

Development of a Practical ERP System for Small and Medium Industries

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Abstract

Companies face increasing competition due to factors such as globalization and rapid technological advancement. In order to remain competitive, organizations must adapt advanced manufacturing practices, improve operational efficiency and reduce process waste in the business process. Extracting key features and learning from business data are important parts of business process improvement. An enterprise resource planning (ERP) system can assist management through the integration and automation of core business processes to improve the performance. However, current ERP systems are mostly unsuitable for small and medium enterprises (SME) industries as these are very expensive, demand lot of resources and require modifications to the business processes to fit the ERP modules. Therefore, SMEs face distinct challenges which can be addressed by developing simple ERP systems. This study reports the design and implementation of an ERP system for ABC¹, a medium size a food processing company located in Queensland, Australia. The aim of this research is to develop a simple and easily usable ERP system to assist in the operations of ABC to improve operational efficiency, increase product quality and consequently customer satisfaction, as well as supporting decision making. Microsoft (MS) Access was used to develop the ERP programme, following a modular approach to facilitate planning and management activities of ABC via the integration of key functional units. The key functional units within the designated ERP framework include Sales, Procurement, Production, Quality Management and Finance. The key realized advantages of the developed ABC ERP system include: Ergonomic and intuitive ERPs, Enable integration between functional units, Ability to visualize data and generate reports, and Scalability and expansion via additional modules and records. This study demonstrates that simple, effective and user-friendly ERP systems are required to address the problems of SMEs.

Keywords

ERP, Framework, Business Process, MS Access, Efficiency and Operations.

1. Introduction

Modern business practices demand increasingly precise controls over the management of supply chains and the economics of critical business functions (Karim et al., 2010). To this end, a system which integrates all facets of business activity ranging from staffing and payroll all the way to procurement and customer relations management is required (Sarhan Et al., 2018). Enterprise Resource Planning (ERP) fills this gap by integrating & synergizing these business functions to allow each individual process to be optimized towards a specific end goal while ensuring standards for production, procurement and pricing are maintained (Arif-Uz-Zaman, 2017). Initially, ERP systems were based on physical documentation and filing processes, however, today all systems are software based and this report development of an effective ERP system for a small or medium enterprise (SME) utilising a basic functional framework.

ABC is a Brisbane based food processor which produces various juices, cordials, as well as canned fruit and vegetables. The company was founded in 1946 and continues to innovate and expand into new lines and productions. This expansion is what drives the requirement for a functional ERP system which is critical for SME which typically

¹ it is a pseudonym. For reasons of confidentiality, the name of the manufacturer cannot be disclosed.

do not have the departmental resources to control these functions independently. This paper presents step by step procedure of the ERP development for the case company.

1.1 Objectives

The aim of this project is to develop an ERP system for the ABC Fruit and Canned Goods Company. This project is significant, as SMEs face several unique operational issues, which are compounded by the perishable nature of ABCs products. This highlights the requirement to control quality and inventory through the integration and decision-making abilities provided by ERP. The developed ERP software will provide an intuitive and ergonomic link between production and sales with all other aspects of company operations to develop efficiencies within the business through the optimized deployment of enterprise resources. The primary goal of this process is waste reduction and improved business performance. Towards this end, the following aims have been identified; to improve operational efficiency, increase product quality, and enable faster and more informed decision making. The objectives of the proposed ERP system include:

- Identification of ABC’s core functional units
- Summary of ABC’s business process
- Exploration of business queries related to the identified functional units
- Development of an ERP framework program
- Development of an ERP package using Microsoft Access
- Validation of developed ERP system

2. Literature Review

2.1 ERP Systems

Enterprise resource planning (ERP) is a comprehensive approach to support the planning and controlling of a business through the integration and execution of the company's functions, as shown in Figure 1. This integration is accomplished using shared resources between functions (Jacobs, 2011, Karim and Halgamuge, 2008). ERP systems are generally complete, packaged software solutions that strive to integrate the whole spectrum of organisational activities and services. (Loshin, 2011). The quality of an ERP system can be determined by its multifunctional scope, its integration, its modularity and ability to facilitate planning and controlling activities (Jacobs, 2011). This provides a holistic view of the business from a centralised programme (Klaus *et al.*, 2000). ERP has many benefits and limitations as summarised in Table 1.



