ IOP → OCB	0.170	0.050	3.428	0.001	Accepted

*) BIG=Big Data; IOT=Internet of Things; IOP=Innovation Organizational Predictor; OCB=Organizational Citizenship Behavior

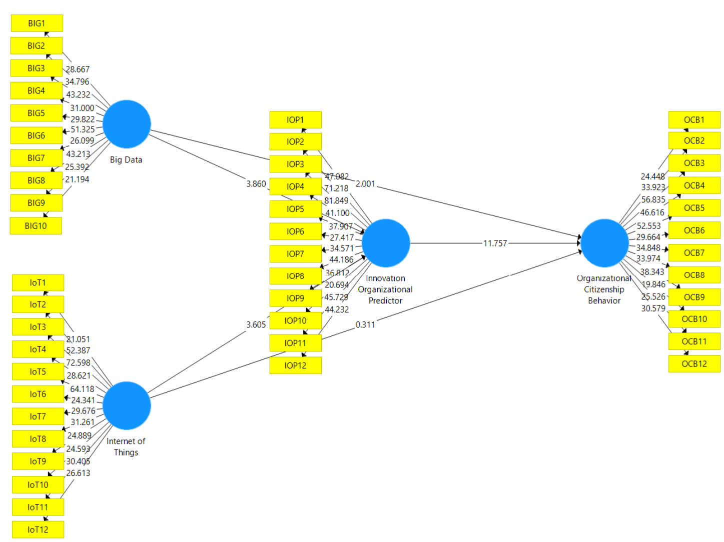

Fig. 2. Bootstrapping result

5. Discussion

Hypothesis 1 (H1) posits that adopting Big Data positively impacts the Innovation Organizational Predictor (IOP). The analysis of the data unequivocally supports the acceptance of this hypothesis. The statistical results reveal a significant relationship between the adoption of Big Data and the Innovation Organizational Predictor, as indicated by a t-statistic of 3.860 and a remarkably low p-value of 0.000. This outcome signifies that organizations within the chemical manufacturing industry when embracing Big Data technologies, experience a discernible enhancement in their Innovation Organizational Predictor. Integrating Big Data into their operations fosters an environment conducive to organizational innovation (Ghasemaghaei & Calic, 2019). It can be attributed to the capacity of Big Data to provide organizations with invaluable insights, real-time data analytics, and predictive capabilities, all of which are instrumental in fueling innovative processes and fostering a culture of innovation within the organization (Grover et al., 2018). The acceptance of H1 underscores the pivotal role that Big Data plays in shaping the predictive capacity for innovation within the chemical manufacturing industry. This finding holds substantial implications for industry practitioners. It underscores the importance of incorporating Big Data strategies into organizational operations to harness the power of data and cultivate an environment that stimulates and nurtures innovation (Bag et al., 2020; McBride et al., 2019; Mikalef et al., 2019).

Hypothesis 2 (H2) posits that the adoption of Big Data has a positive impact on Organizational Citizenship Behavior (OCB). The data analysis results unequivocally support the acceptance of this hypothesis. The statistical findings reveal a significant and positive relationship between adopting Big Data and OCB, with a t-statistic of 2.001 and a p-value of 0.046. This outcome suggests that the integration of Big Data technologies positively influences employees' Organizational Citizenship Behavior within the context of the chemical manufacturing industry. In essence, employees working within organizations that have embraced Big Data are more likely to exhibit behaviors beyond their job descriptions, such as helping colleagues, voluntarily contributing to tasks, or taking initiatives to improve work processes (Pham et al., 2023). It may be attributed to the enhanced decision-making capabilities and access to valuable data insights that Big Data provides, which, in turn, fosters a positive and cooperative work environment (Chierici et al., 2019). The acceptance of H2 underscores the idea that the adoption of Big Data is not only associated with improvements in innovation and operational efficiency but also positively influences the behavior of employees within the organization. This finding holds important implications for organizational leaders and managers, highlighting the potential benefits of integrating Big Data strategies for optimizing processes and cultivating a workplace culture characterized by proactive and cooperative behavior.

