

Intelligent Operations and Public Relations Collaborative Management Model for Corporate Image Enhancement in the Smart Manufacturing Environment

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Abstract: The article focuses on intelligent operational relationships in an innovative manufacturing environment, primarily through the integration of PR strategy. A key focus is on enhancing SMEs' image. Using advanced technologies such as AIoT and data analytics, the article analyzes how optimizing production processes and predicting related demand, along with effective public relations management, can ensure the successful expansion and promotion of these innovations, thereby strengthening corporate trust and brand management. The article also mentions how integrating intelligent operations with public relations can improve operational efficiency and brand awareness, ultimately boosting sales. Furthermore, the article highlights the crucial role of AI tools in media sentiment analysis and related management functions. It explains how data-driven decision support systems can help companies improve crisis management, optimize tools, and enhance brand image.

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1 INTRODUCTION

The Smart Manufacturing Leadership Coalition (SMLC) defines smart manufacturing as the ability to solve existing and future problems through an open infrastructure, enabling solutions to be implemented at the speed of business while creating profitable value. An expert at Infiniti Research stated that, as it permeates manufacturing processes through smart factories and the adoption of Industry 4.0, smart manufacturing is transforming traditional manufacturing^[1]. MIT Professional Education states that "this revolution, based on cyber-physical production systems, challenges conventional operations in the manufacturing sector, making it increasingly dynamic. Smart manufacturing, integrated with modern data science and artificial intelligence, can enable processes suitable for the factory of the future. Innovative manufacturing technologies improve efficiency and eliminate system weaknesses^[2]. They are characterized by a highly interconnected, knowledge-driven industrial enterprise, with all departments and operational systems linked, thereby enhancing productivity, sustainability, and economic performance.

In the innovative manufacturing environment, companies can enhance their competitiveness and brand image by integrating intelligent operations systems with public relations management. For example, Rockwell

Automation's solutions provide a comprehensive, innovative manufacturing platform that optimizes production efficiency and quality through advanced data analytics, IoT, and AI. By leveraging these systems, companies can significantly reduce downtime, improve product consistency, and ensure faster time-to-market, all of which contribute to better customer satisfaction and a stronger brand reputation^[3]. By utilizing IoT-enabled intelligent machines, manufacturers can anticipate potential equipment failures before they occur, thereby minimizing costly downtime and ensuring continuous production. This not only enhances operational efficiency but also reinforces the company's commitment to innovation, safety, and reliability, which are key elements of their brand identity.

At the same time, a company's public relations management ensures that the positive impact of these technological advancements is communicated effectively to both the public and stakeholders. For instance, during a product recall or a manufacturing issue, innovative PR strategies—such as real-time media monitoring and proactive crisis communication—can help mitigate negative press and maintain consumer trust. By aligning smart manufacturing with strategic PR, companies can not only optimize operations but also establish a resilient, trustworthy brand image among consumers and investors^[4].

This integrated approach, as demonstrated by Rockwell

Automation's systems, illustrates how innovative manufacturing solutions and public relations management can work together to elevate a company's market position and enhance its brand perception.

2 RELATED WORK

2.1 ENTERPRISE INTELLIGENT OPERATIONS

Artificial intelligence technology is widely used across all aspects of enterprise operations. In manufacturing, machine learning enables intelligent manufacturing systems to optimize production processes autonomously, supporting intelligent scheduling and quality control. For example, maintenance systems can mine temporal correlation features in equipment operating data to accurately predict equipment failure points, thereby optimizing equipment operations and maintenance cycles, reducing downtime, and enabling efficient, intelligent production [5]. In supply chain management, AI technology is utilized to implement production demand functions, including demand forecasting, inventory optimization, and logistics route planning, thereby enabling intelligent supply chain collaboration. In product marketing, intelligent recommendation engines and user behavior analysis models built on big data can accurately inform marketing strategies, helping companies gain deeper insights into consumer demand and effectively match service solutions to user expectations [6]. In human resources management, applications such as intelligent recruitment, employee training, and performance evaluation are transforming traditional models. In financial management, intelligent financial analysis, risk warnings, and automated reporting have significantly improved efficiency and accuracy.

