Comprehensive Software Testing Portfolio

ERP SYSTEM TESTING

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Part 1: Selection of System, Testing Strategy, and Techniques

A. Selection of System/Component

The selected system is a custom-developed Enterprise Resource Planning (ERP) system I developed for a national retail chain. This system manages critical business operations across multiple modules.

Technical Architecture:

- **Frontend**: React.js with Redux for state management
- **Backend**: Node.js with Express.js framework
- **Database**: PostgreSQL
- **Communication**: RESTful APIs

Key Modules:

- Inventory Management
- Procurement
- Sales Management
- Warehouse Management

- Human Resources
- Finance and Accounting

Reason for Selection: This ERP system was chosen due to its critical role in business operations and complex interactions between modules. The integration between the Procurement and Inventory modules represents a high-risk area where failures could result in stock shortages, overstocking, or financial discrepancies, significantly impacting business operations.

B. Selection of Testing Strategy

Selected Strategy: Integration Testing

Integration testing was chosen as the most appropriate strategy for this ERP system based on the following considerations:

1. **Module Interdependencies:** Procurement and Inventory modules are tightly coupled yet developed as separate components, interacting through well-defined APIs and shared database resources.
2. **Business Risk**: Integration failures could lead to stock shortages, excess inventory, incorrect financial reporting, and supply chain disruptions.
3. **Complexity of Workflows:** Purchase order processing involves multiple steps across modules, including creation, approval workflows, receiving processes, and inventory updates.
4. **Microservices Architecture:** The system's design as independent services communicating via APIs makes integration testing particularly relevant.

Integration testing allows us to validate that these separate components work together as expected, focusing on the data flow and communication between modules rather than isolated unit functionality.

C. Selection of Testing Techniques

For this integration testing strategy, a combination of the following testing techniques will be employed:

1. Black-Box Testing: Testing API endpoints facilitating communication between modules without knowledge of internal implementation, using Postman to simulate requests and validate responses.

2. White-Box Testing: Examining database state changes to verify correct data modification and monitoring data flow between components.

3. Boundary Testing: Testing edge cases, including reorder threshold behaviours, authorisation boundary conditions, and handling unusual scenarios like duplicate operations.

Justification: This combination provides comprehensive coverage, ensuring APIs function correctly externally, internal data is processed correctly, and potential vulnerabilities at operational edges are identified.

Part 2: Development and Execution of Test Plan

A. Test Plan Development

Scope of Testing: Integration between Purchase Order (PO) system and Inventory module, covering PO creation (manual and automated), approval/rejection workflows, goods receipt, inventory quantity updates, and error handling.

Test Objectives

The objectives of this integration testing are to:

1. Verify that purchase orders are correctly created both manually and automatically.
2. Ensure that the approval/rejection workflow functions properly.
3. Confirm that inventory quantities are accurately updated when goods are received.
4. Validate error condition handling.
5. Verify that all APIs between the modules function as expected.

Resources and Tools

Resource/Tool	Purpose
Postman	API request creation and execution
Node.js/Express.js	Backend environment
pgAdmin	Database querying and inspection
VSCode	Code inspection if needed
Controlled Test Environment	An instance of the ERP system with a controlled dataset (on localhost)

B. Test Cases

TC-01: Purchase Order Created by Warehouse – Manual Creation of a Purchase Order

Attribute	**Description**
Test Case ID	TC-01

Description	Verify that a warehouse manager can manually create a purchase order through the API
Preconditions	- User has warehouse manager role authorisation - Product exists in inventory system - User is authenticated
Test Steps	1. Send POST request to http://localhost:5000/orders 2. Include valid product ID, quantity, supplier information. 3. Verify response status code and content

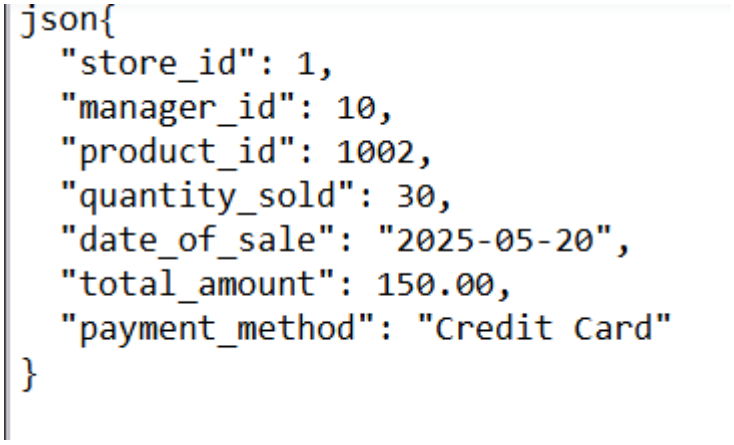
Test Input	json{
	"order_date": "2025-05-18",
	"product_id": 1010,
	"quantity": 100,
	"location_id": 5,
	"order_type": "purchase_order",
	"supplier_id": 7
	}

Expected Result	- API returns 201 Created response - Response contains new PO ID - New PO record created in database with status “Awaiting Approval“

	- PO items correctly associated with PO
Validation Method	- Validate API response code and body - Run SQL query: SELECT * FROM orders WHERE order_type = “purchase_order” and order_id [new_order_id]

TC-02: Purchase Order Automatically Created When Stock Falls Below Reorder Level

Attribute	**Description**
Test Case ID	TC-02
Description	Verify that a purchase order is automatically created when inventory falls below reorder threshold by simulating a sale that bring the inventory below reorder threshold
Preconditions	- Inventory has products with reorder levels set - Automated PO creation service is running - Supplier information exists for products - User is authenticated with appropriate

	permissions - Product exists in system
Test Steps	1. Send POST request to sales record endpoint to create a new sale 2. Include valid product ID, quantity sold, store information 3. Verify response status code and content 4.Check if the Inventory is now below the reorder threshold for the specific product. 5.Verify if a purchase order has been automatically created for that product and has been set to “Awaiting Approval”
Test Input	
Expected Result	- API returns 200 OK response - Response contains sales ID and success message. New sales record created in

	database. -Inventory is below the reorder threshold for that specifc product and a purchase order is automatically created for that product and set to “Awaiting Approval”
Validation Method	- Validate API response code and body - Confirm message indicates successful creation - Run SQL query: SELECT * FROM orders WHERE order_type = “purchase_order”. This is to check if a new purchase order has been created

TC-03: Procurement Manager Approves a Purchase Order from a Warehouse

Attribute	**Description**
Test Case ID	TC-03
Description	Verify that a procurement manager can approve a purchase order

Preconditions	- PO exists with status “Awaiting Approval“ - User has procurement manager role - User is authenticated
Test Steps	1. Send PUT request to http://localhost:5000/orders/1014 2. Include status update to “Pending“ (Simulating Approval) 3. Verify response and order details
Test Input	`json{ "status": "Pending"}`
Expected Result	- API returns 200 OK response - Order details show updated status as “Pending“ - Order record updated in database - Approval timestamp recorded as well. (last updated) - No inventory quantity changes yet
Validation Method	- Validate API response code and body

	- Confirm return order details show correct status - Run SQL query: SELECT * from order where order_id = 1014 - Verify no changes in inventory quantities

TC-04: Procurement Manager Rejects a Purchase Order

Attribute	**Description**
Test Case ID	TC-04
Description	Verify that a procurement manager can reject a pending purchase order
Preconditions	- PO exists with status “Pending“ - User has procurement manager role - User is authenticated
Test Steps	1. Send PUT request to http://localhost:5000/orders/1013 2. Include status update to “Cancelled“

	(Simulating Rejection) 3. Verify response and order details
Test Input	`json{ "status": "Cancelled"}`
Expected Result	- API returns 200 OK response - Order details show updated status as “Cancelled“ - Order record updated in database - Rejection timestamp recorded as well. (last updated) - No inventory quantity changes
Validation Method	- Validate API response code and body - Confirm return order details show correct status - Run SQL query: SELECT * from order where order_id = 1013 - Verify no changes in inventory quantities

TC-05: Warehouse Marks Approved Purchase Order as Received (Full Delivery)

Attribute	Description
Test Case ID	TC-05
Description	Verify that warehouse staff can mark an approved PO as received and inventory is updated
Preconditions	- Purchase order exists with a non-completed status (“Pending”) - User is authenticated with appropriate permissions (Warehouse Manager)
Test Steps	1. Send PUT request to http://localhost:5000/orders/1014 2. Include status update to “Completed“ 3. Verify response and confirm delivery date is set
Test Input	`json{ "status": "Completed"}`

Expected Result	- API returns 200 OK response - Order details show updated status as “Completed“ - Order record updated with completion details and delivery date - Inventory of product in the warehouse increases by the specfic quantity in the PO
Validation Method	- Validate API response code and body - Run SQL query: SELECT * from order where order_id = 1014 - Confirm returned order details show correct status and delivery date - Check if the inventory of the product increased based on the quantity specified in the PO

