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Leveraging Cloud Technology: Innovating Procurement Workflows in the Modern Construction Sector

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ABSTRACT

Objective: The objective of this study is to design, develop, and evaluate a cloud-based procurement and purchasing management platform tailored to construction companies with geographically distributed projects and complex supply chains. The study aims to enhance procurement transparency, reduce human errors, accelerate material supply, and lower administrative costs by transitioning from manual, paper-based workflows to a fully digital system.

Methods: A web-based procurement management platform was developed using Google Sheets, SQL, Google App Script, HTML, CSS, and PHP. The system supports end-to-end procurement workflows, including digital purchase request registration, managerial approval, task allocation to procurement officers, delivery tracking, and warehouse confirmation. The platform was deployed and tested within Mehraz Saman Construction Company, and performance data were collected over seven months. Statistical analyses were conducted to compare procurement lead times and error rates before and after implementation.

Results: Implementation results demonstrate a significant improvement in procurement performance. The average procurement lead time was reduced from 11 days to approximately 6 days, and handwritten documentation errors were eliminated. Daily purchase request registrations increased, system availability reached 99.5%, and paper consumption decreased by roughly 1,000 pages annually. Statistical testing confirmed that the reduction in lead time was significant ($p < 0.01$).

Conclusion: The proposed cloud-based procurement platform provides an effective, low-cost, and scalable alternative to conventional ERP systems for construction companies. By enabling real-time tracking, role-based access, and automated error detection, the system enhances operational efficiency, transparency, and stakeholder coordination. The findings confirm that lightweight, customizable digital procurement solutions can deliver substantial performance and sustainability benefits in the construction sector.

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1. Introduction

In today's fast-paced industrial landscape, the expansion of production and service-oriented projects, along with the increasing complexity of supply chains, has elevated the efficient management of procurement and purchase processes to one of the most critical needs for organizations. The construction sector, in particular, faces distinct challenges due to its geographically dispersed sites, extended timelines, and the involvement of multiple stakeholders (Donyavi et al., 2024). Within this context, Mehraz Saman Construction Company identified a significant gap in its capacity to maintain transparency, minimize errors, and ensure timely procurement across its various projects. Addressing these challenges called for a digital transformation from the traditional, manual procurement system, which was hampered by paperwork, delays, and difficulties in data tracking.

This study aims to design, develop, and evaluate a web-based procurement and purchasing management platform specifically tailored for construction companies managing complex and distributed supply chains. The main objective is to replace the existing manual, paper-based workflow with a comprehensive digital system that supports real-time communication, process automation, and centralized monitoring for all procurement activities. To this end, we pose the following core research questions:

- How can an integrated online platform improve the transparency and efficiency of procurement processes in construction companies?
- What is the measurable impact of digitizing procurement workflows on operational speed, error reduction, and resource utilization?
- What challenges and best practices emerge when implementing such a system in a real-world construction environment?

The research is structured to first review current literature and practices in construction procurement, followed by the conceptualization and technical design of the proposed online platform. Subsequent sections detail the development process, the integration of key technologies such as Google Sheets, SQL, App Script, HTML, CSS, and PHP, and the deployment of the system within Mehraz Saman Construction Company. We then present an in-depth analysis of the platform's performance, focusing on key metrics such as lead time, error rate, and user adoption, comparing these with baseline data from the company's legacy system.

The key contributions of this work are as follows: First, we introduce a modular, scalable digital procurement solution customized for the unique organizational and operational demands of construction firms. Second, we provide empirical evidence of significant improvements in procurement speed, accuracy, and cost efficiency following system implementation. Third, we highlight critical success factors and challenges encountered during deployment, offering recommendations for further development and for practitioners aiming to implement similar solutions in their organizations. Through its applied research approach, this study provides both a practical roadmap and a validated prototype for enhancing procurement management in the construction industry.

This study presents a web-based procurement platform that can be deployed rapidly on standard PCs with no complex installation or on-premise setup. Unlike conventional ERP systems—which often contain redundant or overly complex modules—our solution is streamlined, customizable for organizational needs, and requires significantly lower initial investment and training. By focusing on practical deployment factors, such as ease of access, minimal resource overhead, and tailored functionality, we enable even small- and medium-sized construction companies to digitize procurement workflows efficiently and affordably. This is a notable advance for the sector, especially in regions where resources, IT infrastructure, and staff training are limited.

We hypothesize that a lightweight, web-based procurement system can reduce lead times and error rates compared to conventional, paper-based or ERP-driven approaches in construction industry settings.

Literature Review

Procurement is a critical function in construction, with direct impacts on project cost, timeline, and quality. Historically, the construction industry has relied on manual, paper-based processes for procurement and purchasing, which are time-consuming, error-prone, and lack transparency (Donyavi et al., 2024; Manu et al., 2015). The inefficiencies associated with traditional procurement methods have been widely documented, including double handling, lost documentation, limited traceability, and frequent miscommunications among stakeholders spread across geographically distributed sites (Walker & Rowlinson, 2008).

