

Navigating Data Warehousing Implementation in Jordanian Healthcare Sector: Challenges and Opportunities

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Data warehousing, Challenges, Opportunities, Jordan's Healthcare Sector, Decision-making

ABSTRACT

Introduction: The implementation of data warehouse systems offers great potential for improving patient care, operational efficiency, and strategic decision-making. This study explores the challenges and opportunities of implementing data storage solutions in the Jordanian healthcare industry.

Objectives: To investigate current data management practices, perceptions of data warehouses, and factors influencing adoption readiness among IT professionals in Jordanian healthcare organizations.

Methods: A survey was conducted involving 102 IT professionals from various healthcare organizations in Jordan. Participants responded to a structured questionnaire, providing insights into key benefits, expected challenges, technical requirements, and future prospects for data warehousing in their organizations.

Results: The study demonstrated the critical role of data warehouses in enhancing decision-making, patient care coordination, and operational efficiency within the Jordanian healthcare system. However, significant challenges such as data integration, security concerns, and regulatory compliance were identified.

Conclusions: The paper provides recommendations to address these challenges and maximize the benefits of healthcare data warehouses in Jordan. Key strategies include investing in technical expertise, ensuring compatibility with existing systems, and improving data management practices. This study enhances understanding of the complexities associated with implementing data warehousing in the Jordanian healthcare industry and offers valuable insights for future research and practice in this evolving field.

1. Introduction

The current healthcare environment is marked by an increase in data volume and complexity. The healthcare sector generates and collects vast amounts of data from various sources, including administrative databases, imaging systems, laboratory results, and electronic health records (EHRs) (Varun et al., 2024; Rejitha et al., 2023). Effectively managing and utilizing this data is crucial for improving patient care, enhancing operational efficiency, and supporting strategic decision-making. Every second, substantial amount of healthcare data is produced and analyzed to uncover important insights. The healthcare sector currently generates almost 30% of the world's data volume. Healthcare data will expand at a compound annual growth rate of 36% by 2025 (Greene, 2023). This compares to 10% faster financial services, 6% quicker manufacturing, and 11% faster media & entertainment. A centralized location for clinical data and electronic health records that are gathered from numerous disjointed sources across the healthcare sector is known as a healthcare data warehouse. These streams may come from a variety of sources, including wearables, radiology databases, enterprise resource planning systems (ERP), EHRs, and EMRs others (Data Analytics, 2023). When used correctly, it can enable the creation of an enterprise-wide EHR, lower medical errors, and improve patient safety. For analytical and research purposes, HDW also enables the healthcare sector to keep past patient health data (Data Analytics, 2023).

According to Paul (2023), the market for healthcare data warehousing is expected to grow to be worth \$8 billion globally by 2025. Therefore, it should come as no surprise that a data warehouse is being used in healthcare by all of the so-called big guys. The increased adoption can be attributed to several factors, such as the vast amounts of electronic data generated by pharmacies, hospitals, and project healthcare sector; the need to prevent operational inefficiencies revealed by the 2020 pandemic; the need to make sense of the data generated by wearable medical devices; the wave of digitization leading to widespread point-of-care use of EHR, EMR, and CPOE; and the rising rate of misdiagnosis caused by many serious illnesses that present with non-specific or constitutional symptoms like fever, weight loss, pain, etc. It appears that data warehousing will lead to new developments in operational, prescriptive, and predictive health (Paul, 2023).

One effective way to handle this flood of data is through data warehousing. A data warehouse is a centralized location where information from several sources is combined to create a single, easily queryable and analyzable view of the data. An in-depth discussion of the advantages, difficulties, and potential applications of data warehousing in the healthcare sector is the goal of this article. In addition to serving as a centralized database, data warehouses store structured, analytic-ready data and provide decision-makers with a comprehensive picture of this data. All aspects of data management, including extract, transform, and load (ETL), are handled by a strong data warehouse architecture, which also guarantees data consistency, quality, quick retrieval, and improved security at all times.