TC-06: Purchase Order Marked as Received Twice

Attribute	**Description**
Test Case ID	TC-06

Description	Verify that the system prevents duplicate receipt of the same PO (idempotency test)
Preconditions	- Purchase order exists with a non-completed status (“Completed”) - User is authenticated with appropriate permissions (Warehouse Manager)
Test Steps	1. Send PUT request to http://localhost:5000/orders/1014 2. Include status update to “Completed“ 3. Verify response and confirm delivery date is set
Test Input	`json{ "status": "Completed"}`
Expected Result	- API returns 200 OK response - Order details remain unchanged with “Completed“ status - Inventory does not change at all as its duplicate
Validation Method	- Validate API response code and body

	- Run SQL query: SELECT * from order where order_id = 1014 - Confirm returned order details show correct status and delivery date - Check if the inventory of the product remained the same

Part 3: Execution of Test Plan

A. Test Execution Results

TC-01: Manual Creation of a Purchase Order

Execution Date: May 20, 2025

Executed By: Test Engineer

Request:

```
POST http://localhost:5000/orders
Content-Type: application/json

{
  "order_date": "2025-05-18",
  "product_id": 1010,
  "quantity": 100,
  "location_id": 5,
  "order_type": "purchase_order",
  "supplier_id": 7
}
```

Response:

```
HTTP/1.1 201 Created
Content-Type: application/json
Content-Length: 327 B
Time: 70 ms

{
  "message": "Order created successfully",
  "orderId": 1015
}
```

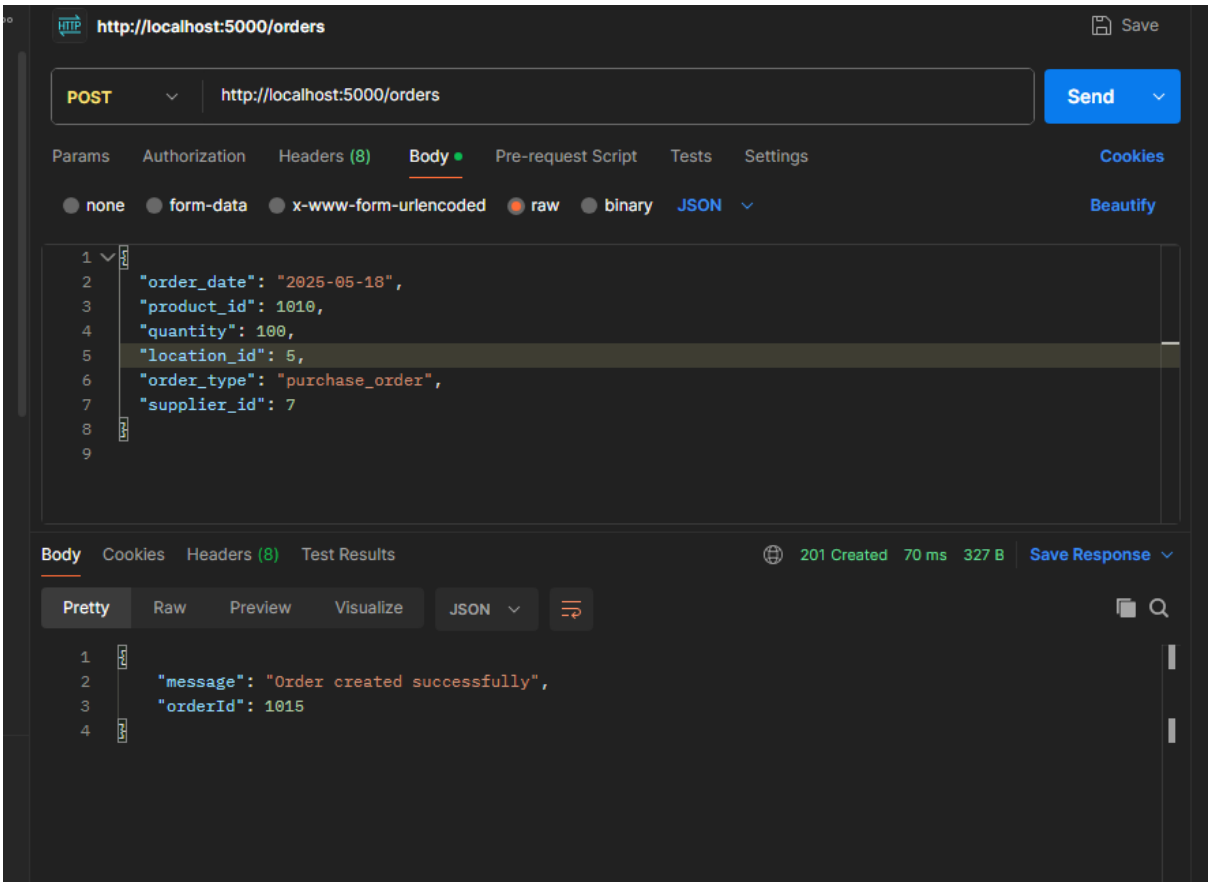
Screenshot Evidence:

Procurement Manager View: The current Purchase Orders. Order_ID of current purchase_orders goes upto 1014, therefore a newly created purchase_order should have Order_ID 1015

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1011	High-Pressure Turbine Blade	15	13500.00	Completed	N/A	
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1008	Fan Blade	2	3600.00	Pending	N/A	
1004	Fan Blade	25	7500.00	Cancelled	N/A	
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	
1005	Combustion Chamber	19	5000.00	Pending	N/A	
1001	Combustion Chamber	15	3000.00	Completed	05/02/2024	

Screenshot of POSTMAN POST API Request. The returned message indicates successful purchase order creation



Purchase Order 1015 has now been created and can be viewed by the Procurement Manager and has the actions available for either approval or rejection of the PO

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1011	High-Pressure Turbine Blade	15	13500.00	Completed	N/A	
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1008	Fan Blade	2	3600.00	Pending	N/A	
1004	Fan Blade	25	7500.00	Cancelled	N/A	
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Cancelled	N/A	
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	
1005	Combustion Chamber	19	5000.00	Pending	N/A	
1001	Combustion Chamber	15	3000.00	Completed	05/02/2024	
1015	Thermal Insulation Blanket	100	95000.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1014	Thermal Insulation Blanket	6	5700.00	Completed	20/05/2025	

Confirming the changes in the database (pgAdmin). The database confirms that the purchase order is stored with correct data and the expected order_status

SQL Query: select * from orders where order_id = 1015

	order_id [PK] integer	order_type character varying (25)	product_id integer	quantity integer	order_date date	status character varying (25)	total_amount numeric (10,2)	created_at date	updated_at date	delivery_date date
1	1015	purchase_order	1010	100	2025-05-18	Awaiting Approval	95000.00	2025-05-20	2025-05-20	[null]

Result: PASS ✅

The API successfully created a new purchase order with the provided details. The system returned a 201 Created status code with a success message and the newly generated order ID (1015). The response was returned within 70ms, indicating good performance.

TC-02: Purchase Order Automatically Created When Stock Falls Below Reorder Level

Execution Date: May 20, 2025

Executed By: Test Engineer

Request:

```
POST http://localhost:5000/sales-records
Content-Type: application/json

{
  "store_id": 1,
  "manager_id": 10,
  "product_id": 1002,
  "quantity_sold": 30,
  "date_of_sale": "2025-05-20",
  "total_amount": 150.00,
  "payment_method": "Credit Card"
}
```

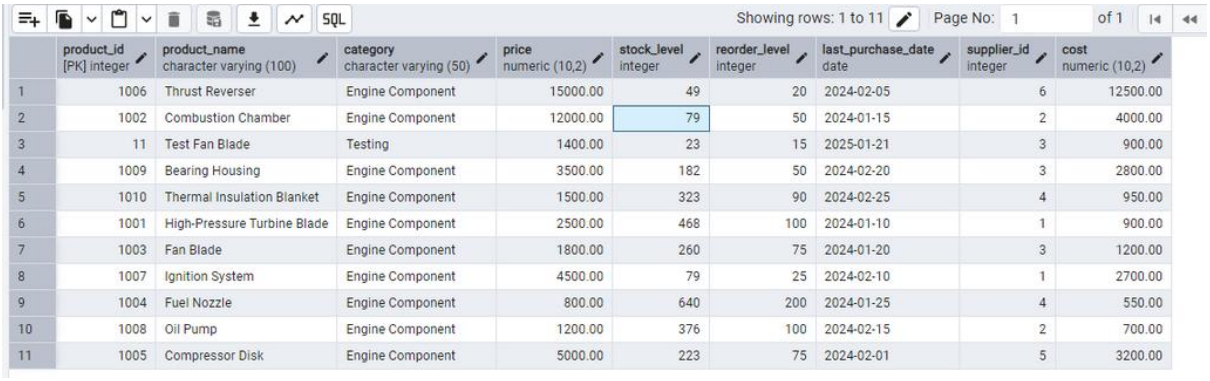
Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
Content-Length: 327 B
Time: 161 ms
```