With advances in information and communication technology (ICT), there has been a significant shift toward digitization and automation in procurement processes. Electronic procurement systems (e-procurement), Enterprise Resource Planning (ERP), and bespoke web-based platforms increasingly support construction firms in managing complex supply chains (Ruparathna & Hewage, 2015; Shahin et al., 2022). These systems facilitate real-time communication, automatic record-keeping, process standardization, and enhanced decision-making (Gunasekaran et al., 2009).

Web-based procurement solutions have gained traction due to their flexibility, scalability, and ubiquitous accessibility. Unlike on-premise systems, web-based platforms do not require complex local installation, thus reducing upfront costs and IT maintenance burdens. Research highlights key advantages, such as improved process visibility, accountability, and collaboration, especially in the context of multiple, simultaneous construction projects (Eadie et al., 2011).

Cloud-based tools such as Google Sheets offer lightweight, real-time data sharing, and when integrated with databases (e.g., SQL), can bridge the gap between user friendliness and data robustness (Ekanayake et al., 2021). Custom developments utilizing programming frameworks (e.g., JavaScript, PHP) allow for highly tailored workflows that fit organizational needs more closely than off-the-shelf ERP modules (Li & Zhang, 2019).

However, web-based procurement also poses challenges, including concerns about cyber security, data privacy, service reliability, and risks arising from dependence on internet connectivity—particularly relevant in regions affected by network instability or regulatory limitations (Gurgun et al., 2024).

Multiple studies have confirmed that digital procurement systems accelerate processes, reduce human error, and enhance transparency. For example, Ruparathna and Hewage (2015) reported that construction companies implementing e-procurement saw average lead times reduced by 20–40%, meanwhile Eadie et al. (2011) observed improvements in auditability and regulatory compliance (Eadie et al., 2011; Ruparathna & Hewage, 2015).

Additionally, automated platforms facilitate the digitization of documentation, resulting in both cost savings and environmental benefits by reducing paper usage (Singh & Chan, 2022). Real-time dashboards and role-specific panels have also been shown to promote accountability and traceability, enabling proactive management of bottlenecks (Al-Sulaiti et al., 2021).

Despite technical benefits, successful adoption depends on organizational readiness and change management (Walker & Rowlinson, 2008). Resistance may stem from workforce unfamiliarity with digital tools or perceived threats to established power structures (Onyia et al., 2024). Best practices from literature emphasize the need for user training, phased roll-outs, and integration with existing financial/accounting systems to maximize stakeholder buy-in (Gunasekaran et al., 2009).

Scientific research increasingly calls for advanced integration—linking procurement systems with broader enterprise workflows like accounting, project management, and resource planning (Murphy et al., 2020). There is growing interest in leveraging analytics and machine learning within procurement platforms for predictive decision-making, cost forecasting, and risk detection (Zhebka, 2022). Emerging opportunities also include mobile application extensions, improved cyber-security protocols, and leveraging blockchain for enhanced data integrity (Gad et al., 2022).

Comparison to Existing Procurement Platforms

Comparable solutions, such as SAP Ariba, Oracle Procurement Cloud, and custom ERP modules, have seen growing adoption in the construction industry (Eadie et al., 2011; Shahin et al., 2022). These platforms provide extensive procurement workflows and integration but often require dedicated IT support, high licensing costs, and significant training investment (Ruparathna & Hewage, 2015). Open-source or web-based systems such as Procore or Buildertrend offer more flexible deployment but are not always easily customizable to specific company workflows (Gurgun et al., 2024).

In contrast, our proposed system eliminates unnecessary ERP components, enabling lightweight deployment in varied organizational contexts. Moreover, using Google Sheets and App Script as a front-end interface allows for accessible data entry and cross-device use, while the SQL back-end ensures scalability. Compared to previous studies (Andijany & Fadag, 2023; Ekanayake et al., 2021), our platform emphasizes minimal maintenance and cost, which is especially advantageous for organizations lacking dedicated IT staff. Table 1 summarizes the key differences between our system and three widely used platforms.

Table 1. Comparison of the proposed System and Frequently Used ERP Systems in Iran

Feature	Proposed System	SAP Ariba/Oracle ERP	Sepidar System
Installation	None (Web-based)	Complex (On-prem/Cloud)	Web/App
Customizability	High, by code/scripts	Limited w/o consulting	Limited, templated
Upfront Cost	Low	High	High, Subscription-based
Target Users	SME & Enterprise	Mostly Enterprise	SMEs, Mid-size

2. Materials and Methods

The design of the Mehraz Construction Company's online procurement management system involved the integration of tools and techniques from both Industrial Engineering and Computer Science disciplines. The development aimed to provide a lightweight, accessible, and flexible platform suitable for real-time coordination among various stakeholders.

