



Case Study of Inventory Management for Biology Laboratory Materials using ERP System

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Abstract— Efficient inventory management is essential for biology laboratories to ensure the availability of materials for research and experiments. This case study explores the implementation of an Enterprise Resource Planning (ERP) system for inventory management in a biology laboratory. The objective is to enhance inventory control, streamline processes, and improve overall efficiency. The ERP system was implemented to address inventory management challenges and improve the accuracy and transparency of material tracking. The study assessed the impact of the ERP system on inventory control, procurement processes, and decision-making related to material planning. The findings of the case study demonstrate the benefits of implementing an ERP system for inventory management in a biology laboratory. The system provided real-time visibility of stock levels, enabling efficient tracking and monitoring of laboratory materials. It also automated procurement processes, reducing manual errors and streamlining the procurement cycle. The ERP system facilitated informed decision-making through data analytics, aiding in material planning and resource allocation. The successful implementation of the ERP system in the biology laboratory serves as a model for other similar laboratories seeking to enhance their inventory management practices. The case study emphasizes the significance of leveraging technology, such as ERP systems, to optimize inventory control and improve operational efficiency. The benefits include improved accuracy, reduced wastage, and increased productivity. This case study contributes to the existing knowledge on inventory management for biology laboratory materials and provides practical insights for organizations considering the implementation of an ERP system.

Keywords—Inventory Management, Biology Laboratory, ERP System, Material Tracking

I. INTRODUCTION

Biology laboratories are complex environments. They require efficient inventory management to support research and experimental activities. Proper, accurate, and well-managed inventory is crucial to ensure the

availability of important materials such as chemicals, reagents, culture media, and other laboratory tools [1]. However, in practice, many biology laboratories face challenges in managing their inventory. Common issues include difficulties in tracking available inventory, stock shortages, wastage, challenges in material planning and procurement, and lack of transparency in inventory management processes.

To address these challenges, the use of Enterprise Resource Planning (ERP) systems has been identified as an effective solution. ERP is a comprehensive, integrated software system designed to manage various operational aspects of a company, including inventory management. In the context of biology laboratories, implementing ERP for inventory management has the potential to improve efficiency, enhance inventory accuracy, optimize procurement processes, and support better decision-making in material planning and usage.

The objective of this research is to conduct a case study on the implementation of ERP for inventory management in a biology laboratory, with a focus on improving inventory control, streamlining processes, and enhancing operational efficiency. Through this study, empirical evidence is expected to be found regarding the benefits and effectiveness of using ERP systems in the context of biology laboratory material inventory management. Additionally, this research will provide practical insights for other biology laboratories considering or planning to implement ERP for their material inventory management. By discussing the research findings and lessons learned from this case study, other biology laboratories can adopt best practices and avoid challenges that may arise during the implementation process.

In this article, we will outline the methodology used in this case study, describe the steps of implementing ERP for biology laboratory material inventory management, and present research findings that encompass the changes observed after the ERP system implementation.

II. RESEARCH METHODS

This research method consists of four stages: Problem Identification, Literature Review, Data Collection, and Software Development. The stages of the research can be seen in Figure 1.

A. Problem Identification

Problem identification involves defining the research problem or objective, involving information systems such as software design, development, testing, and maintenance. In this research, we utilize an ERP system for managing inventory of biology laboratory materials. The research focus in this case study is on selecting a suitable ERP system, outlining the steps of implementing ERP for managing inventory of biology laboratory materials, and observing the findings after the ERP system implementation.

When considering ERP system choices, there are several factors to take into account to ensure the selection aligns with organization's requirements and goals [2]–[15]. Here are some key considerations:

- 1) *Business Needs and Objectives*: Identify the key functionalities, processes, and modules required to support your operations effectively. Consider factors such as industry-specific requirements, scalability, and integration with existing systems [16][17].
- 2) *Vendor Reputation and Experience*: Evaluate the reputation, experience, and track record of ERP vendors [2], [3], [7].
- 3) *System Customization and Flexibility*: Assess the level of customization and flexibility offered by ERP systems. Determine whether the system can adapt to your unique business processes and accommodate future changes and growth [9][18].
- 4) *User-Friendliness and Training*: Assess the user-friendliness and intuitiveness of the ERP system's interface. Consider the learning curve for your employees and the availability of training resources and support from the vendor/consultant [2].
- 5) *Security and Data Privacy*: Evaluate the system's security measures, data encryption, access controls, and compliance with relevant data protection regulations. Ensure that sensitive business data is adequately protected [5], [19].
- 6) *Total Cost of Ownership*: Consider the total cost of ownership, including upfront costs, licensing fees, implementation expenses, ongoing maintenance, and support costs. Evaluate the return on investment (ROI) and long-term benefits the system can provide [8][14] [17].

