AI-Driven Pharmacy Optimisation Management System

Aryav Odhrani
Extended Project Qualification

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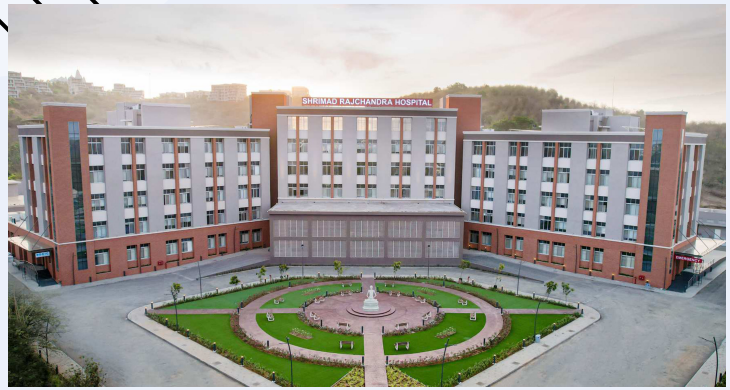
01

INTRODUCTION

MOTIVATION



Why Critical Medicine Access?

The difference between recovery and relapse.

Struggle of Millions

The struggle is a systemic failure, faced by millions in India. Increasing critical medicine access resolves extreme inadequacy of services and directly improves livelihoods of underserved populations.

National Economy

Investment into AI advancements yields long-term returns to India's economy. A scalable national system supports the world's largest producer of generic medicines.

In 2024, U.S. healthcare spending exceeded

$4.5 trillion

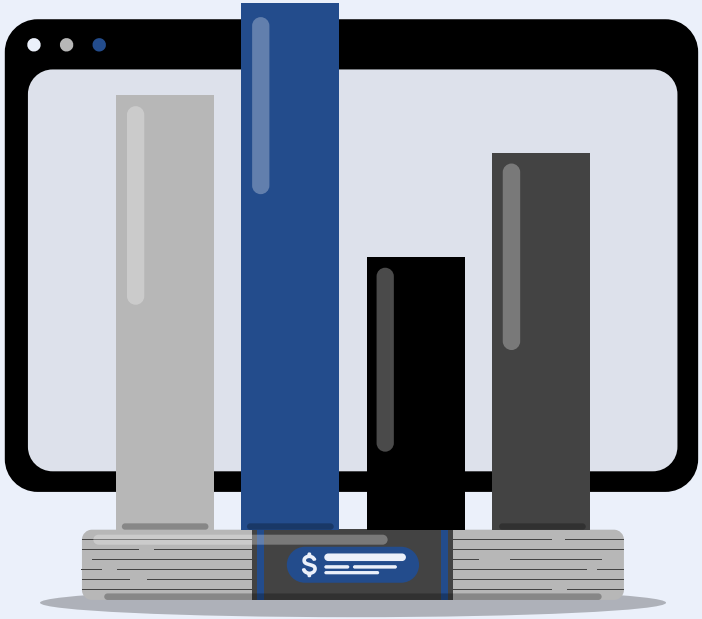
20% of total GDP

(Market Data Forecast, 2025)

AIMS

- Develop a prototype for a platform-agnostic, AI-driven pharmacy optimization system designed to improve the daily operations of charitable hospitals

- Improve efficiency in healthcare distribution and increase access to critical medicines in underserved regions of India



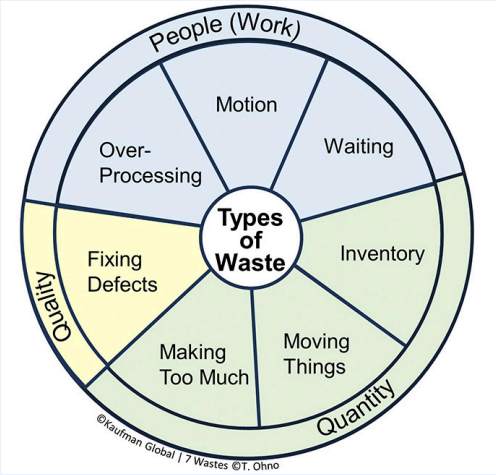
02

RESEARCH REVIEW

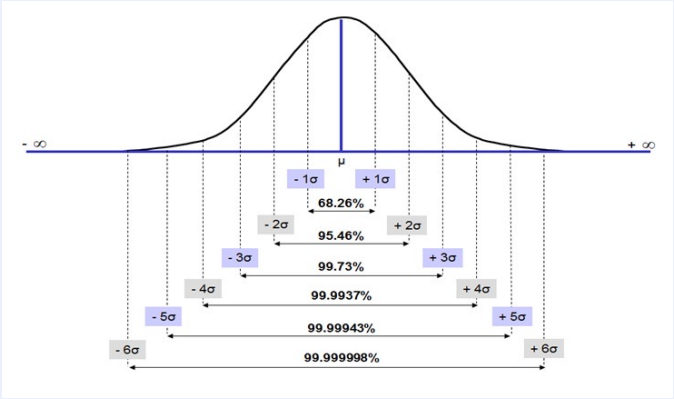
ITOR & PNP

- Inventory turnover rate (ITOR): total cost of products sold / average value of inventory
- Percent net profit (PNP): net profit / average value of inventory
- Higher = correct order quantities, greater profit margins, better management

(Ali, 2011)



(Kaufman Global, n.d.)