The factors driving enterprises' intelligent transformation are multifaceted. From an external perspective, intense market competition necessitates that companies enhance their operational efficiency and responsiveness. The increasing personalization and diversification of customer needs require enterprises to possess stronger, flexible production and service capabilities. Technological advancements, particularly the maturation of artificial intelligence (AI), have enabled intelligent transformation for enterprises. From an internal perspective, demands such as reducing operating costs, improving decision-making quality, enhancing innovation capabilities, and optimizing resource allocation are driving enterprises to embrace intelligent transformation [7] actively. Furthermore, supportive government policies have created a favorable external environment for smart transformation.

This section will explore in depth the implementation paths and key elements of intelligent operational transformation for enterprises from four core perspectives: data-driven decision-making, business process reengineering, production and operations optimization, and supply chain collaboration. This will provide an actionable guidance

framework for enterprises navigating this intelligent transformation.

1. Building a Data-Driven Intelligent Decision-Making System: Data is the foundation of AI, and establishing a comprehensive data system is the primary task of intelligent transformation for enterprises. Enterprises urgently need to build an integrated data platform to eliminate data barriers and promote data standardization, integration, and sharing [8]. On this basis, technologies such as reinforcement learning and deep learning can be used to build intelligent analytical models, enabling a leap from descriptive to predictive, and ultimately to prescriptive, analysis. By establishing an intelligent decision support system, AI can be integrated into decision-making processes across all levels of the enterprise, enhancing the scientific basis and timeliness of decisions [9]. For example, by developing an AI-based production scheduling decision-making system, the company has achieved dynamic optimization and matching of orders, inventory, and production capacity, thereby enhancing production efficiency and improving on-time delivery.

2. Promoting the Intelligent Reengineering of Business Processes: Traditional business processes suffer from multiple links, low efficiency, and poor coordination. Focusing on customer value, companies should systematically leverage AI to optimize and restructure existing business systems [10-12]. By deploying AI-driven workflow engines and intelligent process automation solutions, they can accelerate the digital transformation and intelligent upgrade of business operations. At the same time, they should establish a continuous process-optimization mechanism and use process mining to identify process bottlenecks and opportunities for improvement. In customer service processes, deploying intelligent customer service robots not only provides 24-hour service but also leverages natural language processing to understand customer intent and deliver personalized solutions, thereby significantly improving customer satisfaction.

3. Building an Intelligent Production Operations Platform: In the manufacturing sector, companies need to build an intelligent platform that covers the entire process, including R&D and design, production and manufacturing, quality control, and equipment maintenance. Using digital twin technology, they can establish a mapping between the physical and digital worlds, enabling real-time monitoring and optimization of the production process. Leverage computer vision technology for product quality inspection, predictive maintenance to reduce equipment failures, and intelligent scheduling systems to optimize production plans.

4. Establish an intelligent supply chain collaboration network. Complex supply chain management processes require companies to leverage artificial intelligence technology to achieve supply chain visualization, collaboration, and intelligence. Establish a supply chain control tower to gain end-to-end visibility. Apply machine learning algorithms to forecast demand and optimize

inventory: Leverage intelligent logistics technology to optimize transportation routes and delivery plans. Furthermore, establish data-sharing mechanisms with suppliers and customers to facilitate intelligent collaboration across the supply chain.

