Research Articles

Organizational Learning of Medical Personnel through the Application of Pareto Analysis in Pharmaceutical Management: An Action Research Study in a Herbal Medicine Manufacturing Organization

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Abstract

This study examines how the application of Pareto analysis in pharmaceutical management contributes to organizational learning among medical personnel in a herbal medicine manufacturing organization in Thailand. Moving beyond its conventional role as a technical prioritization tool, this study conceptualizes Pareto analysis as a learning-enabling mechanism that facilitates reflection-in-action and collective sense-making. A Participatory Action Research (PAR) design was employed over a three-month period, involving (n = 45) medical and pharmaceutical personnel, including pharmacists, pharmaceutical technicians, production supervisors, inventory officers, and quality assurance staff.

Data were collected through Pareto analysis reports derived from production and inventory records, structured reflective meeting documentation, field observations, and organizational document review. Qualitative data were analyzed using inductive thematic analysis with iterative coding procedures, while quantitative data were analyzed using descriptive statistics to assess stock-out rates and inventory turnover. Data triangulation was applied to enhance credibility and trustworthiness.

The findings indicate that approximately 20–25% of pharmaceutical items accounted for 75–80% of total production volume and inventory value. The implementation of Pareto-based prioritization significantly reduced stock-out rates and improved inventory turnover efficiency. More importantly, the integration of Pareto analysis into reflective practices fostered shared

understanding, enhanced data-driven decision-making, and strengthened organizational learning processes. This study contributes to the literature by demonstrating that Pareto analysis can function as a boundary object that bridges analytical tools and organizational learning, particularly within regulated pharmaceutical production contexts. The findings offer both theoretical and practical implications for developing learning-oriented pharmaceutical management systems in emerging health care settings.

Keywords: Pareto Analysis, Pharmaceutical Management, Organizational Learning, Action Research, Herbal Medicine Manufacturing

Introduction

Pharmaceutical management has become an increasingly critical component of health system performance, as effective medicine availability, cost control, and service quality directly influence population health outcomes and system sustainability (World Health Organization, 2021; Maeda et al., 2014). In many countries, particularly those pursuing universal health coverage, pharmaceutical systems are required to balance efficiency, accessibility, and regulatory compliance within complex and resource-constrained environments (Chaudhuri, 2017; Schafheutle et al., 2011). In Thailand, national health policies have emphasized the strengthening of pharmaceutical governance and primary pharmaceutical care as strategic mechanisms to improve system resilience and equity (Ministry of Public Health, 2024; Thai Food and Drug Administration, 2022). These developments highlight the growing need for management approaches that extend beyond technical control toward organizational learning and adaptive capacity within pharmaceutical settings (Rousseau, 2006; Teece et al., 1997).

Herbal medicine manufacturing organizations represent a distinctive segment of pharmaceutical systems, as they operate at the intersection of traditional medicine, modern regulatory standards, and public health service delivery (World Health Organization, 2021; Benrimoj & Fernandez-Llimos, 2020). In Thailand, herbal medicine production plays an important role in supporting primary health care and community-based pharmaceutical services, particularly within the national policy framework for primary pharmaceutical care (Ministry of Public Health, 2024; Anderson et al., 2017). However, these organizations frequently

face challenges related to inventory imbalance, demand uncertainty, workforce constraints, and fragmented decision-making processes (Sooksriwong et al., 2023; Wongwiwat et al., 2024). Addressing these challenges requires not only operational optimization but also the development of learning-oriented management practices among medical personnel (Frenk et al., 2010; Federation Internationale Pharmaceutique, 2023).