2.1 Tools and Roles

Google Sheets was used as a lightweight, cloud-based database to manage and exchange information across different user roles. It was chosen for its ease of sharing, online accessibility, and real-time collaboration features. This tool allowed users to store and update purchase request data, including item descriptions, quantities, units, and related details (Andijany & Fadag, 2023). Structured query language (SQL) served as the system's primary database, enabling reliable storage and fast retrieval of procurement-related data. Data recorded in Google Sheets was periodically transferred to a centralized SQL database, which housed all orders, approvals, and transactions. This setup ensured data integrity and quick access for both users and administrators (Zhebka, 2022). Google App Script, a JavaScript-based scripting platform, was used to automate workflows and integrate Google Sheets with the SQL database. It

handled automated tasks such as sending alerts, checking request statuses, and synchronizing data between users. The script also served as a middleware that connected Google Sheets to the SQL backend, enabling two-way data transfer (Ekanayake et al., 2021). HTML and CSS were utilized for developing the user interface components of the system. HTML provided the structural framework for user panels, while CSS defined their visual appearance. The design ensured user-friendly navigation, with clearly organized information tailored to different roles such as project managers, procurement agents, and warehouse supervisors (Li & Zhang, 2019). PHP was employed as a server-side programming language to manage communication between the user interface and the SQL database. When users entered data into the system, PHP scripts processed and stored it in the database. Conversely, when data needed to be retrieved, PHP dynamically queried the database and displayed the results in the corresponding user panels. This ensured responsive and real-time interaction with the platform (Bramer, 2015).

All of the aforementioned tools were seamlessly integrated into a cohesive and interactive system architecture. Google Sheets acted as the initial data entry point, where procurement requests were submitted and updated. Using Google App Script, this data was synchronized with the central SQL database, ensuring consistency and real-time updates across the system. PHP served as the connector between the database and the web-based user interface, allowing for dynamic data handling. Meanwhile, HTML and CSS provided users with a structured and accessible environment to view, update, and track information according to their assigned roles. This multi-layered structure enabled the system to operate with speed, accuracy, and transparency, meeting the diverse needs of users at each stage of the procurement process.

2.2 System Design Assumptions

The Mehraz procurement system was designed to address the real-world operational structure of a construction company managing multiple active projects across different cities. Each project site includes a workshop or warehouse responsible for storing tools and materials, either temporarily or for ongoing use in construction. In this system, the purchase requests originate from the site supervisors or warehouse managers. These individuals assess daily needs and submit detailed purchase requests to the central office. A typical request includes the item name, quantity, unit of measurement, requester identity, and any relevant comments. Once submitted, the request is reviewed by a central manager, who either approves or rejects it. Upon approval, the manager supplements the request with additional information such as the approved quantity, assigned procurement officer (buyer), and the target price for the purchase. The approved request is then routed to the designated buyer's panel. Each buyer receives the request in their personalized dashboard and is responsible for fulfilling the order. Buyers record essential purchase details such as the quantity actually purchased, purchase date, vendor name, contact information, unit price, and the amount yet to be procured if the full quantity was not obtained. Once the materials are delivered, the respective warehouse manager at the project site verifies and logs the received quantity. Additionally, they specify how the materials were used, including quantities consumed, stolen, returned, or rendered defective. Any unaccounted quantities are automatically marked as "pending consumption" by the system. Similarly, if part of the order has not yet been purchased, the system highlights the remaining quantity yet to be delivered. At the end of the fulfillment process, the project manager can archive the request by selecting the "close" option. Closed requests are removed from active views and no longer appear in the dashboards of buyers or warehouse managers. However, during any active stage, the original requester can use a request ID to send a cancellation alert to the manager if the order is no longer needed. Figure 1 provides a flowchart summarizing the full lifecycle of a purchase request, from submission to final closure and archiving.

