Pharmacists' Perspective on the Use of AI Technology to Manage Workflow Disruptions in Community Pharmacies

Abstract

Background: Community pharmacies face increasing workflow complexity, with frequent disruptions and inefficiencies that can affect operational performance and patient safety. Artificial intelligence (AI) can be proposed as a potential decision-support tool to help manage workflow disruptions, yet pharmacist perspectives on the usefulness of AI-based workflow management tools remain underexplored.

Objectives: To identify workflow disruptions in community pharmacies and assess pharmacists' preferences, concerns, and expectations regarding AI-based real-time anomaly detection systems.

Methods: (A cross-sectional survey) multi-method study was conducted among 83 licensed pharmacists practicing in community pharmacy settings. The survey assessed workflow efficiency, sources of operational disruption, perceived usefulness of AI features, implementation concerns, and explainability preferences. Descriptive statistics and ranking analyses were used to summarize responses.

Methods: This multi-method, cross-sectional study combined a structured quantitative survey with qualitative focus group discussions to examine workflow efficiency, operational disruptions, job stress, and perceptions of AI-based workflow management tools. Survey data were analyzed using descriptive statistics, ranking analyses, Spearman correlations, and Welch t-tests to examine relationships among workflow conditions, stress, and perceived AI usefulness. Focus group discussions were analyzed thematically to contextualize survey findings and provide deeper insight into workflow bottlenecks, staffing challenges, interruptions, insurance burden, and expectations for AI-supported workflow management. Together, the quantitative and qualitative findings were used to triangulate results and identify how structural workflow strain shapes pharmacists' acceptance of AI-based support tools.

Results: Nearly half of the respondents rated their current workflows as inefficient. Insurance processing delays and prescription verification were the most frequently reported bottlenecks. Pharmacists expressed strong interest in AI features for workload balancing (63%), workflow optimization recommendations (58%), and early error detection (57%). Integration with existing systems was the most significant concern, followed by training requirements and cost. Respondents emphasized a preference for actionable alerts and transparent explanations when AI systems flag anomalies.

Conclusions: Community pharmacists perceive clear value in explainable, integrated AI-based anomaly detection tools that support workflow efficiency and medication safety. These findings highlight key design and implementation considerations for AI systems intended for real-world pharmacy practice.

Keywords

Community pharmacy, Workflow efficiency, Artificial intelligence, Anomaly detection, Pharmacy operations, Technology adoption

1. Introduction

Community pharmacists play a central role in medication management and patient safety, but rising workloads and operational complexity have strained pharmacy workflows. Research shows that pharmacists increasingly face prescription backlogs, insurance denials, verification delays, and interruptions, all of which contribute to reduced efficiency, increased stress, and reduced time for patient care [1,2]. These workflow challenges are compounded by growing service expectations such as immunizations, chronic care management, and patient counseling, often without a proportional increase in staffing or automation support [3].

Prior studies highlight that the most common bottlenecks in community pharmacy include insurance claim processing, billing errors, manual verification, and refill discrepancies [4,5]. These friction points disrupt task flow and increase the risk of dispensing errors. Walsh et al. [6] observed that automating verification and data entry steps improved technician efficiency and overall prescription turnaround time. Similarly, studies in Canadian and U.S. pharmacies report that workload imbalance is closely tied to errors, burnout, and dissatisfaction among pharmacists [1,7].

Although many pharmacies use basic software alerts for drug interactions or inventory levels, most still depend on staff vigilance to detect problems [8]. This reactive model can delay intervention and limit the ability to prevent disruptions before they impact patients. Emerging approaches, such as AI-supported real-time anomaly detection, may support a shift from reactive to proactive workflow management [9].

AI tools have shown success in other healthcare domains by identifying patterns, forecasting risks, and automating routine decisions [10]. In pharmacy, AI-driven anomaly detection could identify deviations in prescription timelines, workload spikes, or claim rejections in real time. Doing so could support better task allocation, early error detection, and reduced patient wait times. However, practical implementation depends on pharmacists' willingness to adopt such systems and on how well these tools fit within existing workflows [11].

To date, little empirical research has examined how pharmacists perceive the potential of AI-based systems to improve workflow. This study addresses that gap by surveying pharmacists about their current operational challenges, experiences with workflow disruptions, and attitudes toward adopting AI tools for real-time anomaly detection. Our objectives were to (1) identify the most common workflow pain points, (2) assess comfort with AI-assisted systems, and (3) determine which features and safeguards pharmacists value most in such tools.

Understanding pharmacists' expectations and concerns is essential to designing AI systems that are trusted, transparent, and effective in real-world pharmacy settings. This study also supports broader digital transformation in pharmacy practice by aligning AI development with frontline needs.

2. Methods

This study used a cross-sectional descriptive design. An anonymous online survey administered via Qualtrics® was conducted between September and October 2025 to assess current pharmacy workflow inefficiencies and pharmacists' perspectives on AI-based anomaly detection. Eligible participants were licensed pharmacists aged 18 or older working in community or outpatient settings across the United States. Recruitment was conducted through professional pharmacy networks, LinkedIn outreach, email lists, and pharmacy alumni groups. Respondents voluntarily completed the questionnaire without compensation.

The survey consisted of 31 items assessing demographics, prescription processing stages, workflow efficiency, sources of operational disruption, technology use, perceived usefulness of AI-supported features, and preferences for system explainability. Question formats included multiple-choice, Likert-scale, ranking, and open-ended items. The instrument was reviewed by two pharmacy practice faculty members and a clinical informaticist to establish content validity.

Survey data were analyzed using descriptive and inferential statistical techniques. Descriptive statistics were used to summarize respondent characteristics and response distributions. Group comparisons of perceived stress and perceived AI usefulness were conducted across demographic and practice-related variables using Welch's t-tests. Associations between workflow conditions, stress, technology readiness, AI concerns, and perceived AI usefulness were examined using Spearman rank-order correlation tests. A correlation matrix was constructed to visualize relational patterns among key variables. The distribution of perceived AI usefulness scores was examined using graphical distribution plots to assess central tendency, variability, and potential ceiling effects. Effect sizes were calculated to support the interpretation of practical relevance. Summary tables and figures were generated to present categorical responses, ranking distributions, and analytical results.