B. Literature Review

Inventory management is the process of managing materials with the aim of monitoring the inflow and outflow of a material/product. Several experts have proposed definitions of inventory management. According to Indrajit in his book, "Inventory management is an activity related to planning, implementation, and

supervision in determining the material requirements in such a way that operational needs can be fulfilled in a timely manner, and at the same time, material investment can be optimally controlled"[20].

Effective inventory management is crucial for any company that deals with maintaining stock. While it is necessary for companies to have inventories, it is equally important to strike a balance to prevent both out-of-stock and overstock situations. By implementing efficient inventory management practices, companies can enhance their inventory control and reduce associated costs [21].

The research paper utilizes sales and inventory data from the company's records between 2014 to explore different strategies that the organization can employ to enhance product sales. Through conducting two experiments, the study examines the impact of these strategies on inventory and how they can contribute to improving the corporation's Inventory Management. The findings suggest a two-pronged approach for improvement. Firstly, implementing inventory management practices aimed at reducing the company's inventory levels and holding costs by avoiding excessive stock. Secondly, incorporating an agent system to automate inventory management processes and promptly respond to deviations in demand from the forecasted values by adjusting replenishment policies [21].

ERP stands for Enterprise Resource Planning. It is a software system that integrates and manages various aspects of a business, including finance, human resources, manufacturing, supply chain, customer relationship management, and more. ERP systems provide a centralized database and a suite of integrated applications that streamline processes, improve efficiency, and facilitate data sharing across different departments and functions within an organization [22]–[24].

The primary goal of an ERP system is to enable efficient resource utilization, enhance productivity, and support informed decision-making. By consolidating data and automating workflows, ERP systems help businesses optimize their operations, reduce costs, improve customer satisfaction, and gain a competitive edge in the market. Key features of ERP systems typically include modules for financial management, inventory and supply chain management, human resource management, sales and marketing, production planning, and customer relationship management. These modules are interconnected, allowing real-time data exchange and providing a holistic view of the organization's operations. ERP systems can be customized to fit the specific needs of different industries and organizations, ranging from small businesses to large enterprises. They offer a scalable solution that can adapt to the changing needs and growth of a company [23]–[25].

The direct impact of implementing an ERP system on company performance was found to be insignificant. However, the implementation of an ERP system can positively influence inventory level control and enhance the company's information technology capabilities. The level of inventory and the company's information

technology capabilities, in turn, can have an impact on its overall performance. The study highlights the indirect impact of ERP system implementation on company performance through its effects on inventory levels and information technology capabilities [26].

LIMS is a software-based solution used to manage and track laboratory operations, data, and workflows. LIMS is specifically designed to streamline and automate laboratory processes, improve data accuracy, enhance sample and data traceability, and facilitate regulatory compliance [1], [27]–[29]. The functionalities of a LIMS can vary depending on the specific needs of the laboratory, such as Sample Management, Workflow Management, Data Management, Instrument Integration, Quality Control, Reporting and Analysis, Compliance and Audit Trails, Electronic Laboratory Notebook (ELN) and Inventory Management. LIMS-IM helps manage laboratory inventory, including reagents, consumables, and supplies. It tracks stock levels, generates alerts for low inventory, and facilitates procurement processes. It improves efficiency, data integrity, and overall laboratory operations by digitizing and automating manual processes, ensuring data accuracy, and providing comprehensive data management capabilities.

In some cases, organizations may choose to integrate LIMS with their ERP system to enable seamless data exchange and ensure consistency between laboratory data and overall business operations. This integration allows for better coordination between laboratory processes and other functional areas, such as inventory management, procurement, billing, and financial reporting [18], [30], [31]. For example, integrating LIMS with ERP can enable automatic transfer of sample data and test results from LIMS to ERP, allowing for efficient billing and inventory management. It can also provide real-time visibility into laboratory operations for better decision-making and resource planning.

It's important to note that while LIMS and ERP can be integrated, they serve distinct purposes and have different primary focuses. LIMS primarily caters to laboratory management and data analysis, while ERP caters to overall business management. The decision to implement LIMS, ERP, or their integration depends on the specific needs and requirements of the organization.

C. Data Collection

Define methods and tools to collect relevant data. This can involve various techniques, such as interviews, surveys, observations, or automated data collection from software systems. Ensuring that the data collected is in line with the research objectives. Interviews are conducted with laboratory staff and management to understand the current inventory management processes, identify challenges, and gather specific requirements and expectations for the ERP system.

This research presents a case study on the design and implementation of an ERP system for inventory management at Aretha Medika Utama Laboratory, in

2022-2023. This laboratory is a private research laboratory specialized in biomolecular and biomedical research and consulting. The biology laboratory operates under PT. Aretha Medika Utama and has been established since 2012.

Based on the March 2022 Inventory Report, there are 4 categories of materials: Consumable (110 items), Culture & Molecular Materials (184 items), In Vitro Materials (337 items) and Kits (198 items). Some examples of data collection as shown in Figure 1, Figure 2, Figure 3 and Figure 4.

