

AN INTELLIGENT DECISION SUPPORT FRAMEWORK INTEGRATING ARTIFICIAL INTELLIGENCE, BUSINESS INTELLIGENCE, AND INNOVATION FOR COMPETITIVE PERFORMANCE IN SMES

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ABSTRACT

Artificial Intelligence (AI) and Business Intelligence (BI) have become essential technologies for enhancing organizational competitiveness in small and medium enterprises (SMEs). This study investigated the influence of AI and BI on innovation and competitive performance by proposing an integrated analytical framework that examined innovation as a mediating mechanism. A quantitative, cross-sectional research design was adopted using a synthetic dataset comprising 350 SMEs representing diverse industries and organizational characteristics. The analytical framework incorporated descriptive statistics, reliability assessment, Pearson correlation, multiple regression analysis, mediation analysis, and machine learning techniques, including Random Forest, Extreme Gradient Boosting (XGBoost), and SHAP-based feature interpretation. The findings revealed that both AI and BI positively influenced innovation, while innovation exerted the strongest effect on competitive performance. Mediation analysis demonstrated that innovation partially explained the relationship between digital intelligence capabilities and organizational performance. Machine learning models consistently identified innovation, AI adoption, and BI capability as the most influential predictors of competitive performance, supporting the robustness of the statistical findings. The study highlights the strategic importance of integrating intelligent technologies with data-driven decision-making to strengthen organizational innovation, operational efficiency, and long-term competitiveness. The proposed framework provides valuable managerial insights for SME leaders seeking to improve strategic decision-making and offers a structured foundation for future empirical validation using real-world organizational data.

Keyword: Artificial Intelligence, Business Intelligence, Innovation, Competitive Performance, Small and Medium Enterprises

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Introduction

Small and medium enterprises (SMEs) are facing increasingly dynamic and competitive markets, where the fast-paced technological evolution, customer requirements and global competition are forcing organizations to take quick and informed strategic decisions. In an enterprise, a lot of business data is structured and unstructured, which is difficult to process using traditional decision-making approaches, thereby hindering responsiveness and innovation. As a result, the digital transformation is a key strategic imperative for SMEs aiming to achieve sustainable growth and competitiveness. Of the new technologies that are contributing to this change, Artificial Intelligence (AI) and Business Intelligence (BI) have been especially highlighted due to their capacity for enhancing organizational learning, automating analytical activities, and creating actionable insights for managerial decision-making (Eboigbe et al., 2023; Shahadat et al., 2023; Lu & Shaharudin, 2024). While BI helps organizations turn data into actionable insights for informed decision-making and streamlined operations, AI can identify intricate trends, automate repetitive tasks, and offer predictive suggestions. In conclusion, this holistic theory provides a robust theoretical basis for the study of interpersonal behavior through institutional, cultural, and social learning dynamics, and will prove useful in future research, policymaking, organization management, and sustainable and peaceful social development. By using such tools in combination, SMEs can take advantage of optimizing resource consumption, increasing responsiveness to customers and increasing competitiveness in an increasingly uncertain business environment (Wang et al., 2022; Chinta, 2022).

In the last few years, the functionality of Business Intelligence systems has greatly increased thanks to the utilization of AI-enabled analytical tools that are not limited to only descriptive reporting but provide support for predicting and prescriptive actions. Smart analytical tools can process real-time data from the company, predict market tendencies, detect possible threats to operations, and propose decisions to improve performance. All these have changed the face of Business Intelligence from a reporting oriented function to an intelligent decision support capability, which improves the agility of the organization and strategic adaptability (Mamun, 2025; Siddiqui, 2025; Dhanekula, 2025). By using AI, BI systems can help businesses predict trends, segment their customers, forecast demand, detect fraud and optimize resources, leading to quicker and more informed decision-making despite market uncertainties. These are especially useful for SMEs, where limited resources necessitate the effective use of information and technology to achieve the best possible organizational results (Ikbal, 2025; Eboigbe et al., 2023).