This research was approved by the DePaul University Institutional Review Board under protocol IRB-2025-1695. All procedures complied with the Declaration of Helsinki and applicable U.S. research ethics regulations. The study qualified for exempt review under Category 2(i), as data were collected anonymously with no identifying information. An information sheet and consent notice were presented at the beginning of the survey. Participants could skip questions or withdraw at any time. No adverse events or participant complaints were reported.

This manuscript was prepared with researcher oversight using OpenAI's ChatGPT (December 2025 model) to assist with organizing survey data, formatting tables, summarizing prior literature, and converting plain-language findings into academic text. All AI outputs were reviewed, edited, and verified by the authors prior to inclusion. AI was not used for hypothesis generation, data manipulation, or reference generation.

2.1 Focus Group

Focus group discussions were conducted prior to survey development to inform the design of the quantitative instrument and provide foundational insight into community pharmacy workflows. Licensed pharmacists practicing in community pharmacy settings participated in these discussions to describe their lived experiences of workflow disruptions, workload pressures, and interactions with existing and emerging technology, including AI-supported systems.

Participants were recruited using predefined eligibility criteria and provided informed consent prior to participation. Each focus group consisted of approximately 8–10 pharmacists and was conducted virtually via a video conferencing platform. Sessions lasted 60–75 minutes and followed a semi-structured discussion guide developed from the literature and refined iteratively during early discussions.

Discussion topics included daily workflow structure, prescription volume and staffing, interruptions and multitasking, insurance and administrative burden, technology use and system limitations, patient expectations, stress and well-being, safety and accuracy, team communication, and opportunities for workflow improvement. Focus groups were moderated by a member of the research team, with structured notes captured by a second researcher. To promote open discussion, sessions were not audio or video recorded.

All notes were de-identified prior to analysis. An inductive thematic analysis was conducted to identify recurring workflow challenges, sources of strain, and expectations for technology-enabled support. Themes identified from the focus groups were used to derive survey constructs and question wording, which were later compared with survey results to assess convergence and divergence across qualitative and quantitative findings.

2.2 Literature Review

To situate the survey and focus group findings within the broader evidence base, a structured literature review was conducted using established approaches from prior workload reviews in pharmacy practice. Electronic database searches were performed across PubMed, Scopus, Web of Science, and Google Scholar to identify peer-reviewed studies published between 1995 and 2025. The start date was selected to capture early work on pharmacist workload measurement and the evolution of automation, robotics, and information systems in pharmacy practice.

Search terms were applied using combinations of keywords and free-text queries, including pharmacist workload, community pharmacy workflow, automation, pharmacy robotics, artificial intelligence, job stress, job satisfaction, dispensing errors, and workflow disruption. The reference lists of key review articles and highly cited empirical studies were manually screened to identify additional relevant publications not captured in database searches.

Studies were included if they examined pharmacist workload, workflow structure, automation or AI-supported systems, or downstream outcomes such as stress, safety, or professional practice. Both quantitative and qualitative designs were eligible, and studies from community and hospital pharmacy settings were included to capture system-level patterns. Editorials, opinion pieces, and studies without a clear workflow or workload component were excluded.

Using this process, peer-reviewed empirical studies and review articles were retained for synthesis. For each study, data were extracted on practice setting, methodological approach, workflow focus, outcome measures, and reported social, organizational, or ethical implications. Findings from the literature were synthesized narratively to inform survey design, contextualize quantitative results, and support interpretation of focus group themes, rather than to generate pooled effect estimates.

This multi-method approach allowed triangulation of survey and focus group data, strengthening the validity of the findings and providing a richer understanding of how pharmacists experience workflow disruptions and evaluate potential AI-supported interventions.

3. Results

A total of 83 pharmacists responded to the survey, with 78 completing all sections relevant to workflow conditions, AI perceptions, and anomaly detection preferences. Results are organized by survey domains to align with the instrument structure. A complete summary of item-level response distributions for all survey questions is provided in **Table 1 (Summary Statistics for Survey Items)**.

Demographics and Practice Characteristics

Respondents represented a range of practice settings, with the majority working in community or outpatient environments, including retail chain pharmacies, long-term care sites, hospital-based pharmacies, and clinic-affiliated operations. Approximately 80% reported working full-time. More than 70% of respondents were between 25 and 44 years old, and over half reported more than 5 years of pharmacy practice experience. Detailed demographic distributions are reported in **Table 1**.

Workflow Efficiency and Bottlenecks

Perceptions of prescription workflow efficiency were mixed. Nearly half of respondents rated their workflow as “Somewhat Efficient” or “Efficient,” while 44% rated it as “Somewhat Inefficient” or “Inefficient.” Only a small proportion described their workflow as “Very Efficient,” indicating that perceived inefficiencies remain common.

Workflow disruptions were frequently reported. Approximately 46% indicated experiencing bottlenecks “Often” or “Very Often,” with an additional 27% reporting disruptions “Occasionally.” Only 30% described disruptions as rare. The most frequently cited delay-prone stages included insurance processing, final verification, and intake or prescription entry.

When asked to rank the single most delay-prone stage, insurance-related steps were most frequently selected, followed by final verification and intake or entry processes. Free-text responses further highlighted administrative delays in insurance authorizations and vaccination-related documentation. Rankings of delay-prone stages and contributing factors are summarized in **Figure 1,** and item-level frequencies are reported in **Table 1**.