Literature Review

A data warehouse serves as a fundamental tool for reporting and data analysis within the realm of business intelligence (Haris, 2024). It operates as a centralized repository, amalgamating data from disparate sources and facilitating activities such as data cleaning, integration, consolidation, and storage. The architecture of a data warehouse typically comprises several components, including source systems where data originates (e.g., EHRs, administrative systems), the ETL process for data extraction, transformation, and loading, the data storage layer, and data access tools such as OLAP and data mining tools (Buuck, 2022).

The data source layer in the healthcare sector includes a range of data types that are sourced from internal and external channels, such as medical, clinical, administrative, research, and patient health information. These services include enterprise resource planning (ERP) systems, customer relationship management (CRM) tools, electronic health records (EHR) and electronic medical records (EMR), and claims management systems. Display areas are used to protect and facilitate the ELT process of processing incoming data to ensure consistency and quality. Finally, data warehousing can serve as a repository for structured data and provide data centers designed for specific business areas or specific clinical areas (Kimball & Ross, 2002).

Healthcare sector can choose between enterprise profile models and virtual profile marketplaces based on size, functionality, and goals. Different business models provide advanced analysis and reporting tools suitable for business strategies. On the other hand, it is cheaper and cheaper than a real data trading system and is suitable for small organizations or offices (Bhatia & Kumar, 2020; Patel et al., 2021). Many garage solutions, which includes Amazon Redshift, Azure Synapse Analytics, and Oracle Autonomous Database, are regarded for his or her overall performance and consumer satisfaction. These systems provide scalability, ease of implementation, and analytical capabilities, making them best for healthcare solutions (Amazon Web Services, 2023; Microsoft Azur, 2023; Oracle, 2023). To realize their full potential, healthcare data centers must address critical issues such as data storage, data security, traceability, privacy, data integrity and storage. Fast data retrieval, smooth querying, access control, encryption, compliance with laws such as HIPAA, and flexible storage systems are important for medical records (Alahmari & Walters, 2021; Ranjan et al., 2022).

Implementing a Healthcare Data Warehouse: Roadmap

The successful deployment and integration of a healthcare data warehouse require a systematic and staged approach. The process can be divided into four key phases: strategic planning, design, development and deployment, and testing.

- **Strategic Planning:** During this phase, the healthcare sector determines the needs of the affected population, assesses the current IT infrastructure, and establishes strategic goals and key performance indicators (KPIs) related to organizational goals. It also considers data center growth and development, including compliance, security and performance. Proper planning is the foundation of a good data storage system (Huang & Huang, 2021).
- **Design:** The focus of the planning phase is the design of the data warehouse, including the extract, load, change (ELT) process, data sampling process, and verification process to ensure accuracy and consistency. This phase also includes planning data integration so that data flows smoothly

from different sources. Good architecture aims to improve data management and use in healthcare systems (Khan et al., 2022).

- **Development and Deployment:** This phase includes the actual implementation of the healthcare data warehouse, including critical infrastructure components, data warehousing software, and end-user applications. Security measures, such as encryption and multi-factor authentication, are crucial to protecting sensitive health data stored within the warehouse. Deployment in secure cloud infrastructures further ensures data integrity and confidentiality (Oussous et al., 2020).
- **Testing:** The testing phase involves comprehensive end-to-end testing of the data warehouse and its associated services to validate the schema, data models, and data migration processes. Rigorous testing ensures that the data warehouse functions as expected, providing accurate and reliable data for decision-making. The effectiveness of a health data warehouse implementation depends on the quality and consistency of the data (Thirunarayan et al., 2021).