Brand	Nama Produk	No. Cat	Unit	Jumlah Unit	Binus Transfer Per Minggu	Total	Stok Akhir	Keterangan
NPL	Flask T75, filter cap	70075	bag	40		0	40	1 unit Rak
	Flask T25, filter cap	70025	bag	40		0	40	1 unit Rak
	Serological pipette 2 ml	91002	box	1		0	4	1 unit Rak
	Serological pipette 1 ml	91001	box	11		0	11	1 unit Rak
	Serological pipette 2 ml	91005	box	15		0	5	1 unit Rak
	Serological pipette 10 ml	91010	box	9		0	6	1 unit Rak
	5 ml Round Bottom Tube	40205	bag	33		0	33	1 unit Rak
	Scrap Tube 5 ml		bag	10		0	9	1 unit Rak
	Cell Scraper 250 mm	90031	pcs	100		0	95	1 unit Rak
	Ascher collection tube 50 ml	54050	pcs	4		0	4	1 unit Rak
	Ascher collection tube 15 ml	4115	pack	4		0	4	1 unit Rak
	Syringe	90050	pack	100		0	100	1 unit Rak
	Microcentrifuge 1.5 ml tube color	40151	box	5		0	5	1 unit Rak
	Microcentrifuge 0.2 ml	92200	bag	10		0	9	1 unit Rak

Figure 1. Inventory Report: Consumable

Brand	Nama Produk	No. Cat	Unit	Jumlah Unit	Binus Persewaan Per Minggu	Total	Stok Akhir	Keterangan
NPL	MEME Mybag	10001-500	ml	500		0	500,00	
	Dulbecco's Phosphate Buffered saline 10x	30015-500	ml	3750		0	3750,00	
	Dulbecco's Phosphate Buffered saline 10x	30020-500	ml	3750		0	3750,00	
	MEME non essential Amino Acids 100x	30015-100	ml	100		0	100,00	
	DMEM Low Glucose	10006-500	ml	3750		0	3750,00	Kultur 4 C
	RPMI 1640	10006-500	ml	7500		0	7500,00	Kultur = 500; Molecular = 350
	MEME Alpha	10005-100	ml	82		0	82,00	Kultur 4 C
	Huwa F12	10115-500	ml	9000		0	9000,00	Kultur = 500; Molecular = 4 C
	DMEM Low Glucose	10006-500	ml	4500		0	4500,00	Molecular 4 C
	DMEM Alpha	10005-100	ml	4500		0	4500,00	Kultur 4 C
	DMEM Alpha	10005-100	ml	4500		0	4500,00	Kultur 4 C
	DMEM High Glucose	10005-100	ml	1400		0	1400,00	Molecular 4 C
	DMEM High Glucose	10005-100	ml	2500		0	2500,00	Kultur = 150; Molecular = 500
	DMEM	10005-100	ml	4000		0	4000,00	Freeze -20
	DMEM	10005-100	ml	2100		0	2100,00	Freeze -20

Figure 2. Inventory Report: Culture & Molecular Materials

Brand	Nama Produk	No. Cat	Unit	Jumlah Unit	Binus Persewaan Per Minggu	Total	Stok Akhir	Keterangan
NPL	N-3-acetyl-L-Ala-Ala-p-Nitrobenzylamide	54760-100	mg	4,20		0	4,20	
	Nitrobenzyl bromide	0148310	mg	50,00		0	50,00	
	Nitrobenzyl bromide	0148310	mg	50,00		0	50,00	
	(S)-Cinchonidine Hydrochloride	C1798-500	mg	100,00		0	100,00	
	α-galactosidase from <i>Aspergillus niger</i>		U/ml	4,00		0	4,00	
	α-galactosidase		U/ml	4,00		0	4,00	
	2,4,6-Tris(2-pyridyl)-5-sulfonate	T1215-50	grams	2,07		0	2,07	
	2-Dimethyl-2-thiourea	T1214-10	grams	1,50		0	1,50	
	Lipopolysaccharides (LPS)	L1200-10000	mg	100,05		0	100,05	
	Lipopolysaccharides (LPS)	L1200-2500	mg	25,00		0	25,00	
	Deoxyribose	190220-250	grams	25,00		0	25,00	
	Neomycin sulfate Chloride	30076-25000	mg	50,00		0	50,00	
	(S)-α-Tocopherol	T1211-50	grams	2,00		0	2,00	
	Acetylcholinesterase inhibitor	A5755-50	grams	5,00		0	5,00	
	Reactive Oxygen Anion	A5975-500	ml	13,28		0	13,28	

