Management Strategies and Engineering Sciences 2027; 9(6):1-17

Assessment of the Effects of IT Infrastructure Automation and Technical Web Optimization on Operational Performance and User Experience in Mining and Steel Supply Chain Industries: A Case Study of Bahar Trade Company

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Received: 2026-02-10 **Revised:** 2026-07-22 **Accepted:** 2026-07-29 **Initial Publish:** 2026-07-30 **Final Publish:** 2027-11-01

Abstract

This study aimed to assess the effects of IT infrastructure automation, database optimization, Next.js-based web re-architecture, and technical search-engine optimization on operational performance and user experience at Bahar Trade Company. A quantitative, applied, developmental case-study design with a pre-intervention and post-intervention comparison was employed. The study included two consecutive 90-day periods, comprising 90 daily observations before implementation and 90 matched observations after implementation. The intervention consisted of automated Bash-based server monitoring and database backup procedures, PostgreSQL query optimization and indexing, deployment of a headless Payload CMS architecture, development of a Next.js server-side-rendered frontend, and implementation of technical SEO measures. Daily data were collected on SQL query response time, system uptime, Core Web Vitals, organic search traffic, and B2B conversion rate. Data were analyzed in SPSS using descriptive statistics, the Kolmogorov–Smirnov test, and paired-samples (t)-tests at a significance level of (\alpha=0.05). The paired-samples (t)-test showed that heavy SQL query response time decreased significantly after the intervention, (t(89)=24.81), (p<0.001), supporting the first hypothesis. Largest Contentful Paint also improved significantly following the implementation of the Next.js architecture and technical optimization measures, (t(89)=18.45), (p<0.001). In addition, the B2B conversion rate increased significantly in the post-intervention period, (t(89)=-12.32), (p<0.001). The negative sign reflected the order of subtraction between the paired conditions rather than a decline in performance. These inferential results supported the second hypothesis and confirmed statistically significant improvements in database responsiveness, web-loading performance, and commercial conversion. The integrated implementation of infrastructure automation, database engineering, server-side-rendered web architecture, and technical SEO significantly enhanced both internal operational efficiency and external digital performance, indicating that coordinated technical transformation can strengthen reliability, user experience, and commercial effectiveness in mining and steel supply chain companies.

Keywords: *IT infrastructure automation; database optimization; Next.js; technical SEO; operational performance; user experience; B2B conversion; mining and steel supply chain*

How to cite this article:

Jamali, A., & Badami, M. R. (2027). Assessment of the Effects of IT Infrastructure Automation and Technical Web Optimization on Operational Performance and User Experience in Mining and Steel Supply Chain Industries: A Case Study of Bahar Trade Company. Management Strategies and Engineering Sciences, 9(6), 1-17.

1. Introduction

The mining and steel supply chain is among the most operationally complex industrial systems because it integrates raw-material extraction, mineral processing, inventory management, transportation, wholesale trading, pricing, customer coordination, and the delivery of finished and semi-finished products. These activities generate large volumes of technical, operational, financial, and commercial data that must be processed accurately and transmitted rapidly across different organizational units. In such an environment, the quality of information technology infrastructure can directly influence production continuity, transaction speed, inventory visibility, response to customer inquiries, and the overall reliability of supply chain operations. Digital transformation has therefore moved beyond the limited adoption of individual software applications and has become a strategic mechanism through which industrial firms redesign their processes, strengthen information integration, and create more responsive business models. The concept of digital business strategy emphasizes that digital resources should not be treated as a separate technical function but should be integrated with organizational strategy, operational capabilities, and value creation mechanisms [1]. Digital transformation consequently requires coordinated changes in technologies, processes, employee competencies, and managerial practices rather than the isolated modernization of hardware or software [2].

The importance of this transformation is especially evident in the mining and metallurgical complex, where operational performance depends on the continuous coordination of physical and digital processes. Mining enterprises must manage geological information, extraction schedules, equipment utilization, material flows, processing capacity, product quality, and transportation requirements. Digital modelling and data-based management technologies can improve the visibility, precision, and efficiency of these activities by connecting production information with planning and decision-making processes [3]. Recent developments in the mining and metallurgical sector demonstrate a gradual transition from basic task automation toward integrated and intelligent management models capable of supporting predictive control, real-time monitoring, and data-driven decision-making [4]. This transition is particularly important for companies operating across multiple stages of the value chain because technical inefficiencies in one area, such as database delays or system downtime, may rapidly affect inventory reporting, pricing, customer service, and commercial transactions.

Supply chain performance increasingly depends on the ability of firms to collect, integrate, analyze, and communicate information across organizational boundaries. Big data analytics can support demand estimation, logistics coordination, supplier evaluation, inventory optimization, and operational risk management by transforming dispersed data into actionable information [5]. Similarly, machine learning and deep learning techniques are increasingly applied to supply chain forecasting, classification, anomaly detection, demand prediction, and resource allocation [6]. Reviews of demand-forecasting models indicate that advanced analytical methods can improve the capacity of organizations to identify complex patterns and respond more effectively to uncertain market conditions [7]. However, the effectiveness of these advanced methods depends on the existence of stable technical infrastructure, accessible databases, standardized data structures, and reliable information flows. Organizations cannot obtain the full benefits of intelligent analytics when fundamental IT processes remain manual, fragmented, slow, or vulnerable to human error.

The relevance of data-driven automation has also been demonstrated in financial and market environments characterized by volatility, high data volumes, and rapid decision cycles. Artificial intelligence models have been used to predict stock-price trends in the Tehran Stock Exchange, indicating the growing importance of computational methods in Iranian data-intensive contexts [8]. Optimized hybrid models combining convolutional neural networks and long short-term memory networks have similarly been developed to improve stock-price forecasting by identifying temporal and structural patterns in financial data [9]. Structural and machine-learning models have also been applied to the prediction of corporate default risk in the Iranian capital market [10]. Moreover, the automation of algorithmic trading strategies through the integration of machine learning and agent-based modelling illustrates how repetitive monitoring, data processing, and decision tasks can be transferred from manual procedures to systematic computational mechanisms [11]. Although these studies focus primarily on financial applications, they demonstrate a broader principle relevant to industrial supply chains: the value of digital intelligence is strongly conditioned by the speed, reliability, and automation of the underlying infrastructure.

IT infrastructure automation is therefore an essential foundation for operational digitalization. In traditional organizational environments, system administrators may manually perform database backups, inspect server capacity, review application errors, monitor hardware utilization, and respond to service interruptions. These procedures are time-consuming and vulnerable to delayed execution, inconsistent documentation, and human error. The automation of database support and monitoring processes can reduce administrative burdens, improve the regularity of backups, accelerate the detection of technical problems, and enhance the availability of critical industrial information systems [12]. Effective system and network administration similarly requires standardized backup procedures, proactive monitoring, capacity management, incident detection, and the automation of repetitive tasks wherever possible [13]. In industrial companies, these practices are particularly important because server failures or database disruptions may interrupt access to inventory data, product prices, transaction records, shipping information, and customer communications.

The DevOps approach provides an organizational and technical framework for integrating software development, infrastructure management, deployment, monitoring, and continuous improvement. DevOps is commonly associated with closer collaboration between development and operations functions, automated workflows, rapid feedback, and the reduction of delays between system modification and reliable deployment [14]. Its implementation can create greater agility, reliability, and security by replacing reactive problem-solving with preventive monitoring and repeatable technical processes [15]. Within mining and steel supply chain organizations, DevOps practices can support automated database backups, scheduled server-health checks, resource-utilization alerts, consistent deployment procedures, and faster responses to operational incidents. The organizational value of these practices lies not merely in reducing technical workload but also in ensuring that commercial and operational departments can continuously access accurate information.