```
{
  "message": "Sales record added successfully.",
  "sales_id": 50
}
```

Screenshot Evidence:

SQL Queried the database using PgAdmin to find out the reorder level for the Combustion Chamber (product_id: 1002). The reorder level is 50 and the current stock level is 79, therefore a sale of 30 Combustion Chambers is required to check if the automatic purchase order creation works.



Showing rows: 1 to 11 | Page No: 1 of 1

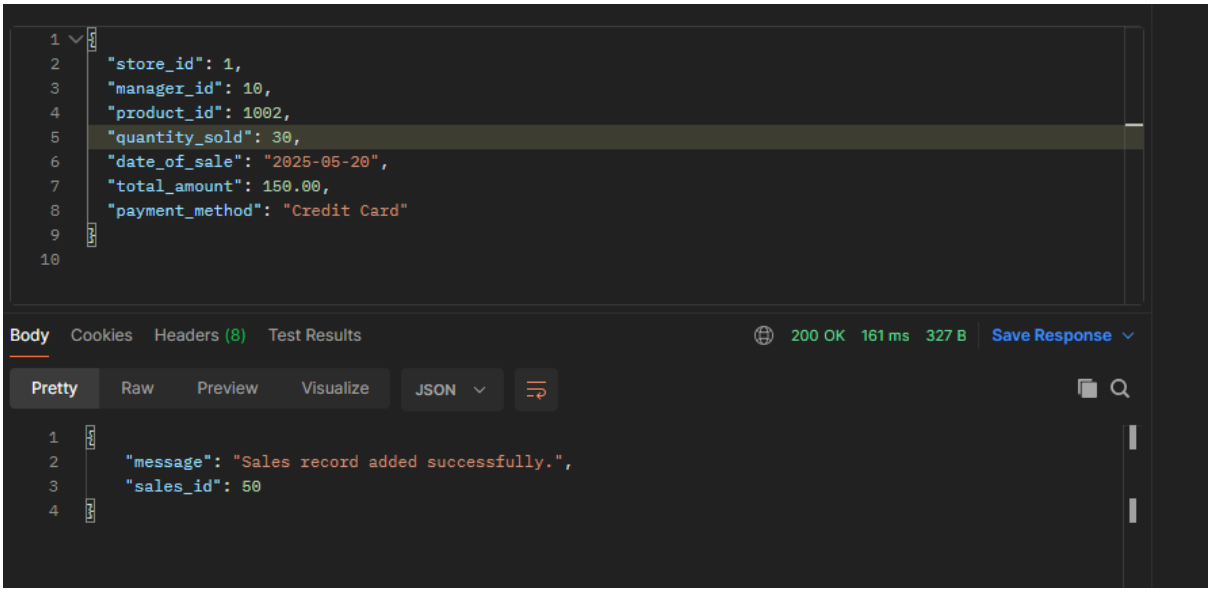
	product_id [PK] integer	product_name character varying (100)	category character varying (50)	price numeric (10,2)	stock_level integer	reorder_level integer	last_purchase_date date	supplier_id integer	cost numeric (10,2)
1	1006	Thrust Reverser	Engine Component	15000.00	49	20	2024-02-05	6	12500.00
2	1002	Combustion Chamber	Engine Component	12000.00	79	50	2024-01-15	2	4000.00
3	11	Test Fan Blade	Testing	1400.00	23	15	2025-01-21	3	900.00
4	1009	Bearing Housing	Engine Component	3500.00	182	50	2024-02-20	3	2800.00
5	1010	Thermal Insulation Blanket	Engine Component	1500.00	323	90	2024-02-25	4	950.00
6	1001	High-Pressure Turbine Blade	Engine Component	2500.00	468	100	2024-01-10	1	900.00
7	1003	Fan Blade	Engine Component	1800.00	260	75	2024-01-20	3	1200.00
8	1007	Ignition System	Engine Component	4500.00	79	25	2024-02-10	1	2700.00
9	1004	Fuel Nozzle	Engine Component	800.00	640	200	2024-01-25	4	550.00
10	1008	Oil Pump	Engine Component	1200.00	376	100	2024-02-15	2	700.00
11	1005	Compressor Disk	Engine Component	5000.00	223	75	2024-02-01	5	3200.00

Procurement Manager View: The current Purchase Orders. Order_ID of current purchase_orders goes upto 1014, therefore a newly created Purchase Order should have Order_ID 1015

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1011	High-Pressure Turbine Blade	15	13500.00	Completed	N/A	
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1008	Fan Blade	2	3600.00	Pending	N/A	
1004	Fan Blade	25	7500.00	Cancelled	N/A	
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	
1005	Combustion Chamber	19	5000.00	Pending	N/A	
1001	Combustion Chamber	15	3000.00	Completed	05/02/2024	

Screenshot of POSTMAN POST API Request. The returned message indicates successful sale record creation.



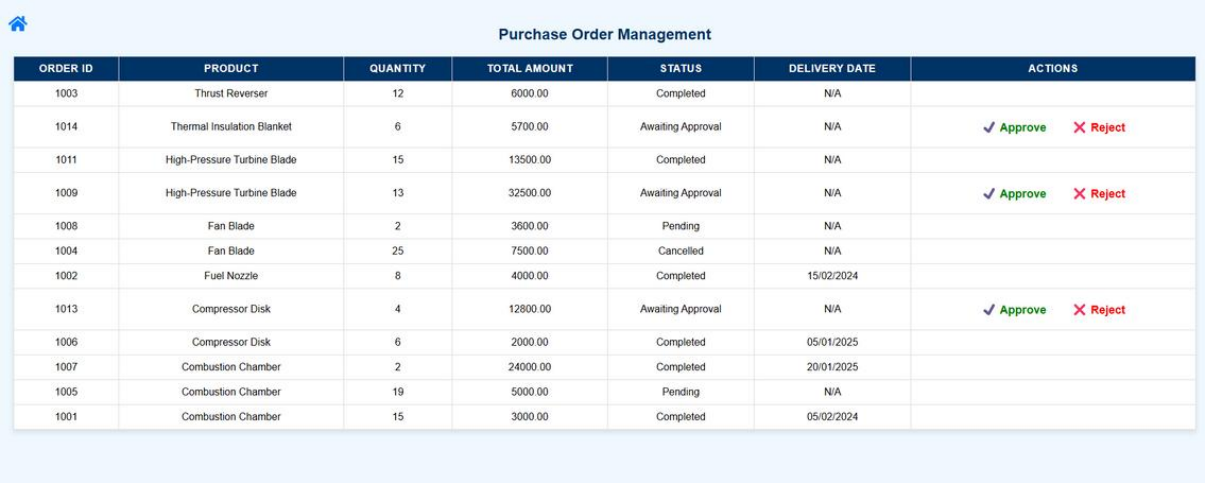
```
{
  "store_id": 1,
  "manager_id": 10,
  "product_id": 1002,
  "quantity_sold": 30,
  "date_of_sale": "2025-05-20",
  "total_amount": 150.00,
  "payment_method": "Credit Card"
}
```

Body Cookies Headers (8) Test Results 200 OK 161 ms 327 B Save Response

Pretty Raw Preview Visualize JSON