Figure 3. Inventory Report: In Vitro Materials

Brand	Nama Produk	No. Cat	Unit	Jumlah Unit	Keterangan (Tempat)	Status	Plat
	Human NF-κB p105 ELISA Kit	E-EL-001386	Kit	1	Molecular 4	New	1 sealed pack
	Human PDGF ELISA Kit	E-EL-002111	Kit	1	Molecular 4	opened	1 sealed pack
	Human VCAM-1/CD106 ELISA Kit	E-EL-001987	Kit	1	Molecular 4	New	1 sealed pack
	Human CRP ELISA Kit	E-EL-001022	Kit	1	Molecular 4	opened	1 sealed pack
	Human CYP2C1 ELISA Kit	E-EL-001974	Kit	1	Molecular 4	opened	1 column
	Superior Chemotaxis (SCE) Assay Kit	E-EL-002020	Kit	1	Molecular 4	opened	1 column
	Human HIF-1α/2 ELISA Kit	HWK1017011	Kit	1	Molecular 4	New	1 sealed pack
	Human ADAM ELISA Kit	HS20204099	Kit	2	Molecular 4	New	2 sealed pack
	Human TIMP-2 ELISA Kit	HS20204097	Kit	2	Molecular 4	New	2 sealed pack
	Human TNF-α/Tumor Necrosis Factor Alpha ELISA Kit	E-EL-0010967	Kit	2	Molecular 4	1 New, 1 Opened	1 sealed pack, 1 column
	Human ANG II R1 (Angiotensin II Receptor 1) ELISA Kit	E-EL-0012967	Kit	2	Molecular 4	New	2 sealed pack
	Human HIF-1α/2 (Hypoxia-Inducible Factor 1α/2) ELISA Kit	E-EL-001974	Kit	2	Molecular 4	New	2 sealed pack
	Human HIF-1α/2 (Hypoxia-Inducible Factor 1α/2) ELISA Kit	E-EL-001974	Kit	2	Molecular 4	New	2 sealed pack
	Human HIF-1α/2 (Hypoxia-Inducible Factor 1α/2) ELISA Kit	E-EL-001974	Kit	2	Molecular 4	New	2 sealed pack
	Human HIF-1α/2 (Hypoxia-Inducible Factor 1α/2) ELISA Kit	E-EL-001974	Kit	2	Molecular 4	New	2 sealed pack
	Human HIF-1α/2 (Hypoxia-Inducible Factor 1α/2) ELISA Kit	E-EL-001974	Kit	2	Molecular 4	New	2 sealed pack

Figure 4. Inventory Report: Kits

D. Software Development

Software Development in some cases, software research may involve developing new software systems (building/buying/using) or tools to address the research problem. This step includes defining software requirements, designing, implementing and testing the software, and documenting the development process.

- 1) *Defining Software Requirements*: The initial step in software development is to clearly define the software requirements. This involves understanding the needs and objectives of the software solution, identifying user requirements, functional specifications, and any constraints or limitations. Effective requirement gathering ensures that the software addresses the desired functionalities and fulfills user expectations. The software requirements for Inventory Management includes Item and Inventory, Purchases, Sales and Reports.
- 2) *Designing System – Use Case, Activity Diagram & Relation Scheme*. The use case diagram is a type of diagram in the Unified Modelling Language (UML) used to illustrate the interaction between external actors and the system being analysed. This diagram visualizes the functions that can be performed by the system and how these actors interact with the system. This diagram also serves as a foundation for designing a better system and ensuring a clear understanding of the functions required by the users. Based on the results of the software requirement, there are two actors: Admin and Staff. The admin has full access to the system, while the Staff is almost the same as the Admin. The admin has access to User Management, while the Staff does not, as shown in Figure 5.

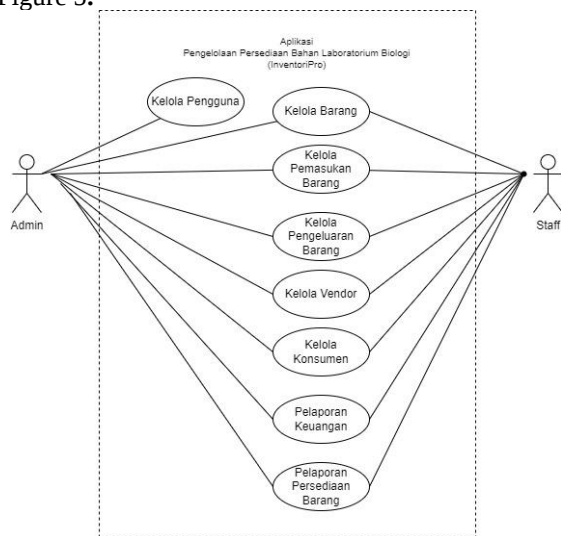


Figure 5. Use Case of Laboratory Inventory Management – Aretha Medika Utama

The activities in the use case diagram are as follows:

- a. User Management: Determining who has the authorization to access the system.
- b. Manage Products: Adding, modifying, and deleting product master data.
- c. Manage Incoming Goods: Receiving goods through vendor purchases or accepting returned goods.
- d. Manage Outgoing Goods: Issuing goods through sales to customers or using them for production.
- e. Manage Vendors: Adding, modifying, and deleting vendor master data.