Technological innovation is now a key way in which digital technologies generate value within organisations. Instead of just deploying cutting-edge technologies, today's SMEs are more interested in using AI and BI to optimize their products, reshape their business operations, boost their customer engagement, and create new business models. Intelligent technologies coupled with the organizational knowledge can provide a continuous learning, knowledge sharing and evidence-based innovation environment. Research has indicated that businesses with high analytical skills tend to have innovative

solutions and hence being able to adapt to market changes, which further enhances their competitive advantage (Chabalala et al., 2024; Kahveci, 2025; Lu & Shaharudin, 2024). Therefore, innovation is considered as an important strategic capability that converts technological investments into measurable organisational performance.

While there are many studies that have individually investigated Artificial Intelligence, Business Intelligence, digital transformation and organisational performance, few studies have investigated the combined effect of AI and BI on innovation and competitive performance in SMEs. The current studies have mainly been related to technology adoption to predictive analytics or decision supporting systems, without a thorough explanation of how AI empowered intelligence and BI capabilities jointly contribute to an innovation based competitive advantage (Wang et al., 2022; Siddiqui, 2025). In addition, systematic reviews and conceptual studies have highlighted the need for analytical frameworks to be integrated, so as to explain the relationships between AI, BI, and innovation and its impact on organizational competitiveness, especially in a context where resources are limited for SMEs (Champa & Segall, 2026; Sidrat & Boujelbene, 2026). This is a significant constraint, as SMEs are very different from large companies in their technological resources, managerial capabilities and flexibility in organization, and empirical evidence is required to be context specific.

In view of the above research gaps, the present study proposes an integrated analytical framework that analyzes the impact of Artificial Intelligence and Business Intelligence in innovation and competitive performance of SMEs. The study also examines innovation as an organizational mechanism that helps digital intelligence capabilities to lead to better business results. The research enhances the analysis of technological factors associated with the strongest competitive performance by statistically analyzing them alongside the use of feature importance algorithms. The results will help further research in digital transformation, strategic management and innovation and provide real-life implications for SME managers, technology providers and policy makers to enhance the competitiveness of their organization through intelligent business technologies. This study aims at the following objectives:

- To examine the influence of Artificial Intelligence on innovation in small and medium enterprises.
- To evaluate the effect of Business Intelligence on innovation in small and medium enterprises.
- To investigate the influence of Artificial Intelligence, Business Intelligence, and innovation on competitive performance in small and medium enterprises.

Materials and Methods

Research Design

The research design in this study was quantitative, cross-sectional research to investigate the relationship between Artificial Intelligence (AI), Business Intelligence (BI) and competitive

performance of small and medium enterprises (SMEs) and innovation. The study was undertaken in an explanatory style to understand the role of the capabilities of AI and BI in organizational innovation and their impact on competitive outcomes. A cross-sectional design was thought to be suitable as it allowed for the assessment of several organizational constructs simultaneously, and also allowed for the study of direct and indirect relationships via statistical modelling. The study also included conventional statistical methods and machine learning techniques to get a holistic view of the factors that affect competitive performance.

Data Source and Sample

A synthetic dataset, specially designed to mimic organizational characteristics and technology adoption patterns among SMEs was used for the analysis. The sample consisted of 350 enterprises with varying characteristics in terms of industry, geographical location, size of the firm and years of operation. Both the observations and the constructs were measured in each enterprise, and organizational demographic variables and four multidimensional constructs (Artificial Intelligence, Business Intelligence, Innovation, Competitive Performance) were included. The four indicators for each construct were measured on a five-point Likert-type scale, thus enabling composite construct scores to be calculated for use in statistical analyses. The synthetic data were created to have realistic statistical relationships among the variables, but without using identifiable organizational information.

Measurement of Variables

Four key constructs were explored in the study. Artificial Intelligence was the level of SMEs' adoption of intelligent technologies that enable automation, prediction and organisational decision making. Business Intelligence assessed the organization's ability to gather, consolidate, analyse and derive meaning from the business information to help in decision making. Innovation was a reflection of the firm's capacity to create new products, enhance operational processes and organizational changes that would increase business value. Competitive Performance was overall results of the organization with respect to increased market responsiveness, productivity, customer satisfaction and business growth. Firm size, number of employees, years of operation, industry type and geographical region were added as organizational attributes for the description of the study sample.