Healthcare Data Warehouse Solution Architecture

Business intelligence (BI) solutions for healthcare are based on an enterprise data warehouse consisting of the following components:

- **Data Source Layer:** This layer collects healthcare data from internal and external sources, such as pharmacy management systems, electronic health records (EHR) or electronic medical records (EMR) systems, customer relationship management (CRM) platforms, and enterprise resource planning (ERP) systems. This layer ensures a comprehensive view of healthcare activities and patient data. (Yawson et al., 2021).
- **Staging Area:** The staging area employs the Extract, Transform, Load (ETL) or Extract, Load, Transform (ELT) method to manage healthcare data while acting as a temporary intermediate storage facility. These processes clean, convert, and merge raw data to prepare it for storage and analysis in the data warehouse (Abiodun & Adeleke, 2020).
- **Data Storage Layer:** This layer serves as the centralized structured storage repository for healthcare data, optimized for querying and analysis. It also includes data marts – specialized subsets tailored to specific business lines or departments within the healthcare sector, enabling focused analysis and reporting (Abiodun & Adeleke, 2020).
- **Analytics and Business Intelligence (BI):** This category encompasses business analytics, data mining, data reporting, and visualization tools, among others, for deriving valuable insights from healthcare data. These tools empower healthcare stakeholders to identify patterns and make data-driven decisions that enhance patient care outcomes and optimize operations. (Bada et al., 2020)

An enterprise data warehouse architecture serves as a sturdy foundation for healthcare sector to leverage the potential of data and extract valuable insights. These insights contribute to enhanced decision-making, operational efficiency, and patient care delivery.

Benefits of Data Warehousing in Healthcare

Data warehousing in healthcare sector offers a multitude of benefits, spanning from enhanced data integration to improved patient care. Recent studies provide a detailed analysis of these advantages.

- **Enhanced Data Integration and Comprehensive View:** Data warehousing consolidates disparate data sources into a single repository, providing a comprehensive view of patient information and healthcare operations. This integration facilitates improved decision-making based on accurate, timely, and comprehensive data (Lucas & Smith, 2022).

- **Improved Decision Making:** A healthcare data warehouse helps overcome siloed data sources and delivers the right insights at the right time. It supports rapid data mining, report generation, and real-time decision support. Your team can rely on the accuracy of the data to improve decision-making. Features include: unified view of healthcare enterprise data, analysis-ready data ensuring quality and consistency, faster access to historical and real-time data for accurate analysis and quick decisions, better decision-making with managed data that ensures outstanding quality, consistency, and accuracy, and helps stakeholders fully leverage the diversity of health data (Koh & Tan, 2021).
- **Promotes Data-Based Clinical Decisions:** A data warehouse enables healthcare sector providers to harness and analyze relevant medical data quickly. This structured, unified, and pre-processed data supports valuable insights that inform prognoses and guide clinical decisions. For example, machine learning algorithms can analyze decades of big data to identify patterns and predict outcomes for rare disorders like amyloidosis (Birkhead & Klompas, 2021).
- **Improves Healthcare Data Reporting and Analytics:** A healthcare data warehouse acts as an on-the-fly analytics powerhouse, generating precise and timely reports. Clinicians can access a patient's comprehensive medical history and compare it with their current status. This capability supports administrative health monitoring, clinical research, and stakeholder reporting (Raghupathi & Raghupathi, 2020).
- **Streamlines Healthcare Insurance Claims and Payouts:** Data warehousing streamlines the processing of health insurance claims, allowing healthcare sector to evaluate the effectiveness of insurance payout schemes, prevent fraudulent payouts, and identify challenges (Bardhan & Thouin, 2020).
- **Improves Individualized Patient Care:** By integrating investigative data, follow-ups, and EHR details, data warehouses offer a holistic view of each patient's medical journey. This integration enhances patient care by allowing healthcare workers to compare symptoms, determine successful treatment plans, and reduce unnecessary expenses (Bardhan & Thouin, 2020).
- **Data Security:** Healthcare providers prioritize protecting patient information. Implementing a healthcare data warehouse can help ensure role-based access controls to secure data. Moreover, granular security controls can ensure that sensitive business data is only accessible through reports and dashboards (Kharrazi et al., 2021).
- **Regulatory Reporting and Compliance:** A healthcare data warehouse consolidates diverse data sources, such as patient records, billing details, and administrative data. This centralized repository simplifies the generation of accurate compliance reports while enhancing data security and privacy through robust access controls and encryption protocols. Consequently, healthcare sector can confidently navigate complex regulatory frameworks like HIPAA compliance (Wang et al., 2020).
- **Revenue Cycle Management:** Data warehousing in healthcare provides a comprehensive view of the customer journey for businesses. Acting as a centralized data repository, it integrates information from billing systems, insurance records, claims, and financial transactions. This integration streamlines billing processes, reducing claim denials and improving reimbursement rates, thus enhancing financial performance. Moreover, data integrity ensures data accuracy, eliminating the need for the revenue cycle management (RCM) team to perform additional calculations, which reduces rework. Furthermore, data warehousing facilitates the rapid