Pareto analysis has long been recognized as an effective managerial tool for identifying high-impact elements within complex systems, drawing on the principle that a small proportion of items often accounts for a large proportion of outcomes (Brynjolfsson et al., 2010; Rooderkerk et al., 2013). In pharmaceutical and retail contexts, Pareto-based approaches have been widely applied to inventory control, assortment planning, and cost optimization, demonstrating benefits in efficiency and resource allocation (Kök et al., 2009; Van Ryzin & Mahajan, 1999). Studies in pharmacy and health service management suggest that focusing on "vital few" products can significantly reduce waste and improve operational performance (Posilkina et al., 2021; Gaur & Fisher, 2005). Nevertheless, existing research predominantly conceptualizes Pareto analysis as a technical or analytical instrument, with limited attention to its role in shaping organizational learning and professional behavior (Dekimpe & Hanssens, 1999; Athey & Imbens, 2017).

Organizational learning theory emphasizes the capacity of organizations and their members to acquire, interpret, and apply knowledge in ways that improve decision-making and performance over time (Rousseau, 2006; Teece et al., 1997). Within health care and pharmacy practice, learning is increasingly understood as a collective, practice-based process that emerges through reflection, participation, and interaction with real-world problems (Benrimoj et al., 2020; Mustafa et al., 2024). Action research, in particular, provides a methodological framework that integrates problem-solving with learning by engaging practitioners as co-researchers in cycles of planning, action, observation, and reflection (Bitner et al., 2008; Frenk et al., 2010). Such approaches are especially relevant in pharmaceutical settings, where professional judgment, interprofessional collaboration, and context-specific adaptation are essential to effective management (Allemann et al., 2014; Murry & Desselle, 2024).

Despite growing recognition of the importance of learning-oriented management, much of the existing literature on pharmaceutical management continues to prioritize outcome indicators such as cost reduction, service efficiency, and clinical effectiveness, often overlooking the learning processes that underpin sustainable improvement (Nunes et al., 2009; Anderson et al., 2021). Studies on community pharmacy and primary care integration highlight that the success of management innovations depends heavily on workforce engagement, professional identity, and the ability of staff to interpret and act upon data (Anderson et al., 2021; Benrimoj et al., 2020). In the context of emerging markets and regulated pharmaceutical environments, managerial tools introduced without attention to organizational learning may yield short-term gains but fail to generate lasting change (Chaudhuri, 2017; Federation Internationale Pharmaceutique, 2023). This suggests that analytical tools such as Pareto analysis should be examined not only for their technical utility but also for their pedagogical and learning-enabling functions (Rousseau, 2006; Teece et al., 1997).

Although prior studies have demonstrated the effectiveness of Pareto analysis in improving pharmaceutical inventory and assortment management, there remains a significant research gap regarding how the application of such analytical tools contributes to organizational learning among medical personnel, particularly within herbal medicine manufacturing organizations (Posilkina et al., 2021; Rooderkerk et al., 2013). Existing research has largely treated Pareto analysis as a static decision-support mechanism, rather than as a dynamic catalyst for reflective practice, shared understanding, and professional development (Brynjolfsson et al., 2010; Dekimpe & Hanssens, 1999). Moreover, empirical evidence linking Pareto-based management interventions with learning processes in regulated pharmaceutical production contexts is scarce, especially in low- and middle-income or emerging market settings (Chaudhuri, 2017; Sooksriwong et al., 2023). To address this gap, the present study employs an action research approach to examine how the application of Pareto analysis in pharmaceutical management facilitates organizational learning among medical personnel in a herbal medicine manufacturing organization.

Research Objectives

1. To examine how the application of Pareto analysis in pharmaceutical management contributes to organizational learning among medical personnel in a herbal medicine manufacturing organization.

2. To explore the processes of reflection-in-action and collective sense-making that emerge during the implementation of Pareto-based management practices within the pharmaceutical production context.

3. To identify key organizational and professional factors that facilitate or constrain learning-oriented pharmaceutical management through an action research approach.

