Bridging Tradition and Technology: Leveraging ERP Systems for Streamlined Supply Chains and Modernized Keropok Lekor Production Management

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***Abstract*—Online marketplace and social media offers substantial opportunities for business growth for many and it has contributed greatly to the increase demand of keropok lekor (fish cracker) from Terengganu throughout Malaysia as the market reach is increasing. Positive effects of these online platforms as significant digital marketing tools encourage keropok lekor producers in Terengganu to invent and diversify their products with the goal to market and increase the sale of keropok lekor in a larger scale. Some of the innovations are selling keropok lekor in pre-packaged form and introduce different versions of keropok lekor by adding more flavors, textures and shapes to meet broader range of customer preferences. This positive development promotes the commercialization of keropok lekor which then requires the producers like ROMA Food Industry Sdn. Bhd. (RFI) to handle higher market demand without significant disruptions. An automated approach is crucial for them to streamline the keropok lekor business operations to enable them handle not only the increased product market demand, but at the same time the volumes of work or expansion without compromising quality or efficiency. ROMAns is an Enterprise Resource Planning (ERP) system built to optimize keropok lekor business processes by facilitating the flow of information across different functions, improve efficiency, and gain a competitive edge by leveraging integrated data and streamlined operations across keropok lekor business operations.**

***Keywords*—Overall equipment effectiveness; real-time information; centralization; data-driven workflows; business digitalization**

I. Introduction

Originated from Terengganu, keropok lekor is a traditional fish snack or appetizer that showcases the rich culinary heritage of Terengganu and very popular among the locals and tourists. With the combination of fish and sago flour as the main ingredients, the unique texture which has both chewy and slightly crispy especially on the outside makes it gain popularity not only in Terengganu but also throughout Malaysia and neighboring countries like Singapore, Indonesia, Brunei and Thailand. In Malaysia, keropok lekor can be found in various parts of the country such as local markets, food stalls, hypermalls and even through online marketplaces and social media. With the recent impressive market development through online platforms, many keropok lekor producers realized that they need to go beyond traditional method of doing their keropok lekor businesses. However, it is not that simple especially when it involves very large volumes of demands from customers. As reported by study [1], in the production of keropok lekor, most producers are still using traditional manufacturing practices with low competitiveness and poor efficiency. This probably due to the strong belief that adhering to age-old methods will maintain the cultural significance of the keropok lekor. The traditional keropok lekor making process using human touch instead of machine will preserve authentic taste and textures of the keropok lekor [2]. On that account, even to this day, traditional keropok lekor businesses continue to involve a highly labor-intensive and hands-on approach to production and distribution [3].

While certain aspects of the business may have undergone modernization, many producers still steadfastly adhere to traditional methods and recipes. However, this scenario can be further improved through the integration of modern production equipments. Without compromising the traditional taste or texture of keropok lekor, the producers will be able to produce large volumes of demands from their customers. Aside from that, to achieve stability and enhance scalability, it is crucial for keropok lekor producers to have a specific automated solution that will help them streamline their business operations, enhance existing skills, manage business enterprise more systematically while at the same time simplify the business processes, and market their products more aggressively. In other words, there is a need to employ a standard processing procedure to maintain the quality while meeting consumer demands for safety, quality and nutritional value of keropok lekor.

Optimizing a traditional business like Keropok Lekor requires finding a balance between age-old methods and modern technology. For this purpose, an Enterprise Resource Planning (ERP) based system seems to fit the bill. ERP variable is the coordinated information system, which can moreover be called a software bundle with an essential function to integrate all core functions in a company, in any case of the field of the industry [4]. ERP-based system was first introduced in 1960s to cater for only inventory management and control in manufacturing industry. However, it has evolved and become more strategic as the technology has gotten better. In 1990s, modern ERP applications emerged that integrate enterprise-wide backend processes by making use of a computerized sys-

tem. According to study [5], ERP systems are most frequently employed in the business setting for document processing, but they can also be utilized to manage information flow within an organization more effectively. Organization utilizes these systems because they have modules tailored to each function inside a business, enabling the right centralization of data.