- f. Manage Customers: Adding, modifying, and deleting customer master data.
- g. Financial Reporting: Reporting income and expenditure.
- h. Inventory Reporting: Reporting incoming and outgoing goods, initial and final inventory quantities.

The activity diagram is used to model the processes that occur within a system. In this system, the activity diagram for the Incoming Goods starts with managing products and product categories, managing vendors, the transaction of incoming raw materials and goods (recording raw materials and goods entering the inventory), and reporting incoming raw materials and goods, as shown in Figure 6.

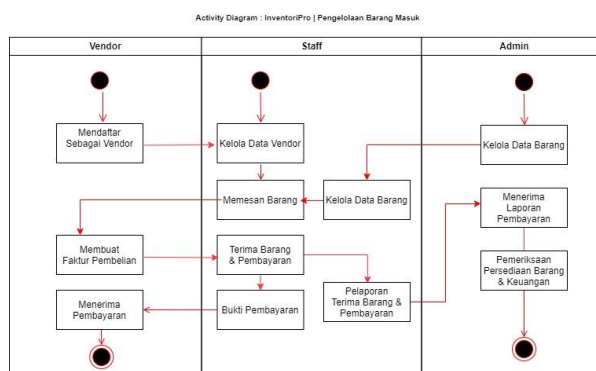


Figure 6. Activity Diagram: Receipt of Raw Materials and Goods

The activity diagram for the Outgoing Goods starts with managing customers, managing outgoing goods, and reporting outgoing goods, as shown in Figure 7. In the Inventory Management System, suppliers are not directly involved in the use case, and customers are not directly involved in the use case. However, in the activity diagram, suppliers and customers provide data that will be entered into system by the staff.

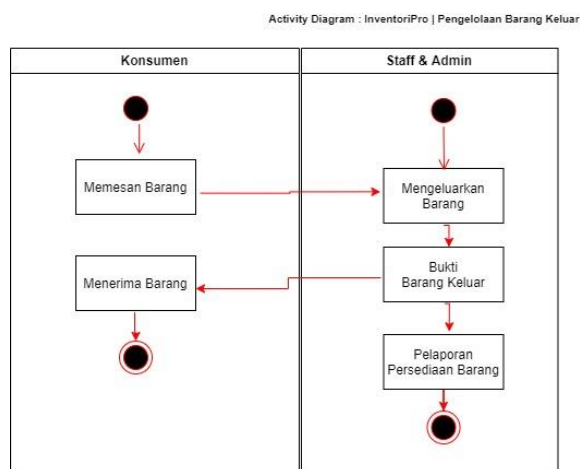


Figure 7. Activity Diagram - Outbound Inventory Management

In the context of databases, a "relationship table" is a table that represents the relationship between two or more other tables. It is also known as an association table, junction table, or linking table. The relationship table is used in many-to-many relationships between entities in a database. It contains foreign key references to the primary

keys of the related tables, effectively establishing a connection between records in those tables. This approach allows for efficient and structured data management and ensures data integrity and consistency in the database.