(International Six Sigma Institute, n.d.)

Lean Six Sigma

- Continuous, small improvements in all stages of production
- Lean Management: ***Kaizen*** & seven ***muda***
- Six Sigma: 99.99966% perfection
- Toyota, Motorola, General Electric
- DMAIC, DMADV, CTQ, SIPOC, PCE, WIP Cap+++

(Wikipedia, 2025), (Chittenden, n.d.), (George, 2010)

Other Solutions

Economic Order Quantity (EOQ)

$$\sqrt{\frac{2DC}{H}}$$

where D is the annual demand (units), C is the cost per order for that medicine, and H is the annual per unit holding cost

ABC-VED Matrix Analysis

ABC-VED Matrix

ABC \ VED	V	E	D
A	AV	AE	AD
B	BV	BE	BD
C	CV	CE	CD

Double Exponential Smooth / Double Moving Average

$$\hat{y}_{t+h|t} = l_t + hb_t,$$
$$l_t = \alpha y_t + (1-\alpha)(l_{t-1} + b_{t-1}),$$
$$b_t = \beta(l_t - l_{t-1}) + (1-\beta)b_{t-1},$$

$$S'_t = \alpha D_t + (1-\alpha)S'_{t-1},$$
$$S''_t = \alpha S'_t + (1-\alpha)S''_{t-1},$$
$$a_t = S'_t + (S'_t - S''_t),$$
$$b_t = \frac{\alpha}{1-\alpha}(S'_t - S''_t),$$
$$F_{t+m} = a_t + b_t$$

(Rachmania & Basri, 2013), (Anusha, 2025), (Jaju, et al., 2023), (Deressa, et al., 2022), (Christopher, 2021), (Hyndman & Athanasopoulos, n.d.)

03

MODEL

MODELS

Optimisation Management

- Demand Forecasting
- Stockout Risk Classification
- Expiry Risk Classification
- Holistic Reporting
- Python, TensorFlow & Jupyter Notebook

Vendor Management

- Vendor Data Ingestion
- Order Processing
- Stock Analysis
- Prescription Analysis
- JavaScript, Node.js, MongoDB, VS Code

DATA: 14 spreadsheets, 7 months, sale & stock levels, IP & OP

SHRIMAD RAJCHANDRA HOSPITAL AND RESEARCH CENTRE (A Unit of Shrimad Rajchandra Sarvamangal Trust)

Dharampur Bypass Road, Bilpudi, Dharampur ,Valsad ,Gujarat, India - 396050

Pharmacy Daily Sales Report (SRST-IP PHARMACY)