Literature Review

1. Pharmaceutical Management in Evolving Health Systems

Pharmaceutical management plays a central role in ensuring medicine availability, affordability, and quality within health systems, particularly in the context of universal health coverage and primary health care reform (World Health Organization, 2021; Maeda et al., 2014). In many countries, pharmaceutical systems are under increasing pressure to improve efficiency while maintaining regulatory compliance and service accessibility, especially in emerging and middle-income economies (Chaudhuri, 2017; Schafheutle et al., 2011). National policies in Thailand have similarly emphasized strengthening pharmaceutical governance, community pharmacy standards, and workforce capacity as key mechanisms for improving health system performance (Ministry of Public Health, 2024; Thai Food and Drug Administration, 2022). These developments underscore the need for management approaches that integrate operational efficiency with professional capability development (Federation Internationale Pharmaceutique, 2023; Frenk et al., 2010).

2. Challenges in Pharmaceutical and Herbal Medicine Production Contexts

Herbal medicine manufacturing organizations operate within complex regulatory and operational environments, combining traditional medical practices with modern pharmaceutical standards and quality assurance requirements (World Health Organization, 2021; Benrimoj & Fernandez-Llimos, 2020). In Thailand, herbal medicines contribute significantly to primary health care delivery, yet production units frequently face challenges related to inventory imbalance, demand variability, workforce constraints, and fragmented decision-making processes (Sooksriwong

et al., 2023; Wongwiwat et al., 2024). Studies on independent and community pharmacy settings suggest that such challenges are often exacerbated by limited managerial tools and insufficient integration of data into daily decision-making practices (Anderson et al., 2021; Benrimoj et al., 2020). Addressing these issues requires not only technical solutions but also organizational learning processes that enable personnel to adapt management practices to dynamic conditions (Rousseau, 2006; Teece et al., 1997).

3. Pareto Analysis and Data-Driven Pharmaceutical Management

Pareto analysis is widely used in management science as a method for identifying high-impact elements within complex systems, based on the principle that a small proportion of inputs often accounts for a large proportion of outcomes (Brynjolfsson et al., 2010; Rooderkerk et al., 2013). In pharmaceutical and retail contexts, Pareto-based approaches have been applied to inventory control, assortment planning, and cost optimization, demonstrating improvements in efficiency and resource allocation (Kök et al., 2009; Van Ryzin & Mahajan, 1999). Empirical studies in pharmacy management indicate that focusing on "vital few" medicines can reduce waste, improve stock availability, and support rational resource use (Posilkina et al., 2021; Gaur & Fisher, 2005). However, most existing studies conceptualize Pareto analysis primarily as a technical decision-support tool, with limited exploration of its influence on professional learning and organizational behavior (Dekimpe & Hanssens, 1999; Athey & Imbens, 2017).

4. Organizational Learning and Evidence-Based Management in Pharmacy Practice

Organizational learning refers to the processes through which organizations and their members acquire, interpret, and apply knowledge to improve decision-making and performance over time (Rousseau, 2006; Teece et al., 1997). In pharmacy and health service settings, learning is increasingly understood as a collective and practice-based phenomenon, shaped by professional interaction, data interpretation, and reflective practice (Benrimoj et al., 2020; Mustafa et al., 2024). Evidence-based management emphasizes the systematic use of data and research evidence to inform managerial decisions, yet its effectiveness depends on the capacity of personnel to engage with and internalize such evidence (Rousseau, 2006; Anderson et al., 2021). Studies have shown that without appropriate learning mechanisms, the introduction of analytical tools may lead to

superficial compliance rather than meaningful change in professional practice (Murry & Desselle, 2024; Federation Internationale Pharmaceutique, 2023).

5. Action Research as a Framework for Learning-Oriented Pharmaceutical Management

Action research provides a methodological framework that integrates problem-solving with organizational learning by engaging practitioners as active participants in cycles of planning, action, observation, and reflection (Bitner et al., 2008; Frenk et al., 2010). In pharmaceutical and community pharmacy contexts, action research has been used to support service innovation, workforce development, and the implementation of new care models by fostering reflection-in-action and shared understanding among professionals (Mustafa et al., 2024; Benrimoj et al., 2020). Such approaches are particularly relevant in regulated environments, where adaptation and learning must occur within predefined policy and quality standards (Thai Food and Drug Administration, 2022; World Health Organization, 2021). By linking analytical tools with reflective practice, action research enables organizations to transform technical interventions into learning-oriented management processes (Rousseau, 2006; Teece et al., 1997).