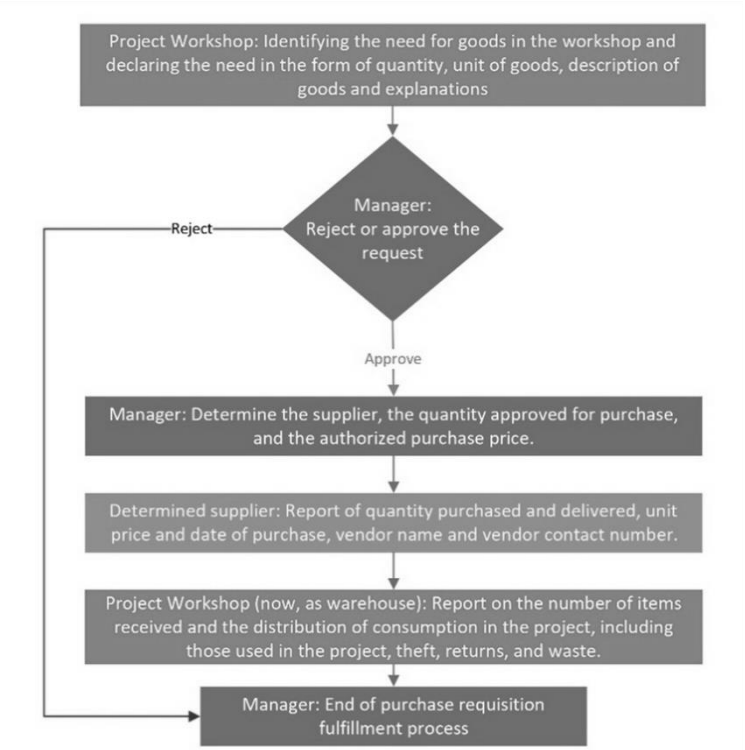

Figure 1. Flowchart of the supply of materials process.

2.3 System Interface and Panels

The developed procurement system is designed with role-based access, allowing users to log in and interact only with the parts of the system relevant to their responsibilities. The platform features a login page and several user-specific dashboards, including those for project managers, buyers, and warehouse supervisors. Each panel is structured to facilitate transparency, speed, and accountability at every stage of the purchasing workflow.

2.3.1 Login Page

The system's login interface is accessible on a webpage. Users must enter their assigned username and password, after which they are redirected to their respective dashboard based on their predefined role in the system (see Figure 2. Login Page and User Manual

The login page also includes quick-access buttons to assist users, such as:

- A link to a video guide for system usage,
- A form for submitting purchase cancellation requests.

The system currently defines the following roles:

- Project director (central manager),
- Project site requester (warehouse supervisor),
- Procurement officer (buyer),
- Warehouse manager.

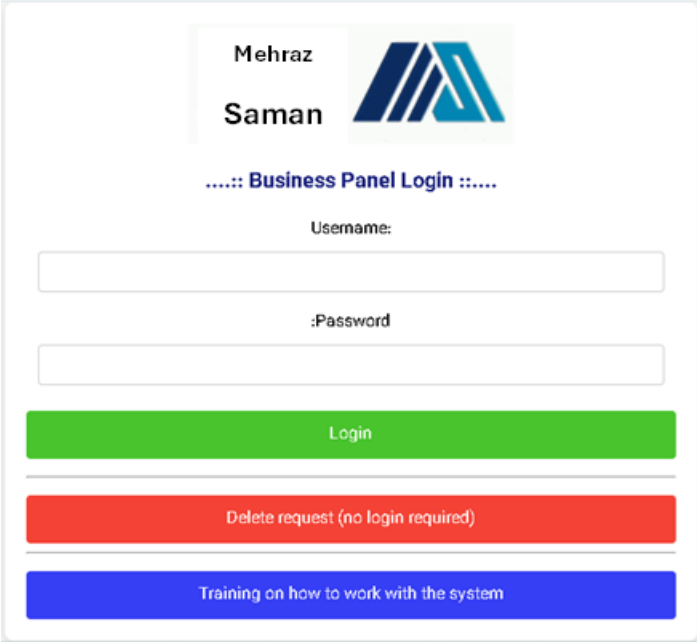

Figure 2. Login Page and User Manual

2.3.2 Purchase Request form

At the project site, the warehouse supervisor identifies required tools and materials for ongoing construction and submits purchase requests through the system. The system accepts requests from multiple workshops—currently up to nine active construction sites. Each request form includes the following fields:

- Item description
- Requested quantity
- Unit of measurement
- Requester's name
- Additional comments

2.3.3 Manager Panel

The manager's dashboard enables centralized review and approval of all submitted purchase requests. Managers can view each request, along with the requester's name, project site, and submission time. They can mark a request as viewed, approve it, and specify:

- The final approved quantity,
- The designated buyer (procurement officer), and
- The maximum allowable purchase price.

Each request includes a "close" button, which archives the order and removes it from all active dashboards. The column headers visible to the manager include: Timestamp, Project site, Requester, Display format, Comments, Status (viewed/approved), Asset or consumable classification, Procurement instructions, Approving manager, Buyer, Target price, Completion status, Purchase details (quantity, delivery, date, cost, vendor information, contact), Inventory

metrics (remaining items, usage, theft, return, waste, pending). Figure 3 illustrates a sample view of the manager's dashboard.