II. Related Works

A qualitative study conducted by [6], involving an interview with a renowned keropok lekor producer in Terengganu, revealed that raw material selection, particularly fish type, significantly influences customers' buying preferences. Sardines (tamban and selayang) were identified as the most preferred fish for taste. The study also emphasized the crucial role of effective vacuum packaging in preserving keropok lekor freshness. While this interviews provide valuable qualitative insights into the experiences and opinions of keropok lekor business owner, it is limited by potential biases. A comprehensive, data-driven solution that enables informed decision-making and strategic planning is essential for efficiently managing keropok lekor business operations, improving processes, optimizing productivity, and enhancing customer satisfaction.

To Ensure the safety of consumers, the quality of keropok lekor is paramount. A study by [7] reported the presence of various microorganisms during different processing stages. However, as this study also suggests, microbiological quality can be improved by using raw materials with lower initial microbial loads, employing effective heat treatment during boiling, and implementing proper cooling procedures for the final product. In contrast, a more recent investigation by study [8] identified the presence of the multidrug-resistant (MDR) E. coli B10 strain in ready-to-eat (RTE) keropok lekor, demonstrating its ability to survive under both air-packed (AP) and vacuum-packed (VP) storage at a chilled temperature of 40C. This discovery underscores the importance of food safety for RTE keropok lekor, which ROMAns can address through its quality and inventory management modules.

Technological innovations like keropok lekor drying machines aim to benefit keropok lekor producers by enhancing business performance and reducing maintenance costs. Ultimately, this can minimize the production cost of keropok keping [9]. RFI leverages both traditional sun drying techniques and a custom-designed drying machine to optimize keropok keping production. In contrast to [9], their machine utilizes gas cylinder as its primary energy source, thereby minimizing operational expenses. Our proposed ERP system will facilitate the accurate assessment of RFI's machine's performance, as elucidated in the production management section.

To capitalize on growing market demand and secure higher returns, keropok lekor producers must aim to fully utilize their production capacity. A study done by [10] on Maja Baroh enterprise, one of the SMEs in keropok lekor Industries has stressed on the method of increasing the production size. They need to improve their production floor method whereby some machines or equipments especially the boiling stove need to be replaced to adapt into lean manufacturing system. As for RFI, they seek to expand their production capacity to a target range of 6 to 10 tons per day.

The employee turnover rate in keropok lekor industry, particularly within the production department is notably high. This elevated turnover is significantly influenced by the unpredictable nature of the keropok lekor market demand. The fluctuating and often random demands of this market directly impact the workload and operational tempo within keropok lekor's production facilities. During periods of high demand, production staff may face increased pressure, longer working hours, and potentially more strenuous tasks to meet the surge in orders for their products [6]. Conversely, during lulls in market demand, there might be periods of reduced activity, which could lead to feelings of instability or under utilization among the workforce.

III. ROMAns Framework

An ERP system offers the optimal solution for automating RFI's keropok lekor business operations by providing centralized data management, streamlined processes, integrated functions, real-time insights and reporting, and ensuring regulatory compliance. Fig. 1 illustrates the stages of the system development process for ROMAns. Essentially, the ROMAns ERP system development project for RFI employs a hybrid approach combining waterfall and prototyping methodologies. The overall project adheres to a waterfall model, except for the system development phase, which utilizes prototyping. Integrating prototyping within the Waterfall methodology leverages the strengths of both approaches. Prototyping helps refine requirements and ensure user satisfaction, while Waterfall provides a structured and systematic framework for development. This hybrid approach can lead to a more effective and user-centered ERP system for RFI keropok lekor business operations.

To gain a comprehensive understanding of RFI's keropok lekor business operations, a meticulous preliminary investigation was undertaken. This involved conducting in-depth interviews with key personnel across departments, a thorough examination of existing documentations detailing their workflows and procedures, and direct observation of their current manual processes on the ground in their factory located at Kuala Nerus, Terengganu. The goal of this initial phase was to capture the nuances of their daily activities, identify existing bottlenecks, and understand the specific information flow within the company. This foundational understanding was deemed critical to ensure that any subsequent technological intervention would be truly aligned with RFI's unique operational context and their expected enhancement requirements.

