

# **Automation Adoption in Saudi Arabia's Fashion Retail Supply Chain: The Saudi Abaya**

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## **Abstract**

Automation is rapidly transforming global supply chains, reducing costs, enhancing efficiency, and improving responsiveness. In Saudi Arabia, the fashion industry is expanding and showing stable growth, contributing approximately 2.5% of the country's overall GDP. Within this sector, the production and distribution of the traditional Abaya offer a unique context for automation adoption, given its cultural significance, high demand, and emerging digital infrastructure. This study explores the current state, drivers, and challenges of automation integration within the Saudi Abaya supply chain. By inspecting technological applications such as cutting and sewing, AI-driven forecasting, and automated warehousing, the research aims to understand how automation can improve operational efficiency and optimize production cycles, all while preserving the culture and values of the Abaya. In addition to exploring the potential benefits, the study addressed barriers and challenges that hinder adoption, including technical barriers, cost of technology, limited expertise, and resistance to change. It also identified gaps in existing literature, highlighting the scarcity of studies on automation in Saudi Arabia's retail. The study aims to provide valuable insights, align with Vision 2030 goals, and contribute to understanding digital transformation in culturally significant fashion supply chains.

## **Keywords**

Automation, AI forecasting, Saudi Arabia, Fashion retail, Abaya supply chain

## **1. Introduction**

In today's interconnected global economy, automation has emerged as one of the most important forces reshaping supply chains. Through advances in machinery, digital tools, and process integration, automation enables industries to enhance efficiency, improve accuracy, and respond more quickly to consumer demand. Around the world, the fashion and apparel sector has adopted various forms of automation to meet growing demand and reduce reliance on manual labour. However, not all regions and industries have experienced this transformation equally. In Saudi Arabia, automation presents both a challenge and an opportunity, particularly in sectors where cultural heritage and human skill play a central role, such as the production of the traditional Abaya.

The fashion industry in Saudi Arabia is steadily expanding, contributing an estimated 2.5% of the national GDP. This growth aligns closely with the goals of Vision 2030, which emphasises economic diversification, innovation, and the advancement of local industries. Within this sector, the Abaya occupies a unique position. More than just a garment, it is an expression of identity, modesty, and tradition. Yet as consumer tastes evolve and the market for modernised and customised Abayas continues to grow, producers and retailers face increasing operational challenges. These include fluctuating demand, short product life cycles, limited production capacity, and the pressure to maintain consistent quality. As a result, there is a growing need to explore how automation could be integrated into Abaya production and distribution systems to improve efficiency while preserving cultural values.

The motivation for this research arises at the intersection of tradition, technology, and industrial development. As Saudi Arabia progresses toward its Vision 2030 objectives, adopting innovative manufacturing and supply-chain practices becomes vital to maintaining competitiveness in both domestic and international markets. The Abaya supply chain includes stages such as fabric selection, cutting, stitching, quality control, packaging, and retail distribution, offering a distinctive case through which to examine the potential of automation in a culturally significant industry. Understanding this transformation requires not only technical insight but also appreciation of the cultural, social, and economic contexts that shape the industry's evolution.

Despite the growing global interest in digitalisation and process automation, there is still limited academic research focusing on the fashion supply chains of Saudi Arabia and, more specifically, the Abaya industry. Much of the existing literature concentrates on Western or Asian markets, where labour costs, industrial structure and cultural factors differ significantly from those in the Gulf region. Consequently, gaps remain in understanding how automation can be applied effectively within Saudi Arabia's fashion sector, what barriers hinder its adoption, and what opportunities it presents for sustainable development. Common obstacles reported in related studies include high investment costs, limited technical expertise, dependence on manual labour, and organisational resistance to change. These challenges highlight the need for a structured and comprehensive review of the available evidence to inform both academic and industry practices.

#### Problem Statement

Although automation continues to transform global manufacturing and retail sectors, its role within Saudi Arabia's Abaya industry remains underexplored. Existing research provides insufficient insight into how automation might enhance productivity and quality while maintaining the cultural integrity of traditional garments. Further, the lack of systematic studies addressing the drivers, barriers, and long-term implications of automation in Saudi Arabia's fashion industry limits the ability of policymakers, designers, and manufacturers to make informed decisions. To address these gaps, this study undertakes a Systematic Literature Review (SLR) to examine current knowledge, identify research trends and barriers, and propose insights that can guide future automation integration in the Abaya supply chain. By synthesising findings from global and regional studies, this review aims to contribute to the broader understanding of digital transformation in culturally significant fashion industries and support the realisation of Vision 2030 objectives.