Figure 1. ERP business integration (Projectline, 2021)

Table 1: Benefits and limitations of ERP system implementation (Shang, 2000) (Jacobs, 2011).

Benefits	Limitations
Integration between company departments Improved data input Standardized procedures and reports Improved customer service Improved decision making Support business growth Operation improvements	Expensive implementation Time consuming Requirement of business process Complexity Human resistance to change

2.2 Applications of ERP

Due to the ever-tightening competitive environment and accelerating globalization, companies are not only competing with organizations in their local market but also from around the world (Amin et al., 2013; Islam, et al., 2011). ERP systems have seen implementations across a plethora of sectors to provide a competitive advantage through increased efficiency, by leveraging integration (AboAbdo *et al.*, 2019). Specifically, small and medium-sized enterprises (SMEs) operate in different environments compared to large enterprises (LEs) and ERP systems can be tailored to their specific requirements and size. However, this customization is very costly and resource heavy which most SMEs are unable to afford. This is due to their decreased resources and capital which limits their ability to directly manage and optimize specific functional units. A customized ERP for SMEs can solve this issue by allowing SME's to compete on a similar playing field by enabling partnerships, value networks and enabling the flow of information between stakeholders (Haddara & Zach, 2011).

3. Materials and Methods

The business process of ABC is outlined in Figure 2, showing the process from customer demand to company profit.

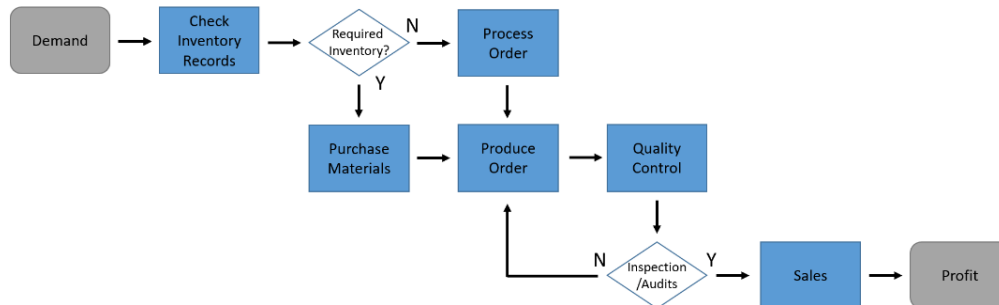


Figure 2. ABC business process

Firstly, the demand for ABCs products prompts an order from a customer. After a customer order has been placed, the inventory is checked to ensure the order can be fulfilled. If the required goods are available, the order will be fulfilled using the inventory. However, if the required goods are unavailable the raw materials inventory will be checked before procurement occurs to ensure the order can be fulfilled. After this, the order is then processed and produced, before the quality assessment. If the quality inspection is passed, the order is then cleared for delivery to the customer. In contrast, if the quality inspection has failed, the order must be reproduced. The overall goal of the company is to maximize profits, whilst ensuring customer satisfaction, quality of products and punctuality.

The company functional unit relationship is outlined in Figure 3, showing the flow of goods, finance, data and service between departments within the company.