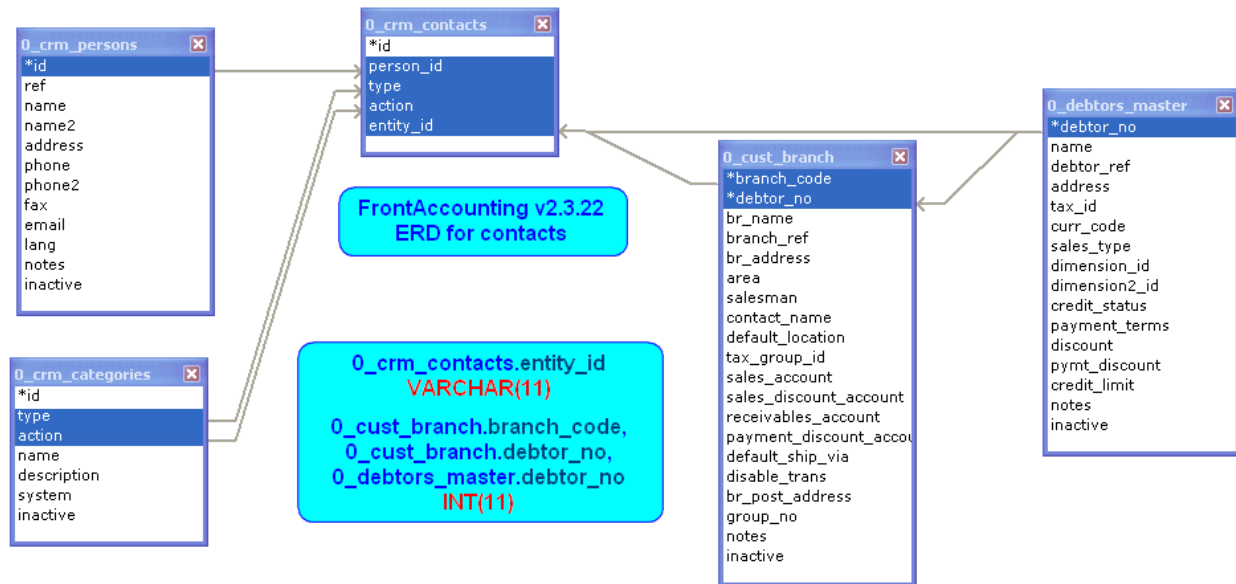


Figure 8. Relationship Tables for Customers Data (Source: <https://frontaccounting.com/fawiki/index.php?n=Devel.ERDiagram24>)