### 1.1 Objectives

This research aims to systematically review and analyze academic studies on automation within fashion supply chains to understand its potential, challenges, and implications for Saudi Arabia's Abaya industry. The specific objectives are:

1. To systematically identify and review existing literature related to automation, digital transformation, and supply chain optimization in the global fashion and apparel industry.
2. To examine the drivers, enablers, and benefits of automation adoption within fashion manufacturing, particularly in contexts similar to Saudi Arabia.
3. To identify key barriers and challenges, technical, economic, cultural, and organizational, that limit automation integration in the Abaya supply chain.
4. To evaluate how automation aligns with Saudi Arabia's Vision 2030 goals, emphasizing cultural preservation, economic diversification, and industrial innovation.
5. To synthesize findings and propose a conceptual framework or improvement strategies for implementing automation in the Saudi Abaya supply chain, ensuring a balance between efficiency and cultural values.

### 1.2 Unique Contributions of This Research

This study contributes new insights by:

- Filling a regional research gap: It provides the first systematic review focused specifically on automation in Saudi Arabia's fashion and Abaya industry.
- Integrating cultural and technological dimensions: It emphasizes how automation can support cultural preservation while improving operational performance.
- Aligning with Vision 2030 objectives: It links industrial modernization with national goals for innovation, women's employment, and sustainable growth.
- Providing a strategic reference for industry stakeholders: The findings and proposed framework offer practical guidance for manufacturers, policymakers, and academics seeking to understand or implement automation in culturally significant industries.

## **2. Literature Review**

The literature on automation in fashion and apparel supply chains reveals a diverse and evolving field that intersects technology, management, and cultural studies. To build a coherent understanding of how automation might be applied to the Abaya industry in Saudi Arabia, the existing research is organised thematically into four major domains: (1) the evolution of automation in fashion and apparel supply chains; (2) drivers and enablers of automation adoption; (3) barriers and challenges to implementation; and (4) socio-cultural and strategic implications, particularly within developing and culturally embedded industries.

### **2.1 Evolution of Automation in Fashion and Apparel Supply Chains**

Automation in fashion manufacturing has evolved from basic mechanisation to sophisticated digital and cyber-physical systems. Early research emphasises the transition from manual sewing and cutting to computer-aided design (CAD), computer-aided manufacturing (CAM), and robotic systems that enhance precision and production speed. With the advent of Industry 4.0, technologies such as artificial intelligence (AI), the Internet of Things (IoT), machine vision, and cloud-based manufacturing systems have further integrated production stages, enabling smart factories capable of self-optimisation and real-time quality monitoring (Gao & Liu 2021; Nguyen 2025). In the context of fashion, automation has been instrumental in addressing the challenges of short product cycles, demand volatility, and mass customisation. Studies highlight how automation supports rapid prototyping, small-batch production, and sustainability by reducing waste and material inefficiencies (e.g., Saha & Chowdhury, 2022). However, much of this literature concentrates on Western or East Asian manufacturing contexts, where labour costs and infrastructure differ markedly from the Gulf region. The limited exploration of automation in Middle Eastern or culturally specific sectors, such as the Abaya industry, suggests a significant regional knowledge gap.

### **2.2 Drivers and Enablers of Automation Adoption**

The adoption of automation in apparel supply chains is influenced by a combination of technological readiness, market dynamics and strategic priorities. Productivity improvement, cost reduction, and product quality are the primary drivers (Jin 2023; Kaur 2024). Automation allows faster turnaround times, improved consistency, and reduced human error, essential features in fashion markets characterised by fast trends and high SKU variety. National digital transformation policies provide an important enabling context. In Saudi Arabia, Vision 2030 encourages industrial modernisation, localisation of production, and workforce innovation. Further, the global shift toward sustainable production has encouraged investment in production systems that minimise resource consumption, enable closed-loop manufacturing, and support circularity (Wang & Liu 2023). Technological enablers such as AI-driven demand forecasting, automated cutting machines, and robotics in stitching and finishing are increasingly accessible, although unevenly distributed across regions. Cloud-based supply-chain management and predictive analytics further enhance supply-chain transparency and coordination (Nguyen 2025). Together, the studies suggest that automation is not simply a technical upgrade but a strategic tool for economic and environmental resilience.