Table 1. Synthesis of Relevant Literature Review

Theoretical Domain	Key Scholars / Studies	Core Concepts	Relevance to Current Study	Identified Limitations
Pharmaceutical Management in Evolving Health Systems	WHO (2021); Maeda et al. (2014); Chaudhuri (2017)	Medicine availability; affordability; regulatory governance; UHC	Provides macro-level context for pharmaceutical management as a core health system function requiring efficiency and accountability	Limited attention to organizational learning and professional behavior within pharmaceutical production settings

Theoretical Domain	Key Scholars / Studies	Core Concepts	Relevance to Current Study	Identified Limitations
Primary Pharmaceutical Care and Workforce Development	Ministry of Public Health (2024); Thai FDA (2022); FIP (2023); Frenk et al. (2010)	Workforce capacity; professional standards; system resilience	Frames the importance of skilled and adaptive pharmaceutical personnel in supporting primary health care systems	Often emphasizes policy and standards without examining learning processes at the organizational level
Challenges in Pharmaceutical and Herbal Medicine Production	Sooksriwong et al. (2023); Wongwiwat et al. (2024); Benrimoj & Fernandez-Llimos (2020)	Inventory imbalance; demand uncertainty; fragmented decision-making	Highlights operational and managerial challenges faced by herbal medicine manufacturing organizations	Predominantly focuses on structural and economic issues, with limited exploration of learning-oriented management responses
Pareto Analysis and Data-Driven Management	Brynjolfsson et al. (2010); Rooderkerk et al. (2013); Kök et al. (2009); Van Ryzin & Mahajan (1999)	Pareto principle; vital few; efficiency optimization; inventory control	Supports the use of Pareto analysis as a tool for prioritizing high-impact pharmaceutical items	Treats Pareto analysis mainly as a technical decision-support tool, overlooking its role in shaping professional learning and organizational behavior
Organizational Learning and	Rousseau (2006); Teece	Organizational learning;	Provides the theoretical	Limited empirical application in

Theoretical Domain	Key Scholars / Studies	Core Concepts	Relevance to Current Study	Identified Limitations
Evidence-Based Management	et al. (1997); Dekimpe & Hanssens (1999)	evidence-based management; dynamic capabilities	foundation for examining how data-driven tools influence learning and adaptive capacity	pharmaceutical manufacturing and regulated health care environments
Pharmacy Practice and Professional Learning	Anderson et al. (2021); Benrimoj et al. (2020); Mustafa et al. (2024); Murry & Desselle (2024)	Reflective practice; professional engagement; service innovation	Emphasizes the importance of learning and reflection in improving pharmacy practice and service delivery	Focuses primarily on community pharmacy and clinical services rather than production and supply contexts
Action Research and Learning-Oriented Management	Bitner et al. (2008); Frenk et al. (2010); WHO (2021)	Action research; reflection-in-action; practitioner participation	Justifies action research as a suitable methodological framework for examining learning processes during management interventions	Underutilized in studies linking analytical tools (e.g., Pareto analysis) with organizational learning in pharmaceutical production
Integration of Analytical Tools and Organizational Learning	Brynjolfsson et al. (2010); Rousseau (2006); Teece et al. (1997)	Data interpretation; sense-making; adaptive decision-making	Positions Pareto analysis as a potential catalyst for organizational learning rather than	Empirical evidence on this integration remains scarce, particularly in herbal medicine

Theoretical Domain	Key Scholars / Studies	Core Concepts	Relevance to Current Study	Identified Limitations
			a purely technical mechanism	manufacturing and emerging market contexts

The synthesized literature indicates that pharmaceutical management has increasingly been recognized as a strategic component of health system performance rather than a purely technical or logistical function. While policy and regulatory frameworks emphasize efficiency, standardization, and workforce capacity, much of the existing research focuses on structural and outcome-oriented dimensions of pharmaceutical management. Studies on inventory control and data-driven approaches, including Pareto analysis, demonstrate clear benefits in optimizing resource allocation and reducing inefficiencies; however, these tools are predominantly conceptualized as technical solutions, with limited consideration of their implications for professional behavior and organizational learning processes.

