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Transforming Apparel Manufacturing with Cloud SaaS: A Blueprint for Legacy System Modernization

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ABSTRACT

The Cloud SaaS implementation of digital transformation of the apparel manufacturing industry offers a strategic avenue for modernizing the legacy system. This article reports the replacement of an AS/400-based shopfloor management system by a contemporary cloud system in one of the North American garment factories. The hybrid modernization framework did not jeopardize the useful legacy business logic but added cloud-native features using the APIs, middleware, and gradual migration. The integration with the enterprise systems and real-time analytics occurred with Microsoft Azure infrastructure, SEQUEL views, and RFID tracking. The change brought significant gains in production throughput, quality, inventory management, and speed of decision-making. The satisfaction of the workers grew because the administrative overhead was reduced, and the financial evaluation showed impressive returns on an investment at a shorter payback period than the conventional ones. The example offers a subsequent example of digital transformation to be adopted in manufacturing premises that rely on legacy systems.

Keywords: Cloud Manufacturing, Legacy System Modernization, RFID Production Tracking, Azure Serverless Computing, Digital Transformation

1. Introduction

Digital transformation is one of the paradigm changes in manufacturing industries that has been influenced by the changing market demands, global competition, and supply chain implications. All of the elements of cloud computing, the Internet of Things, artificial intelligence, and big data analytics have become the key to staying competitive. It is a major challenge for manufacturing organizations that find it hard to modernize the infrastructure that was built decades ago, where the technological update is only one of the components, and the whole change in the organizational culture and business models is needed to achieve the full potential of Industry 4.0 [1].

The production of the clothing industry faces special modernization issues because of low profit margins and multifaceted supply chain relationships. Most of the clothing companies still maintain the systems of the 1980s and 1990s that were on the AS/400 platform, which puts a technological barrier to innovation. These old systems are usually independent, and they cannot be connected to contemporary applications, nor do they provide access to real-time data on production. Proprietary programming languages, monolithic architecture, and the lack of documentation make modernization an especially difficult process, particularly in situations where the knowledge transfer becomes even harder in case older personnel retire [2].

This study reports on a large-scale modernization project at a medium-sized North American garment manufacturing company, which upgraded its AS/400-based shopfloor management system to a new modern Cloud SaaS system without interfering with any of the essential production processes. The secondary goals comprise improved real-time work-in-progress visibility, quality measurements, payroll processing automation, and data-driven decision making by use of high-quality analytics [1].

The subject organization began to digitally transform because of the competitive forces and the needs of customers to know more about production. The prevailing systems had departmental silos where manual data collection created delays in reporting and the management of the workforce. These technological constraints limited the strategic goals of minimizing lead times in production as well as enhancing efficiency in operations. The change was aimed at overcoming these shortcomings without losing the precious business knowledge stored in decades-old systems using RFID technology, cloud-based analytics, and mobile accessibility [2].

The theoretical framework is a hybrid modernization with the acknowledgment of an embedded value in the old systems, as it moves functionalities systematically to modern cloud systems. This is a technique that will maintain useful business logic and will add cloud-native features progressively, using APIs, middleware, and gradual migration. The methodology establishes the connections between old and emerging technologies in a manner that enables gradual adoption whilst creating a gradual return to the benefits in the process of transformation, recognizing that a manufacturing setting cannot withstand any drastic changes in the operations [1].

2. Literature Review

Manufacturing Execution Systems (MES) have been developed significantly since primitive production tracking instruments, becoming an all-encompassing platform with high technologies. Shop floor control systems today represent a dedicated branch of MES adapted to labor-intensive manufacturing sectors such as apparel production, where the visibility of workflow and labor intensity indicators is used to control operational effectiveness. The move to terminal-based interfaces to touchscreen and mobile applications allows the operator and the manager to communicate with the production systems wherever they are, which form the basis of data-based decision making and steady improvement programs [3].