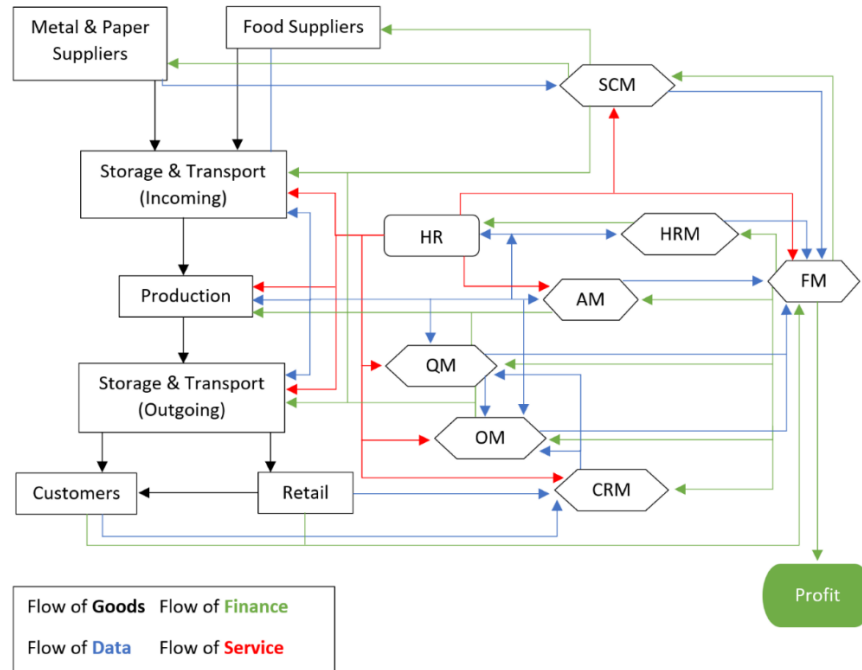


Figure 3. Company functional unit relationship

With a large product base, various suppliers and large quantities of perishable resources, ABC must operate with high level of control to ensure excellent quality products and on time deliveries. ABC's business process are highly sensitive to product spoilage and quality issues. The brand name and goodwill of ABC is paramount to its success and profitability, therefore any defects of quality issues must be reduced. As the company operates in a low margin environment, it is critical that management have access to current and reliable business information to inform fast decision making. To address these concerns the following ERP framework are selected as these are identified to be the most critical elements for the operational success off the business; Procurement, productions, sales, quality management and finance. Because of this, the project aims to develop an ERP system for the ABC based on these five units.

3.1 Proposed ERP Framework

The functional units of the ABC ERP system are shown in Figure 4, along with each of their lower order operational functions. This framework will be used to develop the fundamental processes of the ERP system.

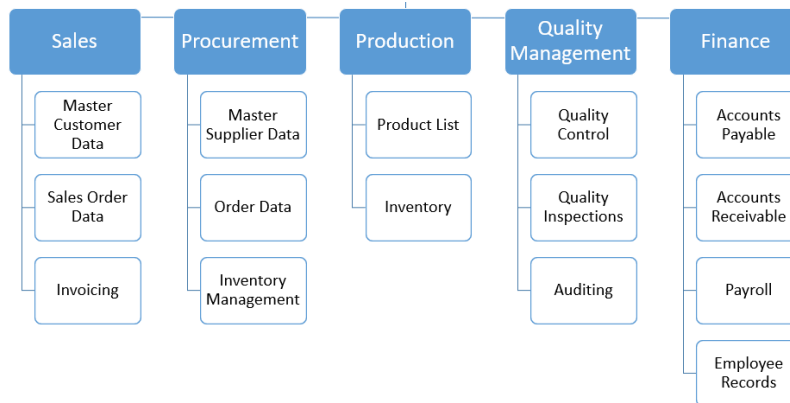


Figure 4. ABC ERP Framework.

Sales is an integral part of customer relationship management (CRM), (Botlik, *et al.* 2021) and includes management of ABCs' customers, sales, as well as their products and pricing. This management requires expanding and maintaining the customer database as well as documenting sales and customer orders. The product list and pricing data outlines the required information regarding the goods produced by the company. This also encompasses advertising and marketing which can be informed by information gathered by the company.