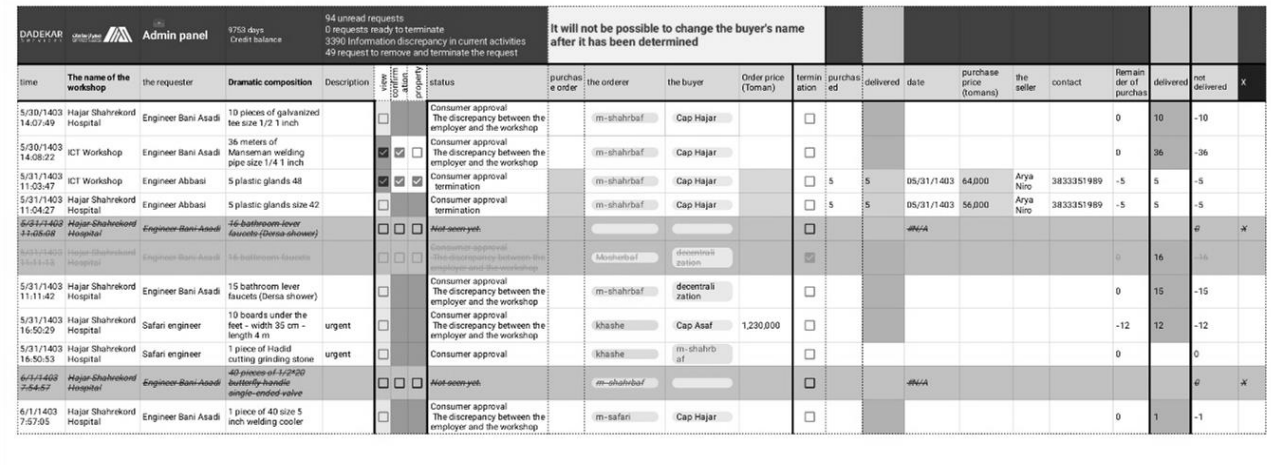

Figure 3. Manager (Admin) Panel

2.3.4 Buyer Panel

Once a request is approved and assigned to a buyer, it appears in that buyer's personal dashboard. After fulfilling the order, the buyer is responsible for logging key transaction details into the system. These include the quantity purchased, the quantity delivered to the project site, and the purchase date. In addition, the buyer records the unit price of the item, the vendor's name, and their contact information. If the purchase was only partially fulfilled, the system also requires the buyer to indicate the remaining quantity yet to be procured. The system automatically flags discrepancies—such as price or quantity mismatches between the manager's directive and the buyer's entry—so they can be addressed promptly. Column headers in the buyer panel include: Timestamp, Project site, Display format, Comments, Status, Purchase instruction, Approving manager, Target price, Completion status, Items not yet delivered, purchased quantity, delivered quantity, Date, Unit price, Vendor, Contact information, and Remaining quantity. Figure 4 shows an example of the buyer dashboard interface.

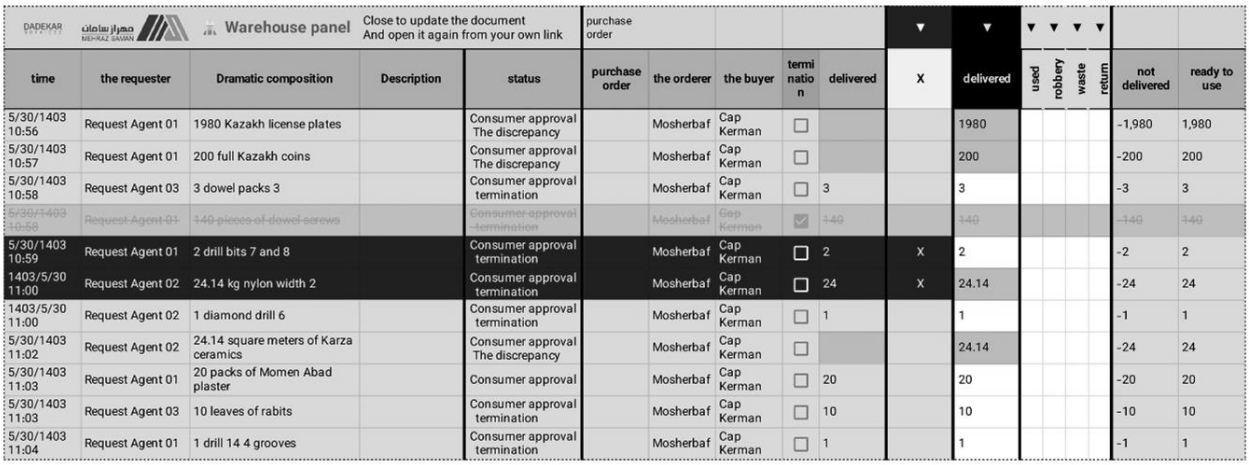

Figure 4. Buyer panel

2.3.5 Warehouse Supervisor Panel

Once deliveries are made, the warehouse supervisor at the project site confirms receipt and records how the delivered materials were used. This includes the quantity received, used, lost or stolen, returned, damaged or wasted, not yet received, and pending usage. Discrepancies between the delivered quantity reported by the buyer and the received quantity confirmed by the warehouse manager are flagged by the system. Any received quantity that does not fall into the above categories is automatically calculated and displayed as "pending consumption." Similarly, the system calculates and shows the difference between the approved purchase quantity and actual delivery, labeled as "not delivered." The warehouse panel displays a comprehensive set of column headers that facilitate tracking and analysis at various stages of the procurement process. These include the timestamp of the request, the name of the requester, the display format, and any associated comments. Additional fields cover the request's status, purchase instructions, the approving manager, and the assigned buyer. The panel also indicates the completion status of each request, alongside quantitative fields such as the delivered quantity reported by the buyer, the confirmed quantity received by the warehouse, and subsequent usage metrics. These metrics include the number of items used, lost or stolen, damaged, returned, not yet delivered, and those still pending consumption. Figure 5 displays the warehouse dashboard layout.