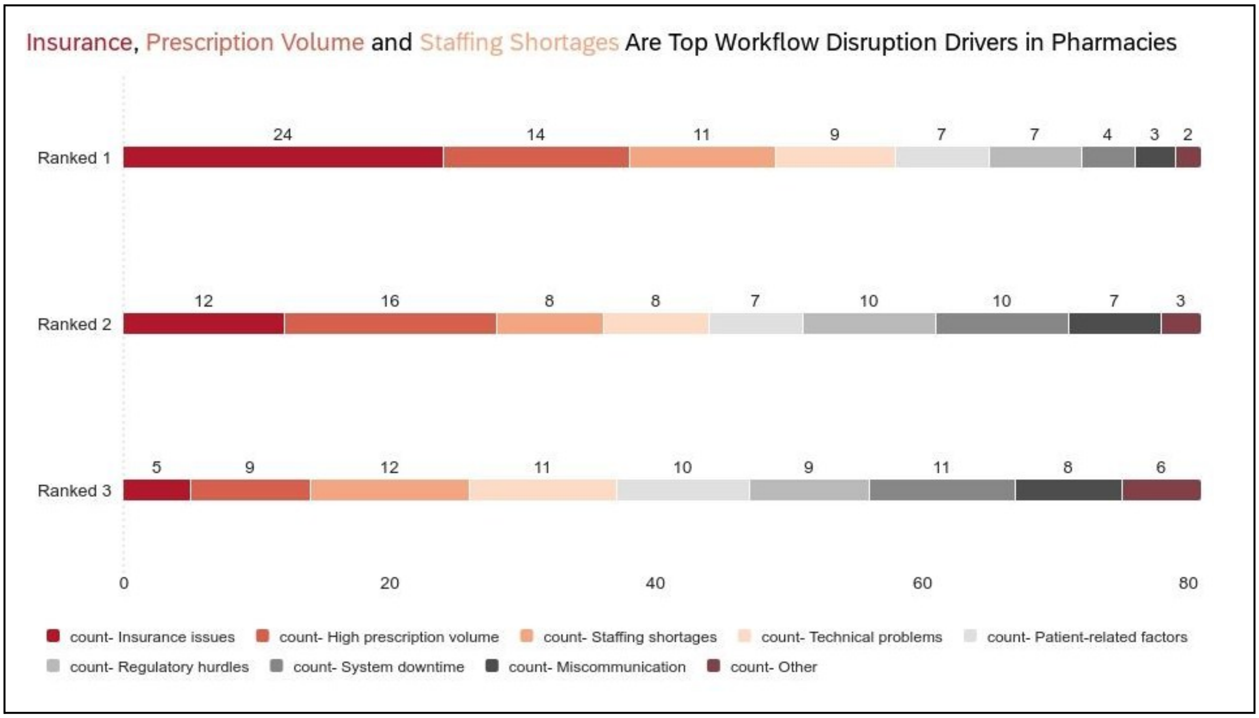

Figure 1. Top-ranked factors contributing to pharmacy workflow disruptions based on pharmacist responses. Insurance issues, high prescription volume, and staffing shortages were most frequently ranked among the top three.

Sources of Workflow Disruption and Operational Anomalies

Insurance and payment-related issues were most commonly ranked as the primary contributor to workflow inefficiency, followed by high prescription volume, technical system issues, and staff miscommunication. Staffing shortages, regulatory burden, and patient-related interruptions were selected less frequently.

The most commonly reported operational anomalies included insurance processing delays, inventory discrepancies, verification delays, and mismatches in patient profiles or entries. Labeling errors and refill timing mismatches were reported less often. These distributions are summarized in **Table 1**.

Technology Use and AI Adoption Readiness

Most pharmacists reported being “Comfortable” or “Very Comfortable” adopting new technology. However, perceived staff comfort with AI systems was lower, with most respondents selecting “Neutral” or “Slightly Comfortable.”

Concerns related to AI adoption centered primarily on system integration challenges, followed by staff training requirements and cost. Privacy, reliability, and usability concerns were reported less frequently. No respondents indicated having no concerns. Rankings and frequencies are summarized in **Table 1**.

Perceived Usefulness of AI Features and Explainability Preferences

Perceived usefulness ratings for AI-based workflow support were high across respondents. Features most frequently selected as valuable included staff workload balancing, workflow optimization, and early error detection. Predictive busy-period alerts and insurance issue identification were selected less often.

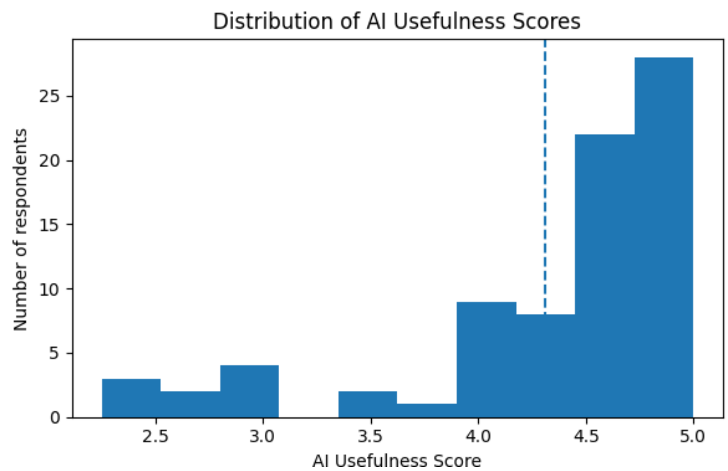

Figure 2. Distribution of perceived AI usefulness scores.

The distribution of overall AI usefulness scores was examined using a distribution plot (**Figure 2**). Scores clustered between 4 and 5 on a 5-point scale, with a mean of approximately 4.31, indicating generally high perceived usefulness with acceptable variability and a mild ceiling effect.