From Date: 01-11-2025 **To Date:** 21-11-2025

S.No	Item code	Item Name	Item Description	Vendor Name	Manufacturer Name	UOM	Item Type	Sales Qty	Unit Price	MRP	Net Rate	Current stock
1	ORD22003950	10ML SYRINGE BD	10ML SYRINGE BD 21G X 1"	GAYATRI DISTRIBUTORS(VALSAD)	BD INDIA PVT LTD	Numbers		26	7.62	37	7.62	952
2	ORD22003691	10ML SYRINGE WITH NEEDLE 21G X1.5"	10ML SYRINGE WITH NEEDLE 21G X1.5"	VARDHMAN ENTERPRISE (VALSAD)	DISPOVAN	Numbers	SURGICAL	13356	3.74	13	3.74	13867
3	ORD22003522	10ML SYRINGE WITH NEEDLE 21G X1"(LL)	10ML SYRINGE WITH NEEDLE 21G X1 (LL)	GAYATRI DISTRIBUTORS(VALSAD)	BD INDIA PVT LTD	Numbers	SURGICAL	3	12.34	44	12.34	160
4	ORD22003836	1ML SYRINGE WITH NEEDLE 26G X 1/2(DISPO VAN)	1ML SYRINGE 26G X 1/2/0.45X13 MM	VARDHMAN ENTERPRISE (VALSAD)	DISPOVAN	Numbers	SURGICAL	2041	3.43	10	3.43	1992
5	ORD22003694	20ML SYRINGE WITHOUT NEEDLE	20ML SYRINGE WITHOUT NEEDLE	GRACE PHARMA (DHARAMPUR)	P.H. HEALTH CARE	Numbers	SURGICAL	268	7.5	19	7.5	392
6	ORD22004165	2ML SYRINGE WITH NEEDLE 24GX1"	2ML SYRINGE WITH NEEDLE 24GX1"	VARDHMAN ENTERPRISE (VALSAD)	DISPOVAN	Numbers	SURGICAL	713	1.77	5	1.77	1011
7	ORD22000682	3ML SYRINGE NEEDLE 24G X 1 (LL)	3ML SYRINGE NEEDLE 24G X 1 (LL)	GAYATRI DISTRIBUTORS(VALSAD)	BD INDIA PVT LTD	Numbers	SURGICAL	6	8.11	30	8.11	98
8	ORD22003692	3ML SYRINGE WITH NEEDLE 24G X 1"	3ML SYRINGE WITH NEEDLE 24G X 1"	VARDHMAN ENTERPRISE (VALSAD)	DISPOVAN	Numbers	SURGICAL	8129	1.96	9	1.96	9039
9	ORD22004225	3 WAY STOP COCK	3WAY STOP COCK	VARDHMAN ENTERPRISE (VALSAD)	DISPOVAN	Numbers	SURGICAL	155	7.5	128	7.5	176
10	ORD22000747	50ML SYRINGE BD (L L)	50ML SYRINGE BD (L L)	GAYATRI DISTRIBUTORS(VALSAD)	BD INDIA PVT LTD	Numbers	SURGICAL	2	46.66	170	46.66	88
11	ORD22003857	50ML SYRINGE WITHOUT NEEDLE	50ML SYRINGE WITHOUT NEEDLE	VARDHMAN ENTERPRISE (VALSAD)	DISPOVAN	Numbers	SURGICAL	1451	18	62	18	2006
12	ORD22003654	5ML SYRINGE WITH NEEDLE 23G X1"(LL)	5ML SYRINGE WITH NEEDLE 23G X1"(LL)	GAYATRI DISTRIBUTORS(VALSAD)	BD INDIA PVT LTD	Numbers	SURGICAL	8	8.74	29	8.74	248
13	ORD22003677	5ML SYRINGE WITH NEEDLE 24G X1"	5ML SYRINGE WITH NEEDLE 24G X1"	VARDHMAN ENTERPRISE (VALSAD)	DISPOVAN	Numbers	SURGICAL	7824	2.3	10	2.3	9764
14	ORD22004282	8X SHAMPOO 120ML	CICLOPIROX AND ZINC PYRITHIONE	LIFECARE MEDICAL AGENCY (SURAT)	CIPLA LTD	Numbers	COSMETIC & PROVISONAL	1	279.43	539	279.43	0
15	ORD22003967	ABDOMINAL BELT (L)	ABDOMINAL BELT (L)	PARIDHI AGENCIES (VALSAD)	VISSCO REHABILITATION AIDS P.LTD.	Numbers	ORTHO APPLIANCES	1	446.2	970	446.2	2
16	ORD22002929	ABDOMINAL BELT (M)	ABDOMINAL BELT (M)	PARIDHI AGENCIES (VALSAD)	VISSCO REHABILITATION AIDS P.LTD.	Numbers	ORTHO APPLIANCES	1	446.2	970	446.2	9
17	ORD22008305	ABDOMINAL BELT (S)	ABDOMINAL BELT (S)	PARIDHI AGENCIES (VALSAD)	VISSCO REHABILITATION AIDS P.LTD.	Numbers		1	358.8	780	358.8	2
18	ORD22005220	ABDOMINAL BELT (XL)	ABDOMINAL BELT (XL)	PARIDHI AGENCIES (VALSAD)	VISSCO REHABILITATION AIDS P.LTD.	Numbers	ORTHO APPLIANCES	3	446.2	970	446.2	3
19	ORD22004136	ABDOMINAL BELT (XXL)	ABDOMINAL BELT (XXL)	PARIDHI AGENCIES (VALSAD)	VISSCO REHABILITATION AIDS P.LTD.	Numbers	ORTHO APPLIANCES	1	446.2	970	446.2	3
20	ORD22008041	ABG SYRING 3ML (BD) REF. 364391	ABG SYRING 3ML (BD) REF. 364391	HINDUSTAN ENTERPRISE (SURAT)	BD INDIA PVT LTD	Numbers		13	35	143	35	104
21	ORD22003707	ADULT DIAPERS (L)	ADULT DIAPERS (L)	VARDHMAN ENTERPRISE (VALSAD)	HEALTHSHINE INDIA PVT LTD	Numbers	OTHER	72	18.5	51	18.5	306
22	ORD22003764	ADULT DIAPERS (M)	ADULT DIAPERS (M)	VARDHMAN ENTERPRISE (VALSAD)	HEALTHSHINE INDIA PVT LTD	Numbers	OTHER	186	17.5	46	17.5	249

```python
# 3 Normalize Sales and Stock (scale 0-1)
scalers = {}  # dictionary to keep scaler per medicine
medicines = df["Medicine"].unique()

for med in medicines:
    df_med = df[df["Medicine"] == med]
    scaler = MinMaxScaler()
    df.loc[df["Medicine"] == med, ["Sales", "Stock"]] = scaler.fit_transform(df_med[["Sales", "Stock"]])
    scalers[med] = scaler

# 4 Create sequences for LSTM
def create_sequences(df_med, history_window=3):
    X, y = [], []
    sales_stock = df_med[["Sales", "Stock"]].values
    for i in range(len(sales_stock) - history_window):
        X.append(sales_stock[i:i+history_window])
        y.append(sales_stock[i+history_window, 0])  # predict next month sales
    return np.array(X), np.array(y)

# Example for one medicine
med = medicines[0]
df_med = df[df["Medicine"] == med].reset_index(drop=True)
X, y = create_sequences(df_med, history_window=3)

# 5 Build LSTM model for 1 medicine
model = Sequential()
model.add(LSTM(50, activation='relu', input_shape=(X.shape[1], X.shape[2])))
model.add(Dense(1))
model.compile(optimizer='adam', loss='mse')

# 6 Train LSTM model for 1 medicine
es = EarlyStopping(monitor='loss', patience=5, restore_best_weights=True)
model.fit(X, y, epochs=50, batch_size=1, verbose=2, callbacks=[es])
```