Procurement functions form a critical part of SCM and are responsible for a variety of processes for logistics and scheduling within the organizations supply chain including the acquisition, transport, and storage of required goods (Karim *et al.*, 2008; Li & Wu, 2021). A four-stage procurement structure is outlined, which ultimately provides a "best fit" procurement option after analysis of available suppliers, price points, lead-times and other key deliverables. This function is specifically important to ABC, not only because it impacts production schedules and stock availability but also because it is customer driven, ensuring goods supplied meet market expectations and reflects the quality levels expected of the brand. The establishment of appropriate evaluation criteria and a sound understanding of business requirements are fundamental to the success of any proposed ERP system. This is because these two processes directly inform the procurement decisions available to purchasing personnel and take into consideration a very wide range of variables. For the purposes of this report, it is therefore stages two and three of the procurement structure outlined below that will most determine the success or failure of any system developed.

The production unit is responsible for the scheduling, operation and management of all manufacturing processes across ABC's products. This is critical because most of the value-adding operations are conducted during manufacturing operations (Jacobs *et al.*, 2018). Effective & efficient management of raw materials, machines, personnel, and data will allow rapid production. The implementation of an ERP system will optimize the production processes of ABC where more than 800 products are created. Data relevant to each of these processes will be integrated and managed through the ERP system to enhance inventory management, production planning, maintenance scheduling and other key activities. In this study the products are assumed to be made-to-order, to simplify the ERP system.

The quality management module is a key component of the ERP system. Quality is exemplified as 'fitness to purpose' i.e., giving a product of enough quality for the function for which it is designed (Sarhan *et al.*, 2020). Proper implementation of quality management systems allows businesses to grow sales, profit, and market share while also enhancing their financial and operational performance (Djekic *et al.*, 2014). In order to ensure that ABC's manufactured products meet regulatory and customer requirements, this business unit is used to monitor and maintain product quality. The management of quality control encompasses pre-manufacturing where the raw resources from suppliers are inspected, to the monitoring of the equipment and machines used during the processes, to the final product before sale (Ahsan *et al.*, 2019). The ERP quality management module minimizes the occurrence and severity of defects in ABC's products. The entire quality of the products is greatly improved through quality control and management, which also enhances the performance of the ERP module. Utilizing quality management ERP software, manufacturers can make sure their goods are both safe to use and flawless.

The finance module is a simplified form of financial management (FM) and is responsible for the consolidation and management of the financial aspects of the organization including inflow and outflow of cash, ensuring sustainability and fiscal stability (Jacobs *et al.*, 2018). This includes the general ledger, which serves as a record of the companies' transactional data. This also includes the accounts receivable, and a balance sheet of money owed to ABC from customers for their products. This also includes the accounts payable, a balance sheet of short-term debts and liabilities of the ABC from vendors/suppliers for goods and services. Similarly, this also includes invoices, which are records of purchases consisting of the customer details, terms of the payment, as well as the description and price of the goods. Finally, this module also encompasses the payroll, which outlines the employees, hours worked, pay scales and pay timings.

4. Data Collection

Primary sources such as ABC's annual reports, procurement documents, delivery schedules, production logs, and maintenance schedules were unavailable on the public domain and consequently data had to be estimated to represent realistic data sets. Publicly available financial reports of ABC were used to understand and create relevant data. Reports from similar firms in the food processing industry were also consulted to assume and generate ABC's datasets. Case studies, articles and several websites were further analyzed to gather some details. Specifically, the quality

management of food processing was inferred from a paper regarding quality control measures in the beverage industry as ABCs specific processes were not openly available (Aadil et al., 2019).

5. Results and Discussion

The ERP system for ABC was developed following the outlined ERP framework in Figure 4. Microsoft Access was used as the development environment, where the system was separated into five key functional units or modules. These modules consisted of sales, procurement, production, quality management and finance. A summary of the ERP system is outlined in Table 2, showing the functional units, queries, forms and reports.

Several key design philosophies guided the development of the ERP package to ensure efficient and ergonomic use of the program. This is evident in the standardized design across all functional blocks, as well as consistency in the features and displays such as the lists and records.

Table. 2. Summary of the ERP system.