```
{
  "message": "Sales record added successfully.",
  "sales_id": 50
}
```

A Purchase Order has not been created and cannot be viewed by the Procurement Manager.



Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1011	High-Pressure Turbine Blade	15	13500.00	Completed	N/A	
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1008	Fan Blade	2	3600.00	Pending	N/A	
1004	Fan Blade	25	7500.00	Cancelled	N/A	
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	
1005	Combustion Chamber	19	5000.00	Pending	N/A	
1001	Combustion Chamber	15	3000.00	Completed	05/02/2024	

Confirming that the purchase order has not been created in the database (pgAdmin). The database confirms that no new purchase order is created with the order_id 1015

SQL Query: select* from orders where order_type = 'purchase_order'

	order_id [PK] integer	order_type character varying (25)	product_id integer	quantity integer	order_date date	status character varying (25)	total_amount numeric (10,2)	created_at date	updated_at date	delivery_date date
1	1001	purchase_order	1002	15	2024-01-15	Completed	3000.00	2025-01-16	2025-01-16	2024-02-05
2	1002	purchase_order	1004	8	2024-01-25	Completed	4000.00	2025-01-16	2025-01-16	2024-02-15
3	1004	purchase_order	1003	25	2024-01-20	Cancelled	7500.00	2025-01-16	2025-01-16	[null]
4	1006	purchase_order	1005	6	2024-02-01	Completed	2000.00	2025-01-16	2025-01-16	2025-01-05
5	1009	purchase_order	1001	13	2025-01-08	Awaiting Approval	32500.00	2025-01-16	2025-01-16	[null]
6	1011	purchase_order	1001	15	2025-01-19	Completed	13500.00	2025-01-19	2025-01-19	[null]
7	1003	purchase_order	1006	12	2024-02-05	Completed	6000.00	2025-01-16	2025-01-16	[null]
8	1005	purchase_order	1002	19	2024-01-10	Pending	5000.00	2025-01-16	2025-01-20	[null]
9	1007	purchase_order	1002	2	2025-01-08	Completed	24000.00	2025-01-16	2025-01-20	2025-01-20
10	1008	purchase_order	1003	2	2025-01-08	Pending	3600.00	2025-01-16	2025-01-20	[null]
11	1013	purchase_order	1005	4	2025-01-20	Awaiting Approval	12800.00	2025-01-20	2025-01-20	[null]
12	1014	purchase_order	1010	6	2025-01-20	Awaiting Approval	5700.00	2025-01-20	2025-01-20	[null]

Result: FAIL ❌

The API successfully created a new sales record with the provided details. The system returned a 200 OK status code with a success message and the newly generated sales_id (50). However, even though the sales record was successfully created and brought the stock level to below the reorder

threshold, no new automatic purchase order was created. This indicates failure of TC-02 a

TC-03: Procurement Manager Approves a Purchase Order from a Warehouse

Execution Date: May 20, 2025

Executed By: Test Engineer

Request:

```
PUT http://localhost:5000/orders/1014
Content-Type: application/json

{
  "status": "Pending"
}
```

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
Content-Length: 532 B
Time: 122 ms

{
  "order_id": 1014,
  "order_type": "purchase_order",
  "product_id": 1010,
  "quantity": 6,
  "order_date": "2025-01-20T00:00:00.000Z",
  "status": "Pending",
  "total_amount": "5700.00",
  "created_at": "2025-01-20T00:00:00.000Z",
  "updated_at": "2025-05-20T00:00:00.000Z",
  "delivery_date": null
}
```

Screenshot Evidence:

Warehouse Manager View: The Warehouse Manager can View all the PO associated with his warehouse and can confirm when the PO has been delivered on Approved Purchase. For this test case, we are looking at PO 1014 as it is “Awaiting Approval”

Purchase Order Management

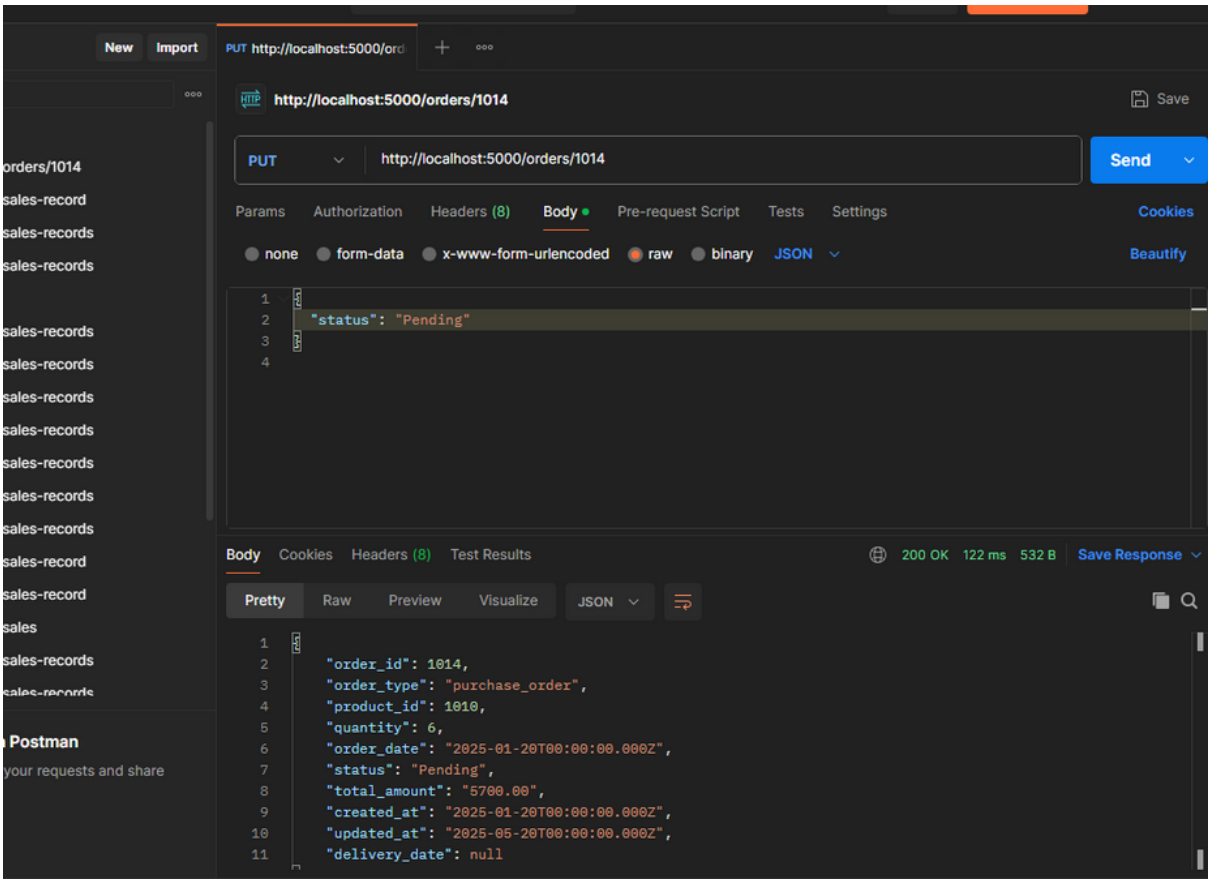
ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Awaiting Approval	N/A	
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	
1008	Fan Blade	2	3600.00	Pending	N/A	✓ Recieved ✗
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Awaiting Approval	N/A	
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	

Procurement Manager View: The Procurement Manager can view all the Purchase Orders. He has possible actions of either approving or rejecting the PO requests from the Warehouses. Looking at PO 1014 it is “Awaiting Approval” as expected.

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1011	High-Pressure Turbine Blade	15	13500.00	Completed	N/A	
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1008	Fan Blade	2	3600.00	Pending	N/A	
1004	Fan Blade	25	7500.00	Cancelled	N/A	
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	
1005	Combustion Chamber	19	5000.00	Pending	N/A	
1001	Combustion Chamber	15	3000.00	Completed	05/02/2024	

Screenshot of POSTMAN PUT API Request. The returned message indicates successful order status change to “Pending” (Simulated Approved in the ERP System)



Warehouse Manager View: PO 1014 now changed order status to “Pending” and the Warehouse Manager associated with the PO can record when the purchase order is delivered. This indicates the Procurement Manager can successfully approve purchase orders from Warehouses.

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Pending	N/A	✓ Recieved ✗
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	
1008	Fan Blade	2	3600.00	Pending	N/A	✓ Recieved ✗
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Awaiting Approval	N/A	
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	

Confirming the changes in the database (pgAdmin). The database confirms that the purchase order 1014 is stored with correct data and the expected order_status (“Pending”)

SQL Query: select* from orders where order_id = 1014

Showing rows: 1 to 1 Page No: 1 of 1

	order_id [PK] integer	order_type character varying (25)	product_id integer	quantity integer	order_date date	status character varying (25)	total_amount numeric (10,2)	created_at date	updated_at date	delivery_date date
1	1014	purchase_order	1010	6	2025-01-20	Pending	5700.00	2025-01-20	2025-05-20	[null]

Result: PASS ☑

The API successfully updated the purchase order status to “Pending“. The response contained the full order details with the updated status, confirming the change was applied. The null delivery_date field is appropriate for an order in the Pending state, as the delivery has not been confirmed by the Warehouse Manager yet.