Following this initial fact-finding mission, a comprehensive feasibility study was conducted. This study delved into the technical, operational, and financial implications of implementing an Enterprise Resource Planning (ERP) system within the keropok lekor business. The technical aspect explored the suitability of available technologies and the potential for integration with existing infrastructure, if any. The operational analysis focused on how the proposed ERP features could streamline and enhance RFI's core business processes, from raw material procurement to the final sale of their keropok lekor. Crucially, the financial component assessed the costs associated with the ERP implementation against the anticipated benefits, ensuring a viable return on investment for RFI. This feasibility study served as a critical checkpoint, ensuring that

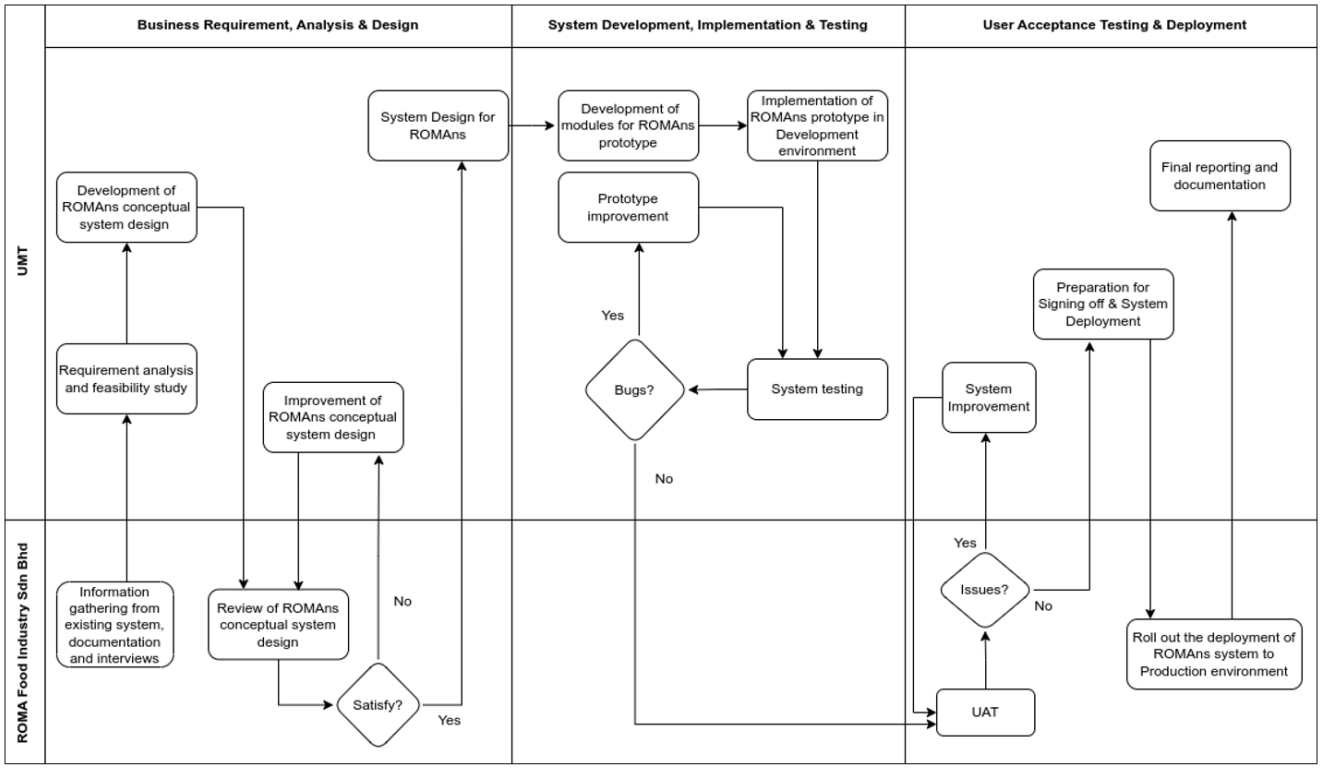

Fig. 1. ROMAns system development.

the proposed ERP solution, which would eventually be named ROMAns, was not only technically sound but also operationally practical and financially justifiable, directly addressing the specific needs and aspirations of the company.

Subsequently, the conceptual design of ROMAns was meticulously modeled. This involved translating the insights gained from the preliminary investigation and the feasibility study into a tangible blueprint of the proposed system. This conceptual model outlined the key functionalities, data flows, and user interfaces of ROMAns. Recognizing the importance of ensuring the system truly met RFI's requirements, this conceptual design underwent an iterative review process. RFI's key personnel were actively involved in examining the proposed model, providing feedbacks, and suggesting modifications until they were completely satisfied that ROMAns accurately reflected their business needs and operational realities. This collaborative approach ensured that the final system design was not just a technical solution but a tool tailored to empower RFI's growth and efficiency within the competitive keropok lekor market of Terengganu.