Module	Tables	Queries	Forms	Reports
Main Menu			Main menu	
Sales	Customer records Sales orders Product list Price list	Most popular products by quantity Most popular products by value Customer queries Product queries Order queries Top customers	Sales Customers Orders Received Products	Most popular product by value Most popular product by quantity Top 5 Customers by sales
Procurement	Supplier records Resource list Order list	Supplier queries Resource queries Order queries	Resources Orders Suppliers Inventory	Most purchased goods Most popular supplier by value Longest lead times
Production	Products list Inventory	Production queries Inventory queries	Inventory	Most produced products Most valuable product Most stocked item
Quality Management	Manufacturing quality record Supplier quality record Equipment quality record	Manufacturing quality Supplier quality Equipment quality	Manufacturing quality Supplier quality Equipment quality	
Finance	Accounts payable Accounts receivable Invoices Payroll	Accounts payable queries Accounts receivable queries Payroll Queries	Accounts payable Accounts receivable Payroll	Fortnightly salaries Accounts payable per unit time Accounts receivable per unit time

The main menu of the developed ERP consists of links to the five ERP modules as shown in Figure 5. The main menu was made as the start-up form to ensure that this is the form displayed when opening the system. From this menu, the user can easily navigate to the desired section, and can also view key information in the sub-forms/sub-reports shown within the tabs. The structure and navigation have been designed to remain as close to the original framework as possible to maintain simplicity.



Figure 5. ERP Main Menu

5.1 ERP Relationship

The relationships of the ERP system are shown in Figure 6. These relationships are important as they allow for the connection of data between tables which allows the integrations. Notably, the referential integrity of the relationships were enforced to ensure no orphan records exist. One-to-Many relationships were used between tables to link key attributes, as shown in the relationships between the products in the product list table (One) to the many products in order detail query and quality product tables (Many).