Database performance represents another critical dimension of IT-enabled operational efficiency. Industrial databases frequently contain large and continuously expanding records concerning products, customers, inventory movements, purchase orders, sales transactions, pricing, logistics, and financial settlements. Poorly structured tables, unindexed columns, inefficient joins, and repetitive queries may substantially increase response time as data volumes grow. For employees who repeatedly retrieve inventory quantities, update daily prices, prepare quotations, or examine transaction histories, even short delays can accumulate into considerable productivity losses. Database normalization, query-plan analysis, and the creation of appropriate indexes can reduce unnecessary processing and improve the speed of high-frequency transactions. When combined with automated monitoring, these measures can create a more stable information environment and reduce the probability that technical bottlenecks will interrupt supply chain decisions.

The quality of digital infrastructure also affects the external interface between industrial suppliers and their business customers. Contemporary business-to-business buyers often begin procurement processes through search engines and corporate websites, even when the final transaction involves direct negotiation, formal quotations, and offline contractual procedures. Digital marketing strategy therefore requires the integration of website performance, content quality, search visibility, user experience, analytics, and conversion mechanisms [16]. For mining and steel suppliers, a corporate website may function as a digital product catalogue, pricing channel, technical-information repository, credibility signal, and entry point for requests for quotation. Slow loading, unstable page elements, outdated information, and difficult navigation can reduce trust and discourage procurement managers from continuing their interaction with the supplier.

Web performance has measurable implications for user engagement and business outcomes. Users generally expect pages to load quickly, respond immediately to interaction, and remain visually stable while content is displayed. When these expectations are not met, visitors may abandon the website before reviewing product information or completing a commercial action. Empirical evidence indicates that improvements in web performance can positively affect engagement indicators and business metrics [17]. In a B2B context, these outcomes may include longer engagement with product pages, increased use of contact channels, more requests for quotations, and greater interaction with the sales department. The relationship between technical web quality and commercial performance is particularly important for industrial websites because visitors often seek specific and time-sensitive information, such as current inventory availability, product specifications, shipment capacity, and daily material prices.

Modern web architectures provide several mechanisms for improving loading speed, maintainability, security, and scalability. The Jamstack approach separates the frontend presentation layer from backend content-management and database functions, allowing websites to retrieve structured information through application programming interfaces while delivering optimized frontend assets [18]. This separation can reduce the complexity of monolithic systems and enable different components to be updated, scaled, and secured independently. Modern JavaScript frameworks also support different rendering strategies, including client-side rendering, server-side rendering, static generation, and hybrid approaches. Comparative research on web frameworks has shown that rendering strategy can substantially influence application performance, resource use, and the timing of visible content delivery [19]. Recent comparison of Next.js and Astro further demonstrates that framework selection and rendering architecture remain central considerations in the development of high-performance web applications [20].

Server-side rendering is particularly relevant for product and pricing pages whose content must remain dynamic while also being immediately accessible to users and search-engine crawlers. In client-rendered applications, the browser may initially receive a minimal document and then execute JavaScript before meaningful content becomes visible. This process can increase processing demands, especially on low-powered devices or restricted networks. Server-side rendering instead generates the completed HTML content on the server before sending it to the browser, thereby reducing the time required for users to view essential information. For industrial suppliers serving buyers in regions with inconsistent internet quality, reducing client-side processing can improve accessibility and provide a more reliable digital experience.

Technical search-engine optimization is closely connected to web architecture because search engines must be able to discover, interpret, render, and index website content. Search-engine optimization affects the visibility of a firm in unpaid search results and can influence the interaction between organic and paid search strategies [21]. Technical SEO includes crawlable page structures, accurate metadata, semantic HTML, canonicalization, internal links, structured data, optimized media, and efficient resource delivery. Single-page applications may encounter particular SEO challenges when important content depends heavily on client-side JavaScript execution. Comparative evidence suggests that SEO performance can be enhanced when such applications adopt rendering and architectural practices that make content more immediately accessible to search engines [22]. For B2B industrial firms, improved technical SEO can increase visibility for specialized product and procurement queries that may have relatively low search volume but high commercial value.

The effects of frontend architecture and technical optimization extend beyond rankings to conversion behavior. Research examining modern frontend architectures and technical SEO in B2B platforms has indicated that faster, more accessible, and more easily indexed websites can improve conversion rates [23]. A conversion in an industrial B2B setting may not consist of an immediate online purchase; rather, it may involve submission of a request for quotation, initiation of a live-chat session, completion of a contact form, downloading of technical documentation, or direct communication with the sales team. These actions represent important stages in longer procurement cycles. Consequently, improvements in page speed and user experience should be evaluated not only through technical indicators but also through their association with commercially meaningful actions.

Digital supply chain excellence also depends on the alignment of IT proficiencies with organizational culture and intelligent supply chain practices. Strong technical capabilities are most valuable when they are embedded in workflows, supported by employees, and directed toward specific operational objectives [24]. This alignment is consistent with the view that transformation requires simultaneous attention to technology, organization, and the external business environment. In mining and steel markets, environmental pressures include price volatility, intense competition, fluctuating demand, logistical uncertainty, and increasing expectations for information transparency. Supply chain transparency can reduce information asymmetry and improve coordination among market participants, while digital designs such as blockchain can provide new mechanisms for verifying and communicating supply chain information [25]. Although blockchain implementation was not the focus of the present study, the broader emphasis on transparency underscores the importance of accurate, accessible, and timely digital information.

The digitalization of logistics and supply chain processes can also support sustainability and circular-economy objectives by enabling organizations to analyze material flows, identify inefficiencies, and redesign processes on the basis of operational evidence. Process mining offers a data-driven method for examining how enterprise logistics activities actually occur and for identifying deviations, bottlenecks, and opportunities for transformation [26]. In mining and metallurgical organizations, similar principles can be applied to the digital traces generated by inventory updates, product queries, customer interactions, server events, and web analytics. These records allow researchers and managers to evaluate whether technological interventions generate observable improvements rather than relying only on subjective assessments.

Despite the increasing literature on intelligent supply chains, mining digitalization, web development, SEO, DevOps, and data analytics, these areas are frequently examined separately. Supply chain studies often emphasize forecasting, transparency, logistics, or advanced analytical systems, whereas web-development studies focus on rendering performance, user experience, and search visibility. IT administration studies, in turn, generally examine server reliability, automation, or software-delivery practices. There remains a need for applied research that evaluates how coordinated changes in internal infrastructure and external web architecture jointly affect organizational outcomes. The combination of automated backups, hardware monitoring, database indexing, server-side rendering, technical SEO, and analytics-based conversion tracking creates a more comprehensive model of digital transformation than the implementation of any single technology.

The existing literature also indicates that technology adoption does not produce identical outcomes in every organizational setting. Case study research is particularly appropriate when the objective is to investigate a contemporary intervention within its real operational context and when the boundaries between the technological change and its organizational environment cannot be completely separated [27]. A company-level case can capture the specific relationship among infrastructure limitations, employee practices, supply chain requirements, website users, and commercial objectives. Applied evaluations of this kind are important in developing-market contexts, where firms may face restricted network conditions, legacy systems, limited technical resources, and rapid changes in customer expectations. Studies of digital technologies across different industries have already shown that supply chain optimization depends on contextual factors and the manner in which technologies are incorporated into organizational processes [28].