The modernization of the legacy systems in manufacturing is based on a number of strategic directions, and many apparel manufacturers still use decades-old systems as they have made heavy investments in customization. The two common methods are interface improvements that maintain the operations of the backend with better user experience, and middleware layers between old databases and cloud-based analytics systems. The manufacturing organizations are moving towards hybrid architectural designs that preserve the essential legacy building blocks but strategically deploy the cloud-native services to ensure scalability and innovativeness [3].

The use of Cloud SaaS in the production of apparel shows a growing momentum as producers are trying to gain a competitive edge by enhancing their visibility and operational flexibility. The migration facilitates smoother operations in various production plants, which can enable the domestic and international production models. The cloud solutions of today cater to the industry-specific needs, such as piece-rate payroll computation, bundling of production, and quality assurance operations. The economic model of subscription is especially beneficial in seasonal manufacturing to adapt to the seasonal changes in production demand without making any serious investments into the capital [4].

Migration of the old and new systems is a great challenge in the already existing manufacturing settings. The effective strategies aim at reducing the disturbances and gradually improving the capabilities by using a connector between the different technologies. Specific points of integration, such as communication among systems based on AS/400 and contemporary cloud systems, are especially problematic, and specialized middleware needs to be developed. The human factor is one more significant factor that should be taken into account, and intensive training programs and change management programmes are necessary to ensure that the workforce adopts [4].

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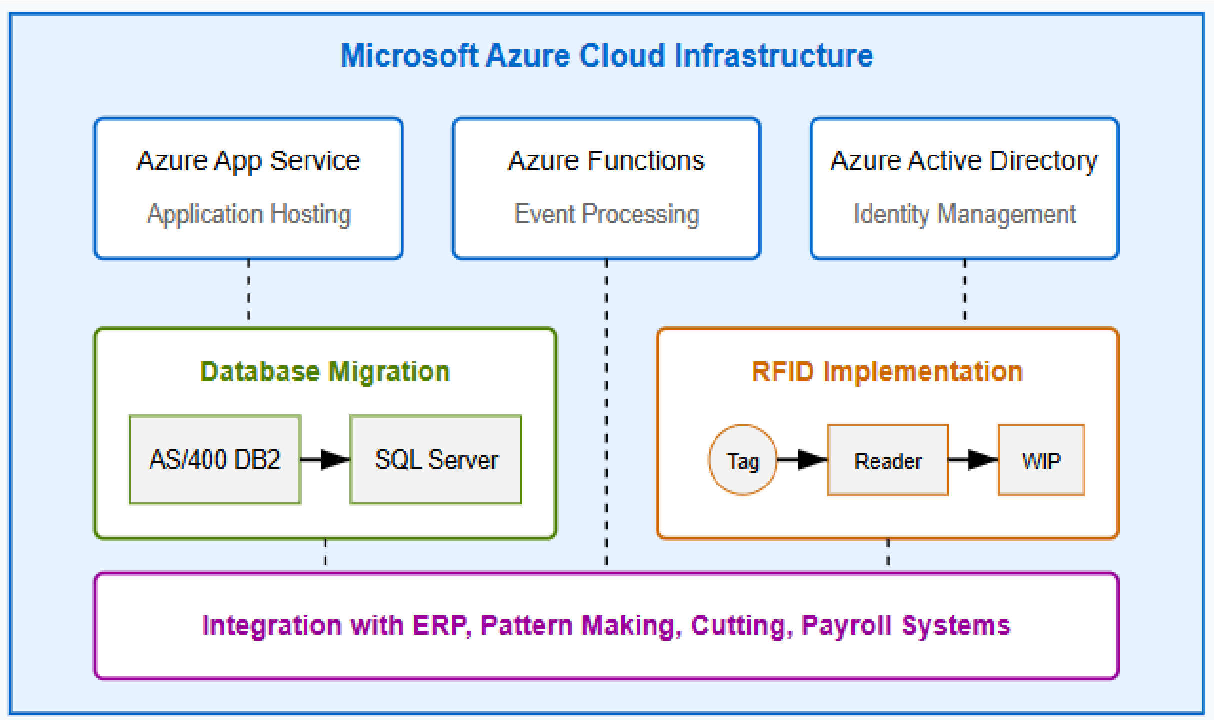

Fig 1: System Architecture Overview [3, 4]

The studies on the adoption of hybrid cloud in the apparel manufacturing sector are still scarce, even as more industries adopt it. Control of available case studies indicates encouraging results in terms of operational efficiency, visibility of the process in the realm of production and management of the workforce, but systematic empirical research involving various settings of implementation is lacking. The existing research gap provides prospects to explore the best architectural design patterns, integration structures, and implementation procedures unique to the apparel manufacturing setting [3, 4].