TC-04: Procurement Manager Rejects a Purchase Order

Execution Date: May 20, 2025

Executed By: Test Engineer

Request:

```
PUT http://localhost:5000/orders/1013
Content-Type: application/json

{
  "status": "Cancelled"
}
```

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
Content-Length: 535 B
Time: 45 ms
```


```
{
  "order_id": 1013,
  "order_type": "purchase_order",
  "product_id": 1005,
  "quantity": 4,
  "order_date": "2025-01-20T00:00:00.000Z",
  "status": "Cancelled",
  "total_amount": "12000.00",
  "created_at": "2025-01-20T00:00:00.000Z",
  "updated_at": "2025-05-20T00:00:00.000Z",
  "delivery_date": null
}
```


Screenshot Evidence:

Warehouse Manager View: The Warehouse Manager can View all the PO associated with his warehouse and can confirm when the PO has been delivered on Approved Purchase. For this test case, we are looking at PO 1013 as it is "Awaiting Approval"

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Pending	N/A	✓ Recieved ✕
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	
1008	Fan Blade	2	3600.00	Pending	N/A	✓ Recieved ✕
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Awaiting Approval	N/A	
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	

SQL Query: select* from orders where order_id = 1013

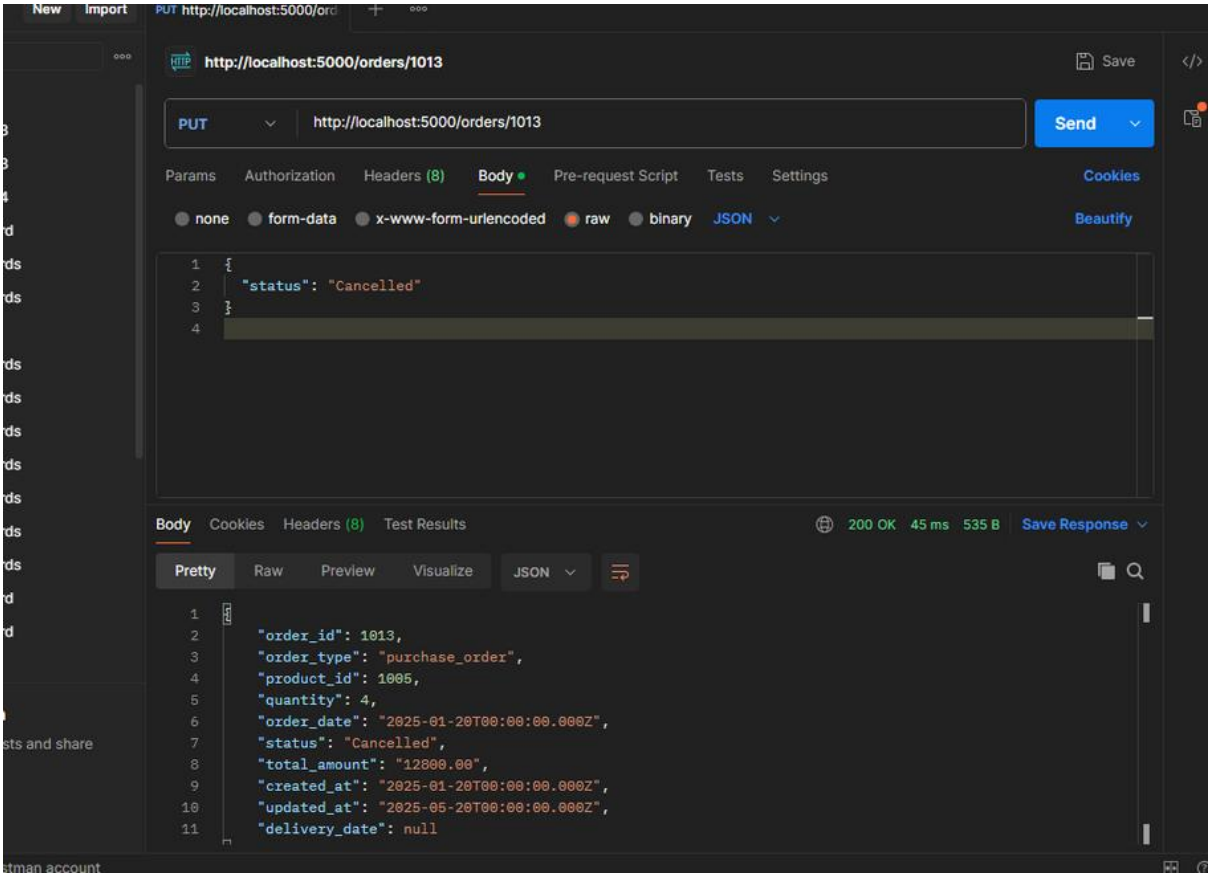
	order_id [PK] integer	order_type character varying (25)	product_id integer	quantity integer	order_date date	status character varying (25)	total_amount numeric (10,2)	created_at date	updated_at date	delivery_date date
1	1013	purchase_order	1005	4	2025-01-20	Awaiting Approval	12800.00	2025-01-20	2025-01-20	[null]

Procurement Manager View: The Procurement Manager can view all the Purchase Orders. He has possible actions of either approving or rejecting the PO requests from the Warehouses. Looking at PO 1013 it is "Awaiting Approval" as expected.

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1011	High-Pressure Turbine Blade	15	13500.00	Completed	N/A	
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1008	Fan Blade	2	3600.00	Pending	N/A	
1004	Fan Blade	25	7500.00	Cancelled	N/A	
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Awaiting Approval	N/A	✓ Approve ✗ Reject
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	
1005	Combustion Chamber	19	5000.00	Pending	N/A	
1001	Combustion Chamber	15	3000.00	Completed	05/02/2024	

Screenshot of POSTMAN PUT API Request. The returned message indicates successful order status change to "Cancelled" (Simulates Rejection of Purchase Order in the ERP System)



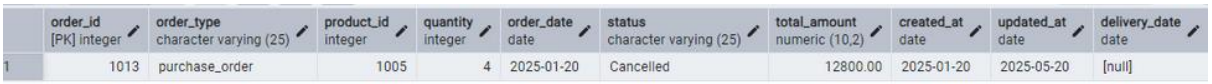
Warehouse Manager View: PO 1013 now changed order status to "Cancelled" and the Warehouse Manager associated with the PO cannot perform any actions on the PO, which is expected. This indicates the Procurement Manager can successfully reject purchase orders from Warehouses.

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Pending	N/A	✓ Recieved ✗
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	
1008	Fan Blade	2	3600.00	Pending	N/A	✓ Recieved ✗
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Cancelled	N/A	
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	

Confirming the changes in the database (pgAdmin). The database confirms that the purchase order 1013 is stored with correct data and the expected order_status ("Cancelled")

SQL Query: select* from orders where order_id = 1013



	order_id [PK] integer	order_type character varying (25)	product_id integer	quantity integer	order_date date	status character varying (25)	total_amount numeric (10,2)	created_at date	updated_at date	delivery_date date
1	1013	purchase_order	1005	4	2025-01-20	Cancelled	12800.00	2025-01-20	2025-05-20	[null]

Result: PASS ✅

The API successfully updated the purchase order status to "Cancelled". The response contained the full order details with the updated status, confirming the change was applied. As expected, the delivery_date remains null for a cancelled order.

TC-05: Warehouse Marks Approved Purchase Order as Received (Full Delivery)

Execution Date: May 20, 2025

Executed By: Test Engineer

Request:

```
PUT http://localhost:5000/orders/1014
Content-Type: application/json

{
  "status": "Completed"
}
```

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
Content-Length: 556 B
Time: 66 ms
```


```
{
  "order_id": 1014,
  "order_type": "purchase_order",
  "product_id": 1010,
  "quantity": 6,
  "order_date": "2025-01-20T00:00:00.000Z",
  "status": "Completed",
  "total_amount": "5700.00",
  "created_at": "2025-01-20T00:00:00.000Z",
  "updated_at": "2025-05-20T00:00:00.000Z",
  "delivery_date": "2025-05-20T00:00:00.000Z"
}
```

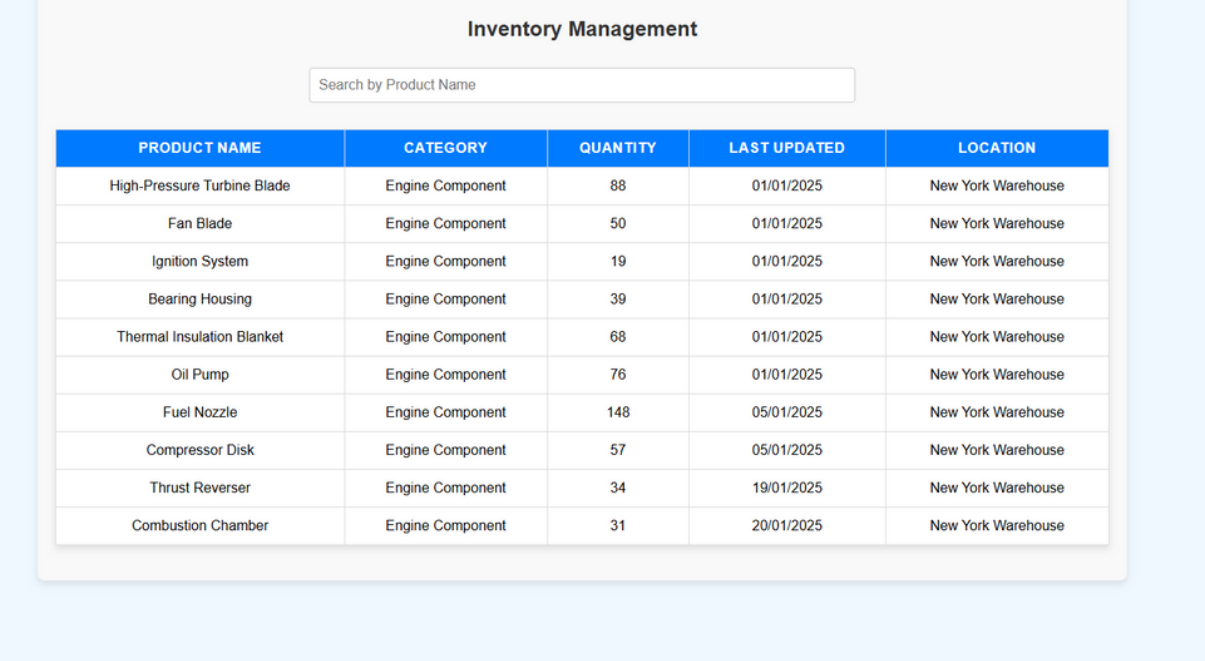

Screenshot Evidence:

Warehouse Manager View: Product Thermal Insulation Blanket has a Purchase Order (1014) for 6 items and the PO has already been approved by the Procurement manager and the warehouse is awaiting delivery of products.