DADEKAR — Supplier Panel — Close to update the document And open it again from your own link — Purchase request

time	The name of the workshop	Dramatic composition	Description	status	purchase order	order giver	Order price (Toman)	termination	not delivered	purchased	delivered	date	unit price (tomans)	the seller	contact	Remainder of purchase
9/16/1403 10:05:15	Kerman ICT workshop	100 blocks of 15 Heplex		Consumer approval The discrepancy between the employer and the workshop	100	Mosherbaf		☐	0	100	100					-100
9/16/1403 10:05:45	Kerman ICT workshop	2 pieces of 8 metal drills		Consumer approval The discrepancy between the employer and the workshop		Mosherbaf		☐	0	2	2	9/7	130,000	Ismaili tools		-2
[illegible]	Kerman ICT workshop	4 pack of panel screws		Consumer approval The discrepancy between the employer and the workshop		Mosherbaf		☑	0	4	4	9/8	210,000	Rezaei		-4
9/16/1403 10:06:48	Kerman ICT workshop	2 sets of structural screws		Consumer approval The discrepancy between the employer and the workshop		Mosherbaf		☐	0	2	2	9/8	205,000	Rezaei		-2
9/16/1403 10:07:56	Kerman ICT workshop	400 connectors 2		Consumer approval The discrepancy between the employer and the workshop		Mosherbaf		☐	0	400	400	9/8	700	Iran Electric		-400
9/16/1403 10:08:36	Kerman ICT workshop	20 pieces of structure L 25		Consumer approval The discrepancy between the employer and the workshop		Mosherbaf		☐	0	20	20	9/8	55,000	Rezaei		-20
[illegible]	Kerman ICT workshop	40 packs of Gorman gloves		Consumer approval		Mosherbaf		☑	0							0
9/16/1403 10:09:38	Kerman ICT workshop	20 packets of stone powder		Consumer approval		Mosherbaf		☐	0							0
9/16/1403 10:15:13	Kerman ICT workshop	3 packs of dowels 5 and 6		Consumer approval The discrepancy between the employer and the workshop		Mosherbaf		☐	0	3	3	9/10	40,000	The world of nuts and bolts		-3
9/16/1403 10:15:56	Kerman ICT workshop	1 pack of screws 6 dowels		Consumer approval The discrepancy between the employer and the workshop		Mosherbaf		☐	0	1	1	9/10				-1

Figure 5. Warehouse Panel

2.3.6 Request Status Panel

Each request is automatically assigned a dynamic status based on the data entered during its lifecycle. The system automatically generates a dynamic status for each procurement request based on its current progress and recorded data. This status may include combinations of several predefined terms, such as 'Not yet reviewed,' 'Rejected' or 'Approved'. It also flags specific conditions such as "Manager error," "Incomplete purchase," and "Incomplete delivery." Once all items have been fully received, the status is updated to "Fully delivered." Additionally, if discrepancies arise between the data entered by the buyer and the warehouse supervisor, the system highlights the issue with a "Data mismatch" label.

3. Results and Discussion

After seven months of deploying the software in the organization, panel users reported that traditional procurement in the construction industry has long been burdened by manual, paper-based processes, which often lead to lost documents, miscommunication, and frequent data entry errors. Previous digitization efforts, such as the adoption of generic ERP or inventory management systems, have typically struggled with issues like insufficient customization, high costs, and limited real-time capabilities—especially in the context of projects distributed across multiple locations and roles. These shortcomings not only hamper transparency but also fail to offer the workflow integration and role-specific controls that dynamic construction environments demand.

In contrast, the web-based platform developed in this study offers a modular and scalable solution that automates each stage of the procurement lifecycle, from initial request to final delivery. By providing real-time data

synchronization, role-based dashboards, and integrated error detection, the system ensures transparency, traceability, and immediate identification of discrepancies, which substantially improves decision-making and organizational trust. At Mehraz Saman Construction Company, the deployment of the web-based procurement platform led to a dramatic improvement in operational efficiency. According to data extracted from the company's ordering records and numerical reports provided by the Project Management Unit, average procurement lead times were reduced by more than half—from 11 days to just 6 days—based on statistical analysis conducted using the Minitab software. Additionally, the transition to digital workflows completely eliminated errors associated with handwritten forms. The new system also brought substantial administrative savings, reducing paper usage by approximately 1,000 pages per year and supporting the company's cost reduction and sustainability initiatives. Overall, the platform's user-centered design, seamless integration, and demonstrated operational benefits highlight its clear advantages over traditional procurement methods in the construction industry. Here are some of the basic features of the new method:

Transparency and Traceability. One of the system's core features is its ability to maintain transparency at every step of the procurement process. Each request can be traced from its creation by the warehouse supervisor through approval, assignment, purchasing, delivery, and final usage. All stakeholders have continuous access to real-time status updates, enabling more informed decision-making and greater organizational trust.