3. Methodology and System Architecture

This study adopts the case study methodology in analyzing the modernization of the old manufacturing systems in the apparel industry. The methodology includes direct observation of production settings, semi-structured interviews with the stakeholders of the organization on different levels, and quantitative analysis of system outputs. Case study methodology offers useful information on complicated socio-technical changes in which the contextual circumstances play an important role. The data gathering plan involves recording decision crossings, implementation obstacles, and readjustment approaches during the migration process [5].

Reading requirements. Requirements analysis starts with a complete mapping of the current processes, identification of essential business rules in the legacy systems, and measurement of modernization goals. It is done through workshops with stakeholders who are representatives of production and quality control, management, and IT departments. Vendor evaluation is a structured evaluation that checks on technical abilities, implementation strategy, industry-specific knowledge, overall cost of ownership, and support abilities. The assessment model focuses on the solutions that can be deployed to maintain the essential functionality with the addition of new functions to monitor and analyze in real-time [5].

The system architecture utilizes cloud infrastructure to give the benefit of scalability, reliability, and accessibility compared to the conventional on-premises implementation. Services of the Microsoft Azure platform form the basis of application hosting, database management, and integration services. The architecture applies the principles of microservices, breaking down monolithic legacy applications

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into small functional blocks interlinked by standardized interfaces, making them easier to maintain and allowing them to be thoroughly modernized in stages [6].

The issue of database migration is a basic technical issue when changing from the old-fashioned IBM DB2 systems to the new and modern cloud-based SQL Server systems. Migration methodology uses special data transformation tools to handle structural disparities between database structures. SEQUEL views establish layers of abstraction between existing applications and underlying data structure changes to allow phased migration with minimal operational impact [6].