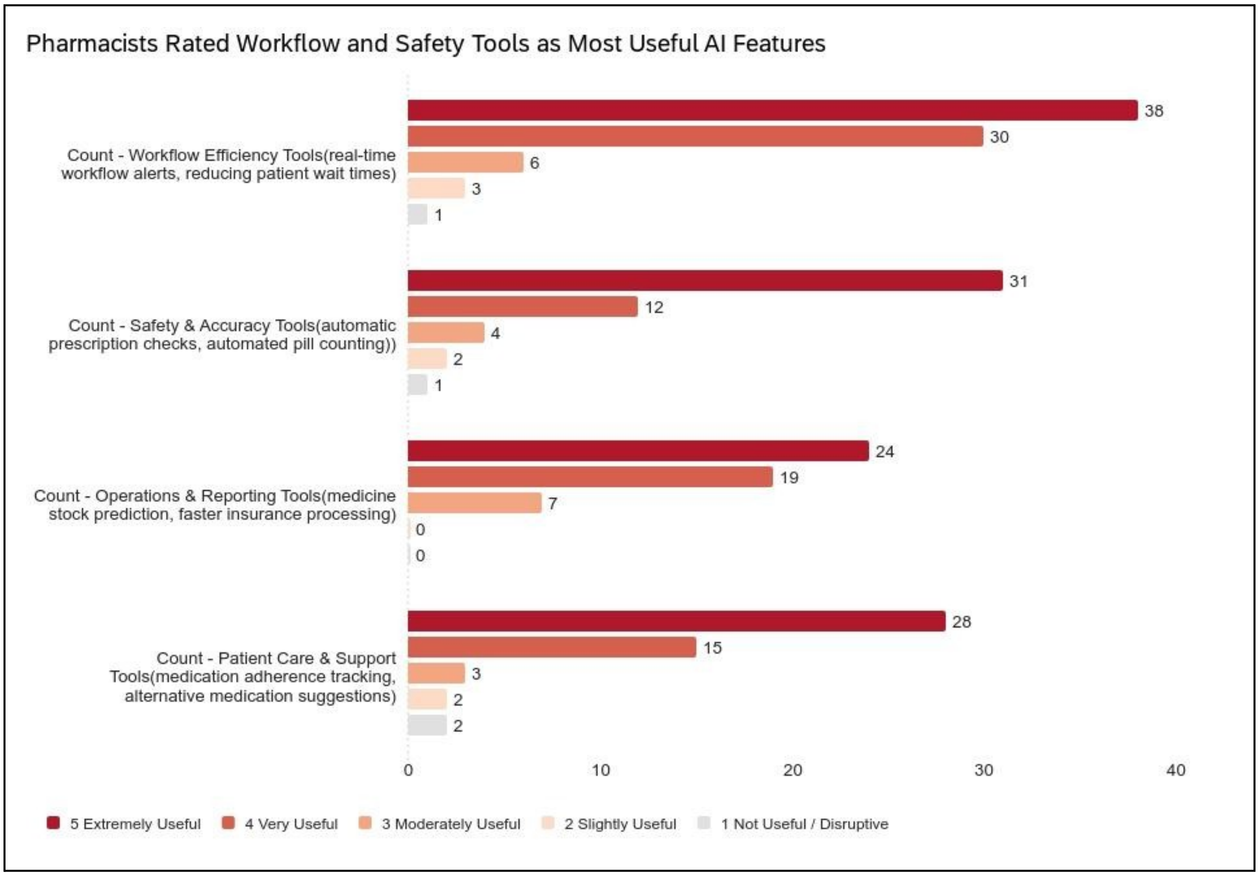

Figure 2. Perceived usefulness of proposed AI system features based on pharmacist ratings. Workflow efficiency and safety tools received the highest scores, with more than 90% of respondents rating them as very or extremely useful.

Preferences for AI feedback emphasized action-based recommendations and plain-text explanations over visual dashboards or historical trend views. More than 85% of respondents reported that understanding why an alert was generated was moderately to extremely important.

Group Comparisons Using Welch t-Tests

Welch independent-samples t-tests were conducted to examine differences in reported job stress and perceived AI usefulness across demographic and practice-related groups. Reported job stress did not differ significantly by gender ($p = .57$, Cohen's $d = 0.13$), practice setting (retail vs other; $p = .34$, $d = 0.23$), or work schedule (full-time vs non–full-time; $p = .95$, $d = 0.02$), with all effect sizes small or negligible.

Perceived AI usefulness was similarly consistent across technology readiness levels. Pharmacists with higher technology readiness reported slightly higher AI usefulness scores ($M = 4.37$)

compared with those with lower readiness ($M = 4.20$), but this difference was not statistically significant (Welch $t \approx -0.95$, $p = .35$, $d = 0.25$).

In contrast, AI usefulness varied meaningfully across operational feature preferences. Pharmacists who prioritized balancing staff workload reported higher perceived AI usefulness than those who did not, with a statistically significant and moderate effect ($p = .030$, $d = 0.57$). Moderate effects were also observed for preferences related to peak busy-period prediction ($p = .013$, $d = 0.49$) and workflow optimization features ($p = .064$, $d = 0.44$). Preferences for error-detection features showed no meaningful difference in AI usefulness ($p = .77$, $d = 0.07$). Full t-test results are reported in Table 2.

Associations Between Workflow Conditions, Stress, and AI Usefulness

Spearman rank-order correlation analyses examined relationships among workflow conditions, job stress, technology readiness, and perceived AI usefulness. AI usefulness was moderately positively associated with workflow bottleneck frequency ($\rho = 0.31$, $p = .006$) and moderately negatively associated with workflow efficiency ($\rho = -0.29$, $p = .008$), indicating that pharmacists experiencing more frequent bottlenecks and lower workflow efficiency perceived greater value in AI-based support tools.

No significant associations were observed between job stress and AI usefulness ($\rho = 0.16$, $p \approx .17$), workflow bottleneck frequency ($\rho \approx 0.00$, $p \approx .97$), or workflow efficiency ($\rho = -0.11$, $p \approx .35$). Technology readiness was also not meaningfully correlated with AI usefulness ($\rho = 0.03$, $p \approx .78$), suggesting that perceived value of AI was driven by operational workflow conditions rather than individual stress levels or comfort with technology.