2.2 PUBLIC RELATIONS MANAGEMENT IN ENHANCING CORPORATE IMAGE

Public relations (PR) play a vital role in shaping a company's image and ensuring its long-term success in the marketplace. A strong corporate image reflects public trust and recognition of the organization, which are essential for building a competitive advantage. PR helps craft and communicate the company's unique identity by aligning its values, products, and services with the expectations and perceptions of its target audience. By strategically managing PR activities, businesses can enhance their visibility, reputation, and trustworthiness—critical factors in gaining the support of customers, investors, and other stakeholders. Furthermore, a well-managed PR strategy ensures that a company is consistently positioned as a reliable and reputable entity, both during periods of success and in times of crisis. This holistic approach enables businesses to differentiate themselves in the competitive market, attract new customers, and retain loyal ones.

In addition to building a positive image, PR also plays a crucial role in crisis management, helping companies mitigate the impact of adverse events on their brand. For instance, when faced with a product defect or an operational failure, a company's prompt and transparent response—such as holding press conferences, issuing public apologies, and offering compensation—can demonstrate its commitment to customer satisfaction and corporate responsibility. Through effective communication and active management of public sentiment, PR helps organizations rebuild trust and repair their reputations. A key example of this is the successful crisis management by the French mineral water company, Perrier, during a contamination scare in 1989. By taking immediate action, including product recalls and public statements, the company not only limited reputational damage but also reinforced its brand's reliability and customer-first approach. This incident underscores the importance of having a comprehensive PR strategy that can effectively handle both routine communications and unforeseen challenges.

2.3 COLLABORATIVE MANAGEMENT MODELS

Collaborative management models emphasize the strategic alignment of business functions, including operations, marketing, and public relations, to achieve mutual benefits for all stakeholders. According to the collaborative business model concept, companies that effectively manage alliances are better positioned to leverage collective strengths and address challenges in a coordinated manner. This approach requires organizations to align their internal goals with those of their partners and the public, thereby ensuring

that both operational and relational objectives are met. In the context of smart manufacturing, this means aligning intelligent operations systems with public relations strategies, allowing businesses to optimize production while building a positive and consistent brand image. Successful collaboration relies on clear communication, trust, and mutual benefit, ensuring that the combined efforts of each party result in a seamless and productive outcome.

Implementing collaborative management models also requires operationalizing these alliances by creating systems that promote effective coordination and communication across departments. For example, integrating data analytics and PR monitoring tools within the same platform can help manufacturing companies track not only operational performance but also public perception in real time. These systems enable businesses to make data-driven decisions that align with both production goals and brand-building efforts. By operationalizing collaborative models, organizations can ensure that all departments work toward common objectives, reducing inefficiencies and enhancing overall performance. Furthermore, such models help businesses anticipate and proactively address challenges, whether operational disruptions or shifts in public sentiment, thereby maintaining a competitive advantage and fostering long-term relationships with stakeholders.

3 METHODOLOGY

3.1 DATA COLLECTION METHOD

In this study, we collected data on multiple key parameters, including temperature, vibration, pressure, and power, from industrial equipment monitoring systems. The data were collected in real time from sensors on equipment, such as turbines, compressors, and pumps, primarily via an Internet of Things (IoT) platform. The data acquisition equipment and sensors were connected to a central data storage system via a wireless network, ensuring immediate data transmission and storage. To ensure data accuracy and reliability, we employed various sensor-fusion techniques to mitigate the impact of single-sensor failures.

The dataset is primarily categorized into the following dimensions:

- **Turbine:** Primarily monitors parameters such as temperature, pressure, and vibration. These data are used to detect equipment health and potential failures.
- **Compressor:** Monitors vibration, temperature, and operating pressure for real-time monitoring of equipment operating status.
- **Pump:** Monitors current, vibration, and pressure to assess equipment efficiency and provide early warning of failures.

The dataset comprises operational data from multiple pieces of equipment, encompassing various operating cycles and environmental conditions. This data enables us to identify equipment operating characteristics, detect anomalies, and make early predictions, thereby improving maintenance and management efficiency.

