BIG DATA MANAGAMENT FRAMEWORK FOR EFFECTIVE DRUG INVENTORY MANAGEMENT SYSTEM IN THE UNITED ARAB EMIRATES (UAE)

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MASTER OF SCIENCE IN INFORMATION AND COMMUNICATION TECHNOLOGY

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Master of Science in Information and Communication Technology

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A thesis submitted in fulfillment of the requirements for the degree of Master of Science in Information and Communication Technology

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2025

DECLARATION

I declare that this thesis entitled “Big Data Management Framework for Effective Drug Inventory Management System in The United Arab Emirates (UAE)” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : _____

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APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Science in in Information and Communication Technology.

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Date	: 18 Aug 2025

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DEDICATION

This work is dedicated to the inspiring person towards my life… my dear father and my dear mother who always want me to have the best, for her love, the prayers that she made for me.

…To my Daughter, Mother …
They encouraged me to achieve objectives, complementing my happiness.

…To my great guide…
My dear supervisor, Dr. Abdul Karim bin Mohamad for his visions in the use in Big Data.

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ABSTRACT

Effective drug inventory management (DIM) is critical for ensuring continuous medication availability, minimizing wastage, and improving patient care. In the United Arab Emirates (UAE), healthcare institutions face persistent challenges such as fragmented data systems, inefficient distribution, and weak decision-making processes. This study introduces a conceptual framework based on Big Data Management (BDM) principles to enhance DIM effectiveness, grounded in three key theories: Information Processing Theory (IPT), which emphasizes data-driven decision-making; Resource-Based View (RBV), which positions big data capabilities as strategic assets; and the Rational Decision-Making Model (RDMM), which structures the decision-making process. Five core BDM factors identified through the Big Data Analytics Capability (BDAC) framework—data integration, data processing, data quality, data security, and information sharing were examined for their influence on effective decision-making, modeled as a mediating variable. A quantitative research design involving 293 healthcare professionals was employed, and Structural Equation Modeling (SEM) was used to test seven hypotheses (H1–H7). The results support the proposition all five big data management (BDM) factors significantly impact decision-making (H1–H5), which in turn positively influences DIM outcomes (H6), with additional evidence suggesting a potential feedback loop (H7). This study contributes to both academic theory and practical healthcare management by validating a big data management (BDM) -based framework that supports data-driven policies, robust infrastructure, and cross-functional integration to optimize inventory performance in healthcare institutions. This research also contributes to the theory and practice by clarifying the role of big data in healthcare inventory management and offering a validated framework for policymakers and practitioners. It also highlights the need for robust data infrastructure, integrated systems, and a decision-oriented culture in healthcare settings to ensure more effective drug inventory operations.

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RANGKA KERJA PENGURUSAN DATA RAYA UNTUK MENINGKATKAN SISTEM INVENTORI UBAT DI EMIRIAH ARAB BERSATU (UAE)