DEMAND FORECASTING

- Predictive analytics through LSTM and Linear Regression (supervised machine learning)
- EACH medicine is a sample/model of its own
  - Input: sequence of sales and stock levels datapoints for the past N months
  - Output: predicted sales level for the next month

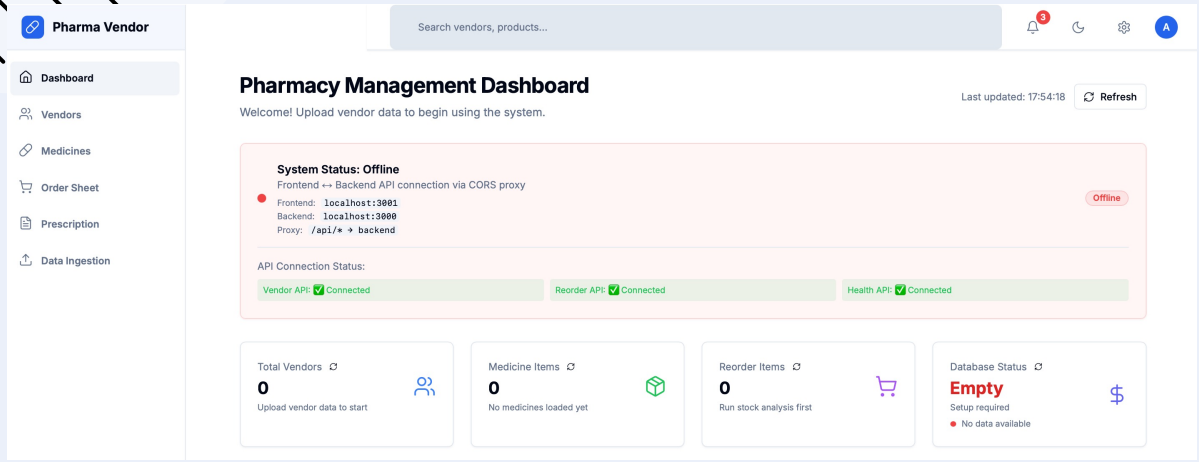
Code	Item	LastMonthSales	PredictedNextMonthSales
98	BETAKIND GARGLE 2%	135	196.8571429
751	INJ T T (BETT) 0.5ML	109	93.57142857
977	NEEDLE NO 18 X 1.5"	1220	1426.428571
1180	SUCTIONPRO72 NO 14FR TT (REFZ216-14)	13	13.42857143
1841	TAB LINOKEM 600MG	33	28.71428571

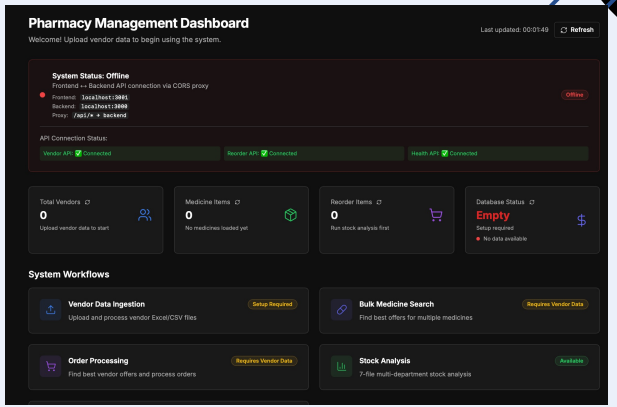
STOCKOUT/EXPIRY RISK CLASSIFICATION

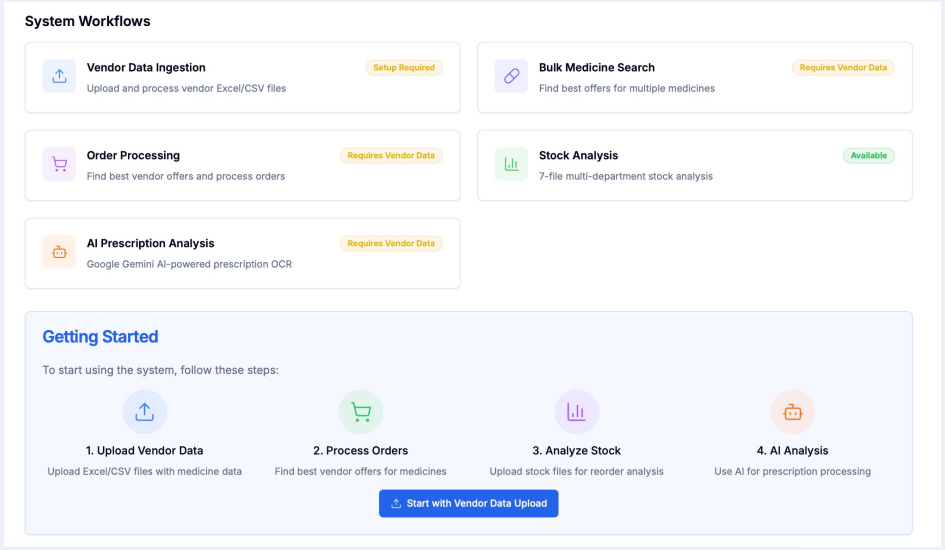
```
# FORMULA:
# RequiredStock = PredictedDemand × SafetyMultiplier
# SafetyMultiplier = 1.5 → 2.0
# ProcurementQty = max( RequiredStock – CurrentStock , 0 )

def calc_order_qty(row):
    demand = row["PredictedNextMonthSales"]
    stock = row["Stock"]

    target = demand * 2.0  # safety buffer: 2 months worth

    return max(target - stock, 0)

df["SuggestedOrderQty"] = df.apply(calc_order_qty, axis=1)
```