3.2 DATA EVALUATION METRICS

To ensure the quality and reliability of collected data, we designed the following data evaluation metrics:

- **Data Integrity:** Data integrity is ensured by identifying and addressing missing values, duplicate values, and outliers. Missing values are handled through interpolation and deletion, and duplicate values and outliers are removed using an anomaly detection model.
- **Temporal Consistency:** Data-collection timestamps are verified to ensure that data are recorded at predetermined intervals and that data from each sensor are synchronized to avoid inconsistencies caused by time offsets.
- **Device Status Consistency:** The authenticity of collected data is verified by comparing device status with actual operating conditions. For example, data is verified by monitoring device startup and shutdown records and fault alarm systems to ensure consistency with the device's actual operating status.

Through data evaluation, we can identify potential data issues and preprocess the data for subsequent modeling and analysis.

3.3 DATA VISUALIZATION AND ANALYSIS

To better understand the collected data and help identify potential equipment issues, we used various visualization techniques. The following is a time series plot of turbine temperature data, illustrating fluctuations in turbine temperature at various points in time.

3.3.1 Turbine Temperature Time Series

Turbine temperature is a key indicator of equipment health. By analyzing turbine temperature time series data, we can identify abnormal fluctuations during operation, such as equipment overheating or cooling system failure.

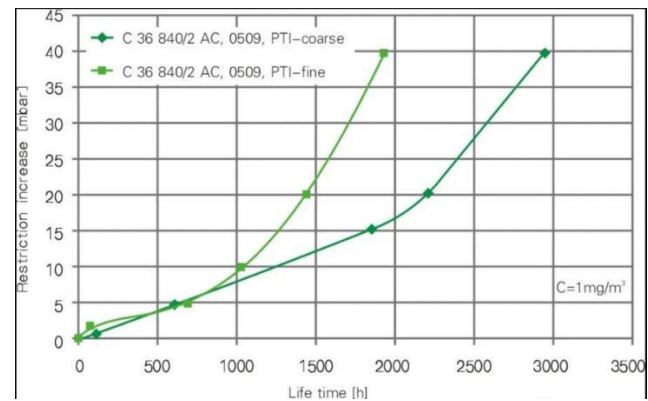


FIGURE 2: EQUIPMENT HEALTH MONITORING - TURBINE TEMPERATURE VARIATION OVER OPERATING TIME

Figure 2 shows turbine temperature fluctuations over different time periods. Large fluctuations may indicate abnormal equipment operation and necessitate maintenance. The data in the figure reflects the temperature changes over time. Large temperature fluctuations may indicate a potential risk of equipment failure and require further inspection and maintenance. Additionally, the equipment categories in the figure (e.g., C36 840/2 AC, 0509) display temperature trends under various operating modes, providing valuable clues for fault diagnosis.

3.3.2 Comparison of Compressor Vibration Data

Compressor vibration data can reflect the equipment's operational stability. The following chart compares vibration data from different compressors. By comparing the vibration levels of each unit, we can assess its health.

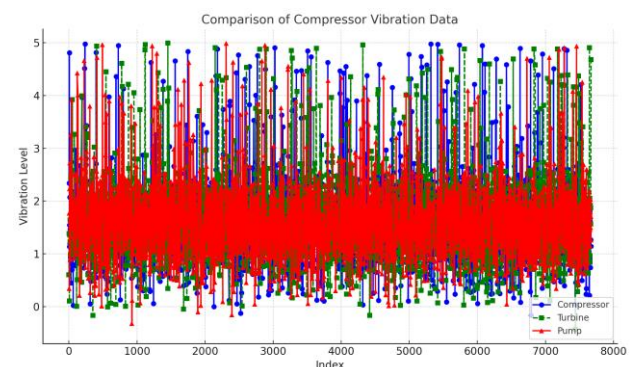


FIGURE 3. COMPARISON OF COMPRESSOR VIBRATION DATA: USING A VIBRATION DATA COMPARISON CHART OR A SPECTRUM CHART

As shown in Figure 3, Unit 1 exhibits a large vibration amplitude, indicating a potential risk of failure. Units 2 and 3, on the other hand, have smaller vibration amplitudes, indicating more stable operation. These analyses can help equipment managers identify equipment that requires priority inspection. 3.3.3 Comprehensive Performance Evaluation Chart. In addition to analyzing individual devices, we constructed a comprehensive device performance evaluation model by combining multiple monitoring indicators (e.g., temperature, vibration, and pressure) from different devices.