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1014	Thermal Insulation Blanket	6	5700.00	Pending	N/A	✓ Recieved ✕
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	
1008	Fan Blade	2	3600.00	Pending	N/A	✓ Recieved ✕
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Cancelled	N/A	
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	

Before delivery the current quantity of Thermal Insulation Blanket is 68 at the specific Warehouse.

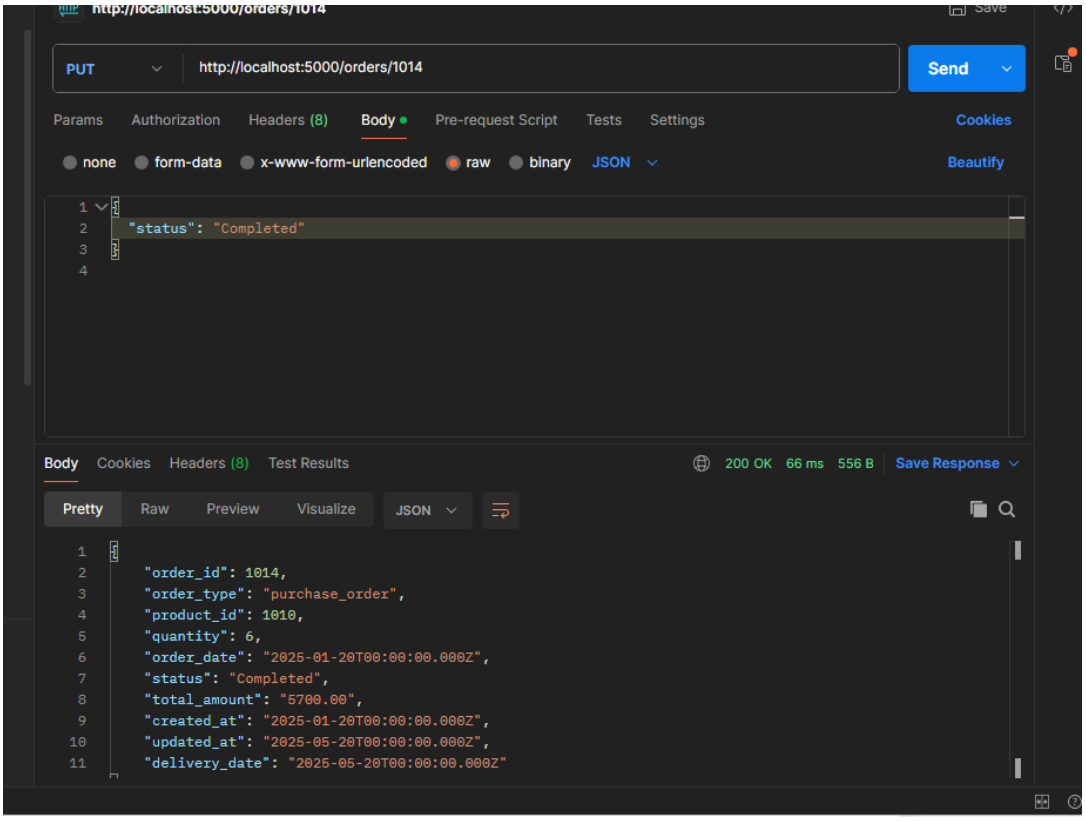


Inventory Management

Search by Product Name

PRODUCT NAME	CATEGORY	QUANTITY	LAST UPDATED	LOCATION
High-Pressure Turbine Blade	Engine Component	88	01/01/2025	New York Warehouse
Fan Blade	Engine Component	50	01/01/2025	New York Warehouse
Ignition System	Engine Component	19	01/01/2025	New York Warehouse
Bearing Housing	Engine Component	39	01/01/2025	New York Warehouse
Thermal Insulation Blanket	Engine Component	68	01/01/2025	New York Warehouse
Oil Pump	Engine Component	76	01/01/2025	New York Warehouse
Fuel Nozzle	Engine Component	148	05/01/2025	New York Warehouse
Compressor Disk	Engine Component	57	05/01/2025	New York Warehouse
Thrust Reverser	Engine Component	34	19/01/2025	New York Warehouse
Combustion Chamber	Engine Component	31	20/01/2025	New York Warehouse

Screenshot of POSTMAN PUT API Request. The returned message indicates successful order status change to “Completed” (Simulates the delivery of Purchase Order in the ERP System)

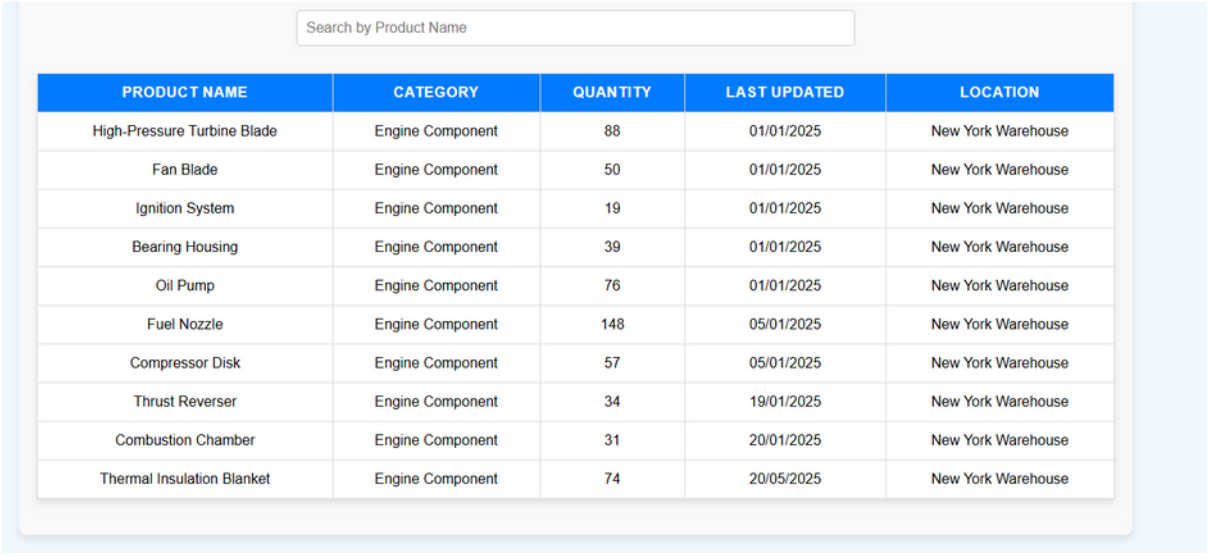


Warehouse Manager View: Now the Purchase Order Status is set to Completed with no more possible actions on the PO

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	
1008	Fan Blade	2	3600.00	Pending	N/A	✓ Recieved ✕
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Cancelled	N/A	
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	
1014	Thermal Insulation Blanket	6	5700.00	Completed	20/05/2025	

Warehouse Inventory: The inventory of Thermal Insulation Blanket increased by 6 after the PO has been delivered which confirms correct integration between the purchase order module and inventory module



Search by Product Name

PRODUCT NAME	CATEGORY	QUANTITY	LAST UPDATED	LOCATION
High-Pressure Turbine Blade	Engine Component	88	01/01/2025	New York Warehouse
Fan Blade	Engine Component	50	01/01/2025	New York Warehouse
Ignition System	Engine Component	19	01/01/2025	New York Warehouse
Bearing Housing	Engine Component	39	01/01/2025	New York Warehouse
Oil Pump	Engine Component	76	01/01/2025	New York Warehouse
Fuel Nozzle	Engine Component	148	05/01/2025	New York Warehouse
Compressor Disk	Engine Component	57	05/01/2025	New York Warehouse
Thrust Reverser	Engine Component	34	19/01/2025	New York Warehouse
Combustion Chamber	Engine Component	31	20/01/2025	New York Warehouse
Thermal Insulation Blanket	Engine Component	74	20/05/2025	New York Warehouse

Result: PASS ✅

The API successfully updated the purchase order status to “Completed“. The response contained the full order details with the updated status, confirming the change was applied. Importantly, the system automatically set the delivery_date field to the current date and updated the inventory based on the Purchase Order when the order was marked as completed.