### **2.3 Barriers and Challenges to Automation Implementation**

Despite its potential, automation adoption faces multiple barriers that are structural, technological, and cultural. High capital cost remains the dominant obstacle, particularly for small and medium-sized enterprises (SMEs) in emerging markets. The purchase, maintenance, and integration of advanced machinery require substantial investment and technical expertise that many local manufacturers lack. Organisational resistance to change poses another major challenge. Research indicates that managers and workers often fear job displacement, skill redundancy, and disruption of traditional craft practices (Rashid 2021). This challenge is particularly relevant in the Abaya industry, where craftsmanship and manual techniques are deeply associated with cultural authenticity and artisanal identity. Additional barriers include inadequate digital infrastructure, lack of skilled labour, fragmented supply-chain coordination, and gender cultural considerations in production environments (Qureshi & Ahmad, 2023). These factors emphasise the importance of context-specific research and policy interventions for successful automation adoption.

### **2.4 Socio-Cultural and Strategic Implications of Automation**

A growing body of literature explores beyond efficiency metrics to examine the broader implications of automation. Automation in fashion manufacturing can reshape workforce structures, creative processes, and cultural representation. Scholars argue that technology integration must be managed in ways that preserve symbolic and aesthetic values, especially in heritage-oriented industries. In the Saudi context, the Abaya functions not only as a fashion item but as a cultural artefact. Research suggests that technological integration can support cultural continuity when applied strategically, for example, by enabling local artisans to focus on high-value design and customisation

while routine manufacturing processes are automated. This hybrid model maintains cultural identity while enhancing productivity. Further, policy frameworks and public-private collaboration play strategic roles in fostering sustainable automation adoption, especially in emerging economies. National innovation policies, training initiatives, and digital literacy programmes are highlighted as essential complements to technological investments (Omar & Lee 2021).

### Synthesis and Research Gap

Overall, the thematic synthesis reveals that while automation has transformed global fashion supply chains, its localized application in culturally embedded industries remains underexplored. There is limited empirical evidence on how automation can be adapted to align with cultural heritage, gender roles, and consumer expectations in the Saudi Abaya market. Furthermore, few studies integrate both technological and socio-cultural analyses within a single framework. This gap justifies the present study’s SLR approach, which seeks to consolidate existing global insights, assess their relevance to Saudi Arabia’s Abaya supply chain, and propose a context-sensitive model for automation adoption.

## 3. Methods

This study utilises a Systematic Literature Review (SLR) methodology to ensure a structured, transparent, and replicable synthesis of existing research on automation within fashion and apparel supply chains, with a specific lens on its applicability to the Saudi Abaya industry. The SLR approach was selected because it provides a rigorous method for identifying, evaluating, and integrating findings from multiple studies, which addresses fragmented evidence and clarifies research gaps. The process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (Figure 1).