ABSTRAK

Pengurusan inventori ubat (DIM) yang berkesan adalah penting untuk memastikan ketersediaan ubat secara berterusan, meminimumkan pembaziran, dan meningkatkan kualiti penjagaan pesakit. Di Emiriah Arab Bersatu (UAE), institusi kesihatan menghadapi cabaran berterusan seperti sistem data yang terpisah, pengagihan yang tidak efisien, dan proses membuat keputusan yang lemah. Kajian ini memperkenalkan satu rangka kerja konseptual berasaskan prinsip Pengurusan Data Raya (BDM) bagi meningkatkan keberkesanan DIM, yang disokong oleh tiga teori utama: Teori Pemprosesan Maklumat (IPT) yang menekankan pembuatan keputusan berasaskan data; Pandangan Berasaskan Sumber (RBV) yang melihat keupayaan data raya sebagai aset strategik; dan Model Pembuatan Keputusan Rasional (RDMM) yang menyusun proses membuat keputusan. Lima faktor teras BDM yang dikenal pasti melalui rangka kerja Keupayaan Analitik Data Raya (BDAC)—integrasi data, pemprosesan data, kualiti data, keselamatan data, dan perkongsian maklumat—dikaji untuk menilai pengaruhnya terhadap pembuatan keputusan berkesan, yang dimodelkan sebagai pemboleh ubah perantara. Reka bentuk kajian kuantitatif melibatkan 293 profesional penjagaan kesihatan, dan Pemodelan Persamaan Struktur (SEM) digunakan untuk menguji tujuh hipotesis (H1–H7). Dapatan kajian menyokong cadangan bahawa kelima-lima faktor BDM memberi kesan signifikan terhadap pembuatan keputusan (H1–H5), yang seterusnya memberi kesan positif terhadap hasil DIM (H6), dengan bukti tambahan mencadangkan kewujudan maklum balas berulang (H7). Kajian ini menyumbang kepada teori akademik dan pengurusan penjagaan kesihatan praktikal dengan mengesahkan rangka kerja berasaskan BDM yang menyokong dasar berasaskan data, infrastruktur yang kukuh, dan integrasi rentas fungsi bagi mengoptimumkan prestasi inventori di institusi kesihatan. Kajian ini turut menjelaskan peranan data raya dalam pengurusan inventori penjagaan kesihatan dan menawarkan rangka kerja yang sah kepada pembuat dasar dan pengamal. Selain itu, kajian ini menekankan keperluan kepada infrastruktur data yang kukuh, sistem bersepadu, dan budaya membuat keputusan berasaskan data untuk meningkatkan keberkesanan operasi inventori ubat dalam sektor kesihatan.

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LIST OF ABBREVIATIONS

APA - American Psychological Association

BDAC - Big Data Analytics Capability

BDM - Big Data Management

CB-SEM - Covariance-Based Structural Equation Modelling

CFA - Confirmatory Factor Analysis

DI - Data Integration

DIM - Drug Inventory Management

DP - Data Processing

DQ - Data Quality

DS - Data Security

EDM - Effective Decision Making

EDIMS - Effective Drug Inventory Management System

EHRs - Electronic Health Records

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IPT - Information Processing Theory

IS - Information Sharing

PCA - Principal Component Analysis

PLS-SEM - Partial Least Squares Structural Equation Modelling

RBT - Resource-Based Theory

RDMM - Rational Decision-Making Model

SPSS - Statistical Package for the Social Sciences

UAE - United Arab Emirates

VIF - Variance Inflation Factor

WHO - World Health Organization

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LIST OF PUBLICATIONS

The following is the list of publications related to the work on this thesis:

Ahmed, Bin Mohamad and Iskandar., 2023. Big Data Factors Toward Enhancing United Arab Emirates DIM System for Effective Decision-Making. *International Journal of Business Society*, 7 (9), pp.801-814

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The 21st century has witnessed a digital revolution with the rise of big data, particularly in sectors such as healthcare. This revolution presents both significant opportunities and challenges for healthcare providers who must manage vast quantities of diverse, complex, and rapidly growing data sources (Raghupathi & Raghupathi, 2014; Belle et al., 2015). Healthcare systems now generate data from multiple origins such as electronic health records (EHRs), pharmacy dispensing systems, patient monitoring devices, clinical trials, and supply chain logistics (Fernandes et al., 2012; Sun et al., 2017). One of the critical domains where big data can deliver transformative benefits is drug inventory management (DIM), where healthcare providers are tasked with ensuring the optimal availability, distribution, and storage of pharmaceuticals while minimizing wastage and avoiding stockouts (Aljumah et al., 2021; Albqowr et al., 2022).