- Five categories: High Risk (no stock), High Risk, Moderate Risk, Safe, Overstock / Expiry Risk
- Compares classification, predicted sales & existing stock
- Generates suggested procurement quantities

Item	LastMonthSales	PredictedNextMonthSales	Stock	RiskCategory	SuggestedOrderQty
BETAKIND GARGLE 2%	135	196.8571429	187	HIGH RISK	206.7142857
INJ T T (BETT) 0.5ML	109	93.57142857	92	HIGH RISK	95.14285714
NEEDLE NO 18 X 1.5"	1220	1426.428571	1268	HIGH RISK	1584.857143
SUCTIONPRO72 NO 14FR TT (REFZ216-14)	13	13.42857143	36	SAFE	0
TAB LINOKEM 600MG	33	28.71428571	36	MODERATE RISK	21.42857143


Pharma Vendor
Search vendors, products...
Dashboard
Vendors
Medicines
Order Sheet
Prescription
Data Ingestion
Pharmacy Management Dashboard
Welcome! Upload vendor data to begin using the system.
Last updated: 17:54:18
Refresh
System Status: Offline
Frontend ↔ Backend API connection via CORS proxy
Frontend: localhost:3001
Backend: localhost:3000
Proxy: /api/* → backend
Offline
API Connection Status:
Vendor API: Connected
Reorder API: Connected
Health API: Connected
Total Vendors
0
Upload vendor data to start
Medicine Items
0
No medicines loaded yet
Reorder Items
0
Run stock analysis first
Database Status
Empty
Setup required
No data available