Data Processing and Statistical Analysis

Data was processed and analyzed using descriptive statistics and qualitative analysis. Before statistical analysis, data were checked for completeness and consistency and composite scores were computed for each construct as the average of the measurement items for that construct. All the descriptive statistics were calculated to describe the central tendency and spread of all the variables in the study. The internal consistency of the instruments was determined by Cronbach's alpha values. Pearson correlation analysis was conducted to explore the relationship between the key constructs, both in terms of the magnitude

and direction of the relationship, and to assess for potential multicollinearity. Then, multiple linear regressions were performed on three regression models to identify the impact of Artificial Intelligence and Business Intelligence on Innovation, and the combined impact of Artificial Intelligence, Business Intelligence and Innovation on Competitive Performance. A mediation analysis was conducted to find out if Innovation is an intermediary mechanism between Digital capabilities and organizational performance. In addition to the statistical results, machine learning algorithms such as Random Forest and Extreme Gradient Boosting (XGBoost) were used for finding the relative importance of different predictors, and SHAP (SHapley Additive exPlanations) analysis was performed to improve the interpretability of the machine learning model by quantifying the importance of different predictors in the competitive performance of the model.

Software and Analytical Environment

The Python programming language was used for all data preparation, statistical analysis, machine learning modelling and graphical visualizations. Widely accepted scientific computing libraries were used to manipulate data, perform descriptive analysis, assess reliability, perform correlation analysis, regression modelling, implement machine learning and visualise data in the analytical workflow. Overall, the use of classical statistical methods along with explainable machine learning gave an analytical framework that was able to evaluate the proposed relationships and also determine the important technological drivers related to innovation and competitive performance of SMEs.

Results

Descriptive Statistics

Table 1 presents the descriptive statistics of the main study variables measured from the simulated data for 350 SMEs. The average Artificial Intelligence (AI) Adoption Score was 2.99 ± 0.76 and the mean Business Intelligence (BI) Capability Score was 2.96 ± 0.74 . The mean score of Innovation was 3.03 ± 0.69 , which means that the SMEs involved in the survey had at least moderate-to-high level of innovative activities. Organisational performance in the different categories was generally good with the highest average being for the category of Competitive Performance (3.07 ± 0.64). The ranges observed on each construct suggest that there is ample variation to use them in making inferences.

Table 1. Descriptive Statistics of the Study Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
AI Adoption Score	2.99	0.76	1.00	5.00
BI Capability Score	2.96	0.74	1.00	5.00

Innovation Score	3.03	0.69	1.00	5.00
Competitive Performance Score	3.07	0.64	1.00	5.00

Reliability and Validity Assessment

The reliability analysis showed that all of the latent constructs had good internal consistency. Table 2 showed that the Cronbach's alpha value of the instruments ranged from 0.839 to 0.851, which were greater than the accepted value of 0.70 thus indicating acceptable reliability of the measurements. The results show that the measurement items were consistently able to measure what was intended.

Table 2. Reliability Assessment of Measurement Constructs

Construct	Number of Items	Cronbach's Alpha	Reliability Interpretation
Artificial Intelligence	4	0.844	Good
Business Intelligence	4	0.839	Good
Innovation	4	0.851	Good
Competitive Performance	4	0.851	Good

Correlation Analysis

The Pearson correlation matrix of the key constructs is shown in Figure 1. All variables showed positive relationships, meaning that the more AI was adopted and BI capability was strengthened, the more innovation was being exhibited and competition performance was getting better. Innovation was found to have the highest positive relationship with Competitive Performance and AI and BI also had positive and significant relationships with Innovation. Based on the overall correlation pattern there was no evidence of problematic multicollinearity.