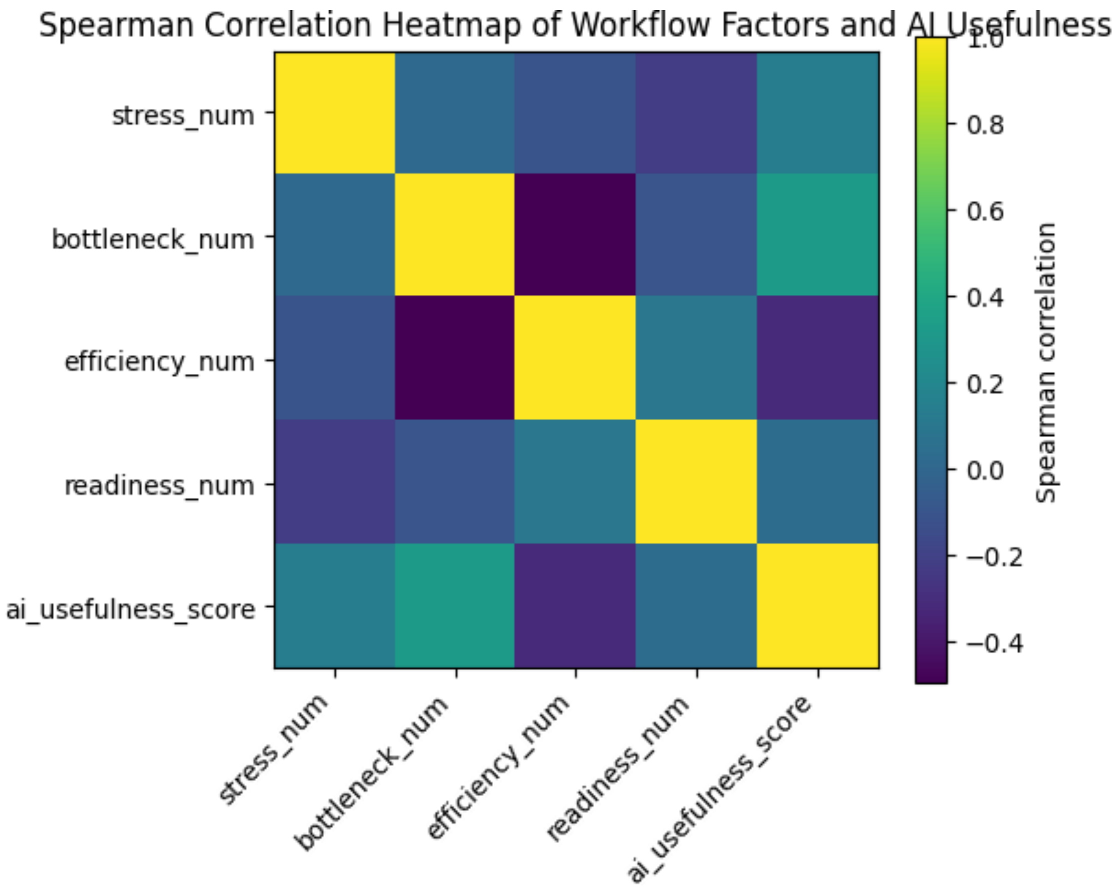

Figure 3. Spearman correlation heatmap of workflow conditions, stress, technology readiness, and perceived AI usefulness

3. 2. Literature Review Results

Study (Year)	Study Context	Workflow Details / Technology Intervention	Outcomes & Findings	Qualitative Insights (Social & Ethical)
Savage et al. (1995)	2 community pharmacies; 4 pharmacists	Direct observation; patient advice events	No measurable staff-time effect on patient interaction	None reported
Bell et al. (1998)	30 community pharmacists (self-report)	Task segmentation study	Dispensing accounted for 60–70% of work time	Overdispensing emphasized
Rutter et al. (1998)	18 community pharmacies	No automation; task-time comparison (NHS vs personal)	NHS task time overestimated (70% vs 57%)	Awareness of overwork bias
Svarstad et al. (2004)	200 community pharmacists	No technology; counselling frequency analysis	Increased busyness reduced pharmacist–patient communication	Workforce fairness concerns
Angelo & Ferreri (2005)	5 community pharmacies	Automated filling with real-time verification	Patient wait time ↓ 28%; counselling time ↑ 19%	Ethical considerations of automation
Hiom et al. (2006)	Welsh hospital pharmacies	Benchmarking dispensing productivity	Average 9.8 items dispensed per hour	Baseline reference for automation
Bond et al. (2008)	68 community pharmacists	Contract reform (non-AI); dispensing and MUR tasks	Dispensing ≈ 50% of time; MUR avg 51 min	Shift toward administrative burden
Eden et al. (2009)	12 pharmacists (qualitative)	No technology; workload and career trajectory	67% exited community practice	Work–life imbalance
McCann et al. (2010)	17 pharmacists (interviews + survey)	No technology; dispensing and counselling focus	Increased stress; break shortages linked to errors	Burnout and fatigue
Silverstein et al. (2010)	1 hospital pharmacy	Robotic carousel with barcode system	85–90% robotic efficiency	Staffing role redefinition
Walsh et al. (2011)	Hospital pharmacy; 10 technicians	Robotic filling device for verification	40 sec reduction per prescription; fewer manual errors	Adaptation challenges; fatigue reduction

Gidman (2011)	48 community pharmacists	No technology; dispensing and management workload	Increased workload associated with lower satisfaction	Role overload
Lea et al. (2012)	Community pharmacy; 13 UK studies (30–392 participants)	No technology intervention; dispensing, counselling, admin	Workload and stress increased; efficiency largely unchanged	Stress, burnout, gender imbalance
Wetsiri et al. (2024)	12 community pharmacies	RPA for inventory management and pricing	42.9% efficiency gain in pricing processes	Need for human oversight
Lin et al. (2024)	Community pharmacy (157 observations)	Robotic prescription-filling system	40 sec reduction per prescription	Workarounds observed in 36% of cases
Basile et al. (2024)	Multi-institutional review	AI and ML applications in pharmacy	Adherence ↑ 40%; errors ↓ 75%	High cost and governance concerns
Wetsiri & Paireekreng (2025)	12 community pharmacies; 120 participants	RPA for prescription and inventory follow-up	Dispensing ↓ 67%; ordering ↓ 83%; follow-up ↓ 80%	Staff satisfaction improved
Meknassi Salime et al. (2025)	129 studies (systematic review)	Various automation systems	Error reduction; improved traceability	Cost and training barriers
Simpson et al. (2025)	32 hospital studies (review)	Pharmacy automation systems (PAS)	Mean effect size 0.505 (CI 0.487–0.523)	Implementation cost and satisfaction trade-offs
Shbaily et al. (2025)	Hospital pharmacy (experimental)	Carousel and XR2 robotic system	0% dispensing errors; 71% workload shift	Staff redeployment effects

Table 1. Summary of Reviewed Studies on Pharmacy Workflow and Automation (n = 20).