In the context of the United Arab Emirates (UAE), healthcare providers face increasing pressure to maintain efficient and responsive drug inventory systems due to a growing population, the expansion of healthcare infrastructure, and rising expectations for world-class healthcare services (Al-Tamimi et al., 2018; Poma et al., 2020). The complexity of pharmaceutical supply chains, variability in patient demand, and frequent disruptions in global drug supplies further complicate the task of managing drug inventories effectively (Hussain et al., 2020). Therefore, harnessing big data in drug inventory management has the

potential to significantly improve decision-making processes, enhance operational efficiency, reduce costs, and ultimately improve patient care outcomes in the UAE healthcare system (Khan, 2019; Mehta & Shukla, 2021).

However, while big data presents considerable potential, many healthcare organizations in the UAE are still struggling with fragmented data systems, poor data integration, inconsistent data quality, and limited information sharing between stakeholders (El Khatib et al., 2022; Alrahbi et al., 2022). These challenges often lead to inefficient inventory control, procurement delays, increased operational costs, and, most critically, patient safety risks due to drug shortages or wastage of expired medications (Patel & Mehta, 2021; Abu Ghazaleh & Zabadi, 2020). In such complex and data-intensive environments, decision-making requires not only timely access to accurate information but also the capacity to process, analyze, and apply this information effectively (Wang et al., 2018; Rao, 2017).

Therefore, this study investigates the role of big data in enhancing the decision-making process related to drug inventory management in the UAE healthcare sector. Specifically, it examines the impact of key big data management factors data integration, data processing, data quality, data security, and information sharing on decision-making effectiveness. Furthermore, the study explores how effective decision-making mediates the relationship between big data factors and the overall effectiveness of the drug inventory management system (Chen et al., 2012; Wamba et al., 2017; Li et al., 2019).

This chapter outlines the background of the study, the problem statement, research objectives and questions, the significance and scope of the study, operational definitions of key terms, and the structure of the thesis. By addressing the challenges faced by the UAE healthcare sector, this study aims to propose a comprehensive big data management framework that can support healthcare providers and policymakers in developing more

resilient, efficient, and patient-centered drug inventory management systems (Sawyer & Gonzales, 2022).

1.2 Background

Drug Inventory Management (DIM) is a crucial aspect of healthcare systems. It involves managing and controlling the storage, procurement, dispensing, and usage of drugs within a healthcare institution (Raman et al., 2018). Effective DIM is key to ensuring the availability of necessary medications, minimizing wastage, reducing costs, and ultimately improving patient care outcomes (Aljumah et al., 2021).

In recent years, the advent of big data has provided significant opportunities for enhancing DIM systems. Big data, in the context of healthcare, refers to the vast amounts of data generated from various sources, including patient records, clinical trials, drug databases, and other electronic health records (Albqowr et al., 2022). When effectively managed and utilized, this data can inform critical processes related to drug procurement, distribution, and control, ultimately improving the efficiency and responsiveness of DIM systems.

In the UAE, DIM is regulated by the Ministry of Health and Prevention (MOHAP), which oversees the procurement and distribution of medications across both public and private healthcare institutions. While policies are in place to ensure the availability of essential drugs, challenges persist due to manual inventory tracking, lack of real-time data access, and inefficiencies in communication between suppliers and healthcare providers (Ministry of Health, 2020). The introduction of automated systems and big data analytics presents an opportunity to overcome these challenges by improving demand forecasting, monitoring drug expiration dates, and optimizing supply chain operations. However, these

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technological advancements require robust data management practices, which remain underdeveloped in many healthcare facilities across the UAE. Consequently, this study aims to address these gaps and explore how big data management can enhance decision-making processes within the UAE's DIM system.

Several key aspects of data management influence the effectiveness of inventory control and decision-making processes in DIM systems. These include data integration, data processing, data quality, data security, and information sharing (Alrahbi et al., 2022). Data integration involves combining data from multiple sources to provide a unified view of drug inventory status. Data processing refers to analyzing large volumes of data to extract actionable insights for inventory control. Ensuring data quality namely accuracy, completeness, and consistency is essential for informed decision-making. Data security entails protecting sensitive healthcare data from unauthorized access, while information sharing promotes the timely exchange of data among healthcare providers and suppliers to facilitate coordination (Taleb et al., 2015).