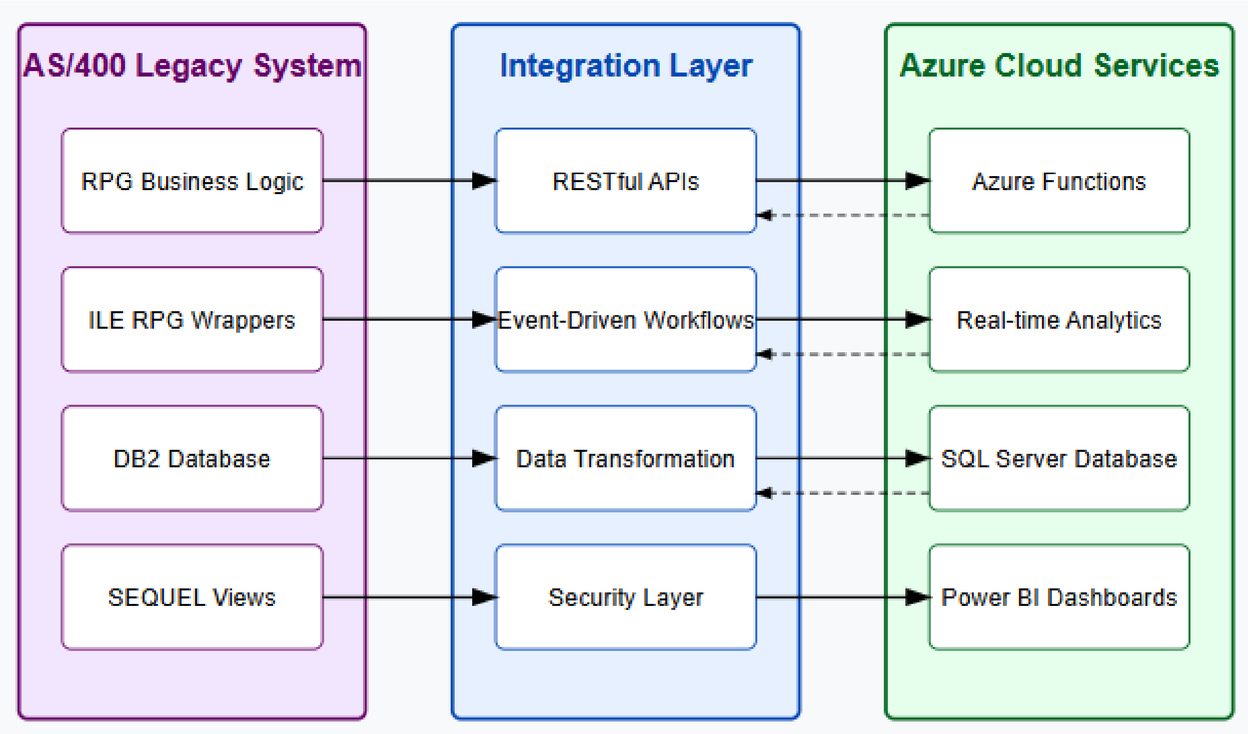

Fig 2: Technical Implementation Framework [5, 6]

The integration architecture provides the linkage between the modernized shop floor control systems and the other enterprise applications, such as the ERP, pattern making, cutting, and payroll systems. The integration strategy incorporates service-based concepts where the interfaces used are standardized and allow the transfer of information among systems that had been isolated. The use of RFID technology offers automated work-in-progress tracking, which substitutes the manual scanning methods with automated work-in-progress monitoring throughout the production processes [5, 6].

4. Technical Implementation and Integration

The technical implementation to provide event-driven processing based on event-processing workflows utilized a serverless computing architecture using Azure Functions. Serverless computing can be of great benefit to manufacturing settings, which would automatically scale up during times of peak production without the need to maintain the infrastructure. The patterns of event-driven substituted the traditional polling in the processes and allowed instantaneous reaction to the production events like bundle completion, quality inspection results, and machine status change. The implementation architecture divided the issues into various functional areas that were consistent with the manufacturing business processes to enable incremental deployment to reduce the impact of development on the running production processes [7].

The API development has dealt with the problem of interconnecting modern cloud services and legacy AS/400 applications that have decades of embedded business logic. The strategy used during the

integration involved the use of RESTful API interfaces on the cloud applications and the creation of the ILE RPG wrapper programs on the legacy system side. These wrappers simply standardized a business logic that was already present, without necessarily wholesale rewriting of established production code. The strategy maintained institutional wisdom stored in legacy applications and allowed the contemporary systems to utilise these features by using the modern interface standards [7].
The preservation of legacy logic was done in a systematic approach that started with the extensive analysis of the existing code in order to determine business rules that were important to the manufacturing business processes. The techniques of the static code analysis were able to identify the main business rule elements in RPG, COBOL, and CL programs, and the dynamic analysis at the time of the manufacturing operations recorded the patterns of execution and their dependencies. The preservation plan gave more emphasis on business logic as the basis of migration in terms of importance to the business, complicated implementation, and modernization [8].
Live analytics was a disruptive innovation compared to the batch-based historical reporting framework. The implementation formed a holistic data pipeline whereby the capture of events at the production workstations was the beginning, and then stream processing was done to provide real-time aggregation, and lastly operational dashboards and data warehousing to analyze the data further. The introduction of manufacturing-specific key performance measures in terms of production efficiency, quality indicators, and labor use offered the clarity of operations never seen before [8].

Focus Area	Approach	Outcome
Event Processing	Serverless Azure Functions	Real-time, scalable reactions
Deployment	Incremental, process-based	Minimal production disruption
Legacy Integration	REST APIs + RPG wrappers	Preserved business logic
Logic Preservation	Code analysis (RPG, COBOL, CL)	Smooth migration, rule retention
Analytics	Stream processing & dashboards	Real-time operational insights
Security & UI	Defense-in-depth + contextual design	Compliance & user-friendly access

Table 1: Key Technical Implementation Strategies in Manufacturing [7, 8]

Security was implemented on both compliance-specific and technical controls as applied to manufacturing locations. The strategy introduced defense-in-depth concepts, where there were both architectural protection measures at various layers. Design of user interface to highlight the diverse user base in manufacturing settings through application of contextual inquiry methods to comprehend the workflow patterns and information requirements, among individuals, including production floor workers as well as management staff [7, 8].