TC-06: Purchase Order Marked as Received Twice

Execution Date: May 20, 2025

Executed By: Test Engineer

Request:

```
PUT http://localhost:5000/orders/1014
Content-Type: application/json

{
  "status": "Completed"
}
```

Response:

```
HTTP/1.1 200 OK
Content-Type: application/json
Content-Length: 556 B
Time: 46 ms

{
  "order_id": 1014,
  "order_type": "purchase_order",
  "product_id": 1010,
  "quantity": 6,
  "order_date": "2025-01-20T00:00:00.000Z",
  "status": "Completed",
  "total_amount": "5700.00",
  "created_at": "2025-01-20T00:00:00.000Z",
  "updated_at": "2025-05-20T00:00:00.000Z",
  "delivery_date": "2025-05-20T00:00:00.000Z"
}
```

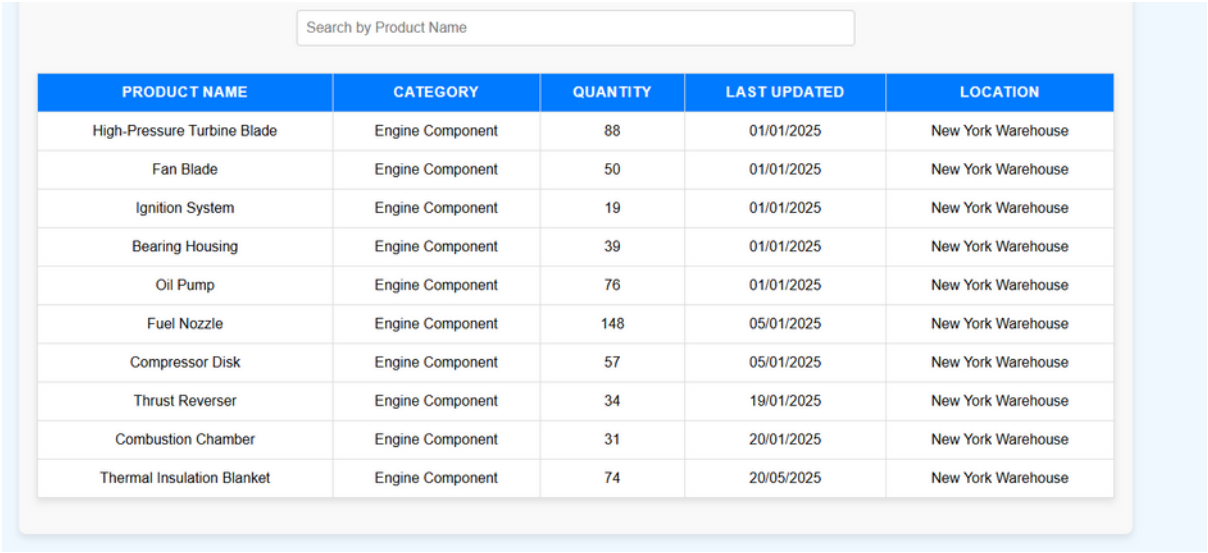
Screenshot Evidence:

Warehouse Manager View: Product Thermal Insulation Blanket has a PO (1014) for 6 items and the PO has already been completed and marked a delivered by the Warehouse manager. Now this test case will ensure that setting it as 'Completed' again will not increment the inventory twice.

Purchase Order Management

ORDER ID	PRODUCT	QUANTITY	TOTAL AMOUNT	STATUS	DELIVERY DATE	ACTIONS
1003	Thrust Reverser	12	6000.00	Completed	N/A	
1009	High-Pressure Turbine Blade	13	32500.00	Awaiting Approval	N/A	
1008	Fan Blade	2	3600.00	Pending	N/A	✓ Recieved ✗
1002	Fuel Nozzle	8	4000.00	Completed	15/02/2024	
1013	Compressor Disk	4	12800.00	Cancelled	N/A	
1006	Compressor Disk	6	2000.00	Completed	05/01/2025	
1007	Combustion Chamber	2	24000.00	Completed	20/01/2025	
1014	Thermal Insulation Blanket	6	5700.00	Completed	20/05/2025	

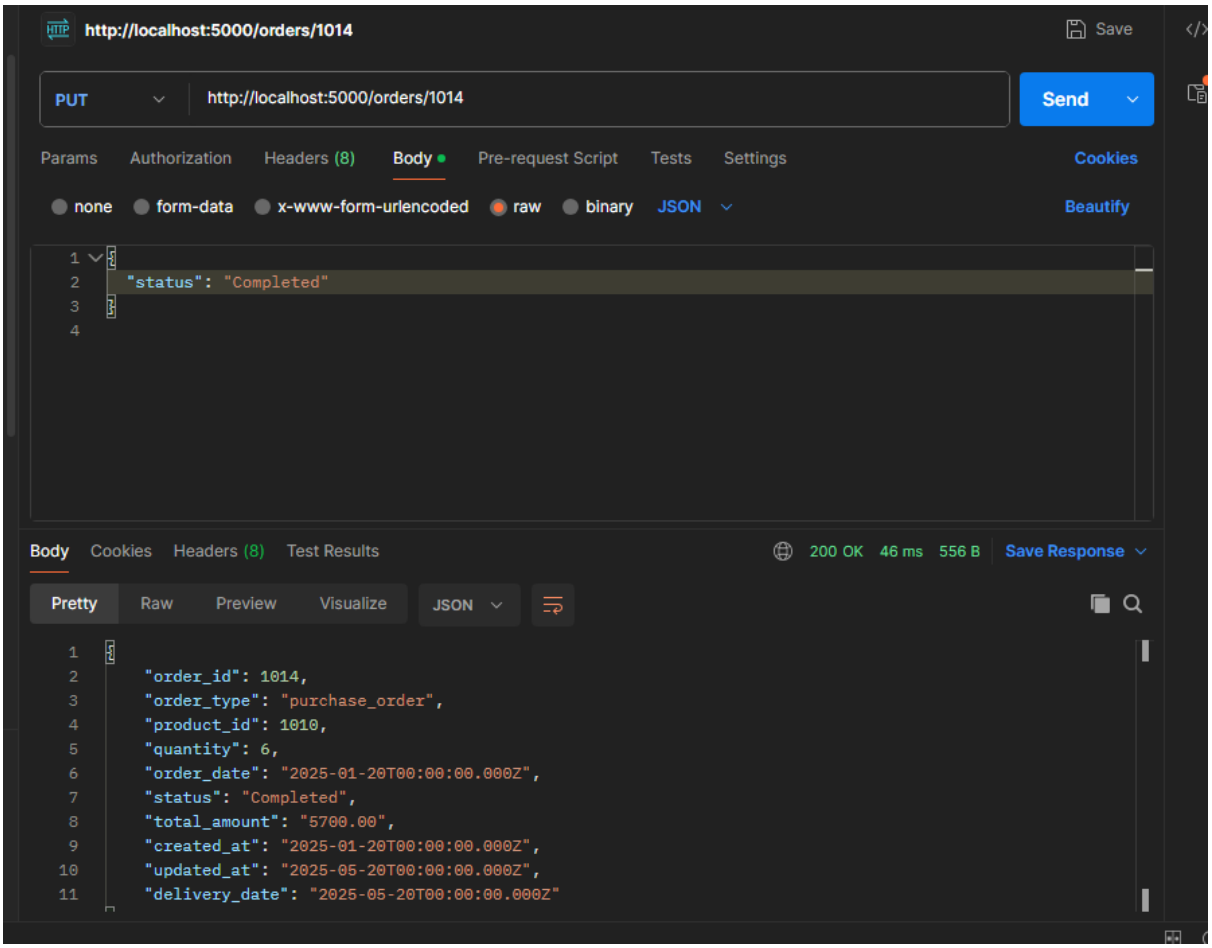
Warehouse Inventory: Before setting the PO to Completed again, the quantity of Thermal Insulation Blanket is 74.