Narrative-driven result for Literature Review

The reviewed literature can be grouped into three overlapping bodies of work: studies describing baseline pharmacy workload without technological intervention, studies evaluating automation and robotics in pharmacy workflows, and more recent reviews examining AI-enabled systems and advanced automation. Together, these streams illustrate how workflow strain has evolved and how technology has altered, but not eliminated, core pressures in pharmacy practice.

Early observational and self-reported studies consistently document high baseline workload in community pharmacy settings. Direct observation and task-sampling studies show that dispensing and administrative tasks account for the majority of pharmacists' time, often exceeding 50% of daily work activities. These studies report frequent interruptions, limited rest periods, and reduced opportunities for patient counseling. Across qualitative interviews and surveys, pharmacists describe persistent stress, role overload, and difficulty maintaining work–life balance. Several studies also link high workload and time pressure to communication breakdowns and increased risk of errors, suggesting that workflow strain is a structural feature of pharmacy practice rather than a temporary condition.

A second group of studies examines the introduction of automation and robotics in both community and hospital pharmacies. These studies report consistent operational improvements following the adoption of automated filling systems, robotic carousels, barcode verification, or robotic process automation for inventory and ordering. Reported outcomes include reduced dispensing time per prescription, fewer manual errors, improved inventory accuracy, and faster service delivery. In several cases, automation enabled measurable reductions in wait times and shifted pharmacist time away from repetitive tasks toward verification or patient-facing activities. These findings suggest that even partial automation can meaningfully improve workflow efficiency.

However, studies in this category also highlight challenges in adaptation. Implementation phases are often associated with temporary fatigue, learning curves, and workflow disruptions. Several papers emphasize the need for ongoing human oversight, noting that automation can introduce new risks if systems are poorly integrated or overly trusted. Qualitative findings describe role redefinition, changes in staff responsibilities, and concerns about deskilling or loss of professional control. These studies indicate that technical performance alone does not determine success; alignment with existing workflow norms and professional judgment is critical.

The most recent literature focuses on advanced automation, AI-supported systems, and large-scale reviews of pharmacy automation technologies. Review studies and multi-institutional evaluation reports indicate stronger, more consistent effects, including substantial reductions in error rates, improved traceability, and enhanced adherence outcomes. Advanced robotic platforms and AI-enabled tools are associated with reduced cognitive load and improved coordination across pharmacy teams. At the same time, these studies raise recurring concerns about implementation costs, training requirements, governance, and transparency. Several reviews note that staff acceptance depends on system explainability and perceived support for, rather than replacement of, pharmacist decision-making.

Across all categories, a consistent pattern emerges. Pharmacists value technologies that reduce manual burden and improve accuracy, but they remain cautious of systems that obscure logic, constrain autonomy, or introduce new forms of oversight without clarity. Workload strain persists even as technology evolves, but perceptions of technology improve when tools are seen as stabilizing workflow rather than controlling it. This body of evidence supports the view that successful AI-based anomaly detection systems must address the structural complexity of workflows while remaining interpretable, supportive, and aligned with professional practice.

Focus Group Results:

Analysis of the focus group discussions revealed a consistent set of themes describing structural workflow strain, sources of disruption, and expectations for technology-supported interventions in community pharmacy practice.

Participants described daily workflows as persistently high-intensity from store opening to closing, with limited temporal separation between prescription intake, data entry, dispensing, verification, and patient pickup. Pharmacists reported that dispensing tasks were frequently interwoven with front-of-store responsibilities, requiring constant task switching and limiting sustained focus on any single activity.

High prescription volume and inadequate staffing emerged as dominant contributors to workflow strain. Seasonal surges, particularly during vaccination periods, were described as amplifying existing staffing limitations. Understaffing during peak hours forced pharmacists to prioritize speed over optimal task sequencing, increasing perceived cognitive load and reducing flexibility in managing competing demands.

Interruptions were reported as pervasive and disruptive. Participants described frequent interruptions from walk-in patients, phone calls, drive-through services, immunizations, and counseling requests. These interruptions were widely perceived to fragment attention, slow task completion, and increase the likelihood of near-miss errors, particularly during verification and dispensing stages.

Insurance-related administrative work was consistently identified as a major source of inefficiency and stress. Pharmacists reported spending substantial time managing rejections, prior authorizations, and billing issues, often requiring repeated communication with both patients and payers. These tasks were viewed as poorly integrated into pharmacy workflows and as diverting time away from clinical responsibilities.

Discussions of technology and automation reflected cautious optimism. Participants acknowledged the potential of improved dispensing systems, automation, and workflow tools to reduce manual burden and streamline operations. However, system limitations, downtime, and inadequate training were frequently cited as sources of frustration. Pharmacists emphasized that new technologies often introduce short-term increases in workload during implementation and require ongoing support to be effective.

Patient expectations and customer service pressures further intensified workflow strain. Managing wait times, handling complaints, and meeting performance metrics were described as ongoing sources of stress, particularly during high-volume periods. Participants noted that customer-facing pressures often conflicted with the need for accuracy and careful verification.

Stress and well-being were discussed as cumulative rather than episodic. Pharmacists identified peak-volume periods, multitasking demands, and administrative tasks as the most stressful aspects of their work. Many described emotional and physical fatigue during shifts and reported that work-related stress frequently carried over into non-work hours.