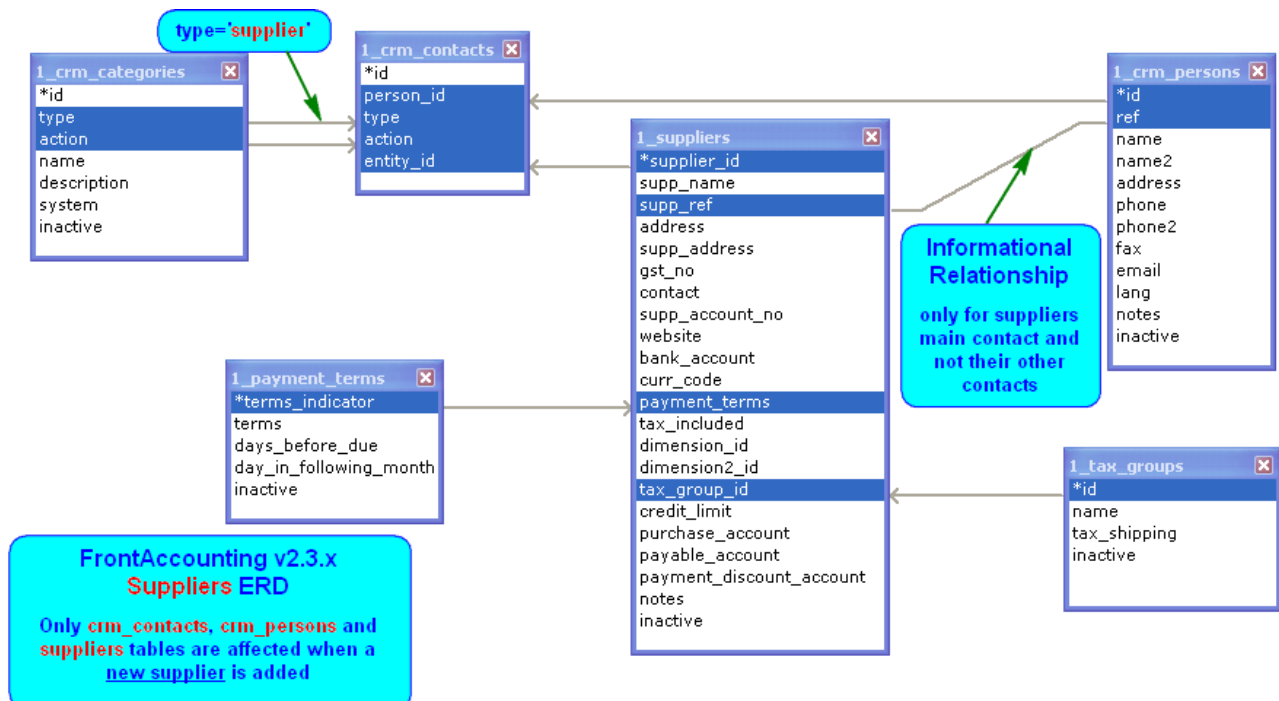
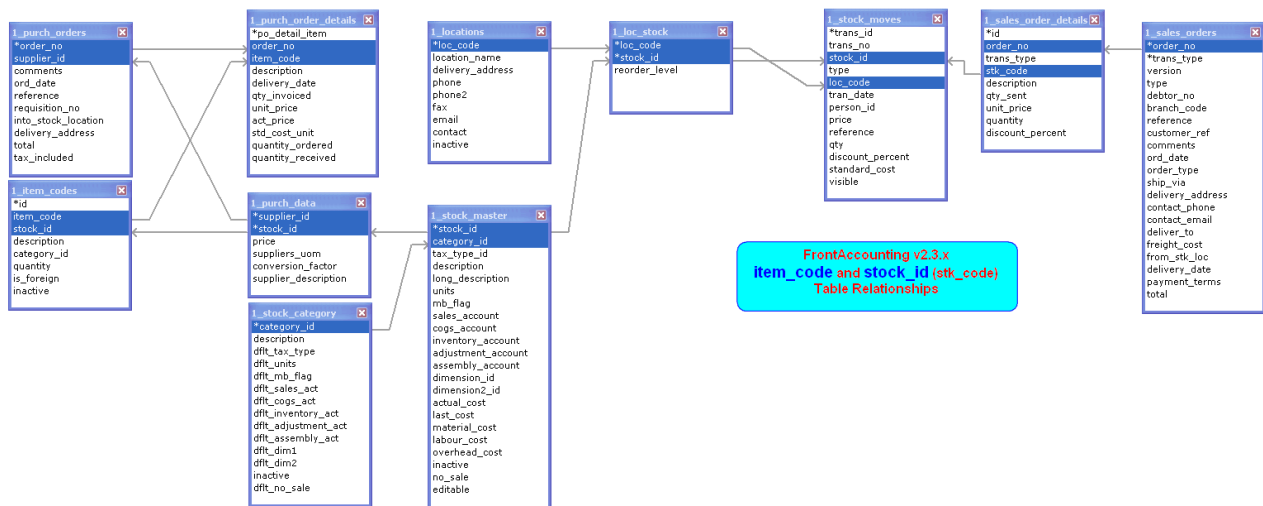
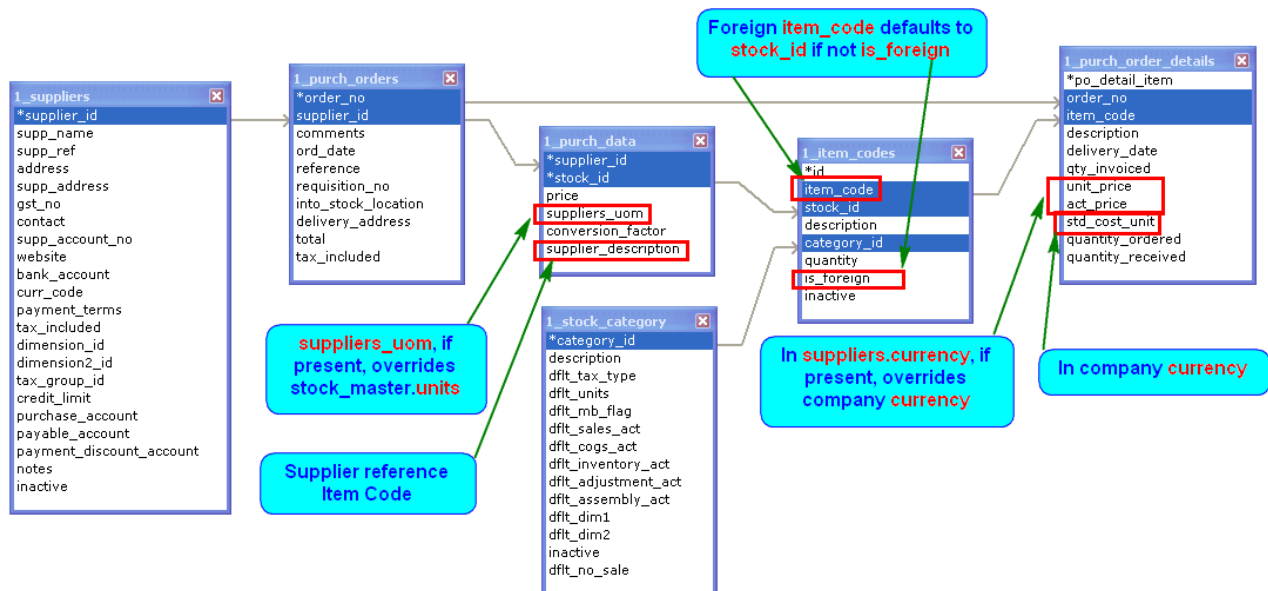
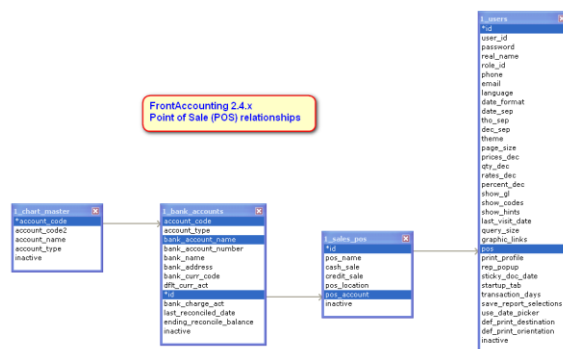


Figure 9. Relationship Tables for Vendors/Suppliers Data (Source: <https://frontaccounting.com/fawiki/index.php?n=Devel.ERDiagram24>)

Figure 10. Relationship Tables for Materials and Inventory (Source: <https://frontaccounting.com/fawiki/index.php?n=Devel.ERDiagram24>)Figure 11. Relationship Tables for Procurement (Source: <https://frontaccounting.com/fawiki/index.php?n=Devel.ERDiagram24>)Figure 12. Relationship Table for Outbound Inventory (Source: <https://frontaccounting.com/fawiki/index.php?n=Devel.ERDiagram24>)

III. RESULT AND DISCUSSION

The implementation of an ERP system for inventory management in Aretha's biology laboratory utilizes ERP Front Accounting (FA), taking several considerations into account, as shown in Table I.