5. Results and Performance Analysis

The use of cloud-based shop floor control systems provided significant performance gains in several manufacturing operations dimensions. The post-implementation evaluation showed that the production throughput, order fulfillment cycle times, and inventory management have improved significantly over the production at the time of baseline. In the area of sustainability, specific progress was observed in the area of material waste decrease and the need to optimize resource use. This is due to the real-time visibility that allowed production managers to spot and deal with bottlenecks instead of dealing with them reactively, thus fundamentally changing the management strategies in operations [9].
Improvement in production quality came out as one of the key advantages of system modernization, whereby first-pass quality improvements were realized. The implementation created the digital traceability of the whole production workflows and allowed identifying the source of defects and patterns very quickly. The processes of quality assurance have shifted their involvement, involving

more manual inspection-based methods to data-oriented processes encompassing statistical process control and predictive analytics. This revolution decreased the reliance on quality checks at the end of the line to in-process checks that limited the spread of defects [9].

Economic evaluation showed good ROI, although the start-up costs are high. The modernization project was pursued using the existing ROI assessment guidelines that include both tangible and intangible attainments. Physical gains were evident in the form of direct labor efficiency, decreased overtime, material wastage, and costs on quality. The intangible benefits included customer satisfaction, better positioning, and the organization. The financial discussion revealed that cloud-based manufacturing systems provide better payback duration than the conventional on-premise options [10].

The decision-making skills also changed significantly after the implementation, and the decision speed and quality were observed to improve significantly. The analytics environment provided in real-time made it possible to conduct evidence-based decision-making across organizational levels, and the ways that were used before were based on intuition. The production planning shifted to more proactive planning to control rather than the reactive production planning. This increased visibility was a direct success in achieving the sustainability goals as it revealed inefficiencies in the use of resources [9].

The working force dynamics proved to be transforming positively, with the workers showing more satisfaction when they had reduced administrative burden, and the skilled personnel could concentrate more on value-added activities instead of the manual collection of data. The system was useful in transferring knowledge between old and new employees, with some of the problems being linked to old-age workforce demographics prevalent in manufacturing facilities [9, 10].

Dimension	Key Improvements	Outcomes
Operational Performance	Higher throughput, faster order fulfillment, better inventory control	Reduced bottlenecks, optimized resource use
Quality	Digital traceability, predictive analytics, and in-process checks	Higher first-pass quality, fewer defects
Economics	ROI despite high start-up costs; savings in labor, overtime, waste	Faster payback vs. on-premise systems
Decision-Making	Real-time analytics, proactive planning	Faster, evidence-based decisions, improved sustainability
Workforce Dynamics	Reduced admin burden, knowledge transfer	Higher satisfaction, focus on value-added work

Table 2: Results and Performance Analysis of Cloud-Based Shop Floor Systems [9, 10]

Conclusion

The effective change of the old apparel manufacturing system under the implementation of the Cloud SaaS proves the feasibility of the hybrid approach to modernization that does not sacrifice the institutional knowledge, but leaves the opportunity to develop technology. The case confirms that cloud-based manufacturing solutions have the potential to provide substantial operational value and reduce the impact on the key production processes. The architecture that will be used to integrate AS/400 systems with the latest cloud systems using APIs and event-driven workflows can be viewed as a blueprint that can be used in other industries, not just in making apparel. Manufacturing companies should understand that digital transformation is more than technology, including organizational culture, skills of the workforce, and optimization of processes. Directions to go further include the use of artificial intelligence in optimising production, making the supply chain more integrated, and being able to predict when to perform maintenance. The shift to data-driven manufacturing is a vital change in order to be competitive in dynamic global markets.

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