Concerns about safety and accuracy were closely linked to workload conditions. Participants described strategies for maintaining accuracy under pressure, including self-imposed double-checks and reliance on experienced technicians, but acknowledged that a high workload and frequent interruptions increased the risk of errors and near misses.

Finally, participants emphasized the importance of team communication and managerial support. Effective coordination between pharmacists, technicians, and front-end staff was viewed as essential for managing high workload, while inadequate support during peak periods negatively affected morale. Suggested opportunities for improvement focused on workflow redesign, clearer role delineation, staffing adjustments, and technology tools that proactively identify bottlenecks rather than react to errors after they occur.

Discussion

The survey results indicate widespread workflow inefficiencies in community pharmacy practice. Although some respondents rated their workflows as efficient, nearly half characterized them as inefficient or only somewhat effective. The most common pain points involved insurance-related steps and pharmacist verification, two stages that consistently emerge in prior literature as labor-intensive and time-sensitive. These bottlenecks are not isolated issues but part of a recurring pattern in high-volume outpatient settings.

Comparing these results to existing studies, similar trends emerge. Lea et al. [1] found that increased workload and time constraints contributed to elevated stress, despite role delegation. McCann et al. [2] similarly reported that insufficient break times and mounting workloads raised error risk. These studies affirm that inefficiency is not simply a technical issue but a source of emotional and safety-related strain. The current survey supports these conclusions, with respondents frequently reporting stress-inducing delays rooted in insurance workflows and system slowdowns.

Technology-based interventions appear to improve many of the issues raised. Wetsiri and Paireekreng [9] found that robotic process automation reduced dispensing time by 67% and ordering time by more than 80%. Walsh et al. [6] reported that robotic verification saved an average of 40 seconds per prescription. The pharmacists in our survey strongly favored AI features designed to balance workload and recommend optimization strategies—the very type of targeted interventions that these robotic tools offered in earlier pilot studies.

Yet the survey also clarifies that any AI system must meet real-world constraints. Integration with existing software and workflows was the most common concern. This mirrors themes in studies by Angelo and Ferreri [4] and Simpson et al. [12], both of which noted that even effective automation can encounter resistance without smooth deployment. Pharmacists want support systems that do not require a full redesign of daily operations or disrupt clinical autonomy. Explainability was another core expectation, consistent with insights from Basile et al. [13], who found that AI-based systems often faced skepticism when they lacked clear reasoning or transparent data models.

Training remains essential. Survey participants emphasized formal instruction, followed by embedded tutorials and peer mentoring. This aligns with patterns observed by Silverstein et al. [14], who found that successful robot adoption depended not only on the technology but also on retraining and team adaptation. The lower emphasis on external technical support suggests that pharmacists expect usable, learnable systems without ongoing vendor handholding.

This study also confirms that pharmacists currently rely on informal, manual signals to detect problems—such as technician alerts or self-observation. Only half reported any support from system-based alerts. This limited detection architecture may delay corrective action and contribute to the sense of inefficiency. AI-driven anomaly detection could fill this gap by providing early, structured alerts and supporting interventions before problems escalate.

The preference for action-based feedback and textual explanations suggests that pharmacists want AI to serve as a guide, not just a flagging system. Basile et al. [13] and Shbaily et al. [15] both warn that trust in automation depends on relevance, clarity, and embedded clinical logic. Survey results here reinforce that trust hinges not only on the accuracy of AI predictions but also on their interpretability and utility.

One strength of this study is that it captures the current moment of readiness and hesitation in pharmacy technology adoption. Although most respondents were personally comfortable with technology, they reported lower confidence in their team's readiness. This signals that future interventions must address both individual and organizational support, building digital competence alongside infrastructure integration.

Limitations include the self-selecting nature of the respondent pool and the descriptive, non-inferential nature of the analysis. The survey captured opinions, not performance metrics. Still, the consistency across ranking questions and the clarity of respondent preferences provide strong signals to guide the development of AI-based workflow tools grounded in pharmacy needs.

Conclusions

This survey reveals that community pharmacists experience frequent workflow disruptions, especially during insurance processing and final verification. These inefficiencies are perceived as persistent and often beyond the pharmacist's direct control. While pharmacists currently rely on manual oversight and basic software features to detect problems, they express interest in real-time AI systems that could proactively identify anomalies and provide actionable guidance.

The most desired AI features include staff workload balancing, workflow improvement suggestions, and early error detection. Pharmacists prioritize integration with current systems, ease of training, and transparency of AI outputs. They expect these tools to support, not replace, their clinical roles.

Training strategies must be multifaceted and practical, combining formal onboarding with in-system learning and peer collaboration. Overall, pharmacists appear ready to adopt anomaly detection tools if they are intuitive, explainable, and embedded in their operational realities.

Future AI development for pharmacy workflows should focus on targeted efficiency gains, real-time support, and the preservation of pharmacist autonomy. By aligning technical design with frontline expectations, AI can serve as a valuable tool to improve both performance and professional satisfaction.

Author Contributions

Conceptualization, A.R.; methodology, A.R. and S.R.R.; validation, S.R.R.; formal analysis, S.R.R.; investigation, S.R.R.; resources, A.R.; data curation, S.R.R.; writing—original draft preparation, S.R.R.; writing—review and editing, A.R.; supervision, A.R.; project administration, A.R. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of DePaul University (protocol code IRB-2025-1695, approved on 19 September 2025) for studies involving humans.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Consent was recorded electronically at the start of the online survey using a digital information sheet and an opt-in checkbox.

Data Availability Statement

The data presented in this study are available from the corresponding author upon request. The data are not publicly available due to institutional data protection policies and the conditions of IRB approval.