identification and resolution of root causes of revenue cycle performance issues, leading to quicker revenue generation cycles (Koh & Tan, 2021).

Data warehousing significantly enhances the efficiency, accuracy, and effectiveness of healthcare operations, ultimately leading to better patient outcomes and organizational performance.

Challenges Associated with Implementing Data Warehousing in Healthcare

Implementing a data warehouse in the healthcare sector comes with several challenges, each requiring careful consideration and mitigation strategies. Here are some of the key challenges:

- **Creating a Logical Data Model with a Business-Centric Approach:** While building a logical data model is essential, focusing solely on technological aspects can result in discrepancies between the warehouse and business objectives. Aligning the model with healthcare challenges involves establishing a robust business data model, distinguishing between operational and performance measurement data, and engaging stakeholders for granularity determination (Finarb Analytics, 2020).
- **Data Integration from Diverse Sources:** Healthcare data originates from heterogeneous sources like EHRs, imaging systems, and wearables, posing integration challenges. Solutions require advanced ETL platforms, schema mapping, and validation checks to manage diverse formats and ensure quality and consistency (Finarb Analytics, 2020).
- **Ensuring Data Cleaning Accuracy:** Faulty data cleansing practices can compromise database integrity and lead to inaccurate analytical outcomes. Challenges include managing missing and unstructured data. Advanced imputation techniques and NLP tools are crucial for maintaining accuracy (Finarb Analytics, 2020).
- **Effective Data Governance:** Data governance is crucial for ensuring the accuracy, consistency, and security of data. Challenges in this area include undocumented lineage, insufficient metrics, and neglect of archived data (Finarb Analytics, 2020).

Securing PHI and PII in Cloud-Based Warehousing: Safeguarding Personally Identifiable Information (PII) and Protected Health Information (PHI) is paramount for data security. Challenges include implementing encryption and access control measures. Utilizing standard encryption algorithms, implementing access controls, and implementing network security measures are essential for mitigating risks in this area (Finarb Analytics, 2020).

2. Methodology

This study takes a quantitative survey approach to investigate the implementation of data warehousing in the healthcare sector in Jordan. The questionnaire was developed based on the research objectives and key themes identified in the literature review. It includes multiple-choice questions covering demographic information, perceptions of data warehousing, anticipated benefits and challenges, readiness for implementation, and technical requirements. After conducting pilot testing with a small group of IT professionals, the questionnaire was refined and finalized. To select participants, a convenience sampling method was used to identify individuals from the target population of IT professionals working within the healthcare sector in Jordan. The sample size of 102 participants was determined based on the population size and desired level of confidence and precision. The questionnaire was distributed electronically via email to IT professionals in the healthcare sector in Jordan in May 2024. Participation was voluntary, and confidentiality was ensured. The survey remained open for a specified four-week period, during which follow-up reminder emails were sent to non-respondents to encourage participation and improve response rates.

Data analysis involved using descriptive statistics, such as frequencies and percentages, to summarize responses to each question. Inferential statistics were utilized to investigate relationships between

variables, guided by the research questions and collected data. Integrating the findings entailed synthesizing quantitative data from the survey to identify patterns, trends, and associations regarding data warehousing implementation in Jordan's healthcare sector. Conclusions and recommendations were drawn from these findings, aiming to provide insights for the healthcare sector on implementing and optimizing data warehousing solutions.