Pharmacy Management Dashboard
Welcome! Upload vendor data to begin using the system.
Refresh
System Status: Offline
Frontend ↔ Backend API connection via CORS proxy
Offline
API Connection Status:
Vendor API: Connected
Reorder API: Connected
Health API: Connected
Total Vendors
0
Medicine Items
0
No medicines loaded yet
Reorder Items
0
Run stock analysis first
Database Status
Empty
Setup required
No data available
System Workflows
Vendor Data Ingestion
Upload and process vendor Excel/CSV files
Setup Required
Bulk Medicine Search
Find best offers for multiple medicines
Requires Vendor Data
Order Processing
Find best vendor offers and process orders
Requires Vendor Data
Stock Analysis
7-file multi-department stock analysis
Available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Setup Required
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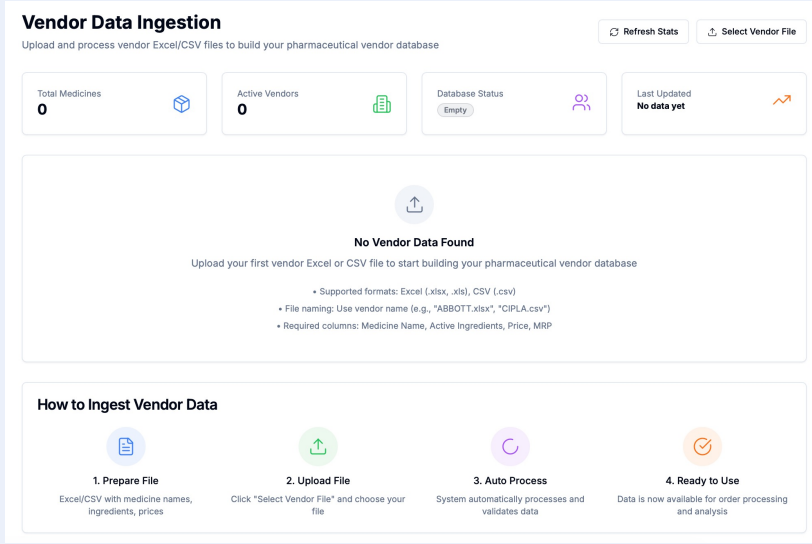
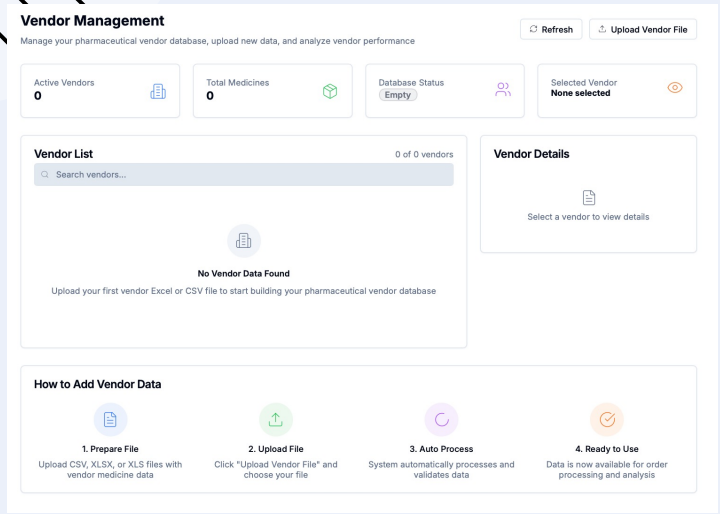
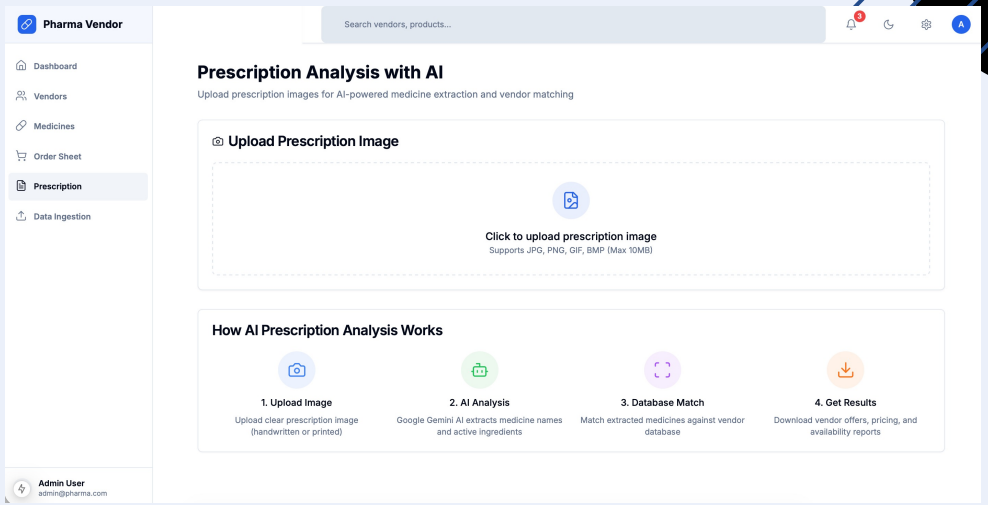
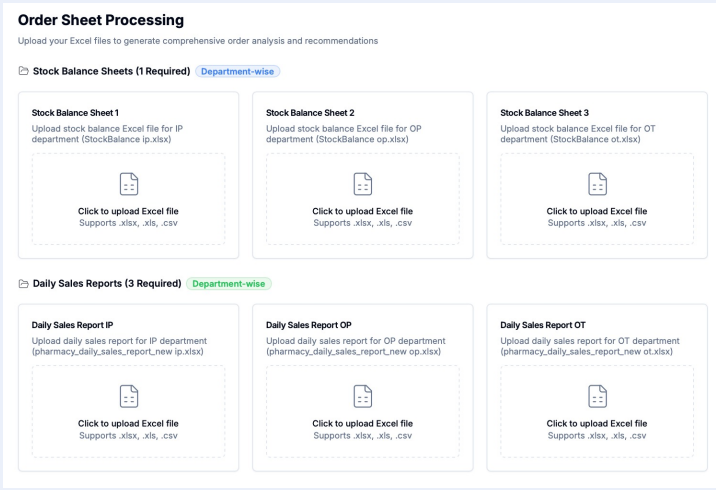
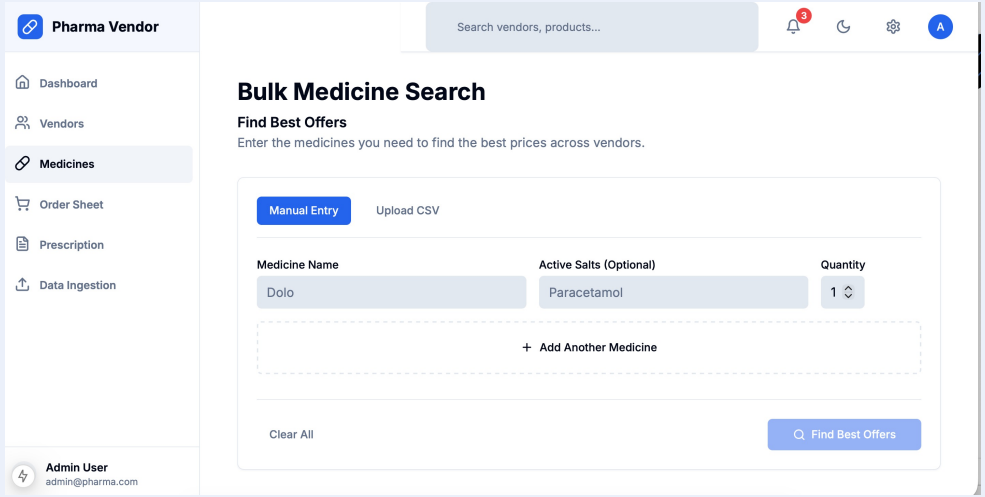
Find best offers for multiple medicines
Requires Vendor Data
Order Processing
Find best vendor offers and process orders
Requires Vendor Data
Stock Analysis
7-file multi-department stock analysis
Available
AI Prescription Analysis
Google Gemini AI-powered prescription OCR
Requires Vendor Data
Getting Started
To start using the system, follow these steps:
1. Upload Vendor Data
Upload Excel/CSV files with medicine data
2. Process Orders
Find best vendor offers for medicines
3. Analyze Stock
Upload stock files for reorder analysis
4. AI Analysis
Use AI for prescription processing
Start with Vendor Data Upload