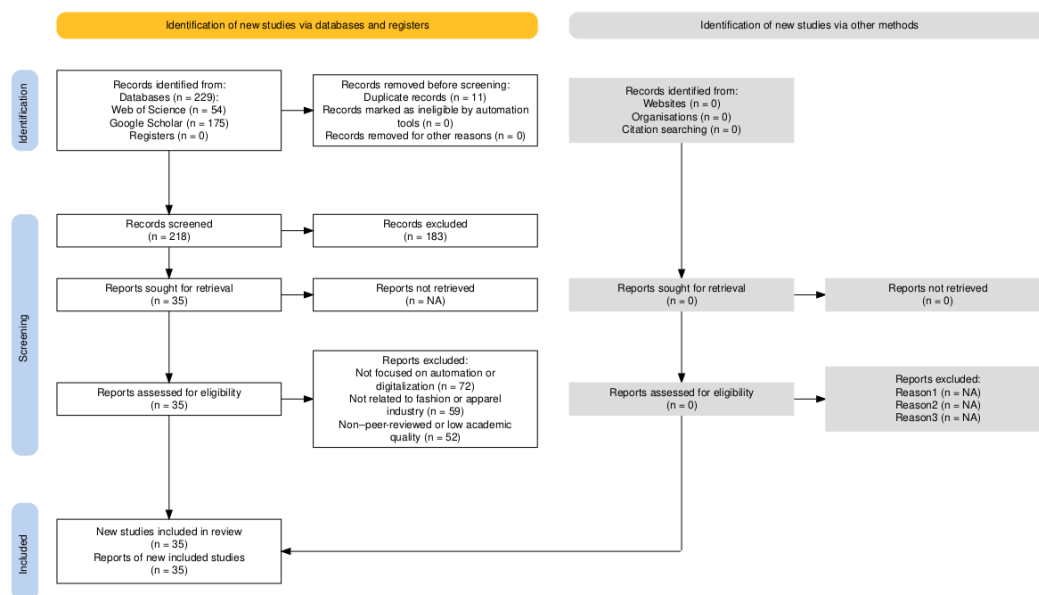


Figure 1. Systematic Literature Review (SLR) methodology

### 3.1 Research Design

The review was designed to address the overarching research question: “How can automation be effectively implemented within the Saudi Abaya supply chain to enhance efficiency, sustainability, and cultural preservation?”

Supporting sub-questions included:

1. What forms of automation are most commonly adopted in fashion and apparel supply chains globally?
2. What drivers and enablers influence automation adoption in emerging markets, particularly in the Middle East?
3. What barriers and challenges limit automation in culturally sensitive industries like the Abaya supply chain?

4. What insights can guide automation implementation in Saudi Arabia's Abaya supply chain? A predominantly qualitative synthesis method was adopted, supported by descriptive statistics to identify trends, gaps, and patterns.

### **3.2 Search Strategy**

A systematic search was conducted in two primary data sources: Web of Science and Google Scholar. Publications from 2010 to 2025 in English were included. The following search terms (and Boolean combinations) were used: (automation OR digitalization OR Industry 4.0 OR robotics OR AI) AND (fashion OR apparel OR garment OR textile) AND (supply chain OR manufacturing OR production) AND (Saudi Arabia OR Middle East OR Abaya) This search yielded 229 records (54 from Web of Science and 175 from Google Scholar). After removal of 11 duplicates (n = 218), title and abstract screening excluded 150 records, leaving 68 for full-text retrieval; of these, 33 were excluded due to relevance or access issues, resulting in a final set of 35 studies for synthesis.

### **3.3 Inclusion and Exclusion Criteria**

To maintain rigor and relevance, the following criteria were applied:

Inclusion Criteria:

- Peer-reviewed journal articles, conference papers, and book chapters published between 2010–2025.
- Studies addressing automation, digital transformation, or technological innovation in fashion, apparel, or related supply chains.
- Research discussing adoption drivers, barriers, or cultural and socio-economic implications.
- Studies published in English.

Exclusion Criteria:

- Non-academic sources such as blogs, news articles, or non-peer-reviewed reports.
- Studies unrelated to manufacturing or supply chain processes.
- Papers lacking empirical, conceptual, or theoretical analysis relevant to automation or digitalization.

### **3.4 Screening and Selection Process**

A total of 229 records were initially retrieved from the databases. After the removal of duplicates, 218 studies remained for title and abstract screening. The screening excluded 150 records, leaving 68 for full text retrieval; of these, 33 were excluded for access issues. Following the exclusion of papers with insufficient methodological detail or limited relevance to the research questions, 35 studies were included in the final synthesis.

The screening process followed four PRISMA stages:

1. Identification – Database search and keyword refinement.
2. Screening – Title and abstract review for thematic relevance.
3. Eligibility – Full-text assessment and quality evaluation.
4. Inclusion – Final set of studies forming the synthesis base.

### **3.5 Quality Assessment**

To ensure reliability and validity, each selected study was evaluated based on three criteria:

- Relevance to the research question
- Clarity of design, data collection, and analysis
- Contribution to theory or practice

Studies rated as “low quality” or “limited scope” were excluded from synthesis but noted for context. Cross-verification between thematic patterns and source validity minimized bias and enhanced transparency.