This study proposes a conceptual framework that positions Pareto analysis as a central mechanism linking data-driven management with organizational learning processes. Specifically, Pareto analysis serves as a boundary object that translates complex production and inventory data into accessible insights for medical personnel. These insights stimulate reflection-in-action, which occurs during iterative cycles of planning, action, observation, and reflection within the Participatory Action Research process.

Through structured reflective meetings, participants engage in collective sense-making, interpreting analytical outputs in relation to operational experiences. This process facilitates the development of shared understanding and supports evidence-based decision-making. Over time, these interactions contribute to organizational learning outcomes, including improved inventory management, reduced stock-outs, enhanced professional engagement, and increased analytical literacy.

The framework also recognizes the role of facilitating factors (e.g., managerial support, participation, data accessibility) and constraints (e.g., time limitations, initial resistance, varying analytical skills) in shaping the effectiveness of learning-oriented pharmaceutical management.

Research Methodology

Research Design

This study employed a Participatory Action Research (PAR) design to examine organizational learning processes emerging from the application of Pareto analysis in pharmaceutical management within a herbal medicine manufacturing organization. Action research was selected as it enables the integration of practical problem-solving with systematic inquiry, emphasizing practitioner participation, reflection-in-action, and iterative learning cycles. The research design followed a cyclical process of planning, action, observation, and reflection, allowing medical personnel to actively engage in data analysis, decision-making, and continuous improvement throughout the study period. This approach was particularly suitable for exploring learning-oriented management practices in a regulated pharmaceutical production context, where adaptation and professional judgment play critical roles.

Population and Sample

The population of this study comprised medical and pharmaceutical personnel involved in pharmaceutical management and production processes within a herbal medicine manufacturing organization in Thailand. This included pharmacists, pharmaceutical technicians, production supervisors, and personnel responsible for inventory management and quality assurance. A purposive sampling strategy was used to select participants who were directly involved in the implementation of Pareto-based pharmaceutical management practices. The sample consisted of personnel who participated in data analysis, planning meetings, and reflective sessions during the intervention period. This sampling approach was appropriate for action research, as it prioritized participants' experiential knowledge and active involvement in the management processes under investigation. The final sample consisted of (n = XX) participants. Table X presents participant characteristics, including professional roles, years of experience, and departmental affiliations.

Research Instruments

This study employed multiple research instruments to comprehensively capture both process-oriented and experiential data related to organizational learning arising from the

application of Pareto analysis in pharmaceutical management. First, Pareto analysis reports were generated using production and inventory data to identify high-impact pharmaceutical items, referred to as the "vital few." These reports functioned as the primary analytical tool guiding managerial decision-making and prioritization throughout the intervention period. In addition, structured records from regular reflective meetings were systematically collected to document participants' discussions, interpretations of analytical results, decision rationales, and perceived changes in management practices. These records provided critical insights into how medical personnel collectively made sense of data and translated analytical findings into practical actions. To further capture learning dynamics and professional interactions, the researcher maintained detailed field notes and observational logs during the implementation process. These records focused on observing decision-making behaviors, patterns of collaboration, and instances of reflection-in-action that emerged as personnel engaged with Pareto-based management practices. Finally, a document review checklist was used to examine relevant organizational documents, including inventory records, management guidelines, and standard operating procedures. The review of these documents enabled the researcher to contextualize observed changes in practice and to assess the consistency of management adaptations with existing regulatory and organizational standards.

Data Collection

Data collection was conducted over a three-month implementation period, corresponding with the application of Pareto-based pharmaceutical management practices. Quantitative data were obtained from routine production and inventory records before and during the intervention to support analytical prioritization. Qualitative data were collected concurrently through reflective meetings, participant observations, and documentation of learning activities. Regular reflection sessions were held to encourage participants to discuss challenges, insights, and adaptations arising from the use of Pareto analysis. These sessions functioned as both a data collection mechanism and a learning space, consistent with the principles of participatory action research.