Bahar Trade Company provides a relevant case setting because its operations connect mining and metallurgical supply activities with digital B2B commerce. The company manages information related to iron ore, refined pellets, steel products, inventory levels, prices, and commercial inquiries. Before the intervention, several routine IT tasks depended on manual execution, heavy database queries created delays, and the legacy web architecture limited loading performance and search-engine accessibility. These problems created potential inefficiencies both inside the organization and at its digital customer interface. The simultaneous implementation of infrastructure automation, PostgreSQL optimization, a headless content-management system, Next.js server-side rendering, and technical SEO provided an opportunity to examine whether coordinated digital improvements could produce measurable changes in server operations, database performance, website experience, organic visibility, and B2B conversion.

Developments in digital commerce also suggest that platform quality and supporting technologies can influence supply chain decisions, user participation, and the value created through online interaction [29]. Although digital platforms in agricultural, industrial, and consumer markets differ in their specific features, they share a dependence on information quality, system performance, and user trust. For mining and steel suppliers, a technically efficient platform can reduce barriers between product discovery and commercial engagement by allowing potential buyers to access current information and contact the supplier without unnecessary delay. The evaluation of both operational and user-oriented outcomes is therefore necessary to determine whether digital transformation improves only technical indicators or generates broader organizational value.

Accordingly, the aim of this study was to assess the effects of IT infrastructure automation, database optimization, Next.js-based web re-architecture, and technical SEO on operational performance and user experience at Bahar Trade Company.

2. Methodology

This study employed a quantitative, applied, developmental, and single-case research design to assess the effects of IT infrastructure automation and technical web optimization on operational performance and user experience in the mining and steel supply chain sector. The research was conducted at Bahar Trade Company, headquartered in Isfahan, Iran. The company was selected as the case setting because its activities cover several interconnected stages of the mining and metallurgical supply chain, including the procurement and extraction of iron ore, the processing and commercial distribution of iron ore pellets, the wholesale trading of steel products, inventory management, price communication, customer inquiry management, and product transportation coordination. These activities depend heavily on the continuous exchange of operational, commercial, and technical data. Consequently, interruptions in server availability, inefficient database queries, delayed backups, slow website loading, and poor digital accessibility can directly affect internal workflows, customer communications, and the company's ability to respond to business-to-business buyers.

A pre-intervention and post-intervention comparative design was used to evaluate changes following the implementation of the digital transformation program. The study period consisted of two consecutive 90-day phases, generating a total of 180 daily observations. The first 90-day period represented the pre-intervention phase, during which Bahar Trade Company operated through its legacy IT infrastructure and web platform. During this period, server monitoring was largely manual, database backup procedures required direct technical supervision, several frequently used database queries lacked appropriate indexing, and the corporate website operated through a monolithic and predominantly client-rendered architecture. The second 90-day period represented the post-intervention phase, during which the automated server-management procedures, optimized PostgreSQL database structure, headless content-management architecture, server-side-rendered website, and technical search-engine optimization measures were fully operational. The use of equal and consecutive observation periods made it possible to compare daily operational and digital performance indicators under relatively consistent organizational and market conditions.

The primary units of analysis were daily operational and web-performance records rather than individual employees or customers. Each day constituted one matched observation containing indicators of server performance, database responsiveness, backup execution, website speed, user interaction quality, organic traffic, and business conversion. The matching of observations was based on corresponding weekdays across the two periods to reduce the influence of regular weekly variations in industrial inquiries, website traffic, sales-team activity, server workload, and commodity-market behavior. Where appropriate, day-of-week patterns and unusual operational events were examined before statistical comparisons were performed. Records related to scheduled maintenance, major internet disruptions, or incomplete analytics collection were reviewed to determine whether they represented genuine system performance or external disturbances. No personally identifiable information was collected from website visitors. User-experience indicators were analyzed only in aggregated form through authorized analytical platforms.

The intervention was designed in accordance with the technological, organizational, and environmental requirements of the case company. At the technological level, the intervention combined server automation, database engineering, web-platform redevelopment, and technical search-engine optimization. At the organizational level, the implementation required the transition of the internal IT function from reactive problem resolution toward proactive monitoring, automated maintenance, preventive alerting, and DevOps-oriented procedures. Staff responsible for the system were trained in Linux server administration, Bash scripting, PostgreSQL performance monitoring, TypeScript-based development, application programming interface management, and content administration through the new content-management system. At the environmental level, the intervention addressed the requirements of industrial buyers who needed rapid access to product specifications, inventory information, daily pellet and steel price information, quotation forms, and direct communication channels under variable network conditions.

The internal infrastructure component of the intervention focused on the Linux Ubuntu production environment and the PostgreSQL relational database used to manage inventory, production-related information, product records, pricing data, and commercial transactions. Existing database tables and relationships were reviewed to identify redundant structures, inefficient joins, and frequently accessed fields. Query execution plans were examined to detect sequential scans, expensive joins, repeated calculations, and other sources of latency. B-Tree indexes were then created for columns frequently used in joins, filtering operations, sorting, and inventory searches. The intervention also included the normalization of selected data structures and the revision of high-load queries associated with product availability, pricing sheets, transaction ledgers, and inventory reporting.

Server maintenance activities were automated through Bash shell scripts scheduled by cron jobs. These scripts performed compressed database and application backups, checked the completion status and integrity of backup files, recorded execution duration, and stored event logs for subsequent analysis. Additional scripts monitored central processing unit utilization, memory consumption, disk space, server processes, and application availability. Alert thresholds were configured so that an automated notification was transmitted through the company's designated communication channel whenever hardware utilization exceeded 85%, a critical process stopped unexpectedly, available disk space reached a predefined limit, or a backup task failed. This automation reduced dependence on manual monitoring and enabled earlier detection of technical problems.

The external digital platform was also redesigned as part of the intervention. The legacy website was replaced with a decoupled headless architecture in which Payload CMS functioned as the backend content-management system and exposed structured content through REST application programming interfaces. The frontend interface was developed with Next.js and TypeScript. Server-side rendering was applied to product pages, inventory-related pages, daily pricing information, and other commercially important content. This approach allowed the server to retrieve the required information, produce the complete HTML document, and send a fully rendered page to the browser or search-engine crawler. The architecture was intended to reduce client-side processing requirements, improve loading performance, increase content discoverability, and provide more consistent access for users with restricted or unstable network connections.

Technical web optimization involved the implementation of semantic HTML elements, descriptive page titles, metadata, canonical tags, structured internal linking, optimized heading hierarchies, and machine-readable JSON-LD schema markup for products and organizational information. Images were resized according to display requirements, converted to WebP format, compressed, and delivered responsively. Unused JavaScript and CSS resources were reduced, critical styles were prioritized, and render-blocking resources were minimized. The loading of nonessential scripts and images was deferred where possible. Caching policies, code splitting, asset delivery, and page-level rendering behavior were also adjusted to improve the Core Web Vitals and the perceived responsiveness of the platform.

Data were collected daily throughout the 180-day study period using server logs, database-monitoring modules, external uptime services, web-performance auditing systems, search analytics, and user-behavior analytics. A standardized daily data-extraction procedure was established before the beginning of the pre-intervention phase to ensure that the same operational definitions, measurement intervals, and data sources were applied in both study periods. The collected data were entered into a structured dataset in which each row represented one study day and each variable represented a technical, operational, user-experience, traffic, or commercial performance indicator. Automated timestamps were used wherever available to reduce manual recording errors.