Hypothesis 3 (H3) posits that the adoption of the Internet of Things (IoT) has a positive impact on the Innovation Organizational Predictor (IOP). The analysis of the data robustly supports the acceptance of this hypothesis. The statistical results demonstrate a highly significant and positive relationship between the adoption of IoT and the Innovation Organizational Predictor, with a substantial t-statistic of 3.605 and an impressively low p-value of 0.000. This outcome signifies that the incorporation of IoT technologies into organizational processes and systems significantly enhances the organization's capacity for innovation within the chemical manufacturing industry. IoT's ability to connect and collect data from various devices, sensors, and processes, coupled with its real-time data analysis capabilities, empowers organizations to make informed decisions swiftly and adapt to changing conditions (Manavalan & Jayakrishna, 2019). It, in turn, contributes to fostering a culture of innovation within the organization, as employees are equipped with the tools and insights needed to drive innovative initiatives and problem-solving (Zheng et al., 2023). The acceptance of H3 underscores the pivotal role that IoT adoption plays in bolstering the Innovation Organizational Predictor, emphasizing its importance in shaping an innovative organizational environment. This finding holds profound implications for industry practitioners, highlighting the potential benefits of embracing IoT technologies for operational efficiency and fostering innovation—a critical component in remaining competitive and adaptive in today's dynamic business landscape.

Hypothesis 4 (H4) postulates that the adoption of the Internet of Things (IoT) has a positive impact on Organizational Citizenship Behavior (OCB). However, the data analysis results firmly reject this hypothesis. The findings reveal no statistically significant positive relationship between IoT adoption and OCB, with a t-statistic of 0.311 and a relatively high p-value of 0.756. In essence, the rejection of H4 indicates that, within the context of the chemical manufacturing industry, IoT technologies do not directly contribute to employees exhibiting Organizational Citizenship Behavior. Unlike the positive influence of IoT on the Innovation Organizational Predictor (IOP) highlighted in H3, this hypothesis suggests that IoT adoption alone does not motivate employees to engage in behaviors beyond their formal job roles, such as voluntarily helping colleagues or contributing to organizational improvement initiatives. This finding underscores the complexity of the relationship between IoT adoption and employee behavior within an organizational context. While IoT may enhance operational efficiency and provide valuable data insights, it may not inherently foster the type of discretionary behaviors associated with Organizational Citizenship Behavior. Other factors, such as leadership, organizational culture, and employee motivation, may significantly encourage OCB. In conclusion, rejecting H4 highlights the need for organizations to consider multiple factors beyond technology adoption when seeking to promote Organizational Citizenship Behavior among their employees. It suggests that more than adopting IoT technologies may be required to cultivate a workplace culture characterized by proactive and cooperative behaviors, additional organizational efforts and interventions may be required to nurture such behaviors.

Hypothesis 5 (H5) proposes that the Innovation Organizational Predictor (IOP) has a positive impact on Organizational Citizenship Behavior (OCB). The data analysis results strongly support the acceptance of this hypothesis. The statistical findings reveal a highly significant and positive relationship between IOP and OCB, with an impressive t-statistic of 11.757 and an exceptionally low p-value of 0.000. This outcome signifies that within the chemical manufacturing industry, an elevated level of Innovation Organizational Predictor—a construct often associated with an organization's capacity for innovation—corresponds to a markedly higher propensity among employees to engage in Organizational Citizenship Behavior. Organizations with a stronger inclination toward innovation tend to foster a culture encouraging employees to contribute to tasks, assist colleagues proactively, and elicit a heightened sense of organizational loyalty and commitment (Wang et al., 2023). This linkage indicates an innovative corporate environment's constructive influence on employee behaviors that transcend formal job descriptions (Khan et al., 2020; Mi et al., 2019; Twemlow et al., 2022). The acceptance of H5 underscores the importance of cultivating an organizational culture that values and promotes innovation. It suggests that fostering innovation leads to improved innovation-related outcomes, as indicated in H3 and H4, and positively impacts employee behaviors such as OCB. This finding holds profound implications for organizational leaders, emphasizing the need to actively nurture innovation to enhance organizational performance and foster a collaborative and engaged workforce.