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Accurate and timely decision-making plays a vital role in managing drug procurement, distribution, and inventory control. Such decisions must be informed, evidence-based, and responsive to changing demands and supply conditions (Abu Ghazaleh & Zabadi, 2020). When healthcare organizations utilize well-managed data, they can better anticipate drug demand, minimize shortages, reduce wastage, and ultimately enhance patient care outcomes.

The UAE healthcare sector has been undergoing rapid development and expansion, with the goal of providing world-class healthcare services to its residents. One of the core components of these services is the effective management of drug inventory, ensuring that medications are available when needed without creating excessive storage costs or wastage from expired drugs. DIM involves comprehensive processes related to procuring, storing,

distributing, and controlling medications within healthcare institutions. In the era of big data, healthcare providers have unprecedented access to vast amounts of data that can be leveraged to optimize DIM operations (Mehta & Shukla, 2021). For example, data related to drug consumption patterns, patient demand trends, and supplier delivery performance can inform decisions regarding procurement quantities, order timing, and distribution strategies. Thus, harnessing big data has the potential to transform the UAE's DIM system by improving efficiency, reducing operational costs, and enhancing patient care quality.

Nonetheless, effective data management continues to face several challenges. Data may reside in fragmented systems, complicating integration and analysis. Data quality issues may result in inaccurate decisions, while insufficient data security measures can jeopardize the confidentiality of sensitive healthcare information. Addressing these challenges requires a comprehensive approach that integrates technological solutions, organizational processes, and human expertise.

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1.3 Problem statement

The UAE healthcare system is facing significant challenges in managing its drug inventory effectively, which is a critical component for ensuring medication availability, minimizing wastage, and enhancing patient care. Despite the availability of large volumes of data related to drug inventory levels, patient demand, and supplier delivery times, the current DIM systems suffer from fragmented data integration and poor data quality, leading to ineffective decision-making (Khan, 2019). These weaknesses are further exacerbated by limited information sharing between healthcare providers, creating data silos that hinder real-time coordination and collaboration (Poma et al., 2020).

Currently, drug inventory management policies in the UAE are primarily governed by the Ministry of Health and Prevention (MOHAP), which oversees centralized procurement, drug registration, licensing, import regulations, and quality control for both public and private healthcare sectors. These policies are intended to ensure consistent drug supply, standardize procurement procedures, and regulate pharmaceutical safety standards (Ministry of Health, 2020). However, several weaknesses remain within these existing policy frameworks. Firstly, the policies rely heavily on manual inventory reporting and static procurement cycles, which limit responsiveness to real-time changes in drug demand. Secondly, there is insufficient integration between healthcare facilities, pharmacies, and suppliers, resulting in fragmented data systems and duplication of efforts. Thirdly, current regulations lack clear mandates for comprehensive data-sharing protocols or integrated national platforms that would enable real-time monitoring of stock levels, patient needs, and supplier performance across the healthcare network. These limitations reduce the ability of healthcare organizations to forecast demand accurately, adjust procurement dynamically, or prevent shortages and wastage (El Khatib et al., 2022; Hussain et al., 2020).

The absence of effective data integration, advanced data processing, and data quality assurance within both policy and operational frameworks compromises the ability of healthcare providers to make timely, evidence-based decisions regarding drug procurement, distribution, and control. As a result, this leads to recurring drug shortages, wastage of resources, inflated operational costs, and, ultimately, adverse impacts on patient care outcomes (Aljumah et al., 2021).

If these systemic issues are not addressed, the consequences will likely include increasing inefficiencies, higher healthcare expenditures, and compromised patient care due to frequent stock imbalances. Therefore, there is a clear need for a more integrated, data-

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