### **3.6 Limitations of the Review Process**

While this SLR provides a structured synthesis of available literature, certain limitations are acknowledged. The reliance on English-language publications may exclude valuable Arabic sources or industry reports. Moreover, the scarcity of empirical studies focusing specifically on the Saudi Abaya sector required extrapolation from related regional and international contexts. Despite these constraints, the systematic approach ensured a robust and comprehensive understanding of the topic.

## **4. Data Collection**

Following the structured methodology outlined in the previous section, data collection focused on systematically extracting, organizing, and synthesizing information from the 35 studies identified during the final stage of the review. The data collection process aimed to ensure transparency, consistency, and comparability across all reviewed sources, while aligning directly with the study's objectives of identifying trends, enablers, barriers, and opportunities for automation in the Saudi Abaya supply chain. The data for this study were collected through a systematic review of existing academic and professional literature. Two main databases were used to ensure coverage of both peer-reviewed and grey literature: **Web of Science** and **Google Scholar**. The search was conducted using combinations of keywords such as "automation," "digitalization," "fashion supply chain," "textile industry," "MENA," "Saudi Arabia," and "Industry 4.0."

### **4.1 Data Verification and Reliability**

To ensure reliability and mitigate subjectivity, the extracted data were cross-checked in three stages:

1. **Internal validation:** Repeated screening of coded segments ensured consistency in thematic assignment.
2. **Cross-source triangulation:** Findings from multiple studies were compared to identify convergence or contradiction across contexts.
3. **Chronological mapping:** Trends were analyzed over time to observe how automation discourse evolved alongside technological advancement and policy changes.

Through this process, the review minimized researcher bias and ensured that conclusions were supported by patterns repeatedly observed across independent studies.

## **5. Results and Discussion**

### **5.1 Significance of the Findings**

This systematic literature review revealed that automation adoption within the Saudi and MENA fashion supply chain remains at an early yet rapidly evolving stage. The findings highlight how technological transformation is influenced not only by economic incentives but also by social, cultural, and institutional factors unique to the region. For Saudi Arabia in particular, the alignment of automation with Vision 2030's diversification and digital transformation goals underscores its strategic importance.

A significant insight emerging from the review is that automation in the fashion sector does not need to conflict with cultural identity. Studies focusing on the Abaya industry illustrate that automation can be introduced selectively, such as in fabric cutting, inventory management, or digital pattern design, while preserving the traditional artistry central to Saudi fashion. This reinforces the idea that modernization can coexist with heritage when guided by thoughtful policy and design choices.

Another important observation is the clear gap between large and small enterprises. While multinational fashion companies and regional leaders are integrating automation to improve speed and reduce waste, many SMEs struggle to adopt such technologies due to financial barriers, lack of technical knowledge, and limited infrastructure. This technological divide emphasizes the need for inclusive strategies and government support mechanisms to ensure that automation benefits are equitably distributed.

### **5.2 Practical Implications**

For industry practitioners, the review underscores the importance of adopting automation strategically rather than wholesale. Firms in the Saudi and MENA fashion sector should approach automation as a phased process, starting with digital tools that complement existing workflows rather than replace human skills. Training programs and partnerships with technology providers can build workforce readiness while mitigating resistance to change.

For policymakers, the study suggests developing tailored incentives for local manufacturers, particularly SMEs, to experiment with low-cost automation technologies. These could include subsidies, innovation grants, or shared digital infrastructure to lower the financial barriers of entry. Moreover, collaboration between fashion institutes and industrial organizations can foster innovation ecosystems that integrate cultural sensitivity with technological advancement.

For academia and educators, this review highlights an urgent need to expand business and design curricula to include digital supply chain management, automation ethics, and sustainable fashion technologies. Such educational

reforms can create a new generation of fashion professionals who understand both creative design and digital operations.

### **5.3 Theoretical Implications**

From a theoretical standpoint, the review contributes to the understanding of automation adoption as a socio-technical process influenced by local norms, institutional maturity, and cultural meaning. It bridges two streams of literature, technology adoption and cultural sustainability, that are rarely discussed together in the context of the MENA fashion industry. The synthesis suggests that existing technology adoption models, such as the Technology Acceptance Model (TAM) and the **Diffusion of Innovations (DOI)** theory, may require contextual adaptation to capture cultural and gender-specific dimensions in Saudi Arabia and neighboring countries.

