Insights & Storytelling Report

Introduction :

Healthcare organizations operate in complex environments where operational efficiency directly impacts patient outcomes, and staff well-being. In order to maintain excellent service quality, hospitals must constantly balance patient demand, staff availability, and infrastructural capacity.

This Business Intelligence system was developed for a town hospital facing operational inefficiencies such as long patient waiting times, uneven workload distribution among doctors and departments, and declining patient satisfaction.

Designed using a dataset of 12,000 patient visits, the project provides hospital management with data-driven insights into patient flow, doctor utilization, departmental capacity, and service quality.

This report's objective are to interpret the analytical findings, explain their significance from a business standpoint, and offer practical suggestions to enhance hospital operations and patient satisfaction.

Methodology :

This project follows a classical Business Intelligence lifecycle :
Business Understanding → Data Preparation → Data Modeling → Visualization → Insights.

The process begins with the identification of a core business event (a patient visit) which serves as the foundation for data modeling and analysis.

Raw operational data was generated and processed using Python, transformed through an ETL pipeline, and stored in a PostgreSQL database designed using a dimensional star schema.

Analytical queries and DAX measures were then applied to support interactive visualization in Power BI.

Data Overview :

The analysis is based on a fact table representing individual patient visits, where each row corresponds to a single appointment handled by a doctor in a department during a specific shift.

The dataset includes time-based metrics, operational capacity indicators, doctor workload measures, and patient satisfaction scores.

The KPIs selected for this BI solution were designed to reflect both operational efficiency and service quality.

- Patient waiting time
- Department demand and capacity
- Doctor utilization and productivity
- Patient satisfaction and service quality

Key Findings :

- ***Patient Waiting Time Analysis***

The Executive Summary dashboard reveals differences in patient waiting times across departments. Departments such as Emergency and Cardiology show higher average waiting times compared to others.

From an operational perspective, prolonged waiting times negatively affect patient experience and may discourage patients from returning to the facility.

Long wait times also put medical professionals under more stress, which raises the risk of burnout.

- ***Department Demand and Capacity Imbalance***

Analysis of patient volume per shift highlights uneven workload distribution among departments.

This imbalance suggests inefficiencies in resource allocation rather than an absolute shortage of capacity. Sustained overload in a department is an example of an operational bottleneck that can lower employee performance and service quality.

Doctor Utilization and Productivity

Doctor utilization analysis reveals that several doctors consistently operate at utilization levels above 70%, indicating potential overutilization. While other doctors show significantly lower utilization rates, suggesting underuse of available medical expertise.

The analysis of average patients seen per doctor per shift confirms this imbalance. Certain doctors handle substantially more patients than their peers.

These findings suggest that workload imbalance is not only a departmental issue but also a personnel management challenge.

- ***Patient Satisfaction and Service Quality***

The scatter plot visualization demonstrates a negative correlation between average waiting time and average satisfaction score: as waiting time increases, patient satisfaction decreases.

Departments experiencing long waiting times consistently report lower satisfaction levels. This highlights how crucial operational effectiveness is as a major factor influencing the patient experience.

From a strategic perspective, declining satisfaction scores pose a risk to the hospital's reputation and long-term competitiveness.

Business Impact :

The analytical results highlight several critical operational challenges :

- Reduced patient satisfaction caused by prolonged waiting times.
- Increased staff burnout due to uneven doctor utilization.

- Inefficient resource allocation across departments and shifts.
- Potential higher turnover rates, revenue and reputation loss.

From a management perspective, these inefficiencies represent hidden financial risks through lost patients, reduced reputation, and inefficient use of human resources. But, by identifying these issues through data, hospital management gains the ability to move from reactive problem-solving to proactive, evidence-based decision-making.