Once the conceptual design of ROMAns received the full endorsement of RFI, the final system design was constructed. This detailed blueprint served as the foundational architecture for the subsequent development of all identified system modules. This stage involved specifying the technical specifications, data structures, and integration points between different components of ROMAns. The design laid the groundwork for a cohesive and integrated system capable of managing various aspects of RFI's operations. As a result of this thorough planning and design phase, five core modules were identified as being absolutely crucial for the effective management of RFI's keropok lekor business operations. These fundamental modules are: Human Resource (HR), Production, Finance, Sales, and Inventory. Each of these core modules is further comprised of several vital submodules. These submodules are specifically designed to provide granular support for RFI's diverse keropok lekor business processes and operational workflows, as visually represented in Fig. 2, offering a clear overview of the system's modular structure and interdependencies.

1) Human resource management: The volatility stemming from the external market forces acting upon the keropok lekor industry, contributes to the challenges RFI faces in retaining its production employees. The inconsistency in workload and the perceived lack of stability can make employment at the production site less appealing in the long term for some individuals. Consequently, employees might seek more stable employment opportunities elsewhere, leading to the observed high turnover rates. Addressing this issue is crucial for RFI to maintain consistent production quality, reduce recruitment and training costs associated with frequent staff changes, and foster a more experienced and skilled production team dedicated to crafting their Terengganu-style keropok lekor. Understanding the direct link between the market's unpredictability and employee retention is the first step towards developing strategies to mitigate this challenge and create a more stable and attractive working environment within RFI's production operations. Therefore, ROMAns provides Human Resource (HR) module comprises of five significant submodules for smooth resource allocation: Employee Profile (to record and maintain employee details), Schedule (to systematically allocate manpower based on workloads and market/customer demand), Payroll (to record and

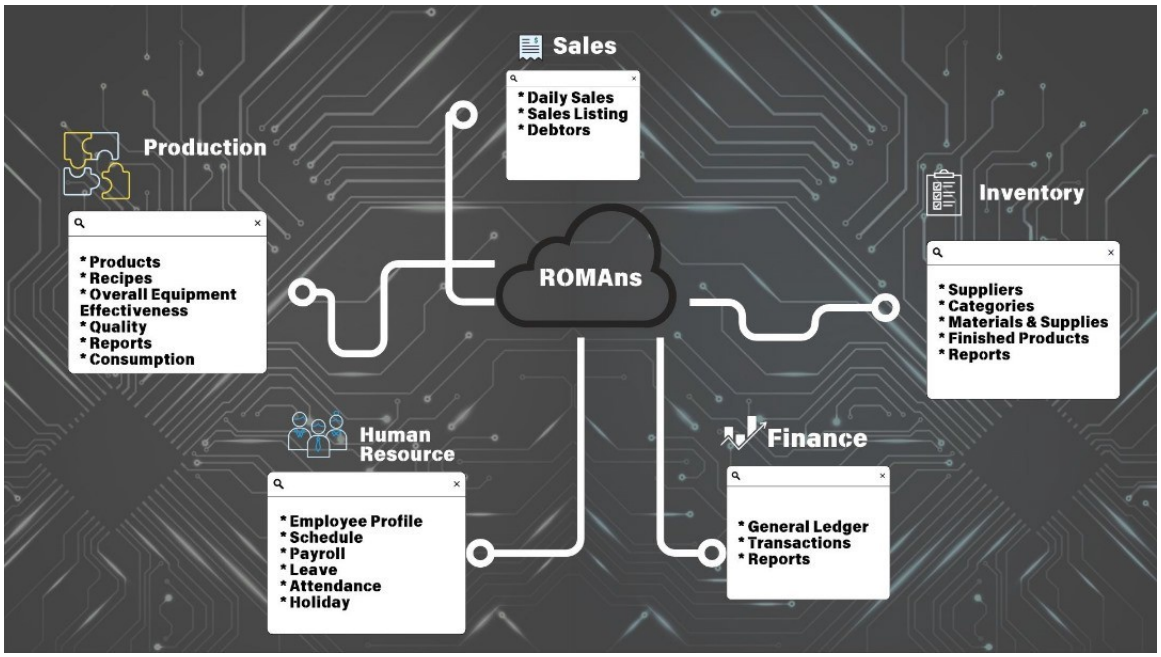

Fig. 2. ROMAns modules.

manage employee salaries), Leave and Attendance (to track and organize employee leaves and attendance), and Holiday (to track national and state public holidays, which are streamlined with staff salaries according to Malaysian employment law).