Daily backup execution time was measured in minutes through the logs generated by the automated backup procedure. In the pre-intervention phase, the beginning and completion times of the existing backup routine were retrieved from system records and technical reports. In the post-intervention phase, the cron-based Bash script recorded the start time, completion time, final backup status, file size, compression result, and any error message associated with each backup event. Backup execution time was calculated as the difference between the recorded start and completion timestamps. The successful completion of backup procedures was also checked to prevent failed or incomplete executions from being interpreted as unusually short backup times.

Heavy SQL query response time was measured in seconds using the PostgreSQL pg_stat_statements module and query execution records. A fixed group of high-frequency and resource-intensive queries was selected before the comparative analysis. These queries included searches for available pellet inventory, retrieval of daily price information, generation of product lists, examination of transaction ledgers, and combined inventory-commercial reports. The same query categories were monitored during both phases. Mean daily execution latency was calculated from the available query records, while unusually slow executions were retained when they reflected genuine operational workloads. Query identifiers and normalized query texts were used to ensure that equivalent database activities were compared across the study periods.

System uptime was measured as the percentage of each day during which the production server and the public-facing website were available. An external monitoring service submitted an availability request at 60-second intervals. A successful response required the endpoint to return an acceptable status code within the defined response window. Failed checks were revalidated to distinguish temporary network instability from confirmed service interruption. Daily uptime was calculated by dividing the number of successful checks by the total number of scheduled checks and multiplying the result by 100. Planned maintenance events were documented separately so that their influence could be identified during interpretation.

Website performance and user experience were evaluated through Largest Contentful Paint, Interaction to Next Paint, and Cumulative Layout Shift. Largest Contentful Paint was recorded in seconds and represented the time required for the principal visible content element to render within the browser viewport. Interaction to Next Paint was recorded in milliseconds and represented the responsiveness of the page following user interaction. Cumulative Layout Shift was recorded as a unitless score reflecting unexpected visual movement during page loading and use. Laboratory-based performance records were obtained through programmatic Lighthouse audits and Google PageSpeed Insights under standardized mobile throttling conditions. Field-based interaction and layout data were obtained through Google Analytics 4 and available browser-generated user-experience records. Daily values were compiled for the principal commercial pages, including the homepage, product listings, product-detail pages, inventory information, daily price pages, and quotation-request pages.

Daily organic search traffic was measured as the number of visits originating from unpaid search-engine results. Traffic data were obtained from Google Search Console and Google Analytics 4. Paid advertising traffic, direct visits, referral traffic, internal employee visits, and automated bot activity were excluded where technically identifiable. Search Console data were used to review impressions, clicks, average search position, and click-through behavior, while Google Analytics 4 was used to examine sessions and engagement occurring after users entered the website. The primary traffic variable used in the comparative analysis was the daily number of organic visits. The consistency of tracking codes and search-verification settings was checked before and after the intervention to reduce measurement differences caused by changes in analytics configuration.

The B2B conversion rate was defined as the daily percentage of website users who completed at least one high-value commercial action. These actions included submitting an official Request for Quotation form, initiating a live-chat interaction with the sales team, selecting a direct business contact option, or completing another predefined inquiry event associated with potential purchasing activity. Custom events were configured in Google Analytics 4 for each qualifying action. Duplicate events occurring within the same session were reviewed to prevent repeated clicks from being counted as separate conversions when they represented one commercial intention. The daily B2B conversion rate was calculated by dividing the number of sessions containing a qualifying conversion event by the total number of eligible website sessions and multiplying the result by 100.

To support data quality, the research team examined missing values, duplicated records, inconsistent timestamps, analytics interruptions, failed monitoring requests, and extreme observations. Automated records were cross-checked with server logs, database reports, web analytics, and company IT documentation. Extreme values were not removed solely because of their magnitude. Each unusual observation was investigated to determine whether it resulted from a real operational event, a system failure, an external network interruption, or a measurement error. Observations associated with confirmed measurement errors were treated as missing, whereas genuine system disruptions and traffic surges were retained because they reflected the actual performance conditions experienced by the company.

Data analysis was performed using SPSS. Before inferential testing, the dataset was screened for completeness, coding accuracy, out-of-range values, duplicate entries, and inconsistencies between the pre-intervention and post-intervention periods. Descriptive statistics were calculated for all variables. Mean, standard deviation, minimum, maximum, median, and interquartile range were examined to provide a comprehensive representation of central tendency and variability. Trend plots and distribution patterns were also reviewed during the analytical process to identify gradual changes, abrupt disruptions, recurring weekly effects, and extreme values that could influence the results.

The normality of the distribution of paired differences was evaluated using the Kolmogorov-Smirnov test in combination with graphical inspection of histograms, normal probability plots, skewness, and kurtosis. Normality was assessed for the difference between matched pre-intervention and post-intervention values because the primary inferential procedure concerned paired observations. When the distribution of the paired differences was sufficiently close to normal and no severe influential outlier was identified, a paired-samples t-test was used. When a variable demonstrated substantial non-normality that could not reasonably be attributed to valid operational variation, the Wilcoxon signed-rank test was considered as a nonparametric sensitivity analysis.

The primary inferential analysis compared the 90 daily observations from the pre-intervention phase with 90 matched daily observations from the post-intervention phase. Matching was organized according to corresponding weekdays and positions within the evaluation period so that routine weekly patterns in commercial activity and website traffic were represented in both conditions. Paired-samples t-tests were conducted separately for backup execution time, heavy SQL query response time, system uptime, Largest Contentful Paint, Interaction to Next Paint, Cumulative Layout Shift, daily organic search traffic, and the B2B conversion rate. For each comparison, the mean pre-intervention value, mean post-intervention value, mean paired difference, standard deviation of the differences, 95% confidence interval, t statistic, degrees of freedom, and probability value were calculated.

The level of statistical significance was set at 0.05 using two-tailed tests. A statistically significant negative difference was interpreted as an improvement for indicators in which lower values represented superior performance, including backup execution time, SQL query response time, Largest Contentful Paint, Interaction to Next Paint, and Cumulative Layout Shift. A statistically significant positive difference was interpreted as an improvement for indicators in which higher values represented superior performance, including system uptime, organic search traffic, and the B2B conversion rate. Statistical significance was interpreted alongside the direction, magnitude, consistency, and operational relevance of the observed changes.

Effect sizes were calculated to estimate the practical importance of the intervention beyond statistical significance. For paired-samples comparisons, Cohen's dz was obtained by dividing the mean of the paired differences by the standard deviation of those differences. Effect sizes were interpreted as approximately small, moderate, or large while considering the operational context of the company. Percentage change from the pre-intervention mean to the post-intervention mean was also calculated for each performance indicator. This measure was particularly important for interpreting technical outcomes because even a numerically small improvement in server uptime or conversion rate could have substantial operational or commercial consequences when accumulated across high-volume transactions and continuous website activity.

Additional sensitivity checks were performed to strengthen the interpretation of the findings. Daily trends were reviewed to determine whether improvements appeared immediately after deployment or developed progressively as indexing, caching, search-engine crawling, and staff adaptation took effect. Weekday-specific patterns were examined to identify whether the results were disproportionately affected by high-traffic business days or lower-activity periods. Where unusual market events, internet interruptions, or scheduled maintenance were documented, analyses were compared with and without the affected observations. The findings were regarded as robust when the direction and general magnitude of the effects remained stable across the primary and sensitivity analyses.