This approach provides a more comprehensive perspective for device health prediction.

The chart shows the comprehensive scores of different devices across multiple parameters. Devices with lower scores require more detailed maintenance and overhaul. This multi-dimensional evaluation approach can help improve device operating efficiency and extend device life.

3.4 DATA PREPROCESSING AND MODEL

BUILDING

After completing data collection and preliminary evaluation, we performed further data preprocessing. The main steps included denoising, normalization, and feature engineering. Denoising primarily removes noise from sensor data through filtering. Normalization ensures that data from different devices and sensors can be compared. Feature engineering enables us to extract key features of device operation, thereby improving the accuracy of subsequent machine learning models.

Using the preprocessed data, we applied various machine learning algorithms for device health prediction and fault diagnosis, ultimately building predictive models based on random forests and support vector machines (SVMs). These models can provide fault warnings and device health assessments based on real-time data.

4 COLLABORATIVE MANAGEMENT OF INTELLIGENT OPERATIONS AND PR IN SMART MANUFACTURING

4.1 STRATEGIC ALIGNMENT OF INTELLIGENT OPERATIONS AND PUBLIC RELATIONSHIP MANAGEMENT

In smart manufacturing, aligning intelligent operations with public relations (PR) is crucial for enhancing a company's brand value. Intelligent operations, powered by technologies like AI, IoT, and data analytics, optimize production processes, improve efficiency, and predict maintenance needs. PR management, on the other hand, ensures that these technological advancements are effectively communicated to the public, building trust and strengthening the brand's reputation. By integrating these functions, companies can establish a unified approach that fosters both operational efficiency and a positive brand perception.

AI-powered PR tools play a key role in this alignment by automating media monitoring, sentiment analysis, and content creation. These tools enable PR teams to craft timely, data-driven messages that highlight the benefits of innovative manufacturing technologies, including improved product quality and enhanced sustainability efforts. By using AI to

monitor public sentiment and adjust strategies in real time, businesses can ensure that their brand image remains aligned with their operational advancements, thereby enhancing both their market position and stakeholder trust .

4.2 DATA-DRIVEN COLLABORATIVE DECISION

SUPPORT SYSTEMS

In the intelligent manufacturing environment, enterprises face rapidly changing market demands and complex operational challenges. To make timely and informed decisions in this dynamic environment, building a data-driven collaborative decision support system (DSS) is crucial. As mentioned earlier, enterprises need to establish decision support systems based on big data analytics and artificial intelligence technologies to facilitate intelligent decision-making.

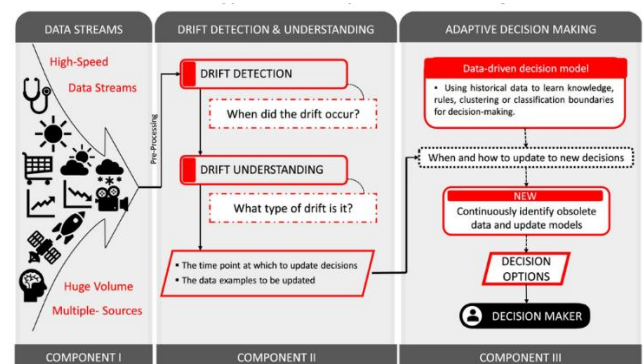


FIGURE 4. DATA-DRIVEN DECISION SUPPORT UNDER CONCEPT DRIFT IN STREAMED BIG DATA

Through the components of Data Streams, Drift Detection & Understanding, and Adaptive Decision Making, Figure 4 shows how real-time data is processed and analyzed to detect shifts in data trends (or "drift"), ensuring that decisions are updated promptly based on the latest information. For example, modern DSSs typically include database management systems, model management systems, and user interface systems. Through these components, managers can access and analyze large volumes of historical and real-time data to support predictive analytics and decision-making. In intelligent manufacturing, DSSs can help enterprises monitor production processes in real time, predict equipment failures, optimize production scheduling, and adjust product strategies based on market feedback. Furthermore, DSSs can integrate with public relations management systems to obtain real-time data on public opinion and brand image, providing data support for crisis management and brand maintenance.