2) Production management: Recipes are the fundamental blueprint of any food business, crucial for maintaining consistent quality, inspiring culinary creativity and captivating customer loyalty. ROMAns incorporates a recipe submodule to facilitate comprehensive documentation of RFI?s keropok lekor recipes. This module ensures product consistency, enables precise cost control through accurate ingredient quantification, minimizes waste, and optimizes inventory management, ultimately driving their business profitability.

The production module incorporates a quality management submodule to establish and document keropok lekor product standards. Regular customer feedback analysis drives product improvements to align with evolving preferences. In case of quality issues, detailed records are maintained, investigated by the floor production manager, and addressed with corrective actions. The RFI CEO reviews and approves resolutions, ensuring consistent product quality, which is essential for building and maintaining customer trust and loyalty.

RFI utilizes six pieces of equipment or machine in the production of keropok lekor: 1) fish deboner, 2) ingredient mixer, 3) meat mincer, 4) burner, 5) vacuum and 6) drying machine. The productivity of these manufacturing machines can be effectively assessed using Overall Equipment Effectiveness (OEE) metrics, a widely adopted industry standard introduced by Seiichi Nakajima in the 1960s [11]. OEE provides a clear benchmark for evaluating equipment performance, identifying inefficiencies such as machine downtime, defects, and underperformance. Therefore, in this study, the OEE submodule was designed to evaluate overall performance of the utilization of these machines, assess daily keropok lekor production, and increase output while reducing costs related to downtime, repairs, and defective products. Using ROMAns, OEE percentage can be calculated automatically based on the following formula:-

$$\text{OEE\%} = \frac{\text{Actual Output}}{\text{Target Output}} \times 100\% \tag{1}$$

To determine the Target Output(TO), ROMAns will first calculates the Actual Hour (AH) using this equation:

$$\text{AH} = \text{PH - IH - RH - DT} \tag{2}$$

Where

IH = Idle Hour, RH = Rest Hour, DT = Down Time

The Target Output (TO) is then calculated by multiplying the Actual Hour (AH) by the Total Manpower (TM) and the Rate Besen Per Hour (RBHR):

$$\text{TO} = \text{AH x TM x RBHR} \tag{3}$$

A besen holds sixteen kilograms of keropok lekor dough.

Therefore, the final equation to measure the OEE percentage using ROMAns is:

$$\text{OEE} = \frac{\text{AO}}{\text{AH x TM x RBHR}} \times 100\% \tag{4}$$

Meticulous monitoring and management of raw material consumption allow RFI to optimize resource utilization, minimize waste, and enhance product margins. Consumption submodule supports understanding consumption patterns, enabling accurate production cost calculations, informed pricing strategies, and precise profit-loss tracking. Given the reliance on perishable ingredients, effective waste management is crucial for RFI's keropok lekor business. Designed to significantly enhance operational efficiency by identifying and addressing reported waste, analyzing these wastes can provide valuable insights into production inefficiencies, leading to more accurate inventory levels and ultimately improving overall production efficiency and cost analysis. At RFI, waste can occur with both raw materials and finished products. ROMAns automatically tracks this, flagging a high waste event if the combined daily waste exceeds 3% of production. This triggers an immediate alert to RFI Management, prompting them to address the issue in current production or implement preventative measures for future batches. Additionally, the quality of both raw materials and finished products is recorded to assess their impact on production, sales, and the company's overall financial health.