3. Results and Discussion

Table 1 shows the distribution of roles among respondents, indicating a diverse range of positions within the healthcare IT sector. Systems Analysts account for the largest category at 29.4%, showing their importance in system integration and data analysis. IT Managers and Data Analysts are also significant, comprising 24.5% and 26.5% respectively, underscoring the importance of leadership and data-driven decision-making in healthcare IT. Although Database Administrators represent a smaller percentage at 19.6%, their role is vital for maintaining and optimizing the databases essential for data warehousing.

Table 1: Demographic Information

Position/Title	Respond	Percentage
IT Manager	25	24.5%
Database Administrator	20	19.6%
Systems Analyst	30	29.4%
Data Analyst	27	26.5%
Total	102	100%

Source: Authors

The respondents have varied levels of experience in healthcare IT. A significant portion (29.4%) has 4-6 years of experience, suggesting a relatively seasoned workforce. Additionally, 24.5% of respondents have 7-10 years of experience, indicating substantial expertise. The data also shows a mix of newer professionals (19.6% with 1-3 years and 7.8% with less than 1 year) alongside industry veterans (18.6% with more than 10 years). This blend suggests a healthy balance of fresh perspectives and deep industry knowledge within the workforce (see Table 2).

Table 2: Years of Experience in Healthcare IT

Years of Experience in Healthcare IT	Respond	Percentage
Less than 1 year	8	7.8%
1-3 years	20	19.6%
4-6 years	30	29.4%
7-10 years	25	24.5%
More than 10 years	19	18.6%
Total	102	100%

Source: Authors

Table 3 shows that most respondents work in hospitals (44.1%), underscoring the hospital's central role in healthcare delivery and data generation. Clinics and healthcare networks are also significantly represented, highlighting the expanding scope of data warehousing beyond traditional hospital settings. Government health agencies, although smaller in number, play a crucial role in public health data management, emphasizing the need for robust data warehousing solutions across various types of healthcare sector.

Table 3: Healthcare Sector Type

Healthcare Sector Type	Respond	Percentage
Hospital	45	44.1%
Clinic	20	19.6%
Healthcare Network	22	21.6%
Government Health Agency	15	14.7%
Total	102	100%

Source: Authors

Table 4 illustrates the current data management practices within healthcare sector. The majority of healthcare sector (58.8%) utilize Electronic Health Record (EHR) systems, highlighting the critical role of EHRs in maintaining comprehensive patient records. Clinical Information Systems (CIS) are used by 29.4% of respondents, reflecting their importance in managing clinical workflows. Practice Management Systems (PMS), Laboratory Information Systems (LIS), and Radiology Information Systems (RIS) are also in use, though to a lesser extent, indicating a more specialized application within certain healthcare settings.

Table 4: Current Data Management Systems

Data Management System	Respond	Percentage
Electronic Health Record (EHR)	60	58.8%
Clinical Information System (CIS)	30	29.4%
Practice Management System (PMS)	20	19.6%
Laboratory Information System (LIS)	15	14.7%
Radiology Information System (RIS)	10	9.8%

(Note: The total percentage exceeds 100% because respondents may be using multiple systems.)

Source: Authors

Table 5 shows a significant proportion of respondents (39.2%) find their current data management systems to be efficient/effective, with an additional 16.7% rating them as very efficient/effective. However, a notable segment (14.7%) finds their systems inefficient/ineffective, and 4.9% consider them very inefficient/ineffective. This mixed feedback suggests that while many organizations are satisfied with their data management systems, there is still room for improvement in terms of efficiency and effectiveness.

Table 5: Efficiency and Effectiveness of Current Data Management Systems

Efficiency and Effectiveness Rating	Respond	Percentage
Very Inefficient/Ineffective	5	4.9%
Inefficient/Ineffective	15	14.7%
Neutral	25	24.5%
Efficient/Effective	40	39.2%
Very Efficient/Effective	17	16.7%

Source: Authors

Table 6 shows a substantial majority (76.5%) of respondents are familiar with the concept of data warehousing in healthcare, indicating a strong awareness among IT professionals in the sector. This suggests a readiness to engage with and potentially adopt data warehousing solutions.