Business Recommendations :

- **Optimize doctor scheduling during peak periods ;**
  Adjust staffing levels during high-demand shifts to reduce waiting times and improve service flow.
- **Rebalance workload across doctors ;**
  Reallocate underutilized doctors to departments experiencing persistent overload.
- **Implement dynamic staff allocation ;**
  Use real-time dashboards to adjust staffing based on patient inflow patterns.
- **Monitor doctor utilization as a key performance indicator ;**
  Regularly track utilization rates to prevent burnout and ensure fair workload distribution.
- **Increase capacity in high-pressure departments ;**
  Review bed availability and resource allocation for departments with sustained demand.
- **Use satisfaction scores as an operational feedback tool ;**
  Integrate patient satisfaction metrics into performance reviews and improvement initiatives.

Limitations :

While this BI project provides valuable insights, it has several limitations.
The analysis is based on a simulated dataset and may not fully reflect the complexity of real hospital environments. Factors such as emergency cases, patient demographics, medical severity, are not explicitly modeled.

In this report, logical assumptions inspired by real-world cases were made to ensure analytical consistency and data coherence.

Future Improvements :

Future improvements could include :

- Integration of real-time hospital data.
- Inclusion of patient demographic and clinical complexity indicators.
- Predictive analytics to forecast patient demand.
- Advanced time-series analysis for seasonal trends.

Ethical Considerations :

Although the dataset used in this project is simulated, real-world implementations would require compliance with data protection regulations, anonymization of patient identifiers, and controlled access to analytical systems.

Ensuring ethical use of data is essential to maintain patient trust and prevent misuse of health information. Future BI implementations should integrate privacy-by-design principles and role-based access controls.

Conclusion :

This Business Intelligence project demonstrates how data-driven analysis can uncover operational inefficiencies in hospital environments.

By transforming raw patient visit data into meaningful insights, the BI system enables hospital management to understand patient flow dynamics, optimize staff utilization, and improve service quality.

The findings emphasize that reducing waiting times, balancing workloads, and monitoring satisfaction are not independent goals but interconnected drivers of healthcare performance.

Implementing the recommended actions can help the hospital improve patient experience, protect staff well-being, and strengthen its operational sustainability.

Extract of the raw dataset :