3) Financial management: The general ledger serves as the fundamental backbone of any organization's financial management framework, meticulously documenting every financial transaction that occurs within the business. These transactions are systematically categorized and recorded under specific accounts, providing a comprehensive and auditable trail of the company's financial activities. Currently, RFI's approach to managing their critical financial data involves the manual entry and upkeep of all business transactions within Microsoft spreadsheets. While this method may have served its purpose in the past, it presents limitations in terms of efficiency, accuracy, and the ability to seamlessly integrate financial data with other operational aspects of the business. Recognizing the inherent constraints and potential for errors associated with manual spreadsheet management, the ROMAns system introduces a significant upgrade through its dedicated General Ledger, Transactions, and Reports submodules. These integrated submodules are specifically engineered to provide a more systematic and robust solution for organizing and managing the entirety of RFI's financial transactions. By automating the recording and categorization of financial data, ROMAns aims to enhance accuracy, reduce manual effort, and provide real-time insights into the RFI's financial health. Furthermore, these financial submodules are designed with seamless interlinking capabilities, ensuring that financial data is readily accessible and integrated with all other pertinent modules within the ROMAns system, offering a holistic view of RFI's business performance.

4) Sales management: ROMAns's sales module is designed to comprehensively manage RFI's sales activities, accommodating their practice of allowing both cash and credit payments. To achieve this, the module incorporates three key submodules: Daily Sales Transaction, Sales Listing, and Debtor Details. The Debtor Details submodule is particularly crucial given that a significant portion of RFI's clientele comprises agents and resellers who typically purchase keropok lekor in substantial quantities, often on credit terms. The Daily Sales Transaction submodule facilitates the recording of each individual sales event, while the Sales Listing provides an overview of all sales activities within a specified period. Together, these submodules are pertinent for RFI to effectively track all types of business and sales transactions, monitor outstanding payments from their reseller network, and gain a clear understanding of their sales performance. This structured approach ensures accurate record-keeping and supports informed decision-making regarding sales strategies and credit management.

5) Inventory management: In Terengganu?s highly competitive market, a systematic inventory management system is crucial for RFI's keropok lekor business not just for stock tracking but also for enhancing operational efficiency, sustainability, and cost control. By minimizing waste (especially for perishable ingredients) and ensuring product freshness through First In First Out (FIFO) method, RFI can maintain quality while meeting customer demand promptly, particularly for its agent and reseller network. To address these needs, ROMAns inventory module was developed to cater for a comprehensive inventory management solution. It tracks and manages data on suppliers, raw materials, supplies, and finished products. This system enables RFI to monitor stock levels accurately, provide real-time information to customers, and make informed business decisions based on reliable data.

IV. System Development and Implementation

Prototyping methodology is employed as the system development approach due to RFI's expectation of immediate system utilization, as well as the incomplete understanding of certain requirements and the potential evolution of some parts of production processes. Using this approach, prototypes of the five core modules, as shown in the Fig. 2, are created individually. In the development environment, crude prototype models for each core module are developed and tested individually. Subsequently, these modules are integrated, and the overall ROMAns system undergoes testing. At this stage, RFI representatives also witness all these tests to understand the system's functionality and provide feedback and suggestions. Once system testing is completed and all bugs are rectified, User Acceptance Testing (UAT) is performed by RFI staff. Iterative improvements are made to the ROMAns system until it meets their needs and requirements. Upon successful UAT, the project moves to the deployment phase.

Most keropok lekor producers in Terengganu are small and medium-sized enterprises (SMEs) that rely on traditional methods for production and business practices. Implementing an ERP system for these companies requires a complete shift from their traditional approach. A big bang implementation strategy is suitable due to its shorter implementation timeframe [12]. As bold and ambitious strategy, big bang approach allows simulataneous switch from existing system to the new ERP across departments, functions and processes in a rapid, time saving and cost effective manner. Deploying the ERP through the big bang approach offers easy coordination of streamlined processes that may help RFI achieve quicker returns on investment, easier integration and reporting, reduced running costs as legacy systems are retired simultaneously, a faster implementation timeline, and allows the entire company to benefit from the deployed system by enforcing process changes.

V. Conclusion

ERP plays a crucial role in driving business digitalization and will significantly impact keropok lekor business operations by transforming traditional processes into more efficient, data-driven workflows. Built with Laravel Framework, PHP, and JavaScript, ROMAns is particularly significant for SMEs like RFI, enabling them to consolidate data into a single database for real-time access to accurate information vital for their keropok lekor business processes and effective decision-making. By embracing automation through ROMAns, RFI can enhance its competitiveness in the keropok lekor industry, optimize operations, adapt to market changes, deliver high-quality products, and improve customer service, ultimately leading to sustainable business growth. These advantages contribute to the overall success and competitiveness of the business in today's dynamic landscape.

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