Hypotheses 6 (H6) and 7 (H7) introduce the concept of mediation in the context of understanding how the Innovation Organizational Predictor (IOP) plays a role in mediating the relationships between technology adoption (Big Data and IoT) and Organizational Citizenship Behavior (OCB). The data analysis results strongly support the acceptance of both these mediation hypotheses.

H6: Innovation Organizational Predictor mediates the relationship between Big Data adoption and Organizational Citizenship Behavior: The results affirm the mediation role of IOP in the relationship between Big Data adoption (BIG) and OCB. This finding suggests that the positive impact of Big Data adoption on OCB is not just a direct result but is partially explained by its influence on the IOP. In other words, when organizations embrace Big Data, it fosters innovation within the organizational environment (as indicated in H1), which, in turn, leads to the manifestation of OCB (as shown in H5). This indirect pathway highlights the significant role played by innovation in connecting technology adoption to enhanced employee behaviors.

H7: Innovation Organizational Predictor mediates the relationship between IoT adoption and Organizational Citizenship Behavior: Similarly, the analysis supports the mediation role of IOP in the relationship between IoT adoption and OCB. The positive impact of IoT adoption on OCB is not a direct outcome but is partly explained by its effect on IOP. In this case, IoT adoption contributes to innovation within the organization (as indicated in H3), subsequently influencing the emergence of OCB (as shown in H5). This mediation pathway underscores the pivotal role of innovation in linking IoT adoption to enhanced employee behaviors. In summary, accepting H6 and H7 elucidates the underlying mechanisms by which technology adoption (Big Data and IoT) indirectly influences Organizational Citizenship Behavior. These results highlight that the Innovation Organizational Predictor (IOP) serves as a critical mediator, channeling the positive effects of technology adoption on fostering innovation, which, in turn, drives the emergence of OCB. These findings provide valuable insights for organizations aiming to promote a culture of innovation and encourage proactive employee behaviors that go beyond their formal job roles.

6. Conclusion

In the ever-evolving landscape of the chemical manufacturing industry, the adoption of cutting-edge technologies, particularly Big Data and the Internet of Things (IoT), is pivotal in shaping organizations' dynamics. This research explored how these technological adoptions influence critical aspects of organizational functioning, with a specific focus on the Innovation Organizational Predictor (IOP) and Organizational Citizenship Behavior (OCB). The analysis of the data yielded insightful findings:

Firstly, it was established that Big Data adoption significantly and positively impacts the Innovation Organizational Predictor (IOP) and Organizational Citizenship Behavior (OCB). Organizations that harness the power of Big Data cultivate a culture of innovation and witness employees engaging in behaviors that transcend their formal job roles, contributing positively to the overall organizational environment. Secondly, the adoption of the Internet of Things (IoT) substantially enhanced the Innovation Organizational Predictor (IOP). However, in contrast to Big Data adoption, IoT adoption was not directly associated with increased Organizational Citizenship Behavior (OCB). Instead, IoT adoption indirectly influenced OCB through its impact on IOP, underlining the mediating role of innovation in this relationship. Furthermore, the Innovation Organizational Predictor (IOP) was confirmed to play a pivotal role in fostering Organizational Citizenship Behavior (OCB). Organizations prioritizing innovation within their operational frameworks were more likely to witness employees exhibiting proactive behaviors that benefitted the organization. These findings collectively emphasize the significance of fostering innovation as a catalyst for organizational growth and employee engagement. While both Big Data and IoT adoption contribute to innovation, their influence on OCB differs, with innovation as the nexus that drives positive employee behaviors. In practical terms, this research offers valuable insights for leaders and managers within the chemical manufacturing industry. It underscores the importance of embracing technological advancements and cultivating an organizational culture that values and encourages innovation. Such a culture not only leads to enhanced innovation but also influences employees to go above and beyond their job descriptions, ultimately contributing to the holistic success of the organization. Consequently, organizations that strategically integrate Big Data, IoT, and innovation into their DNA are better positioned to thrive in the dynamic landscape of the chemical manufacturing industry.

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