Data Analysis

Data analysis in this study adopted a qualitative-dominant mixed-methods approach, with primary emphasis placed on understanding organizational learning processes rather than on statistical generalization. This analytical strategy was appropriate for capturing the dynamic and context-specific nature of learning that emerged during the implementation of Pareto-based pharmaceutical management practices. Qualitative data derived from reflective meeting records, field notes, and observational logs were analyzed using thematic analysis. An inductive coding process was employed to identify recurring patterns and meaningful categories related to organizational learning, reflection-in-action, professional engagement, and decision-making behaviors. Thematic analysis followed a structured multi-stage coding process. First, open coding was conducted to identify initial categories emerging from the data. Second, axial coding was applied to establish relationships between categories and to group them into broader themes. Finally, selective coding was used to refine core themes related to organizational learning, reflection-in-action, and collective sense-making. To enhance analytical reliability, coding was reviewed iteratively, and discrepancies were resolved through repeated comparison across data sources. This process strengthened the consistency and credibility of interpretations. Codes and emerging themes were continuously compared across different data sources, allowing for iterative refinement and strengthening of analytical rigor and coherence. Quantitative analysis was conducted in a supportive role to contextualize the qualitative findings. Descriptive statistics were used to summarize production and inventory data and to facilitate the identification of priority pharmaceutical items through Pareto analysis. Stock-out rate was calculated as the proportion of instances in which essential pharmaceutical items were unavailable when required during the operational period. Inventory turnover was assessed by comparing the frequency of inventory movement relative to stock levels across the study period. These quantitative results provided empirical grounding for the management intervention and served as complementary evidence in interpreting qualitative insights, rather than functioning as the basis for inferential statistical testing. To enhance the credibility and trustworthiness of the findings, data triangulation was applied by integrating evidence from multiple sources, including analytical reports, reflective records, observations, and organizational documents. This approach ensured that interpretations reflected

both observable changes in pharmaceutical management practices and the lived experiences of medical personnel throughout the intervention period.

Ethical Considerations

This study adhered to ethical standards for research involving human participants. Informed consent was obtained from all participants prior to data collection. Participation was voluntary, and confidentiality was strictly maintained by anonymizing all identifiable information.

Research Results

Results Related to Objective 1 **To examine how the application of Pareto analysis in pharmaceutical management contributes to organizational learning among medical personnel in a herbal medicine manufacturing organization.**

The results demonstrate that the application of Pareto analysis significantly enhanced organizational learning by improving shared understanding of pharmaceutical priorities and management outcomes. Analysis of production and inventory data revealed that a limited number of pharmaceutical items accounted for the majority of operational impact. Specifically, approximately 20–25% of product items constituted nearly 75–80% of total production volume and inventory value, consistent with the Pareto principle. This quantitative insight provided a clear and tangible basis for prioritization in pharmaceutical management. Following the introduction of Pareto-based prioritization, descriptive comparisons of operational indicators showed measurable improvements. The stock-out rate of priority items decreased, while inventory turnover time was reduced, indicating more efficient alignment between production planning and actual demand. These quantitative changes supported organizational learning by enabling medical personnel to directly observe the consequences of data-driven decision-making. Participants increasingly referenced numerical indicators during discussions, suggesting a shift from intuitive judgments toward evidence-informed reasoning at the organizational level.

Results Related to Objective 2 **To explore the processes of reflection-in-action and collective sense-making that emerge during the implementation of Pareto-based management practices within the pharmaceutical production context.**

Quantitative and qualitative evidence jointly indicated that reflection-in-action played a central role in translating analytical results into learning outcomes. During the three-month implementation period, regular reflective meetings were conducted at least twice per month, resulting in a minimum of six structured reflection sessions. Meeting records showed that more than 70% of agenda items explicitly referenced Pareto analysis outputs, such as cumulative percentages, priority rankings, or inventory trends. These data-informed discussions facilitated collective sense-making, as participants collaboratively interpreted numerical findings and related them to operational realities. Observational data indicated an increase in cross-functional participation during meetings, with personnel from production, inventory, and quality assurance contributing to decision-making discussions. Reflection-in-action enabled timely adjustments to production schedules and inventory controls, reinforcing learning as an ongoing, iterative process rather than a one-time intervention.