TABLE I
CONSIDERATION VS FEATURES FA

Considerations of FA	Features FA
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Considerations of FA	Features FA
Business Needs and Objectives: Sales & Customer, Purchases & Vendor, Materials & Categories, Inventory	FA has features, such as: Sales Transaction: Sales Quotation Entry, Add and Manage Customers, Customer Payments, Customer and Sales Reports Purchases Transaction: Purchase Order Entry, Suppliers, Payments to Suppliers, Supplier and Purchasing Reports Items and Inventory: Items, Item Categories, Units of Measure, Import CSV Items, Inventory Locations, Inventory Adjustments, Inventory Item Movements, Inventory Reports
Vendor Reputation and Experience	The vendor has a proven track record demonstrated by comprehensive documentation, consistent version development, and the presence of a community for support and Q&A.
System Customization and Flexibility	FA is based on open-source technology using PHP programming and MySQL database, allowing for easy customization and excellent flexibility.
User-Friendliness and Training	FA is user-friendly with a well-organized menu structure, minimizing the time required for user training, and has comprehensive documentation.
Security and Data Privacy	FA is a web-based system that can be installed on a self-hosted server (on-premises) or in the cloud with HTTPS features, ensuring secure usage and data privacy. FA has features such as: User Accounts Setup, Access Setup, Login, Logout
Total Cost of Ownership	FA is open source, eliminating the need for license purchases and allowing continuous usage without subscription fee

FrontAccounting is a comprehensive open-source accounting system that can be used for various accounting tasks, including managing inventory, sales, purchases, and financial transactions. Here is a step-by-step guide on how to use FrontAccounting:

1) Installation and Setup:

- Download and install FrontAccounting on your local server or web hosting environment.
- Set up the database and configure the necessary settings during the installation process.

2) Company Setup:

- Access the FrontAccounting dashboard and navigate to the "Company Setup" section.
- Enter company details, such as company name, address, contact information, and financial year settings, as shown in Figure 13.

Figure 13. Company Setup

3) Chart of Accounts:

- Set up your chart of accounts by defining various account groups and individual accounts.
- Configure account settings, such as account codes, account types, and tax-related information.

4) Inventory Setup:

- Create item categories, units of measurement, and price lists, as shown in Figure 14

Figure 14. Create Item Categories

- Define your inventory items by accessing the "Items & Inventory" module, as shown in Figure 15.

Figure 15. Entry New Item

- Set up inventory locations, such as warehouses or stores, and specify the default inventory accounts.
- 5) Sales Process:
- Create customer records by entering their details, such as name, contact information, and billing address.

- Generate sales quotations, sales orders, and invoices for your customers, as shown in Figure 16 and Figure 17.
- Record sales payments and track outstanding balances.

Figure 16. Entry Sales Quotation Items

Figure 17. Sales Quotation

- 6) Purchasing Process: (*Purchasing transactions are like the sales process, so there is no need to illustrate them with a picture*)
 - Create vendor records by entering their details, such as name, contact information, and payment terms.
 - Generate purchase orders for your vendors to procure inventory items.
 - Record purchase invoices and track accounts payable.
- 7) Inventory Management:
 - Enter stock receipts to record incoming inventory items.
 - Perform stock transfers between different inventory locations, if applicable.
 - Issue stock outflow transactions to record the movement of inventory items.
- 8) Reporting and Analysis:
 - Utilize the various reporting features in FrontAccounting to generate financial statements, inventory reports, sales reports, and purchase reports.
 - Analyse your financial data and make informed decisions based on the generated reports.

IV. CONCLUSION

In this study, Inventory Management for the Biology Laboratory was successfully developed using an ERP system. Several considerations for selecting an ERP system, such as Business Needs and Objectives, Sales & Customer, Purchases & Vendor, Materials & Categories, Inventory, Vendor Reputation and Experience, System Customization and Flexibility, User-Friendliness and Training, were fulfilled by ERP Front Accounting.

The test results demonstrated that Front Accounting (FA) can function according to the planned inputs and outputs. Starting from Installation and Setup, Company Setup, the utilization of Chart of Accounts, Inventory Setup, Sales Process, Purchasing Process, Inventory Management, and Reporting and Analysis, everything worked well.

For further company development, implementing additional ERP modules such as Manufacturing or Production would be beneficial. The Dimensions module can be used to group performance records per project, cost centers, departments/work units, and warehouses. Additionally, incorporating features for Bank Reconciliation and General Ledger would be advantageous.

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