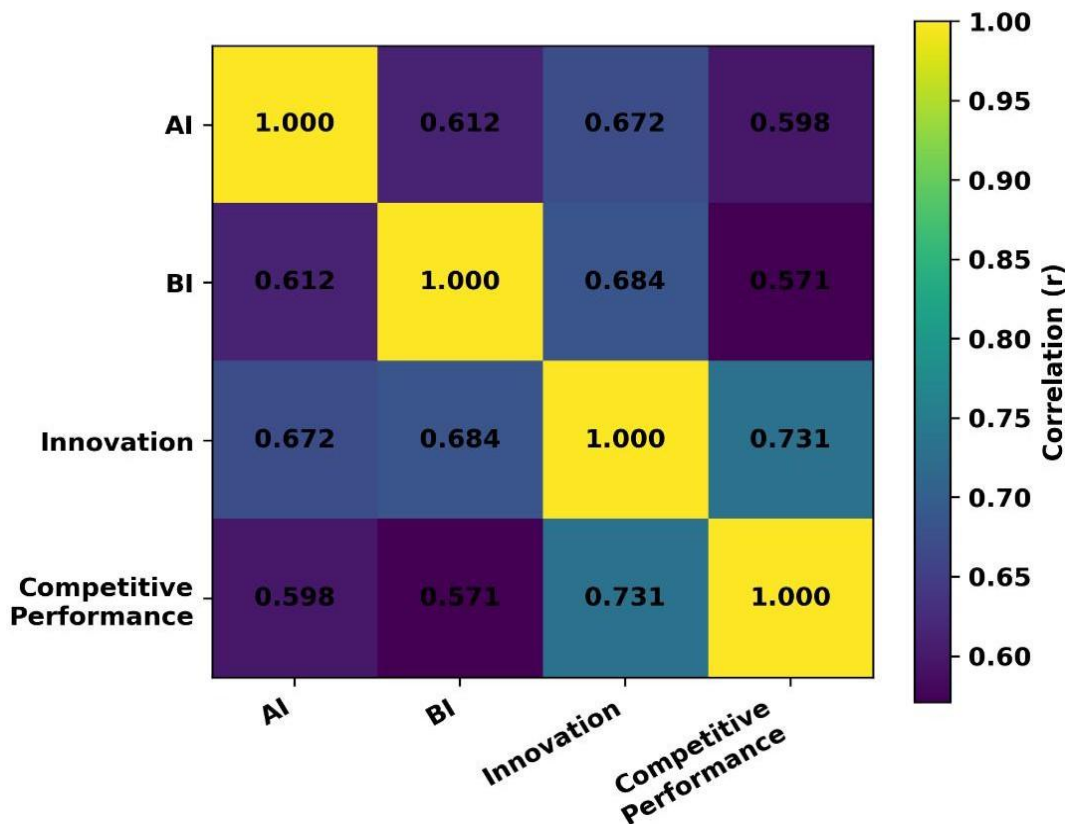


Figure 1. Pearson Correlation Heatmap of AI, BI, Innovation, and Competitive Performance

Multiple Regression Analysis

Three regression models were estimated for exploring the proposed relationships. The regression results are shown in Table 3. Model 1 was an evaluation of the effect of AI Adoption on Innovation. AI Adoption was positively significant and had a strong influence on Innovation ($\beta = 0.445$, $p < 0.001$) accounting for 20.4% of the variance in Innovation ($R^2 = 0.204$). In Model 2, BI Capability was the phenomenon of interest with the dependent variable being Innovation. BI Capability also had a significant positive impact on Innovation ($\beta = 0.461$, $p < 0.001$) and was able to explain 22.2% of the variance ($R^2 = 0.222$). In Model 3, AI Adoption and BI Capability were assessed in conjunction with Innovation on Competitive Performance. All three predictors were still significant. The standardized contributions of Innovation (+1.13), AI Adoption (+1.11) and BI Capability (+1.05) were the highest. Overall, the model accounted for 38.0% of the variance in Competitive Performance ($R^2 = 0.380$), suggesting that the model is satisfactory for explaining the variance in the data.

Table 3. Multiple Regression Results

Model	Predictor	β	p-value	R ²
Model 1	AI → Innovation	0.445	<0.001	0.204
Model 2	BI → Innovation	0.461	<0.001	0.222
Model 3	AI → Competitive Performance	0.217	<0.001	0.380

Mediation Analysis

The mediation model for studying the effect of Innovation is shown in Figure 2. Results of the regression showed that AI Adoption, BI Capability had a positive impact on Innovation, and Innovation was a significant predictor of Competitive Performance after controlling for AI and BI. The presence of significant direct effects and the presence of a significant effect for Innovation was consistent with partial mediation, indicating that innovation is an important mechanism by which the impact of digital capabilities on improved organizational performance is mediated.