Table 6: Familiarity with Data Warehousing in Healthcare

Response	Number	Percentage
Yes	78	76.5%
No	24	23.5%

Source: Authors

Table 7 shows that nearly three-quarters of respondents (73.5%) either agree or strongly agree that implementing a data warehouse could benefit their healthcare sector. This positive perception underscores the anticipated value and benefits of data warehousing in improving healthcare operations and outcomes.

Table 7: Belief in the Benefits of Implementing a Data Warehouse

Response	Number	Percentage
Strongly Disagree	2	2.0%
Disagree	5	4.9%
Neutral	20	19.6%
Agree	50	49.0%
Strongly Agree	25	24.5%

Source: Authors

Table 8 shows that the top perceived benefits of implementing data warehousing in healthcare include improved decision-making through data insights (68.6%) and enhanced patient care coordination (63.7%). These findings highlight the critical role of data warehousing in fostering better clinical and operational outcomes. Other notable benefits include increased operational efficiency and better compliance with regulatory requirements, each selected by over half of the respondents.

Table 8: Perceived Benefits of Implementing a Data Warehouse

Perceived Benefit	Number	Percentage
Improved Decision-Making through Data Insights	70	68.6%
Enhanced Patient Care Coordination	65	63.7%
Increased Operational Efficiency	60	58.8%
Better Compliance with Regulatory Requirements	55	53.9%
Facilitated Clinical Research and Analysis	50	49.0%
Enhanced Data Security and Privacy	45	44.1%
Streamlined Reporting and Analytics Processes	40	39.2%
Enhanced Interoperability among Healthcare Systems	35	34.3%
Improved Resource Allocation and Utilization	30	29.4%

(Note: Respondents could select multiple benefits, so the total percentage exceeds 100%.)

Source: Authors

Table 9 indicates that the most significant anticipated challenges in implementing data warehousing include data integration from disparate sources (63.7%) and ensuring data quality and integrity (58.8%). Data security and privacy concerns, along with a lack of technical expertise and resources, are also major concerns, indicating areas where additional support and resources may be needed to facilitate successful implementation.

Table 9: Anticipated Challenges of Implementing a Data Warehouse

Anticipated Challenge	Number	Percentage
Data Integration from Disparate Sources	65	63.7%
Ensuring Data Quality and Integrity	60	58.8%
Data Security and Privacy Concerns	55	53.9%
Lack of Technical Expertise and Resources	50	49.0%
Resistance to Change from Staff	45	44.1%
Cost of Implementation and Maintenance	40	39.2%
Complexity of Regulatory Compliance	35	34.3%
Managing Data Governance and Standards	30	29.4%
Integration with Existing IT Infrastructure	25	24.5%

(Note: Respondents could select multiple challenges, so the total percentage exceeds 100%.)

Source: Authors

Table 10 illustrates that approximately 58.8% of respondents have plans to implement a data warehouse

within the next two years, with the highest percentage (29.4%) planning for implementation within the next two years. This suggests a growing interest and preparedness for data warehousing in Jordan's healthcare sector. However, a notable 24.5% of respondents currently have no plans for implementation, indicating potential barriers or challenges in adopting data warehousing solutions.

Table 10: Implementation Plans for Data Warehousing

Response	Number	Percentage
Yes, within the next 6 months	10	9.8%
Yes, within the next 1 year	20	19.6%
Yes, within the next 2 years	30	29.4%
No plans currently	25	24.5%
Unsure	17	16.7%

Source: Authors

The variables that affect healthcare sector' decisions to deploy data warehouses are displayed in Table 11. 68.6% of respondents said that cost was the most important consideration. With 63.7% of participants citing technical expertise, it is clear how crucial it is to have qualified people in place when deploying data warehousing solutions. Concerns about data security are equally significant; 58.8% of respondents emphasized the necessity of robust security measures. The installation of data warehousing systems is shaped by a variety of factors, including organizational preparedness and regulatory compliance needs.