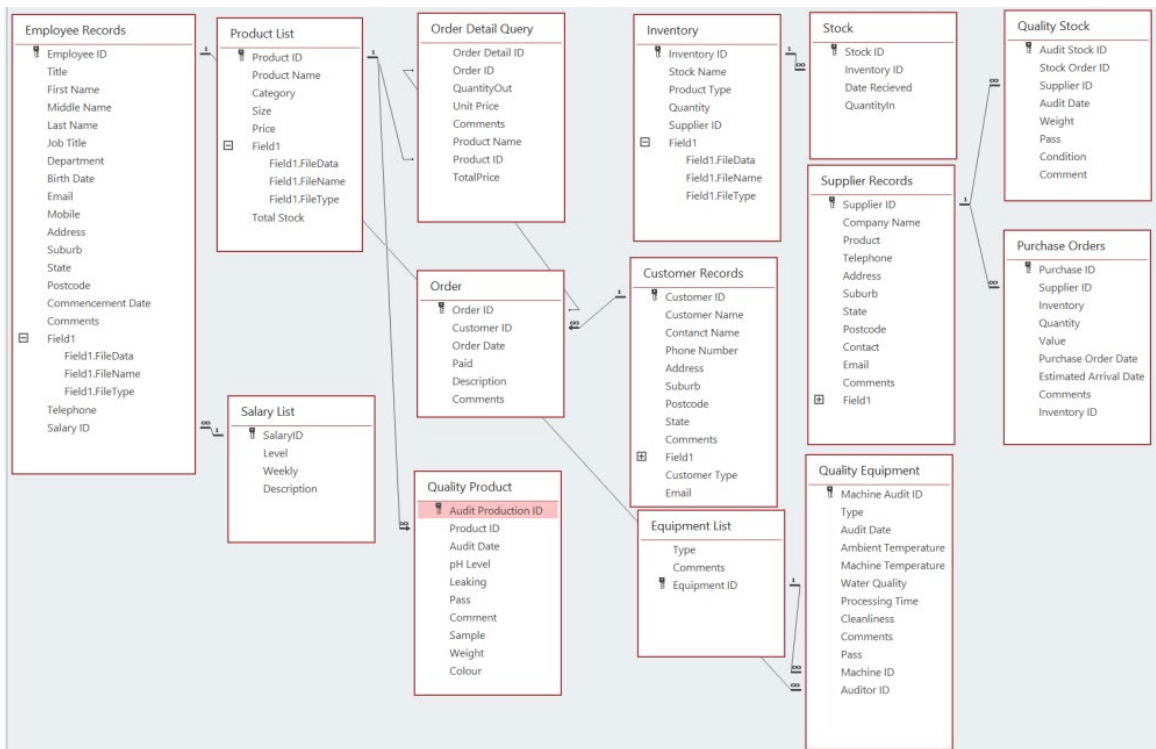


Figure 6. Relationships

As previously mentioned, all modules replicate the same layout. Because of this, the sales module will be explored here to demonstrate its functionality. The sales menu form can be seen in Fig. 7, showing the associated forms as well as the associated reports generated. In this case, the customer list shown in Fig. 8, customer records shown in Fig. 9, and orders records shown in Figure 10 can be easily accessed. The lists, such as the customer list shown in Fig. 8, also follow a standardized design, where buttons to the modules menu alongside features to search, add, remove, print are displayed.

The records also follow a standardized design, where record navigation buttons are arranged on the left as well as the ability to create a new record. Links to other relevant areas of the system can also be found, such as the link to the associated orders of the customer where the invoice report can be found, as shown in the customer records in Figure 11.

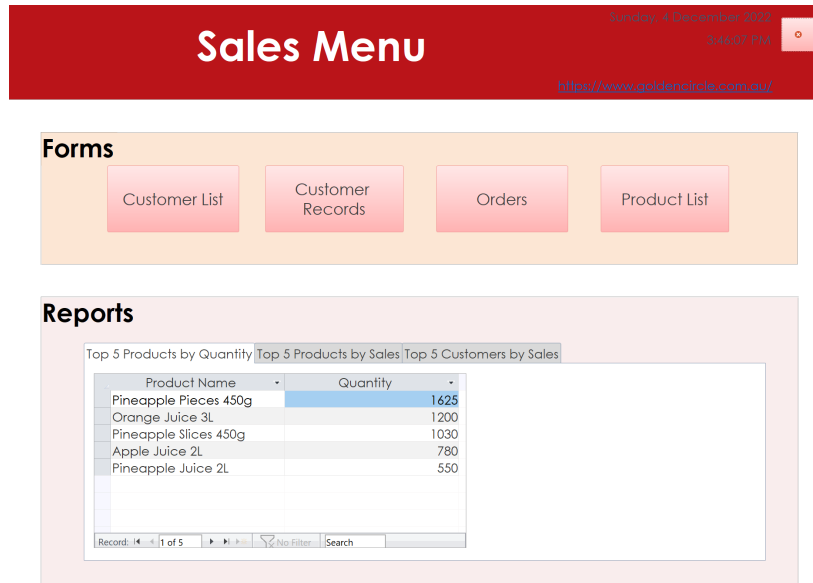


Figure 7. Sales Menu

Customer Records										
Sales Menu Search Customers Add Customer Remove Customer Print										
Customer ID	Customer Name	Logo	Customer Type	Contact Name	Phone Number	Email	Address	Suburb	Postcode	State
1	Coles		Retailer	Joe	0398295111	joe@coles.com.au	800 Toorak Road	Hawthorn East	3123	VIC
2	Woolworths		Retailer	Anthony	0288850000	anthony.f@woolworths.	1 Woolworths Wa	Bella Vista	2153	NSW
3	Amazon		Retailer	Bill	1800571894	b.b@amazon.co	300 George Stree	Brisbane	4000	QLD
4	IGA		Retailer	Ritchie	0387877488	ritchie@iga.com.au	1095 Frankston Dr	Carrum Downs	3201	VIC
5	Costco		Wholesaler	Steve	0294697999	steve@costco.com.au	17 Paramatta Rd	Lidcombe	2141	NSW
6	Coffee Club		Restaurant	Sarah	0738442551	sarah@coffeeclubcafe	199 Grey Street	South Brisbane	4101	QLD
7	Factory Outlet		Wholesaler	David	0732452477	v david@factoryoutlet.c	200 Old Clevelan	Capalaba	4157	QLD
8	Breakfast & Brunch Caf		Restaurant	Tim	0743434532	tim@breakfastcafe.cor	1 Kingsford Smith	Albion	4010	QLD
9	Kellys Distrubter		Wholesaler	Kelly	0733452688	kelly@kellysdistributers.c	215 Jackson Roa	Sunnybank Hills	4109	QLD
*	(New)								0	