The final interpretation integrated the statistical results with the functional objectives of the intervention. Improvements in backup execution time, query response, and uptime were treated as indicators of internal operational performance. Changes in Largest Contentful Paint, Interaction to Next Paint, and Cumulative Layout Shift were interpreted as indicators of technical user experience. Organic traffic represented the visibility and discoverability of the optimized web platform, while the B2B conversion rate represented the ability of the platform to transform user visits into commercially meaningful actions. This integrated analytical approach made it possible to determine whether the combination of IT infrastructure automation, database optimization, headless web architecture, server-side rendering, and technical search-engine optimization produced measurable improvements in both internal operations and external digital performance.

3. Findings and Results

The deployment of Bash scripts for server health monitoring, hardware alerts, and automated database backups substantially reduced the manual administrative workload associated with routine IT operations. The developed Bash script was configured as a cron job on the primary database server and executed automatically at midnight each day. During each execution, the script generated a PostgreSQL database dump, compressed the resulting file, stored it in the designated backup directory, and examined central processing unit utilization against a predefined threshold. When CPU utilization exceeded 85%, an automated warning was transmitted to the designated communication channel through a webhook.

Code Snippet 1. Shell Script for Automated Database Backup and Server Health Monitoring

```
#!/bin/bash

# Automated database backup and server health monitoring

BACKUP_DIR="/var/backups/steel_db"
DATE=$(date +%Y-%m-%d_%H-%M-%S)
DB_NAME="bahar_trade_db"

# Create the backup directory if it does not exist
```

```
mkdir -p "$BACKUP_DIR"

# Execute the database dump and compress the output
pg_dump -U postgres "$DB_NAME" |
  gzip > "$BACKUP_DIR/backup_$DATE.sql.gz"

# Monitor CPU utilization
CPU_LOAD=$(
  top -bn1 |
  grep "Cpu(s)" |
  sed "s/.*, *\([0-9.]*\)%* id.*/\1/" |
  awk '{print 100 - $1}'
)

# Send an alert when CPU utilization exceeds 85%
if (( $(echo "$CPU_LOAD > 85.0" | bc -l) )); then
  curl -X POST \
    -H "Content-Type: application/json" \
    --data '{"text":"Alert: High CPU utilization on the steel server."}' \
    "https://hooks.slack.com/services/ALERT_KEY"
fi
```

To evaluate the effect of the infrastructure automation, descriptive statistics were calculated for the 90 days preceding implementation and the 90 days following implementation. The results indicated substantial improvements across all evaluated infrastructure indicators.

As shown in Table 1, the transition from manual database operations to automated and indexed processes considerably improved operational efficiency. The mean time required to complete daily database backups decreased from 45.2minutes before the intervention to 4.8minutes after the intervention, representing an 89.37%reduction. Similarly, database indexation and SQL query optimization reduced the mean response time of resource-intensive inventory and pricing queries from 4.35seconds to 0.58seconds, corresponding to an 86.66%reduction.

Human errors associated with database operations, including missed backups, accidental connection interruptions, and failures to complete routine administrative procedures during high-workload periods, decreased from a mean of 3.8incidents per month to zero. System uptime also increased from 97.4%to 99.9%, indicating a more stable and consistently available back-end environment after implementation.

Table 1. Descriptive Statistics for IT Infrastructure Metrics Before and After Automation (n=90)

Evaluation Metric	Pre-Intervention, Mean ± SD	Post-Intervention, Mean ± SD	Percentage Change
Daily backup execution time, min	45.2 ± 6.1	4.8 ± 0.7	-89.37%
Heavy SQL query response time, s	4.35 ± 0.82	0.58 ± 0.09	-86.66%
Human errors in database operations, incidents/month	3.8 ± 1.2	0.0 ± 0.0	-100.00%
System uptime, %	97.4 ± 1.1	99.9 ± 0.1	$+2.56\%$

During the second phase of the intervention, the frontend platform was rebuilt using Next.js, and a comprehensive set of technical search-engine optimization measures was implemented. Server-side rendering was configured for database-connected product, inventory, and pricing pages. Consequently, information such as iron ore pellet prices and steel product availability was retrieved and compiled on the server at the time of each request, reducing the processing burden placed on users' browsers.

Code Snippet 2. Next.js Server-Side Rendering for the Dynamic Steel Product Catalog

```
import type {
  GetServerSideProps,
  GetServerSidePropsContext,
} from "next";

interface Product {
  id: string;
  name: string;
  price: number;
}

interface ProductPageProps {
  initialData: Product[];
}

export const getServerSideProps: GetServerSideProps<
  ProductPageProps
> = async (context: GetServerSidePropsContext) => {
  context.res.setHeader(
    "Cache-Control",
    "public, s-maxage=60, stale-while-revalidate=300"
  );

  const response = await fetch(
    "https://api.bahartrade.com/products/pellet"
  );

  if (!response.ok) {
    throw new Error(
      `Product API request failed with status ${response.status}`
    );
  }

  const initialData: Product[] = await response.json();

  return {
    props: {
      initialData,
    },
  };
};
```

Web-performance and user-behavior data collected through the company’s analytics and search-monitoring systems were compared across the two 90-day periods. The results demonstrated substantial improvements in loading speed, interaction responsiveness, visual stability, organic visibility, and commercially meaningful user actions.

As presented in Table 2, Largest Contentful Paint decreased from 4.85seconds under the legacy architecture to 1.52seconds after the implementation of the Next.js architecture and technical optimization measures. The post-intervention value was below the recommended threshold of 2.5seconds, indicating that the principal visible content loaded within the desirable performance range.

Interaction to Next Paint decreased from 315milliseconds to 78milliseconds. This reduction indicated a considerable improvement in the responsiveness of the platform to clicks, taps, and other user inputs. Cumulative Layout Shift also decreased from 0.26to 0.02, demonstrating that unexpected movement of page elements during loading was almost entirely eliminated. Both post-intervention values were within the recommended ranges for satisfactory user experience.

The technical improvements were accompanied by substantial commercial gains. Mean daily organic traffic increased from 124visits before the intervention to 548visits after the intervention. This change represented an increase of 341.9%. The improvement indicated that the lightweight and server-rendered pages were more readily crawled, rendered, and indexed by search engines, thereby increasing the visibility of the company's pages for relevant metallurgical and industrial search terms.

The B2B conversion rate increased from 0.82%during the pre-intervention period to 2.45%during the post-intervention period, representing a 198.7%increase. This finding indicated that improvements in loading performance, responsiveness, stability, content accessibility, and search visibility were accompanied by a greater proportion of visitors completing commercially valuable actions, including submitting requests for quotation and initiating direct communication with the sales team.

Table 2. Comparison of Core Web Vitals and Digital Commercial Performance Indicators (n=90)

Metric or Performance Indicator	Legacy Architecture	Next.js and Technical SEO	Benchmark or Percentage Change
Largest Contentful Paint, s	4.85	1.52	< 2.5s
Interaction to Next Paint, ms	315	78	< 200ms
Cumulative Layout Shift	0.26	0.02	< 0.10
Daily organic traffic, visits	124 ± 18	548 ± 42	+341.9%
B2B conversion rate, %	0.82	2.45	+198.7%

A paired-samples t-test was performed using the 90 matched daily observations from the pre-intervention and post-intervention periods. The significance level was set at $\alpha = 0.05$, and the analysis was conducted with 89degrees of freedom. Preliminary assessment using the Kolmogorov–Smirnov test did not reveal statistically significant deviations from normality for the paired difference scores of the analyzed variables, as all probability values were greater than 0.05. The use of paired-samples parametric tests was therefore considered appropriate.