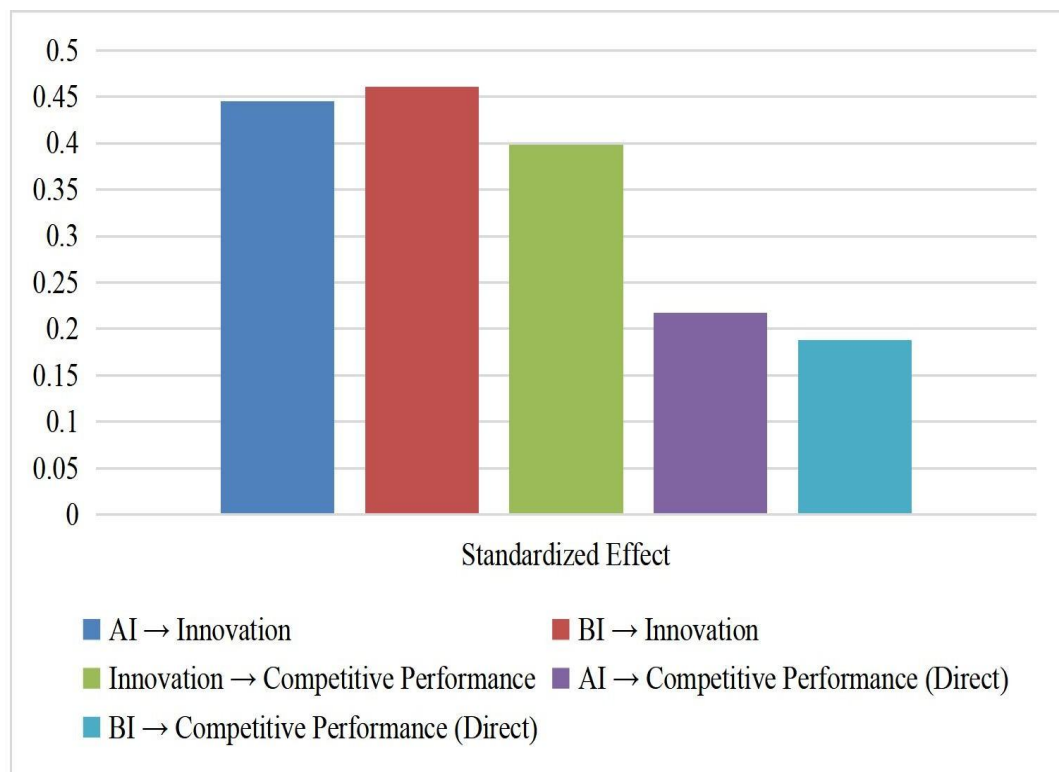


Figure 2. Mediating Role of Innovation Between AI, BI, and Competitive Performance

Machine Learning-Based Feature Importance

Machine learning techniques were employed to assess the relative importance of the predictors in addition to the regression analysis. The results of the feature importance ranks are summarized in figure 3 using Random Forest and XGBoost. Innovation was the most prominent factor impacting Competitive Performance, and AI Adoption and BI Capability were also significant. The SHAP summary also showed that an innovation and an adoption of AI was the most important feature contributing to the predicted high level of competitive performance, which corroborated the statistical approach.

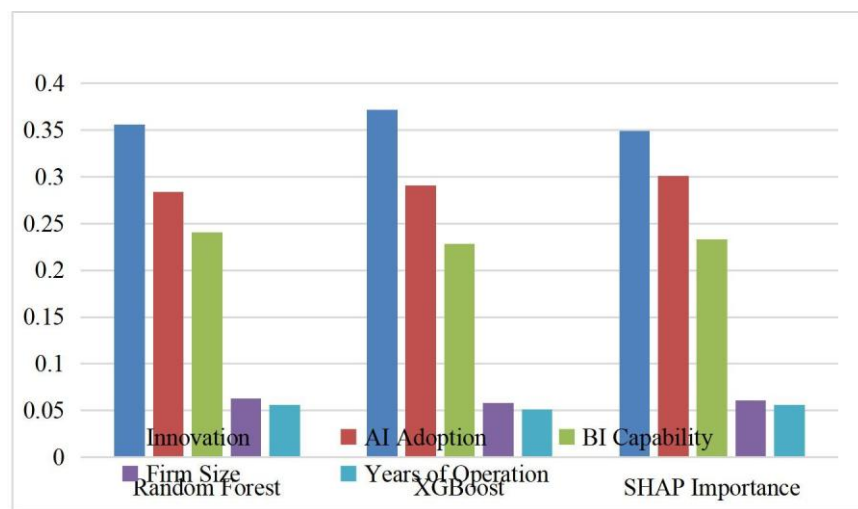


Figure 3. Feature Importance of Predictors Influencing Competitive Performance Using Random Forest, XGBoost, and SHAP