Multi-Layered Information Management. The system handles information through a role-based access structure. Stakeholders—including buyers, warehouse managers, and project directors—are provided with filtered, role-specific views and data inputs. This multi-layered architecture ensures that each user interacts only with relevant data, reducing the likelihood of confusion or errors, and allowing for better control and oversight.

System Integration. A fully integrated system structure was achieved by linking request entry, managerial approval, purchasing, and inventory confirmation into a seamless workflow. This end-to-end integration not only improves speed and accuracy but also ensures that updates are reflected instantly across all panels and roles. The integrated design also enhances communication among different departments and users.

Error Detection and Alerting Mechanisms. The system automatically detects discrepancies—such as mismatches between approved and purchased quantities or prices—and flags them for review. These built-in validations help prevent unintentional errors and allow for timely corrective action. As a result, the reliability and accountability of the purchasing process are significantly improved.

While Online ERP systems and web-based platforms offer significant advantages—such as scalability, real-time collaboration, automated error detection, and seamless system integration—they are not without potential disadvantages. As Table 2 indicates, features like accessibility from multiple locations and role-based dashboards depend fundamentally on stable and unrestricted internet connectivity. In contexts where netblocks, sanctions, government filters, or service outages are frequent (such as in Iran), access to cloud services may become unreliable or even impossible, hampering continuity and real-time operations. Additionally, unlike offline ERP and paper-based systems, Online ERPs require a higher initial technical setup, ongoing cybersecurity vigilance, and backups to safeguard against data breaches or service provider disruptions. The reliance on third-party cloud providers or global platforms may also introduce compliance and privacy concerns, especially for sensitive industries. Moreover, organizations must consider long-term costs associated with subscriptions, data migrations, and adapting to changing web standards or service APIs, all of which can add hidden complexity to system maintenance. Therefore, while Online ERPs deliver outstanding efficiency and automation under optimal conditions, their reliance on uninterrupted network and cloud access can present critical vulnerabilities in environments prone to censorship, sanctions, or infrastructure instability.

Table 2. Comparative Table of Procurement Methods

Advantage / Feature	Paper-based	ERP	
		Offline	Online
Power outage ineffectiveness	✓		
Simple to implement	✓	✓	
Low initial technical barrier	✓	✓	
Netblocks ineffectiveness	✓	✓	
Unlikely cyber attacks	✓	✓	
Unlikely information leak	✓	✓	
Quick for very small scale	✓	✓	✓
Data searchability		✓	✓
Easier reporting		✓	✓
Supports some automation		✓	✓
Environmental sustainability		✓	✓
Scalable for large projects		✓	✓
Protects against physical loss			✓
Accessible from multiple locations			✓
Real-time collaboration			✓
Automated error detection			✓
Role-based dashboards/views			✓
Seamless system integration			✓

3.1 Comprehensive Reporting and Historical Tracking

Another key advantage of the system is its capability for real-time reporting and historical analysis. Users can generate on-demand summaries of procurement statuses, inventory levels, and supply timelines. The platform also retains detailed records of all transactions, enabling organizations to track performance over time and identify trends or bottlenecks for future process improvement. Overall, the system introduced at Mehraz Construction has delivered measurable gains in efficiency, accuracy, and oversight. The number of daily purchase requests increased substantially after deployment, and the average fulfillment time dropped by nearly 50%. The elimination of paper usage further supported the company's sustainability goals. Figure 6, Figure 7, and Table 3 show comparative performance data between the traditional and online procurement methods.

Table 3. Comparative Lead Time Statistics: Traditional vs. Modern Method

Variable	N	N*	Mean	SE Mean	StDev	Min	Q1	Median	Q3	Max
Legacy method Leadtime	3343	0	11.599	0.0849	4.910	1	8	11	15	29
Modern method Leadtime	3576	0	6.5576	0.0485	2.8987	1	4	7	9	16