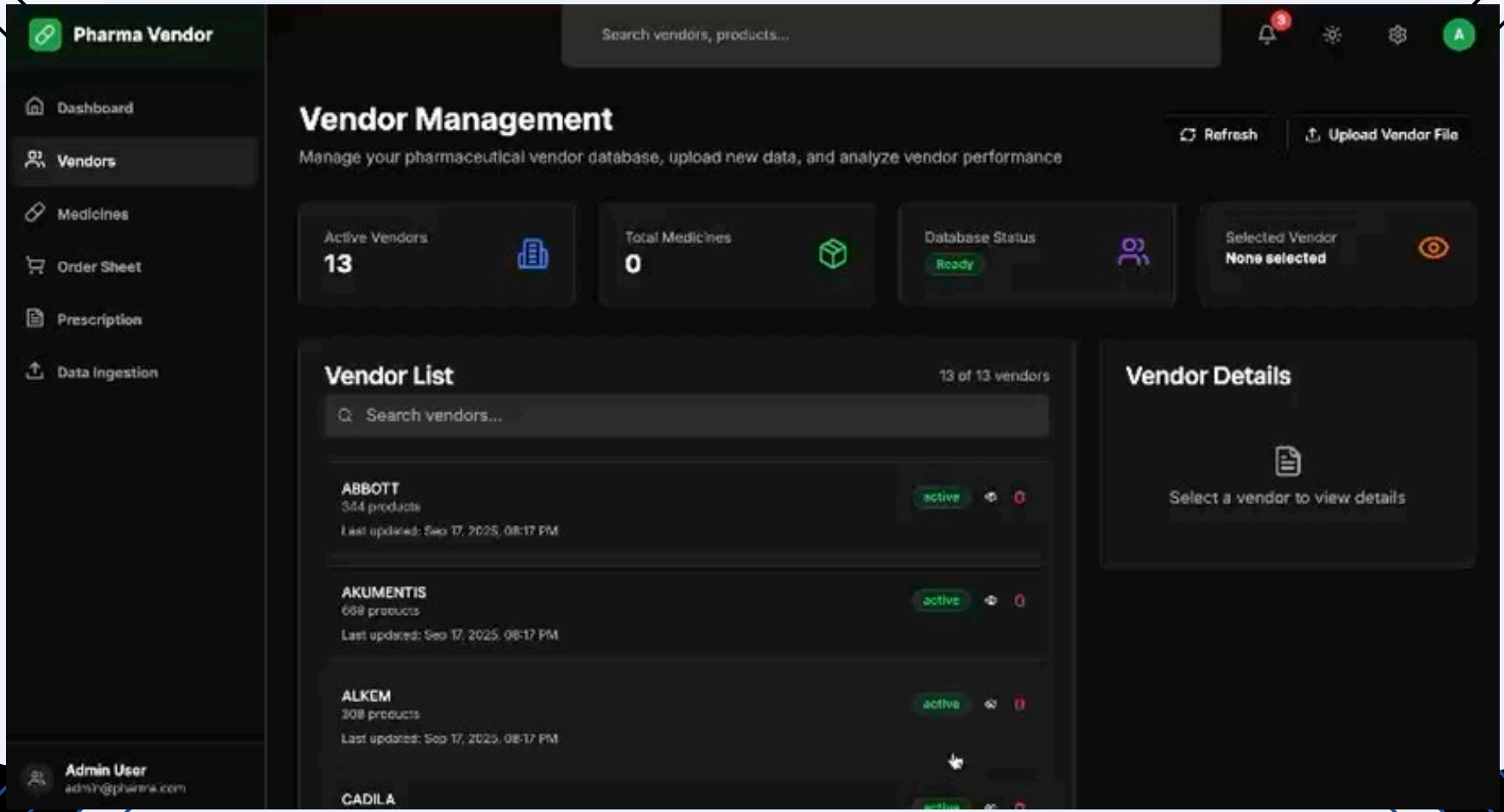

Vendor Data Ingestion
Upload and process vendor Excel/CSV files to build your pharmaceutical vendor database
Refresh Stats
Select Vendor File
Total Medicines
0
Active Vendors
0
Database Status
Empty
Last Updated
No data yet
No Vendor Data Found
Upload your first vendor Excel or CSV file to start building your pharmaceutical vendor database
• Supported formats: Excel (.xlsx, .xls), CSV (.csv)
• File naming: Use vendor name (e.g., "ABBOTT.xlsx", "CIPLA.csv")
• Required columns: Medicine Name, Active Ingredients, Price, MRP
How to Ingest Vendor Data
1. Prepare File
Excel/CSV with medicine names, ingredients, prices
2. Upload File
Click "Select Vendor File" and choose your file
3. Auto Process
System automatically processes and validates data
4. Ready to Use
Data is now available for order processing and analysis


Vendor Management
Manage your pharmaceutical vendor database, upload new data, and analyze vendor performance
Refresh
Upload Vendor File
Active Vendors
0
Total Medicines
0
Database Status
Empty
Selected Vendor
None selected
Vendor List
0 of 0 vendors
Search vendors...
No Vendor Data Found
Upload your first vendor Excel or CSV file to start building your pharmaceutical vendor database
Vendor Details
Select a vendor to view details
How to Add Vendor Data
1. Prepare File
Upload CSV, XLSX, or XLS files with vendor medicine data
2. Upload File
Click "Upload Vendor File" and choose your file
3. Auto Process
System automatically processes and validates data
4. Ready to Use
Data is now available for order processing and analysis