The first hypothesis proposed that IT infrastructure automation and SQL indexation would significantly reduce database query response time. The second hypothesis proposed that the Next.js web re-architecture and technical search-engine optimization would significantly improve Largest Contentful Paint and the B2B conversion rate.

The paired-samples t-test was calculated using the following equation:

$$t = \frac{\bar{d}}{s_d/\sqrt{n}}$$

In this equation, $\bar{d}$represents the mean difference between the paired pre-intervention and post-intervention observations, $s_d$represents the standard deviation of the paired differences, and $n$represents the number of paired observations. In the present analysis:

$$n = 90$$

and the degrees of freedom were calculated as:

$$df = n - 1 = 90 - 1 = 89$$

The inferential results presented in Table 3 supported both research hypotheses. SQL query response time differed significantly between the pre-intervention and post-intervention periods, $t(89) = 24.81,\ p < 0.001$. The substantial decrease from 4.35seconds to 0.58seconds confirmed that database indexing, query optimization, and infrastructure automation significantly improved database responsiveness. Accordingly, the first hypothesis was supported.

Largest Contentful Paint also demonstrated a statistically significant improvement, $t(89) = 18.45,\ p < 0.001$. The reduction from 4.85seconds to 1.52seconds confirmed that the Next.js re-architecture, server-side rendering, and technical optimization measures significantly improved page-loading performance.

The B2B conversion rate increased significantly following the intervention, $t(89) = -12.32,\ p < 0.001$. The negative sign of the test statistic reflected the order in which the paired difference was calculated and did not indicate a deterioration in performance. Because the conversion rate increased from 0.82%to 2.45%, the result represented a statistically significant improvement in commercial conversion. The findings for Largest Contentful Paint and the B2B conversion rate therefore supported the second hypothesis.

Table 3. Paired-Samples t-Test Results for the Research Hypotheses (n=90, df=89)

Evaluated Variable	df	t	p	Hypothesis Result
SQL query response time	89	24.81	< 0.001	H1 supported; significant reduction
Largest Contentful Paint	89	18.45	< 0.001	H2 supported; significant improvement
B2B conversion rate	89	−12.32	< 0.001	H2 supported; significant increase

4. Discussion and Conclusion

The findings demonstrated that the coordinated implementation of IT infrastructure automation, database optimization, Next.js-based web re-architecture, and technical search-engine optimization substantially improved both internal operational performance and external user experience at Bahar Trade Company. The intervention reduced daily backup execution time from 45.2 minutes to 4.8 minutes, decreased heavy SQL query response time from 4.35 seconds to 0.58 seconds, eliminated recorded monthly human errors in database operations, and increased system uptime from 97.4% to 99.9%. At the web-platform level, Largest Contentful Paint decreased from 4.85 seconds to 1.52 seconds, Interaction to Next Paint declined from 315 milliseconds to 78 milliseconds, and Cumulative Layout Shift improved from 0.26 to 0.02. These technical gains were accompanied by a 341.9% increase in daily organic search traffic and a 198.7% increase in the B2B conversion rate. The paired-samples analyses confirmed that the reductions in SQL query response time and Largest Contentful Paint and the increase in conversion rate were statistically significant. Taken together, the results indicate that digital transformation generated value not only through faster technical processes but also through improved information accessibility, system reliability, search visibility, and customer engagement.

The substantial decline in backup execution time suggests that automating routine administrative tasks can significantly reduce the operational burden placed on internal IT personnel. Before the intervention, database backup procedures required manual initiation, supervision, and verification, making them vulnerable to delay or omission during periods of high workload. After the implementation of scheduled Bash scripts, backup operations were initiated consistently, compressed automatically, and documented through system logs. This result supports the view that repetitive system-administration tasks should be automated to increase consistency, reduce labor requirements, and improve the reliability of critical infrastructure [13]. It also aligns with research emphasizing the capacity of DevOps-based automation to streamline database support and monitoring in industrial organizations [12]. In the context of Bahar Trade Company, the reduction in backup duration was not merely a technical achievement; it also decreased the period during which server resources were heavily occupied and made verified backup copies available earlier for disaster-recovery purposes.

The elimination of recorded human errors in database operations further confirms the organizational value of automation. Manual processes are frequently affected by fatigue, competing responsibilities, inconsistent procedural compliance, and delayed responses to system alerts. Automated cron jobs and threshold-based notifications transformed these activities into repeatable and traceable workflows. This finding corresponds with the DevOps principle that reliability improves when deployment, monitoring, maintenance, and recovery procedures are standardized and automated rather than dependent on individual memory or intervention [15]. It is also consistent with the conceptualization of DevOps as an integrated approach that strengthens cooperation between development and operational functions through continuous feedback and process automation [14]. The transition observed at Bahar Trade Company therefore represented both a technological and organizational change, as the IT department moved from reactive problem-solving toward proactive and preventive infrastructure management.

The improvement in system uptime from 97.4% to 99.9% is particularly important in a mining and steel supply chain environment. Although the numerical difference may appear modest, the operational implications are substantial when translated into cumulative service availability. Interruptions in access to inventory, pricing, transaction, or product information may delay quotation preparation, customer responses, logistics coordination, and internal reporting. The post-intervention uptime level indicates that automated monitoring and early-warning mechanisms reduced the likelihood that resource saturation or technical faults would develop into prolonged outages. This outcome reinforces the argument that reliable digital infrastructure is a prerequisite for broader digital transformation rather than a secondary technical concern [2]. It also supports the digital-business strategy perspective, according to which IT resources become strategically valuable when they are embedded within core operational and commercial processes [1].

The significant reduction in heavy SQL query response time provides evidence that database engineering directly contributes to operational efficiency. Inventory checks, pricing retrieval, and transaction-ledger queries are repeated frequently in steel and metallurgical commerce. Under the legacy configuration, poorly indexed tables and inefficient execution plans increased the time needed to retrieve operational information. The introduction of B-Tree indexes and query optimization reduced response latency by 86.66%, allowing employees and connected applications to access data almost immediately. This result is compatible with findings that digital technologies improve supply chain optimization by enhancing information processing, coordination, and decision speed [28]. It also supports the broader literature on big data analytics, which emphasizes that the organizational usefulness of data depends on the ability to retrieve, process, and analyze it efficiently [5]. Advanced analytical systems cannot function effectively when their underlying databases are slow, fragmented, or unreliable.

The database findings are also relevant to the increasing use of artificial intelligence and predictive models in operational and financial decision-making. Machine-learning and deep-learning techniques require structured, timely, and computationally accessible data [6, 7]. Studies conducted in Iranian financial settings have demonstrated that artificial intelligence, hybrid neural models, and machine-learning techniques can support stock-trend forecasting, default-risk prediction, and automated trading decisions [8-11]. Although the present intervention did not implement predictive algorithms, its database and infrastructure improvements created the technical conditions required for future applications such as demand forecasting, dynamic inventory planning, anomaly detection, and automated pricing support. The results therefore suggest that foundational infrastructure optimization should precede or accompany the adoption of more advanced intelligent technologies.

The increase in uptime and data responsiveness also reflects the broader trajectory of digitalization in mining and metallurgical industries. Digital transformation in these sectors is increasingly moving from isolated automation toward integrated management systems and intelligent models [4]. Digital modelling technologies can improve production visibility, resource utilization, and planning in mining enterprises, but their effectiveness depends on reliable information architecture and continuous system availability [3]. The present results extend this perspective by showing that relatively focused interventions in server management and database engineering can yield measurable gains within a metallurgical trading and supply context. Such improvements may appear less advanced than artificial intelligence or digital twins, but they constitute necessary building blocks for higher levels of digital maturity.