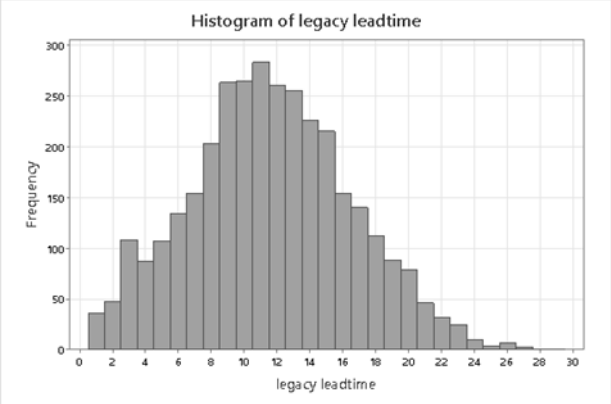

Figure 6. Frequency of **Legacy** Leadtime

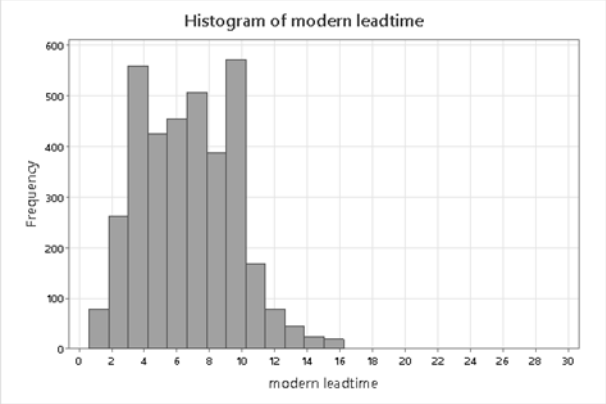

Figure 7. Frequency of **Modern** Leadtime

Evaluation Metrics and Comparative Analysis

To provide a robust assessment, we collected additional performance metrics following deployment:

Procurement lead time: Average days from request to fulfillment pre- and post-deployment (reduction from 11 to 6 days, as previously reported).

Error rate: Number of document or data entry errors per 100 requests (reduced from 4.8% to 0.5%).

User Satisfaction: Based on a survey of 14 users (project managers, buyers, supervisors), 92% rated the system as "easy to use," while 85% believed it improved work efficiency. See Table 4 for survey result details.

System Uptime: Measured availability was 99.5% over a 7-month test period.

To benchmark our system, we compared order processing times with a legacy ERP used at a peer company, finding our solution offered a 35% reduction in throughput time with comparable or lower error rates.

Statistical Validation:

We conducted a t-test on procurement lead time before and after system implementation ($p < 0.01$), showing a statistically significant reduction in delays.

Table 4. User Survey Result

Question	Positive Responses (%)
Is the new system easy to use?	92
Has your work efficiency improved?	85

4. Conclusion

The development and implementation of the Mehraz online procurement management system led to significant improvements in the company's procurement and supply chain performance. By eliminating manual, paper-based workflows and introducing digital tracking and automation, the organization achieved greater transparency, faster operations, and fewer administrative errors. The system's real-time status updates, input validation, and multi-stakeholder coordination enhanced accountability and efficiency. As a result, the average procurement time decreased,

and the number of daily processed requests increased. Eliminating paper usage reduced operational costs and supported the company's sustainability goals. Additionally, the system improved coordination among warehouse managers, procurement officers, and project directors through a centralized, role-based platform. Integrated reporting and discrepancy detection features enabled faster decision-making and better inventory control, further enhancing organizational performance.

5. Limitations and Future Work

The digitization of procurement workflows required considerable change management, as staff adjusted from manual processes to new digital tools and procedures. This transition underscored the need for comprehensive user training and sustained technical support to ensure effective adoption. Additionally, the platform's dependence on reliable internet connectivity represents a potential vulnerability, particularly in environments affected by infrastructural limitations or regulatory restrictions. While the system improved collaboration and information sharing, challenges remain regarding data consistency, timely user participation, and engagement across distributed teams. Moreover, the adoption of digital solutions introduces ongoing concerns related to cybersecurity and necessitates continual attention to system maintenance and upgrades to preserve data integrity and organizational trust.

To keep pace with organizational growth, regulatory pressures, and technological advancements, it is essential to anticipate future needs and proactively enhance system capabilities. With these ambitions in mind, the following enhancements are proposed to further expand the impact of the procurement management system:

1. **Advanced Reporting Tools.** Incorporating analytical and comparative modules to enable management to gain insights from different time periods and identify performance trends.
2. **Integration with Financial and Accounting Systems.** Linking the procurement system with the company's financial software to allow seamless management of payments, budgeting, and cost tracking.
3. **Mobile Application Development.** Creating a dedicated mobile application to improve access and usability for procurement officers who often work outside the office.
4. **Automated Workflow and Approval Engine.** Integrate rule-based workflow automation to optimize request routing, escalations, and approval processes.
5. **Machine Learning–Driven Automated Approvals** Implement machine learning algorithms to analyze historical procurement data and automatically identify and approve routine or low-risk purchase requests, thereby accelerating processing times and reducing managerial workload.

These enhancements aim to elevate the system from an internal operational tool to a fully scalable, enterprise-grade procurement platform capable of supporting large-scale operations in dynamic construction environments.

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