Pharma Vendor
Search vendors, products...
Dashboard
Vendors
Medicines
Order Sheet
Prescription
Data Ingestion
Admin User
admin@pharma.com
Prescription Analysis with AI
Upload prescription images for AI-powered medicine extraction and vendor matching
Upload Prescription Image
Click to upload prescription image
Supports JPG, PNG, GIF, BMP (Max 10MB)
How AI Prescription Analysis Works
1. Upload Image
Upload clear prescription image (handwritten or printed)
2. AI Analysis
Google Gemini AI extracts medicine names and active ingredients
3. Database Match
Match extracted medicines against vendor database
4. Get Results
Download vendor offers, pricing, and availability reports


Order Sheet Processing
Upload your Excel files to generate comprehensive order analysis and recommendations
Stock Balance Sheets (1 Required)
Department-wise
Stock Balance Sheet 1
Upload stock balance Excel file for IP department (StockBalance ip.xlsx)
Click to upload Excel file
Supports .xlsx, .xls, .csv
Stock Balance Sheet 2
Upload stock balance Excel file for OP department (StockBalance op.xlsx)
Click to upload Excel file
Supports .xlsx, .xls, .csv
Stock Balance Sheet 3
Upload stock balance Excel file for OT department (StockBalance ot.xlsx)
Click to upload Excel file
Supports .xlsx, .xls, .csv
Daily Sales Reports (3 Required)
Department-wise
Daily Sales Report IP
Upload daily sales report for IP department (pharmacy_daily_sales_report_new ip.xlsx)
Click to upload Excel file
Supports .xlsx, .xls, .csv
Daily Sales Report OP
Upload daily sales report for OP department (pharmacy_daily_sales_report_new op.xlsx)
Click to upload Excel file
Supports .xlsx, .xls, .csv
Daily Sales Report OT
Upload daily sales report for OT department (pharmacy_daily_sales_report_new ot.xlsx)
Click to upload Excel file
Supports .xlsx, .xls, .csv


Pharma Vendor
Search vendors, products...
Dashboard
Vendors
Medicines
Order Sheet
Prescription
Data Ingestion
Admin User
admin@pharma.com
Bulk Medicine Search
Find Best Offers
Enter the medicines you need to find the best prices across vendors.
Manual Entry
Upload CSV
Medicine Name
Dolo
Active Salts (Optional)
Paracetamol
Quantity
1
Add Another Medicine
Clear All
Find Best Offers


Pharma Vendor
Search vendors, products...
Dashboard
Vendors
Medicines
Order Sheet
Prescription
Data Ingestion
Vendor Management
Manage your pharmaceutical vendor database, upload new data, and analyze vendor performance
Refresh
Upload Vendor File
Active Vendors
13
Total Medicines
0
Database Status
Ready
Selected Vendor
None selected
Vendor List
13 of 13 vendors
Search vendors...
ABBOTT
344 products
Last updated: Sep 17, 2025, 08:17 PM
active
AKUMENTIS
669 products
Last updated: Sep 17, 2025, 08:17 PM
active
ALKEM
308 products
Last updated: Sep 17, 2025, 08:17 PM
active
CADILA
Vendor Details
Select a vendor to view details
Admin User
admin@pharma.com

04

CONCLUSION & EVALUATION

Quantitative Impact Stats

25,000

hours of manual labour saved & redirected towards better service quality

$35,000

Cost savings annually from less medicine wastage, better vendor deals, and more

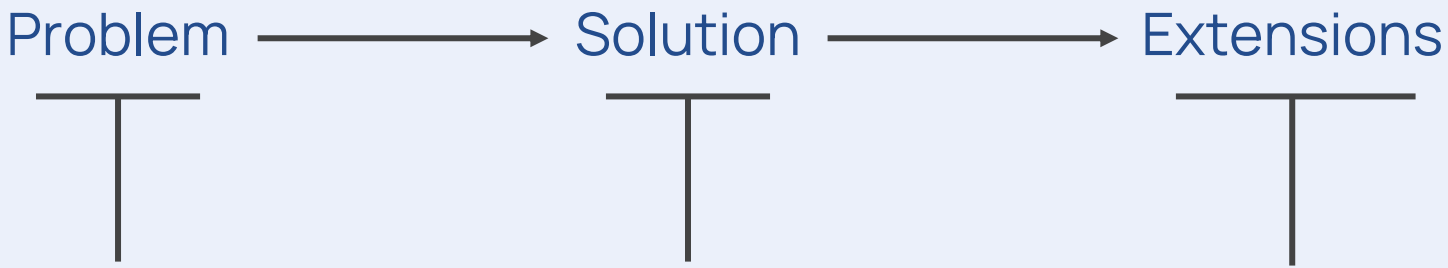
25,000

Low-income patients in multiple states benefitted each month

6,000

Unique medicines (SKUs) managed better provided to patients more effectively

What have I told you today?



- Medicine unavailability
- Distribution inefficiencies
- Trillion-dollar markets suffering

- Existing solutions
- Demand forecasting
- Integrated, scaleable platforms: POMS/PVMS

?

Further Study

Deep Learning Models

Scaling Globally

Business Management

THE CORE TAKEAWAY:

AI-driven pharmacy optimisation platforms can enhance operational efficiency and reduce costs in healthcare systems.

THANK YOU!

Do you have any questions?