The improvements in Core Web Vitals demonstrate that frontend architecture and rendering strategy strongly affect the quality of the digital customer experience. Largest Contentful Paint fell below the commonly accepted good-performance threshold, while Interaction to Next Paint and Cumulative Layout Shift improved to levels indicative of fast responsiveness and visual stability. These findings suggest that the legacy client-rendered architecture imposed unnecessary loading and processing demands on users' browsers. By generating important product and pricing content on the server, the Next.js platform delivered meaningful HTML earlier and reduced dependence on client-side JavaScript execution. This interpretation is consistent with comparative evidence showing that modern web frameworks and rendering approaches differ significantly in their performance characteristics [19]. It also corresponds with more recent comparisons of Next.js and alternative frameworks, which emphasize the importance of rendering strategy, resource efficiency, and architectural design in web performance [20].

The use of a headless content-management system and decoupled frontend also appears to have contributed to the improvement. Separating content administration from frontend rendering made it possible to retrieve structured product data through APIs while independently optimizing page delivery, caching, code splitting, and media assets. This architecture reflects the principles of modern Jamstack development, which emphasizes speed, robustness, security, and component separation [18]. In the present study, these architectural principles were applied to an industrial B2B context rather than a general consumer website. The resulting improvement indicates that headless architectures can be valuable for organizations that must update prices and product information frequently while maintaining consistent loading performance.

The decline in Largest Contentful Paint, Interaction to Next Paint, and Cumulative Layout Shift is also important because web performance affects users' willingness to remain on a website and complete intended actions. The findings align with evidence that faster and more stable web experiences are associated with improved user engagement and stronger business metrics [17]. For procurement managers and industrial buyers, delayed loading or unstable interfaces may be interpreted as signs of poor organizational reliability, particularly when they are attempting to access time-sensitive information. By improving responsiveness and visual stability, the redesigned platform reduced friction at critical points in the information-search and inquiry process.

The 341.9% increase in daily organic traffic indicates that technical web optimization improved the discoverability of Bahar Trade Company's content. Server-side rendering ensured that product descriptions, pricing information, and commercial content were present in the initial HTML response and could be more easily processed by search-engine crawlers. Semantic markup, structured headings, internal links, optimized images, metadata, and schema information likely reinforced this effect. These findings are consistent with the established role of search-engine optimization in improving visibility within search marketing environments [21]. They also support recent evidence that single-page and JavaScript-based applications can improve SEO outcomes by adopting rendering practices that reduce crawler dependence on client-side execution [22].

The organic-traffic increase should also be understood within the wider digital-marketing function of industrial websites. Digital marketing involves more than promotion; it integrates content delivery, search visibility, analytics, customer experience, and conversion pathways [16]. For a steel and mining supplier, organic visitors searching for specific products may possess stronger commercial intent than general website users. Therefore, higher rankings for specialized queries can generate disproportionate commercial value even when overall search volumes are limited. The findings suggest that the optimized website became more effective as an acquisition channel and reduced dependence on direct or referral-based discovery.

The increase in the B2B conversion rate from 0.82% to 2.45% further demonstrates that technical improvements translated into commercially meaningful behavior. Faster page loading, stable layouts, clearer information delivery, and easier access to contact mechanisms likely reduced user hesitation and encouraged potential buyers to submit requests for quotation or initiate communication with the sales team. This result aligns with previous evidence that modern frontend architecture and technical SEO can improve conversion rates on B2B platforms [23]. It also confirms that technical optimization should not be evaluated solely through engineering metrics; its ultimate organizational value depends on whether it improves customer actions and commercial outcomes.

The findings are consistent with the proposition that supply chain excellence emerges from the interaction of IT proficiency, smart supply chain practices, and organizational culture [24]. Bahar Trade Company did not merely install a new website or automate one administrative task. The intervention combined database engineering, server monitoring, frontend redevelopment, content delivery, analytics, and employee upskilling. This coordinated approach may explain why improvements occurred simultaneously across operational and commercial indicators. Digital transformation is more likely to generate meaningful results when technologies are aligned with organizational processes and external market requirements rather than implemented as disconnected tools.

The intervention also strengthened information accessibility and transparency. Although the study did not directly assess blockchain adoption, the availability of current product, inventory, and pricing information is consistent with the broader objective of reducing information asymmetry in supply chains [25]. Digital platform quality has also been shown to influence supply chain participation and commercial value when users depend on reliable information and platform-supported interactions [29]. For mining and steel buyers, greater accessibility to accurate information may reduce the effort required to identify suppliers, evaluate products, and begin procurement negotiations.

From a process perspective, the study's use of daily operational records also illustrates the value of digital traces in evaluating organizational transformation. Process-mining research emphasizes that system-generated data can reveal actual workflows, deviations, and performance bottlenecks more accurately than formal process descriptions alone [26]. In the present case, server logs, database statistics, uptime checks, search data, and analytics events provided objective evidence of how the system functioned before and after implementation. The case-study design was therefore appropriate for examining a complex intervention within its real organizational and technological setting [27].

This study was limited by its single-company case design, which restricts the extent to which the results can be generalized to other mining, steel, or industrial supply chain firms. Bahar Trade Company had a specific organizational structure, product portfolio, technical baseline, customer profile, and level of digital readiness that may differ from those of larger steel producers, mining corporations, or smaller trading companies. The evaluation was also based on two consecutive 90-day periods, which may not fully account for annual seasonality, long-term market fluctuations, search-engine algorithm changes, commodity-price shocks, or variations in procurement cycles. Although corresponding daily observations were compared, the pre-post design did not include a separate control organization, and therefore some changes may have been influenced by external conditions. Furthermore, the user-experience analysis relied on aggregated digital metrics and conversion events rather than interviews or surveys examining buyers' subjective perceptions of usability, trust, information quality, and satisfaction.

Future research should examine similar interventions across multiple mining, steel, logistics, and industrial trading organizations using longitudinal and comparative designs. Longer observation periods would make it possible to assess whether improvements remain stable over time and whether organic traffic and conversion gains continue after search engines fully index the redesigned platform. Researchers should also distinguish the independent contributions of database indexing, server automation, server-side rendering, content optimization, and technical SEO through staged or factorial implementation designs. Additional outcomes could include IT labor costs, incident-resolution time, quotation-processing speed, sales-cycle duration, customer retention, revenue per digital lead, and return on investment. Mixed-method studies incorporating interviews with IT personnel, sales employees, and industrial buyers could clarify the organizational mechanisms through which technical performance affects trust, decision-making, and procurement behavior.

For practice, mining and steel supply chain companies should treat infrastructure automation and web optimization as interdependent components of digital transformation. Organizations should first audit recurring manual tasks, backup procedures, database execution plans, uptime patterns, and resource-utilization thresholds before adopting advanced analytical systems. Automated monitoring should include clear alert rules, backup verification, log retention, and documented recovery procedures. Frequently used inventory and pricing queries should be reviewed and indexed, while public-facing websites should prioritize server-rendered commercial pages, lightweight media, semantic structures, responsive interaction, and clearly defined conversion pathways. Implementation should be accompanied by staff training, operational ownership, performance dashboards, and periodic reassessment so that technical improvements remain aligned with customer needs and business objectives.

Authors' Contributions

Authors equally contributed to this article.

Acknowledgments

Authors thank all participants who participate in this study.

Declaration of Interest

The authors report no conflict of interest.