Figure 8. Customers List

Figure 9. Customer Records

Product ID	Product Name	Quantity	Unit Price	Total Price
1	Orange Juice 3L	200	\$3.20	\$640.00
4	Breakfast Juice 3L	200	\$3.20	\$640.00
6	Apple Juice 3L	200	\$3.20	\$640.00
*	0	0	\$0.00	
				\$1,920.00

Figure 10. Order Records

Product Name	Quantity	Unit Price	Total Price
Orange Juice 3L	200	\$3.20	\$640.00
Breakfast Juice 3L	200	\$3.20	\$640.00
Apple Juice 3L	200	\$3.20	\$640.00
Total			\$1,920.00

Figure 11. Invoice

6. Conclusions

The ERP programme developed in this project has been effective in integrating the operational processes of ABCs' business processes. The resultant package provides an easy-to-understand user experience and intuitive user interface

that clearly achieves the stated aims and objectives of the project by improving operational efficiencies, appropriately controlling product quality and enabling more rapid decision-making in response to a dynamic and increasingly competitive market environment. Additionally, the clear and functional layout of user inputs and programme outputs means the software is approachable for employees across all levels and business functions of the enterprise, lowering barriers to further implementation.

Through the application of a four-stage procurement framework used in the initial development of the ERP package, the five core business functions of ABC's operation were identified. This then enabled an expanded framework of required business processes to form the basis of the package validated in the examples above and the generation of queries and associated reports providing powerful insights into business operations. This has been achieved by leveraging the integration of core business functions and their associated lower order processes through Microsoft Access.

While successful in achieving the aims and objectives outlined in the project scope, some limitations exist in terms of functionality where the basic framework and narrow design brief could be readily expanded with additional modules and larger datasets to enable further optimization of broader business functions and deeper insights into more complex operations at a later stage.

Given the success of the ERP programme developed throughout this project, it is thought that this system may be further enhanced by including other modules or further customized. This would be achieved through the adoption of an expanded functionality or framework to support analogous business functions in other enterprises with relatively low complexity and cost, due to the simplicity of the underlying framework and efficient reporting functions. Examples of similar organizations that could use the developed package include meat processing, other food processing companies and nurseries due to their similarities which would align with ABC's and therefore would have similar operational issues which can be addressed through ERP.

Future work may include production scheduling to plan time efficient switching of multiple product lines, expanded data entry, additional modules as mentioned previously and the deeper integration of many more granular business functions such as dynamic supply chain management. This being a very contemporaneous and critical aspect of business planning in a post-COVID environment, making the deployment of ERP more valuable than ever.

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Biography

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Samuel Idowu is currently undertaking a dual Masters in Engineering management and Project management at the Queensland University of Technology, Australia. He is a graduate from the University of Ilorin in Nigeria where he earned a Bachelor's Degree with Honors in Civil Engineering in 2016. He has also earned himself to be a registered Engineer (R.Engr) under the statutory body that controls and regulates engineering training and practices in Nigeria (2021). He has experience in Engineering design, design verification, reverse engineering, and project engineering. His current research includes environmental management, sustainability, and circular economy. His interest includes advanced project management, construction and installation management, project controls, among others.