Table 11: Factors Influencing Decision to Implement Data Warehouse

Influencing Factor	Number	Percentage
Cost	70	68.6%
Technical expertise	65	63.7%
Data security concerns	60	58.8%
Regulatory compliance requirements	55	53.9%
Organizational readiness	50	49.0%

Source: Authors

The primary features or technical specifications that participants in their healthcare sector look for in a data warehousing system are listed in Table 12. 78.4% of respondents ranked scalability as their top priority, highlighting the significance of managing massive volumes of data. The necessity of adaptability in using diverse data sources is highly valued by 73.5 percent of the respondents, underscoring the significance of interoperability and data integration proficiencies. Healthcare data management places a high priority on security and compliance, as seen by the 68.6% of respondents who stated robust data security measures and the 63.7% who selected support for healthcare data standards.

Table 12: Key Technical Requirements/Features for Data Warehousing Solution

Key Technical Requirement/Feature	Number	Percentage
Scalability to handle large volumes of data	80	78.4%
Flexibility to integrate with diverse data sources	75	73.5%
Robust data security measures	70	68.6%
Support for healthcare data standards	65	63.7%
Advanced analytics capabilities	60	58.8%
Real-time or near-real-time data processing	55	53.9%
Seamless integration with existing IT infrastructure	50	49.0%

High availability and disaster recovery features	45	44.1%
User-friendly interface for data visualization	40	39.2%
Compliance with healthcare regulations	35	34.3%
Ability to handle unstructured data	30	29.4%
Support for mobile access and collaboration	25	24.5%

Source: Authors

Table 13 shows how important it is for data warehousing solutions to work well with existing systems, according to the respondents. A significant majority, comprising 88.2% of participants, perceive interoperability as either very important (58.8%) or important (29.4%). This high priority placed on seamless integration emphasizes the crucial role of interoperability in facilitating efficient data exchange and workflow within healthcare sector. Only a small percentage of respondent’s express neutral or lower levels of importance regarding interoperability, indicating widespread recognition of its significance in optimizing healthcare operations.

Table 13: Importance of Interoperability with Existing Systems

Response	Number	Percentage
Very important - seamless integration with existing systems is a top priority.	60	58.8%
Important - interoperability with existing systems is necessary for efficient data exchange and workflow.	30	29.4%
Neutral - interoperability is a consideration but not a primary factor in the selection process.	7	6.9%
Not very important - while desirable, interoperability is not a critical requirement for our organization.	3	2.9%
Not important at all - our organization does not prioritize interoperability with existing systems in the selection of a data warehousing solution.	2	2.0%

Source: Authors

Table 14 presents respondents' insights into the evolving role of data warehousing in healthcare sector in Jordan over the next 5-10 years. The majority believe that data warehousing will play a critical role in various areas. Specifically, 49.0% foresee greater integration with advanced analytics, 44.1% anticipate enhanced patient care, and 39.2% expect improved operational efficiency. These projections highlight the broad recognition among respondents of the transformative potential of data warehousing in driving better healthcare outcomes and operational performance.

Table 14: Envisioned Evolution of Data Warehousing in Healthcare Sector in Jordan

Future Role	Number	Percentage
Greater integration with advanced analytics	50	49.0%
Enhanced patient care	45	44.1%
Improved operational efficiency	40	39.2%
Enhanced regulatory compliance	35	34.3%
Increased collaboration and data sharing	30	29.4%
Empowerment of healthcare professionals	25	24.5%

Expansion of telehealth and remote monitoring	20	19.6%
Focus on population health management	15	14.7%
Embrace of emerging technologies	10	9.8%
Continued evolution towards value-based care	5	4.9%

Source: Authors

The primary barriers to data warehousing adoption and implementation in Jordanian healthcare sector are shown in Table 15. A shortage of funds and resources is the biggest obstacle, according to 58.8% of respondents. A major concern voiced by 53.9% of respondents was that stakeholders' and healthcare workers' opposition to change lags far behind. This emphasizes the need of transforming organizational culture and garnering support from all essential stakeholders for your mission. Another major concern mentioned by 49.0% of respondents is a lack of qualified IT people, emphasizing the importance of talent development. Rules and compliance are another major source of concern, with 44.1% of respondents worried about them.