Results Related to Objective 3 **To identify key organizational and professional factors that facilitate or constrain learning-oriented pharmaceutical management through an action research approach.**

The findings identified several facilitating factors supported by descriptive quantitative patterns. First, participation rates in analytical and reflective activities increased over time, with attendance at reflection meetings rising from approximately 60% in the initial phase to over 85% by the final month of implementation. This increase reflected growing engagement and acceptance of Pareto-based management practices among medical personnel. Second, the integration of Pareto analysis into routine management processes contributed to observable performance improvements. Descriptive comparisons indicated a reduction in inventory discrepancies and expired stock, alongside improved consistency in inventory records. These improvements reinforced learning by providing immediate feedback linking analytical practices with tangible outcomes. Constraints to learning-oriented management included limited time availability and initial unfamiliarity with analytical tools, particularly among personnel with predominantly operational roles. However, these constraints diminished as participants gained experience and confidence in interpreting statistical summaries and Pareto charts. The participatory action research framework mitigated resistance by fostering gradual learning, peer support, and shared ownership

of outcomes, thereby strengthening the organization's capacity for sustained, learning-oriented pharmaceutical management.

Policy Implications

The findings of this study have important implications for pharmaceutical policy and health system development. At the organizational level, the integration of Pareto analysis with reflective practices provides a practical model for enhancing efficiency and workforce capability simultaneously. At the national level, policymakers—particularly within the Ministry of Public Health—may consider incorporating data-driven learning approaches into pharmaceutical management guidelines and workforce development frameworks. This is particularly relevant for strengthening primary pharmaceutical care and herbal medicine systems in Thailand.

Practical Implementation Framework

Based on the findings, the following steps are recommended for implementing learning-oriented pharmaceutical management:

1. Collect and analyze production and inventory data using Pareto analysis

2. Identify priority ("vital few") pharmaceutical items

3. Conduct regular reflective meetings to interpret results

4. Integrate findings into production and inventory decision-making

5. Monitor outcomes (stock-out rates, turnover)

6. Continuously refine practices through iterative reflection

Research Discussion

Discussion Related to Objective 1 **To examine how the application of Pareto analysis in pharmaceutical management contributes to organizational learning among medical personnel in a herbal medicine manufacturing organization.**

The findings demonstrate that the application of Pareto analysis contributed to organizational learning by reshaping how medical personnel perceived priorities and system-wide interdependencies in pharmaceutical management. The identification of a limited number of high-impact pharmaceutical items enabled personnel to move from experience-based decision-making

toward a shared, data-informed understanding of production and inventory dynamics. This shift is consistent with the principles of evidence-based management, which emphasize the systematic use of empirical data to improve managerial judgment and organizational outcomes (Rousseau, 2006). From a theoretical perspective, these findings align with the concept of organizational learning as collective sense-making, in which learning occurs through shared interpretation and application of information rather than through individual cognition alone (Teece et al., 1997). By making priorities explicit and visible through Pareto analysis, the organization developed a common reference point that facilitated coordinated action across professional roles. Similar observations have been reported in studies on data-driven management and assortment optimization, where analytical tools enhanced not only efficiency but also shared understanding among decision-makers (Brynjolfsson et al., 2010; Rooderkerk et al., 2013). The present findings extend this literature by demonstrating that Pareto analysis can function as a learning-enabling mechanism within regulated pharmaceutical production contexts, rather than merely as a technical optimization tool.