However, building an efficient DSS faces challenges, including data quality, system integration, and user acceptance. Enterprises must ensure data accuracy and consistency by employing advanced data integration technologies to facilitate cross-departmental data sharing and collaboration. Furthermore, DSS design should consider user

needs and operational habits, providing a user-friendly interface and interactive methods to enhance system efficiency and scientific decision-making. Through these measures, enterprises can achieve both operational efficiency and improvements in brand value.

4.3 COLLABORATIVE CRISIS MANAGEMENT AND BRAND RESTORATION STRATEGIES

In the innovative manufacturing environment, public relations management plays a crucial role in crisis management. Through real-time data monitoring, intelligent manufacturing systems can promptly identify potential production issues, such as equipment failures or production delays. If not addressed promptly, these issues could damage the brand image. Public relations teams can leverage this real-time data to quickly develop crisis-response strategies, ensuring the company responds promptly to emergencies and mitigates negative impacts through effective communication. For example, when an equipment failure is predicted and monitored, the public relations team can use open and transparent communication to explain the root cause of the problem, the company's response measures, and future prevention strategies to the public and stakeholders, helping to restore public trust and safeguard brand image.

Furthermore, the synergy between smart manufacturing and public relations management can enhance the speed and accuracy of crisis-response efforts. By integrating data from production lines, equipment, and market feedback, companies can quickly assess the extent of brand damage and adjust communication strategies to minimize negative impacts. This data-driven crisis-response model not only enables companies to respond more effectively to emergencies but also helps maintain long-term reputation and consumer trust through timely brand restoration. By continuously optimizing this collaborative response mechanism, companies can establish a stronger brand image and respond effectively to future crises.

5 CONCLUSION

In the context of smart manufacturing, the strategic alignment of intelligent operations with public relations (PR) management is pivotal for enhancing corporate image and building competitive advantage. The integration of technologies such as artificial intelligence (AI), the Internet of Things (IoT), and data analytics enables the optimization of production processes, real-time equipment monitoring, and predictive maintenance, thereby improving operational efficiency. However, this operational enhancement is only beneficial when effectively communicated to the public, which is where PR strategies come into play. Through AI-powered PR tools, companies can monitor media sentiment, analyze public opinion, and craft timely, data-driven messages that highlight the advantages of these technological innovations. The synergy between intelligent operations and PR ensures that companies can not only optimize their

internal operations but also enhance their external brand image. This integrated approach fosters a more resilient corporate identity, enhances stakeholder trust, and strengthens the company's position in a competitive market.

The incorporation of data-driven decision support systems (DSS) into innovative manufacturing environments further underscores the importance of collaboration between intelligent operations and PR management. By leveraging real-time data from production processes and public opinion, companies can optimize decision-making and ensure that production strategies are aligned with market demands. Moreover, this data-driven approach proves essential during crises, where quick and effective communication is critical to maintaining brand integrity. In the event of production issues or operational failures, PR teams can use real-time data from manufacturing systems to assess the impact of the problem, craft transparent communication strategies, and manage stakeholder expectations. The collaboration between operational teams and PR ensures that companies not only address the immediate crisis effectively but also maintain consumer trust in the long term. By continuously refining this collaborative model, organizations can respond more efficiently to challenges, safeguard their brand reputation, and establish a solid foundation for sustainable growth in the smart manufacturing ecosystem.

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CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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