appointment_id	patient_id	doctor_id	department	visit_date	shift	check_in_time	consultation_start_time	check_out_time	available_beds	patient_volume_shift	patients_seen_by_doctor_shift	doctor_available_minutes	doctor_worked_minutes	satisfaction_score
1	2095	61	Orthology	12/04/2024	Night	12/04/2024 18:00	12/04/2024 18:19	12/04/2024 18:39	48	151	23	480	414	3
2	1130	22	Orthology	28/03/2024	Morning	28/03/2024 09:00	28/03/2024 10:48	28/03/2024 11:21	11	117	16	480	391	4
3	3300	108	Emergency	03/10/2024	Morning	03/10/2024 17:00	03/10/2024 18:02	03/10/2024 18:33	58	248	14	480	387	3
4	4202	101	Neurology	29/12/2024	Morning	29/12/2024 09:00	29/12/2024 10:08	29/12/2024 10:42	16	50	13	480	366	2
5	3612	2	Pediatrics	29/03/2024	Night	29/03/2024 19:00	29/03/2024 19:13	29/03/2024 19:48	37	140	11	480	463	3
6	4459	2	Dermatology	24/07/2024	Morning	24/07/2024 09:00	24/07/2024 09:54	24/07/2024 10:11	15	83	14	480	459	5
7	1201	62	Pediatrics	09/07/2024	Night	09/07/2024 15:00	09/07/2024 15:48	09/07/2024 15:59	23	124	20	480	470	4
8	2076	24	Cardiology	08/07/2024	Night	08/07/2024 10:00	08/07/2024 11:26	08/07/2024 11:50	34	217	17	480	240	5
9	3568	88	Emergency	15/01/2024	Morning	15/01/2024 06:00	15/01/2024 07:33	15/01/2024 07:49	53	165	28	480	262	3
10	1378	5	Cardiology	21/03/2024	Night	21/03/2024 08:00	21/03/2024 10:47	21/03/2024 10:57	48	70	11	480	400	4
11	2751	37	Neurology	02/02/2024	Night	02/02/2024 12:00	02/02/2024 14:35	02/02/2024 15:14	53	133	26	480	234	1
12	2028	90	Dermatology	14/08/2024	Morning	14/08/2024 19:00	14/08/2024 21:15	14/08/2024 21:25	48	56	13	480	406	2
13	4312	52	Orthology	11/02/2024	Night	11/02/2024 18:00	11/02/2024 19:07	11/02/2024 19:23	41	161	9	480	430	5
14	2183	71	Neurology	22/05/2024	Morning	22/05/2024 18:00	22/05/2024 18:40	22/05/2024 19:02	31	57	6	480	369	5
15	2051	108	Pediatrics	02/03/2024	Morning	02/03/2024 10:00	02/03/2024 12:18	02/03/2024 12:55	29	59	15	480	327	2
16	2306	62	Emergency	13/12/2024	Morning	13/12/2024 12:00	13/12/2024 14:13	13/12/2024 14:47	22	32	11	480	397	3
17	1683	24	Neurology	16/05/2024	Night	16/05/2024 10:00	16/05/2024 10:55	16/05/2024 11:14	41	125	28	480	432	4
18	4581	39	Cardiology	22/04/2024	Night	22/04/2024 06:00	22/04/2024 06:56	22/04/2024 07:17	12	142	9	480	312	1
19	2589	87	Orthology	05/07/2024	Morning	05/07/2024 07:00	05/07/2024 09:14	05/07/2024 09:51	41	158	23	480	325	2
20	2439	119	Pediatrics	22/02/2024	Night	22/02/2024 15:00	22/02/2024 17:44	22/02/2024 17:59	20	213	21	480	454	5
21	3191	97	Emergency	07/04/2024	Night	07/04/2024 11:00	07/04/2024 13:23	07/04/2024 13:48	15	237	7	480	347	4
22	2843	105	Emergency	11/12/2024	Morning	11/12/2024 08:00	11/12/2024 10:32	11/12/2024 10:48	49	157	11	480	328	3
23	1262	16	Cardiology	30/05/2024	Morning	30/05/2024 19:00	30/05/2024 19:46	30/05/2024 19:58	57	89	21	480	201	1
24	4062	9	Emergency	30/10/2024	Night	30/10/2024 17:00	30/10/2024 17:41	30/10/2024 18:17	44	176	20	480	407	3
25	1627	75	Emergency	31/05/2024	Night	31/05/2024 13:00	31/05/2024 15:45	31/05/2024 16:18	17	193	10	480	303	4
26	2884	18	Dermatology	10/09/2024	Morning	10/09/2024 19:00	10/09/2024 20:43	10/09/2024 21:17	27	223	26	480	362	5
27	1397	21	Pediatrics	17/06/2024	Night	17/06/2024 06:00	17/06/2024 07:12	17/06/2024 07:22	17	164	7	480	327	1
28	4446	22	Dermatology	24/06/2024	Night	24/06/2024 16:00	24/06/2024 17:59	24/06/2024 18:30	39	67	10	480	250	3
29	3331	111	Emergency	27/01/2024	Night	27/01/2024 10:00	27/01/2024 10:34	27/01/2024 10:44	14	90	20	480	346	4
30	2243	30	Orthology	04/02/2024	Night	04/02/2024 06:00	04/02/2024 06:21	04/02/2024 06:42	55	146	10	480	298	4
31	1301	53	Neurology	20/08/2024	Morning	20/08/2024 13:00	20/08/2024 14:37	20/08/2024 15:03	42	145	25	480	360	3
32	2346	104	Dermatology	07/05/2024	Night	07/05/2024 14:00	07/05/2024 14:58	07/05/2024 15:33	33	143	19	480	350	2
33	1784	104	Emergency	06/05/2024	Morning	06/05/2024 15:00	06/05/2024 17:14	06/05/2024 17:49	18	72	26	480	375	5
34	1920	24	Orthology	18/06/2024	Morning	18/06/2024 15:00	18/06/2024 16:43	18/06/2024 17:10	16	86	8	480	372	4
35	1971	115	Pediatrics	16/11/2024	Night	16/11/2024 19:00	16/11/2024 21:28	16/11/2024 21:51	43	95	27	480	250	1