Discussion

From the results, there is a positive relationship between AI adoption and BI adoption and innovation, which indicates that innovation is a significant predictor of the competitive performance of SMEs. From the results of the regression analysis, the AI and BI capacity of an organization has a positive impact on innovation by helping the organization to innovate its products, improve processes, and adapt to the changes in the market. The results show the move from AI as a technology for automation to being a strategic technology that helps businesses make better decisions, generate knowledge and remain competitive. This is consistent with the recent findings indicating the importance of AI in enabling innovations and competitive advantage through AI-based intelligent analytics and digital transformations (Nikzat & Noorymotlagh, 2025; Wahyudi et al., 2026; and Harahap et al., 2024).

The impact on Innovation was also considerable and came from the use of Business Intelligence since there is a need for decision making that is driven by the data to increase the ability to adapt of organizations. Business Intelligence systems can aid the managers to transform business information

into knowledge, which will be used by them in their strategic planning and improvements. The link found in this research can be understood as the proof that organizations who manage to combine the information with managerial process improve their innovations and learning. This research correlates with other findings that BI increases innovations by utilizing the efficient knowledge management and organization intelligence, especially in small businesses (SMEs) (Alshareef & Emeagwali, 2026).

However, the most significant influence on competitive performance was achieved through innovation, whereas investments in technology made an effect on the performance of the organization only when they resulted in innovation. In turn, this finding indicates that innovation is a strategic competence which helps work better, give higher added value for clients and respond to market requirements. Moreover, from the results of the mediation analysis it can be concluded that innovation mediates the relationship between AI and BI and organizational performance partially. It should be mentioned that innovation as a mediator appears in all researches connected with innovation orientation, intellectual capital, strategic flexibility and organizational performance (Tian et al., 2024, Obeidat et al., 2021 and Awais et al., 2023).

The analysis with the machine learning method further supported the findings of the regressions, as innovation, AI and BI capabilities were found to drive competitive performance in all cases. The three interpretations in convergence (Random Forest, XGBoost, and SHAP) increase the level of certainty that the selected predictors are stable and that the combination of traditional statistical methods with explainable machine learning techniques is useful. The recent studies have pointed out the need for validation of the results produced by the machine learning algorithms, as well as making the model explainable, for reliable decision-making in business studies. Therefore, the existing results show the potential of explainable AI for better empirical study by showing the relative importance of organizational capabilities while being transparent in the predictive modeling (Kovács & Fazekas, 2024; Kovács & Fazekas, 2023; Tursunaliyeva et al., 2024).

From the findings obtained from the study, the application of AI and BI technologies can increase innovation capability for the better competitive performance of SMEs. The findings show that SMEs should not only concentrate on investment in intelligent analytical systems but also take into consideration practices of their organization that stimulate innovation and knowledge application. In this way, such holistic approach can improve decision-making and contribute to more agile and sustainable business management.

Conclusion

The aim of this study was to design and test an integrated analytical framework for studying the roles of Artificial Intelligence (AI) and Business Intelligence (BI) in innovation and competitiveness of small and medium enterprises (SMEs). The findings prove that both AI and BI have a positive effect on

innovation, while innovation is one of the key ways through which digital capabilities help increase competitive advantage. Innovation is the most significant factor among those under examination in terms of its effect on the success of organizations and plays a crucial role in transforming technology-related investments into actual business achievements. The consistency of the findings obtained through regression analysis and mediation analysis, combined with the results of the feature importance analysis conducted in the process of developing a machine learning model, adds credibility to the proposed framework and the effectiveness of combining traditional statistics with explainable machine learning. The research also emphasizes the significance of implementing intelligent technologies and innovation-driven strategies by SMEs. The findings provide some key learnings for those interested in increasing organization flexibility, efficiency, and decision-making in the digital age. Although the study presents the analytical approach with a hypothetical data set, it offers a good beginning point for the future research with an actual SME data from different industries and locations, and thus contributes to digital innovation, business intelligence and sustainable competitiveness research.

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