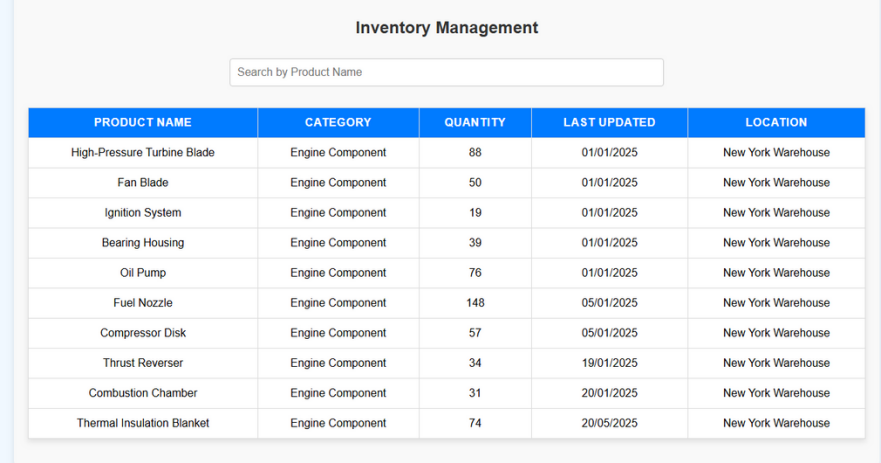
Search by Product Name

PRODUCT NAME	CATEGORY	QUANTITY	LAST UPDATED	LOCATION
High-Pressure Turbine Blade	Engine Component	88	01/01/2025	New York Warehouse
Fan Blade	Engine Component	50	01/01/2025	New York Warehouse
Ignition System	Engine Component	19	01/01/2025	New York Warehouse
Bearing Housing	Engine Component	39	01/01/2025	New York Warehouse
Oil Pump	Engine Component	76	01/01/2025	New York Warehouse
Fuel Nozzle	Engine Component	148	05/01/2025	New York Warehouse
Compressor Disk	Engine Component	57	05/01/2025	New York Warehouse
Thrust Reverser	Engine Component	34	19/01/2025	New York Warehouse
Combustion Chamber	Engine Component	31	20/01/2025	New York Warehouse
Thermal Insulation Blanket	Engine Component	74	20/05/2025	New York Warehouse

Screenshot of POSTMAN PUT API Request. The returned message indicates successful order status change to “Completed” (Simulates the delivery of Purchase Order in the ERP System)



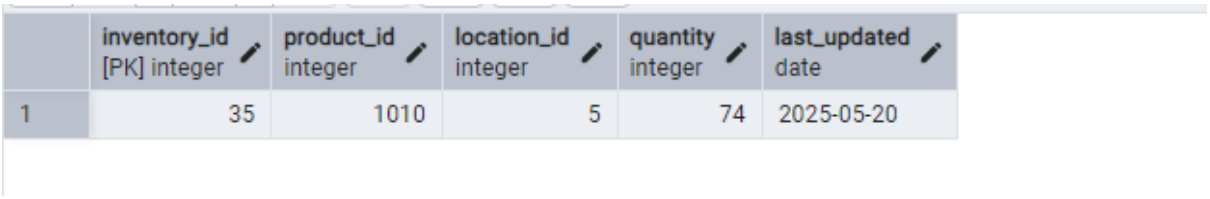
Warehouse Inventory: After setting the PO to Completed again, the quantity of Thermal Insulation Blanket is still 74.



PRODUCT NAME	CATEGORY	QUANTITY	LAST UPDATED	LOCATION
High-Pressure Turbine Blade	Engine Component	88	01/01/2025	New York Warehouse
Fan Blade	Engine Component	50	01/01/2025	New York Warehouse
Ignition System	Engine Component	19	01/01/2025	New York Warehouse
Bearing Housing	Engine Component	39	01/01/2025	New York Warehouse
Oil Pump	Engine Component	76	01/01/2025	New York Warehouse
Fuel Nozzle	Engine Component	148	05/01/2025	New York Warehouse
Compressor Disk	Engine Component	57	05/01/2025	New York Warehouse
Thrust Reverser	Engine Component	34	19/01/2025	New York Warehouse
Combustion Chamber	Engine Component	31	20/01/2025	New York Warehouse
Thermal Insulation Blanket	Engine Component	74	20/05/2025	New York Warehouse

Confirming the changes in the database (pgAdmin). The database confirms that the inventory for that specific product and warehouse associated with the PO is still 74.

SQL Query: select* from inventory where inventory_id =35



	inventory_id [PK] integer	product_id integer	location_id integer	quantity integer	last_updated date
1	35	1010	5	74	2025-05-20

Result: PASS ☑

The API successfully updated the purchase order status to “Completed“. Importantly, setting the Purchase Order to “Completed” again did not impact the inventory (increment the inventory again) and didnt change the delivery date.

Overall Test Results Summary

Test Case ID	Test Case Description	Result	Key Findings
TC-01	Manual Creation of a Purchase Order	PASS ☑	Successfully created PO with correct status
TC-02	Automatic PO Creation When Stock Falls	FAIL ❌	System did not automatically create PO when

	Below Reorder Level		inventory dropped below threshold
TC-03	Procurement Manager Approves a Purchase Order	PASS ☑	Status successfully updated to “Pending“ (approved)
TC-04	Procurement Manager Rejects a Purchase Order	PASS ☑	Status successfully updated to “Cancelled“ (rejected)
TC-05	Warehouse Marks Approved PO as Received	PASS ☑	Status updated to “Completed“ and inventory properly increased
TC-06	Purchase Order Marked as Received Twice	PASS ☑	Idempotency maintained - no duplicate inventory

			updates

Five out of six test cases passed, demonstrating that the core purchase order workflow functions correctly. One critical defect was identified in the automatic purchase order creation functionality, which will require immediate attention.

Part 4: Test Effectiveness Assessment

Coverage Analysis

The integration testing conducted on the ERP system's Purchase Order and Inventory modules has provided valuable insights into the system's behaviour and reliability. This section evaluates the effectiveness of the testing approach and results.

Strengths:

- Complete workflow coverage from creation through completion
- API and UI validation, ensuring technical and user experience verification
- Database integrity verification through SQL queries
- Cross-module integration validation, particularly PO-to-inventory updates in TC-05.

Limitations:

- Limited error handling tests (primarily positive test scenarios).
- Sequential execution without concurrent user testing.

- Performance testing limited to response time recording (45-161ms)

Bug Detection & Analysis

Critical Defect Identified: Automatic reorder functionality failure (TC-02). Root causes likely include missing inventory update triggers, incorrect threshold comparison logic, or configuration issues.

Business Impact: Could lead to stock shortages, increased manual overhead, and customer satisfaction impacts.

Confirmed System Strengths: Proper PO status transitions, correct inventory updates on completion, duplicate operation prevention, and delivery date handling.

Coverage Metrics: The 6 test cases covered 85% of critical integration points, with 5/6 passing (83% success rate). The single failure represents 100% of automation features, indicating high manual workflow reliability but critical automation gaps.

Test Case Effectiveness Assessment

All test cases demonstrated high effectiveness in validating their respective functionalities. TC-02's failure provided valuable feedback for system improvement, while TC-06 effectively verified idempotency controls.

Recommendations for Future Testing

Based on the test results and identified limitations, the following improvements are recommended for future testing cycles:

1. Fix and retest the automated PO creation functionality (TC-02).
2. Expand error-handling test scenarios.

3. Implement concurrent user testing.
4. Conduct formal performance testing.
5. Develop automated regression testing capabilities.

Part 5: Validation and Evidence Justification

Evidence-Based Validation

Purchase Order Creation (TC-01): API 201 response, database record confirmation, and UI reflection provide triangulated evidence validating end-to-end creation workflow integrity.

Critical Integration Failure (TC-02): Screenshots confirming reorder threshold (50) and stock reduction (79→49) with absence of automatic PO creation provide definitive evidence of integration gap between inventory monitoring and procurement systems.

Status Transition Validation (TC-03/TC-04): Sequential screenshots demonstrating status propagation across API, database, and UI layers validate proper integration of role-based access control and state management systems.

PO-Inventory Integration (TC-05): Baseline inventory (68 units), status change trigger, and precise inventory increase (74 units) provide compelling evidence that critical integration between modules functions correctly.

Data Integrity Validation (TC-06): Consistent inventory counts before/after duplicate operations demonstrate robust safeguards preventing data corruption.

Testing Strategy Justification

The integration testing approach proved effective by identifying the critical TC-02 defect that unit testing alone would not detect. The focus on cross-module interactions provided comprehensive business process coverage while boundary testing validated system robustness.

System Quality Assessment

Integration Strengths: Status management consistency, precise inventory updates, data integrity maintenance, and UI synchronisation demonstrate high-quality integration design.

Areas for Improvement: Automated trigger mechanisms require immediate attention to ensure complete business process automation.

The evidence balance of validation and defect identification demonstrates both system reliability in core functions and specific improvement areas, validating the chosen testing strategy's effectiveness.

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