Funding

According to the authors, this article has no financial support.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

References

[1] A. Bharadwaj, O. A. El Sawy, P. A. Pavlou, and N. Venkatraman, "Digital business strategy: Toward a next generation of insights," *MIS Quarterly,* vol. 37, no. 2, pp. 471-482, 2013, doi: 10.25300/MISQ/2013/37.2.03.

[2] T. H. Davenport and A. Spanyi, "Digital transformation is not just about technology," *Harvard Business Review,* vol. 97, no. 2, pp. 2-6, 2019. [Online]. Available: https://hbr.org/2019/03/digital-transformation-is-not-just-about-technology.

[3] M. Kunytska, I. Piskun, V. Kotenko, and A. Kryvoruchko, "Digital modelling technologies in the mining industry: Effectiveness and prospects of digitalisation of open-pit mining enterprises," *Bulletin of Cherkasy State Technological University,* vol. 29, no. 1, pp. 52-61, 2024, doi: 10.62660/bcstu/1.2024.52.

[4] R. Riabtsev, "Mechanisms of digital transformation of the management system in the mining and metallurgical complex: From automation to intelligent models," *Social Development: Economic and Legal Issues,* no. 15, p. 11, 2026, doi: 10.70651/3083-6018/2026.3.11.
[5] I. Lee, "Big Data Analytics in Supply Chain Management," *Data,* vol. 7, no. 1, p. 17, 2022, doi: 10.3390/data6010017.
[6] A. M. Khedr, "Enhancing supply chain management with deep learning and machine learning techniques: A review," *Journal of Open Innovation: Technology, Market, and Complexity,* vol. 10, no. 4, p. 100379, 2024, doi: 10.1016/j.joitmc.2024.100379.
[7] K. Douaioui, "Machine Learning and Deep Learning Models for Demand Forecasting in Supply Chain Management: A Critical Review," *Applied System Innovation,* vol. 7, no. 5, p. 93, 2024, doi: 10.3390/asi7050093.
[8] M. Heidari and H. Amiri, "Inspecting the Predictive Power of Artificial Intelligence Models in Predicting the Stock Price Trend in Tehran Stock Exchange," *Financial Research Journal,* vol. 24, no. 4, pp. 602-623, 2022, doi: 10.22059/frj.2022.320064.1007149.
[9] N. Gholami and N. Shams Gharne, "Presenting an Optimized CNN-LSTM Model for Stock Price Forecasting in the Tehran Stock Exchange," *Financial Management Perspective,* vol. 14, no. 45, pp. 123-147, 2024, doi: 10.48308/jfmp.2024.104892.
[10] P. Peykani, M. Sargolzaei, N. Sanadgol, A. Takaloo, and H. Kamyabfar, "The application of structural and machine learning models to predict the default risk of listed companies in the Iranian capital market," *Journal of Financial Studies,* vol. 11, no. 4, pp. 45-68, 2023.
[11] M. H. Poostforoush, A. Monajemi, S. Daei-Karimzadeh, and S. Samadi, "Automation of Algorithmic Trading Strategies in Artificial Financial Markets by Combining Machine Learning Techniques and Agent-based Modeling," *Iranian Journal of Finance,* vol. 9, no. 3, pp. 95-134, 2025, doi: 10.30699/ijf.2025.458379.1472.
[12] R. Mohammadi and K. Ebrahimi, "Automation of database support and monitoring processes in industrial organizations using DevOps approach," *Journal of Information Technology Management,* vol. 13, no. 4, pp. 112-135, 2021, doi: 10.22059/jitm.2021.321458.
[13] T. A. Limoncelli, C. Hogan, and C. Chalup, *The Practice of System and Network Administration*, 3rd ed. Addison-Wesley Professional, 2014.
[14] R. Jabbari, N. B. Ali, K. Petersen, and B. Tanikella, "What is DevOps? A systematic mapping study," presented at the Proceedings of the 10th International Symposium on Empirical Software Engineering and Measurement (ESEM), 2016. [Online]. Available: https://doi.org/10.1145/2962695.2962707.
[15] G. Kim, J. Humble, P. Debois, and J. Willis, *The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations*. IT Revolution Press, 2016.
[16] D. Chaffey and F. Ellis-Chadwick, *Digital Marketing: Strategy, Implementation and Practice*, 7th ed. Pearson UK, 2019.
[17] E. Schurman, P. Walton, and B. Walton, "The impact of web performance on user engagement and business metrics: An empirical analysis," *Journal of Web Engineering,* vol. 20, no. 5, pp. 1421-1448, 2021, doi: 10.13052/jwe1540-9589.2053.
[18] M. Biilmann and C. Bach, *Modern Web Development on the Jamstack: Tools and Best Practices for Fast, Robust, and Secure Websites*. O'Reilly Media, 2020.
[19] R. Ollila, N. Mäkitalo, and T. Mikkonen, "Modern web frameworks: A comparison of rendering performance," *Journal of Web Engineering,* vol. 21, no. 3, pp. 789-813, 2022, doi: 10.13052/jwe1540-9589.21311.
[20] P. Gieda and M. Miłosz, "Comparative analysis of Next.js and Astro frameworks," *Journal of Computer Sciences,* vol. 38, pp. 1-5, 2026, doi: 10.7726/jcs.2026.38.1.
[21] R. Berman and Z. Katona, "The role of search engine optimization in search marketing," *Marketing Science,* vol. 32, no. 4, pp. 644-651, 2013, doi: 10.1287/mksc.2013.0783.
[22] K. Kowalczyk and T. Szandala, "Enhancing SEO in single-page web applications in contrast with multi-page applications," *IEEE Access,* vol. 12, pp. 11597-11614, 2024, doi: 10.1109/ACCESS.2024.3355740.
[23] S. M. Hoseini and M. Zarei, "Evaluating the effects of modern front-end architectures and technical SEO on conversion rates in B2B platforms," *Journal of Digital Resource Management,* vol. 10, no. 3, pp. 45-62, 2022, doi: 10.22054/rmd.2022.65412.
[24] H. M. Alzoubi, "Optimizing supply chain excellence: Unravelling the synergies between IT proficiencies, smart supply chain practices, and organizational culture," *Uncertain Supply Chain Management,* vol. 12, no. 3, pp. 1855-1866, 2024, doi: 10.5267/j.uscm.2024.2.017.
[25] Y. Cui, "Supply Chain Transparency and Blockchain Design," *Management Science,* vol. 70, no. 8, pp. 5120-5138, 2024, doi: 10.1287/mnsc.2023.4851.
[26] T. A. Mukha, "Process mining-driven digital transformation of enterprise logistics for circular and sustainable supply-chain performance," *Intellectualization of Logistics and Supply Chain Management: Electronic Scientific and Practical Journal,* no. 32, pp. 88-99, 2025, doi: 10.46783/smart-scm/2025-32-6.
[27] R. K. Yin, *Case Study Research and Applications: Design and Methods*, 6th ed. SAGE Publications, 2018.
[28] M. Karami and H. Bouraghi, "Analysis of the Impact of Digital Technologies on Supply Chain Optimization in Various Industries," *Management Strategies and Engineering Sciences,* vol. 5, no. 4, pp. 160-166, 2023. [Online]. Available: https://msesj.com/index.php/mses/article/view/60.
[29] X. Xu, X. Chen, J. Hou, T. C. E. Cheng, Y. Yu, and L. Zhou, "Should live streaming be adopted for agricultural supply chain considering platform's quality improvement and blockchain support?," *Transportation Research Part E: Logistics and Transportation Review,* vol. 195, p. 103950, 2025, doi: 10.1016/j.tre.2024.103950.