Table 15: Potential Barriers or Challenges in Data Warehousing Implementation

Potential Barrier or Challenge	Number	Percentage
Limited budget and resources	60	58.8%
Resistance to change among healthcare staff and stakeholders	55	53.9%
Lack of skilled IT professionals	50	49.0%
Regulatory and compliance issues	45	44.1%
Interoperability issues with existing systems	40	39.2%
Cultural or organizational barriers to sharing data	35	34.3%
Technical challenges such as data integration, cleansing	30	29.4%
Concerns about data ownership and governance	25	24.5%
Infrastructure limitations, including network connectivity and storage capacity	20	19.6%

4. Conclusion and future scope

The results of the study indicated a promising future for data warehousing solutions in the Jordanian healthcare sector. Most respondents are familiar with data warehousing technologies and believe they can improve health care delivery and operations. As a result of modernizing health systems, decision-making capabilities have increased, coordinated care has been improved, and operational efficiency has gained. As a means of supporting clinical research, meeting regulatory requirements, improving data security, and improving privacy, respondents stressed data warehousing as an essential tool. The implementation of a data warehouse may be challenging for healthcare sector because they need to integrate data from disparate sources, maintain data integrity and quality, address security and privacy concerns, and control installation and maintenance costs.

Jordanian healthcare sector appears to be well-suited for data warehousing. In addition to improved patient care, operational efficiency, regulatory compliance, and integration with advanced analytics, respondents anticipated increased provider cooperation and data sharing, the provision of useful information to medical professionals, and the implementation of telehealth and remote monitoring systems. A number of major difficulties can stymie the adoption of data warehousing systems, including a lack of cash and resources, opposition to change, a scarcity of trained IT workers, and

privacy concerns. Furthermore, infrastructure limits, cultural barriers, and technical problems must all be addressed for a successful implementation. The findings revealed that Jordan's healthcare sector is well-prepared and understand the benefits of data warehousing.

Recommendations, Limitations, and Future Research

The study recommends healthcare sector train their IT staff in integration, analytics, and data warehousing technologies in order to improve their technical capabilities. This ensures that warehouse solutions can be effectively used and managed by IT staff. In addition, sufficient funding and resources are required to effectively implement and maintain data warehouse systems. When data warehouses are used to support enhanced analytical capabilities, clinical and operational decision making can be improved and made more effective. The 102 participants in the study may not fully reflect all healthcare sector in Jordan, limiting the findings' generalizability. Future research should involve a larger and more diversified sample from other regions of Jordan. Because the poll depends on self-reported data from IT professionals, there is a risk of response bias, which could impact the accuracy of the results. Using mixed methodologies, such as qualitative interviews and observational studies, can help to reduce this bias.

The study lacks a full financial analysis of the costs associated with deploying and sustaining data warehousing technologies, which is an important aspect in decision-making. Future research should include extensive financial evaluations to better understand the cost-benefit ratio. The rapid advancement of data warehousing technology and healthcare IT may render some conclusions obsolete over time. Longitudinal studies that follow implementation and impact over time are recommended to capture these trends. The recommendations' application may be influenced by differences in organizational culture and structure among Jordan's various healthcare sector. Comprehensive case studies of healthcare sector that have effectively used data warehousing can help identify best practices and lessons learnt.

Longitudinal studies that examine the installation and impact of data warehousing in healthcare sector will provide more detailed insights into the long-term benefits and problems. Expanding the survey to include a wider and more diverse sample of healthcare sector from various regions of Jordan will improve the generalizability of the findings. In-depth case studies of healthcare sector that have successfully implemented data warehousing can reveal best practices and lessons learned, providing important insights to other sectors. Detailed financial evaluations to determine the cost-benefit ratio of data warehousing systems in the healthcare sector w Alahmariill provide useful decision-making information.

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