Conflicts of Interest

The authors declare no conflict of interest. The funders and institutions had no role in the design of the study; in the collection, analysis, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Abbreviations

The following abbreviations are used in this manuscript:

Abbreviation	Description
AI	Artificial Intelligence

EHR	Electronic Health Record
IRB	Institutional Review Board
PAS	Patient Administration Systems
RPA	Robotic Process Automation
XR2	Pharmacy Robotics System (Carousel Technology)
MUR	Medicines Use Review
US	United States
RPh	Registered Pharmacist

Appendix A

Survey Questionnaire Sections

The complete Qualtrics survey consisted of 31 questions grouped into the following sections:

Demographics

Q1. What is your gender?
Male, Female, Prefer not to say, Other

Q2. What is your age group?
18–24, 25–34, 35–44, 45–54, 55–64, 65+

Q3. How many years have you been practicing as a pharmacist?
Less than 1 year, 1–5 years, 6–10 years, 11–20 years, More than 20 years

Q4. What is your primary practice setting?
Retail or Community Pharmacy, Hospital Pharmacy, Clinical Pharmacy, Long-term Care Pharmacy, Industry or Research, Other

Q5. How satisfied are you with your current pharmacy practice overall?
Extremely Dissatisfied, Very Dissatisfied, Dissatisfied, Neutral, Satisfied, Very Satisfied, Extremely Satisfied

Q6. How would you rate the level of job stress in your current role?
Very Low, Low, Moderate, High, Very High

Q7. What is your primary work schedule?
Full-time 40+ hours per week, Part-time less than 40 hours per week, Per diem or Flexible schedule

Efficiency and Workflow Bottlenecks

Q8. What is the average time from prescription entry to patient pickup at your pharmacy?
Less than 30 minutes, 30 minutes to 1 hour, 1–2 hours, Greater than 2 hours

Q9. How often do you experience stockouts of critical medications?
Never, Very Rarely, Rarely, Occasionally, Often, Very Often, Always

Q10. How often are prescriptions filled within the expected timeframe?
Never, Very Rarely, Rarely, Occasionally, Often, Very Often, Always

Q11. How would you rate the efficiency of your current prescription processing workflow?
Very Inefficient, Inefficient, Somewhat Inefficient, Neutral, Somewhat Efficient, Efficient, Very Efficient

Q12. How often do you experience bottlenecks in your prescription processing workflow?
Never, Very Rarely, Rarely, Occasionally, Often, Very Often, Always

Q13. Please rank the stages of prescription processing by how frequently they experience delays.
Intake and review, Prescription verification, Insurance processing, Billing, Drug dispensing, Final verification, Pickup or delivery, Other

Q14. What are the top three factors that most commonly contribute to workflow disruptions in your pharmacy?
High prescription volume, Staffing shortages, Insurance issues, Technical problems, Patient-related factors, Regulatory hurdles, System downtime, Miscommunication, Other

Patient Care

Q15. What percentage of patients receive counseling when picking up a new prescription?
Less than 10%, 10–20%, 21–30%, 31–40%, Greater than 40%

Q16. How often do patients report issues with prescription labeling or instructions?
Never, Very Rarely, Rarely, Occasionally, Often, Very Often, Always

Q17. Do you offer any patient education programs focused on medication management?
Yes, No

Financial Performance

Q18. What percentage of profits do you allocate monthly to pharmacy technology and software expenses?
Less than 10%, 10–20%, 21–30%, 31–40%, Greater than 40%

Technology and Data

Q19. Do you integrate your pharmacy system with electronic health records EHR?
Yes, No

Q20. How often do you analyze data to identify opportunities for improvement in your pharmacy operations?
Never, Very Rarely, Rarely, Occasionally, Frequently, Very Frequently, Always

Q21. How do you currently identify workflow inefficiencies in your pharmacy?
Manual observation, Staff feedback, Patient complaints, Error reports, Workflow data analysis, We do not systematically track this, Other

Q22. How comfortable are you with adopting new technologies in your pharmacy practice?
Extremely Uncomfortable, Very Uncomfortable, Uncomfortable, Neutral, Comfortable, Very Comfortable, Extremely Comfortable

Q23. How comfortable is your pharmacy staff with adopting an AI system for prescription processing?
Extremely Uncomfortable, Very Uncomfortable, Slightly Uncomfortable, Neutral, Slightly Comfortable, Very Comfortable, Extremely Comfortable

AI Concerns and Features

Q24. What are your top three concerns about implementing AI systems in your pharmacy?
Cost, Training requirements, Privacy concerns, Reliability, Integration with existing systems, Other

Q25. How useful would you find the following AI features for real-time anomaly detection?
1 Not Useful or Disruptive, 2 Slightly Useful, 3 Moderately Useful, 4 Very Useful, 5 Extremely Useful

Q26. Which features would be most valuable in a real-time anomaly detection system?
Early detection of prescription errors, Workflow optimization recommendations, Staff workload balancing, Prediction of peak busy periods, Identification of insurance processing issues, Other

Q27. How important is it for you to understand why an AI system flags a potential workflow issue?
Not at all Important, Slightly Important, Somewhat Important, Moderately Important, Very Important, Extremely Important, Absolutely Essential

Q28. What type of explanation would be most helpful when an anomaly is detected?
Visual indicators charts or graphs, Text explanation, Comparison to normal patterns, Specific action recommendations, Historical context, Other

Errors, Responsibility, and Training

Q29. What types of errors or anomalies do you encounter most often in your pharmacy operations?
Prescription entry errors, Insurance processing delays, Inventory discrepancies or stock unavailability, Labeling errors, Delayed prescription verification, Data entry mismatches, Refill timing inconsistencies, Other

Q30. When an anomaly occurs, who is typically responsible for identifying and resolving it?
Pharmacist identifies and resolves immediately, Technician escalates to pharmacist, Flagged by software system, Patient brings it to staff attention, Not consistently tracked or no clear responsibility, Other

Q31. What kind of training or support do you think your staff might need to effectively use an AI-based system?
Formal training session, Self-paced modules, In-system walkthroughs, Peer mentoring, Ongoing tech support, Other

Survey delivery was anonymous, hosted via Qualtrics, with completion time under 12 minutes. A PDF version of the complete question set is available upon request.

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