This research, therefore, enriches theory by emphasizing cultural compatibility as a determinant of automation adoption, a dimension often overlooked in Western-centric models of digital transformation.

### **5.4 Future Research Directions**

The findings open several promising avenues for future research. First, empirical studies are needed to measure the real-world impact of automation on productivity, employment, and sustainability within Saudi and regional fashion supply chains. Quantitative assessments could validate the benefits suggested in this review and identify areas where automation adds the most value.

Second, future research could explore the social acceptance and gender dynamics of automation in fashion workplaces, especially given the growing participation of Saudi women in the design and manufacturing sectors.

Third, comparative regional studies could assess how automation progresses across different MENA countries, identifying policy and market conditions that either accelerate or hinder adoption.

Finally, as sustainability becomes a strategic priority, future investigations could focus on how automation supports eco-friendly production, such as fabric waste reduction, energy optimization, and sustainable logistics.

## **6. Conclusion**

This study set out to systematically review the integration of automation within Saudi Arabia's Abaya and fashion supply chains. The research objectives were to:

1. To systematically identify and review existing literature related to automation, digital transformation, and supply chain optimization in the global fashion and apparel industry.
2. To examine the drivers, enablers, and benefits of automation adoption within fashion manufacturing, particularly in contexts similar to Saudi Arabia.
3. To identify key barriers and challenges, technical, economic, cultural, and organizational, that limit automation integration in the Abaya supply chain.
4. To evaluate how automation aligns with Saudi Arabia's Vision 2030 goals, emphasizing cultural preservation, economic diversification, and industrial innovation.
5. To synthesize findings and propose a conceptual framework or improvement strategies for implementing automation in the Saudi Abaya supply chain, ensuring a balance between efficiency and cultural values.

All objectives were successfully achieved through thematic synthesis of existing literature. The study found that while automation adoption in Saudi Arabia's fashion industry is at an emerging stage, it holds strong potential to improve operational efficiency, sustainability, and market competitiveness without compromising cultural authenticity.

The key unique contribution of this research lies in its focus on the intersection of technology and culture within the context of the Saudi Abaya supply chain, a topic largely overlooked in prior studies. By emphasizing cultural sensitivity as a core component of digital transformation, this study provides both theoretical enrichment and practical direction for industry leaders and policymakers.

In conclusion, automation presents a powerful tool for the Saudi fashion sector to balance modernization and tradition. As Vision 2030 continues to shape the nation's industrial landscape, future collaboration between researchers, government agencies, and private firms will be essential to ensure that automation serves as a bridge between innovation, cultural identity, and sustainable economic growth.

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## **Biographies**

**Maryam Alawlaqi** is a junior undergraduate student pursuing a Bachelor of Science in Operations and Supply Chain Management at Effat University, Jeddah, Saudi Arabia. She is a motivated and detail-oriented student with strong communication and public speaking skills, actively seeking opportunities to gain practical experience through internships, research, and collaborative projects. Fluent in Arabic and English, with conversational proficiency in German, she brings a multicultural perspective to her academic and professional endeavors. Her research interests include supply chain automation, digital transformation, and sustainable operations, with a particular focus on the Saudi fashion industry and culturally significant supply chains. Maryam is passionate about bridging theory and practice by engaging in applied research and contributing to the growing discourse on innovation in supply chain management within the context of Saudi Arabia's Vision 2030.

**Dr. Sarah Y. Osailan** is an Assistant Professor and Chair of the Operations and Supply Chain Management Department at Effat College of Business, Effat University. She holds a Ph.D. and a master's in information systems & technology with a concentration in Geographic Information Systems (GIS) from Claremont Graduate University.

Her research and teaching focus on digital transformation, data analytics, and business model innovation, with a particular interest in how emerging technologies are reshaping supply chains and operations. Building on her foundation in GIS, she explores how spatial data, intelligent systems, and automation can support areas such as AI-driven logistics, digital supply chains, and autonomous mobility. Dr. Osailan is passionate about bridging academia and industry, designing engaging, technology-enabled learning experiences, and preparing future leaders to navigate an increasingly data-driven and digitally connected world.