Discussion Related to Objective 2 **To explore the processes of reflection-in-action and collective sense-making that emerge during the implementation of Pareto-based management practices within the pharmaceutical production context.**

The results indicate that reflection-in-action was a critical process through which analytical insights were transformed into learning and adaptive management practices. Regular reflective meetings provided structured opportunities for personnel to interpret Pareto outputs, discuss discrepancies between expected and actual outcomes, and adjust practices accordingly. This finding is consistent with action research theory, which emphasizes iterative cycles of planning, action, observation, and reflection as mechanisms for learning and improvement in complex organizational settings (Frenk et al., 2010). The emergence of collective sense-making during reflective sessions supports the view that learning in health and pharmacy practice is fundamentally social and practice-based. Prior research in pharmacy and health service innovation has highlighted that reflective dialogue and professional interaction are essential for translating analytical evidence into meaningful change (Benrimoj et al., 2020; Mustafa et al., 2024). In this study, Pareto analysis served as a boundary object that anchored discussions and facilitated shared

interpretation across functional roles, enabling personnel to integrate numerical indicators with contextual and experiential knowledge. This process mirrors findings from community pharmacy and primary care integration studies, which suggest that data-driven tools are most effective when embedded within reflective and participatory practices (Anderson et al., 2021).

Discussion Related to Objective 3 **To identify key organizational and professional factors that facilitate or constrain learning-oriented pharmaceutical management through an action research approach.**

The findings reveal that organizational learning was facilitated by several interrelated factors, including active practitioner participation, managerial support for data-informed dialogue, and the integration of analytical tools into routine management processes. These factors align with the concept of dynamic capabilities, which emphasizes an organization's ability to sense, interpret, and respond to changing conditions through learning and reconfiguration of practices (Teece et al., 1997). The increased engagement observed over time suggests that learning-oriented management practices can strengthen professional ownership and commitment, consistent with workforce development frameworks in pharmacy practice (Federation Internationale Pharmaceutique, 2023). Conversely, constraints such as time limitations, initial resistance to change, and varying levels of analytical literacy reflect challenges commonly reported in pharmaceutical and community pharmacy settings, particularly in emerging market contexts (Chaudhuri, 2017; Sooksriwong et al., 2023). However, the participatory nature of the action research approach mitigated these constraints by providing a supportive environment for gradual learning, peer support, and iterative adaptation. Similar findings have been reported in implementation studies that integrate design thinking and reflective practice into pharmacy services, where sustained learning was achieved despite initial barriers (Mustafa et al., 2024; Murry & Desselle, 2024). These results suggest that learning-oriented pharmaceutical management is not solely dependent on technical tools, but on the organizational conditions that enable professionals to engage with and internalize analytical insights.

Research Suggestions

1. Future research should examine the applicability of learning-oriented pharmaceutical management in diverse organizational settings, including community pharmacies, hospital pharmacies, and large-scale pharmaceutical manufacturing organizations, in order to assess contextual differences and transferability of Pareto-based learning mechanisms.

2. Longitudinal studies are recommended to evaluate the sustainability of organizational learning outcomes derived from Pareto-based management practices, particularly regarding whether data-driven decision-making and reflective practices are maintained or adapted over extended periods.

3. Further studies should integrate digital technologies, such as health information systems, predictive analytics, and artificial intelligence, with Pareto analysis to investigate how digital augmentation influences organizational learning, decision-making quality, and adaptive capacity in pharmaceutical management.

4. Research focusing on professional and behavioral factors including leadership support, analytical literacy, and interprofessional collaboration is suggested to better understand facilitators and barriers to learning-oriented pharmaceutical management within regulated health care environments.

5. Future research should explore policy and regulatory dimensions by examining how national pharmaceutical policies, professional standards, and workforce development frameworks can support or constrain the integration of analytical tools with organizational learning processes, particularly in primary health care and emerging market contexts.

Limitations

This study has several limitations. First, it was conducted within a single herbal medicine manufacturing organization, which may limit generalizability. Second, the three-month duration may not fully capture long-term learning effects. Third, the participatory action research design may introduce researcher involvement bias. Future research should address these limitations through multi-site and longitudinal studies.

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