AS/RS Warehouse Management System and Vehicle Loading Optimization

User Manual

Contents

1. Getting Started

The following is the guideline to successfully run this application:

1.1 Install Anaconda:

The application requires a “conda” environment. Visit Anaconda's download page and install it.

1.2 Open Anaconda Navigator and Spyder:

After installation, open Anaconda Navigator and launch Spyder. Install the following libraries required for machine learning, solvers, and user interface functionality:

- pyomo
- tk
- tkmacosx (if on MAC-OS)
- ortools
- mayavi
- sklearn
- Mlxtend

1.3 Install GLPK and CBC on Windows:

For GLPK Installation:

- Visit the GLPK website and download the binary distribution for Windows under the "Download" section.
- Choose the version appropriate for your system (32-bit or 64-bit).
- Extract the ZIP file to a location on your computer.
- Add the path to the GLPK binaries (e.g., glpsol.exe) to your system's PATH environment variable.
    - Open the Start menu and search for "Environment Variables."
    - Click "Edit the system environment variables" and then the "Environment Variables" button.
    - Under "System variables," select the "Path" variable and click "Edit." ○ Click "New" and enter the GLPK path (e.g., C:\path\to\glpk\bin).
    - Click "OK" to save the changes.

For CBC Installation:

- Visit the CBC website and download the binary distribution for Windows under the "Download" section.
- Choose the version appropriate for your system (32-bit or 64-bit).
- Extract the ZIP file to a location on your computer.
- Add the path to the CBC binaries (e.g., cbc.exe) to your system's PATH environment variable (similar to the steps above for GLPK).

1.4 Restart your computer

After completing the above steps, restart your computer. Click on the desktop application icon to launch the main menu.

Figure 1: Main Menu

2. Warehouse Management System

Click on the **AS/RS Warehouse Management System** button from the main menu to access the warehouse management functionalities. The following screen will appear:

Figure 2: AS/RS Warehouse Management System Menu

The menu offers three options:

- **Finished and Semi-Finished Products**: Allocations for finished and semi-finished product categories.
- **Raw Materials and Packaging**: Allocations for raw materials and packaging categories.
- **Change Warehouse Layout**: Modify the existing warehouse layout.

2.1 Excel File Format

To ensure the decision support system functions correctly, the input file must strictly adhere to the required Excel format.

- Column names, order, and case sensitivity must be preserved. ● Below is an example format:

Palet Numarası	Malzeme kısa metni	Tek /Çift / Diğer	Nihai İstif Yükekliği (cm)	İstif	Müşteri	Birleşik ID	Ürün	Palet En	Palet Boy	Sevkiyat Tarihi
5001333873	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4909	76	85	2021-05-25
5001333684	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4909	76	85	2021-05-25
5001333699	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4909	76	85	2021-05-25
5001333944	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4909	76	85	2021-05-26
5001333865	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4909	76	85	2021-05-26
5001333949	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4909	76	85	2021-06-12
5001333863	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4909	76	85	2021-06-12
5001334162	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4863	76	115	2021-06-16
5001333729	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4863	76	115	2021-06-16
5001334095	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4863	76	115	2021-04-15
5001333705	DULL1_20_P	Çift	175	1	C60	C60DULL1	P4863	76	115	2021-04-15

Figure 3: Excel Format

Upload the input file to the decision support system every time new products are received at the warehouse.

2.2 Product Placement Within the Warehouse

Depending on the product category, click on either the **Finished and Semi-Finished Products** or **Raw Materials and Packaging** button. This will take you to the placement menu shown below:

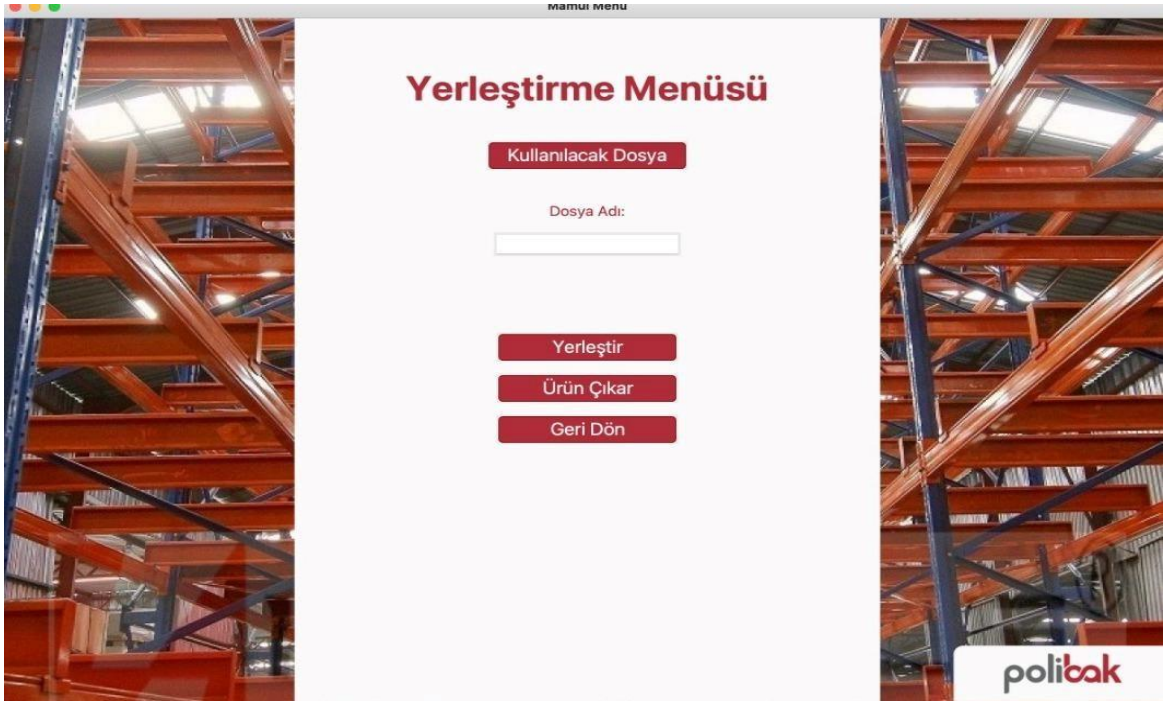

Figure 4: Placement Menu

To begin, click on the **Select File** option to load the Excel file containing product data.

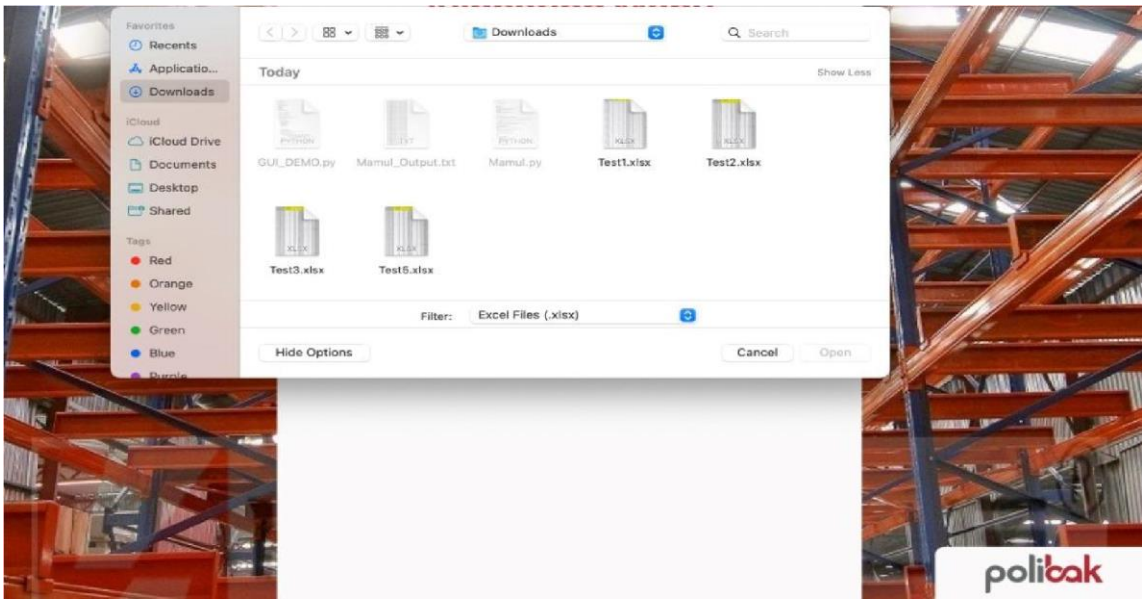

Figure 5: File Selection Window

After uploading the Excel file, click on the **Place** button to allocate products in the warehouse. The resulting allocations will appear as shown:

Figure 6: Product Placement Screen

Products (identified by their IDs) are assigned 4D coordinates (row, column, shelf level, depth). These coordinates can also be exported to a text file for printing or saving.

2.3 Product Retrieval from the Warehouse

To retrieve an order from the warehouse:

1. Select the **Pick Order** option and enter the dispatch date of the stored product.
2. The screen will display the products scheduled for dispatch on the date entered.
3. The output can be exported to a text file for printing or saving.

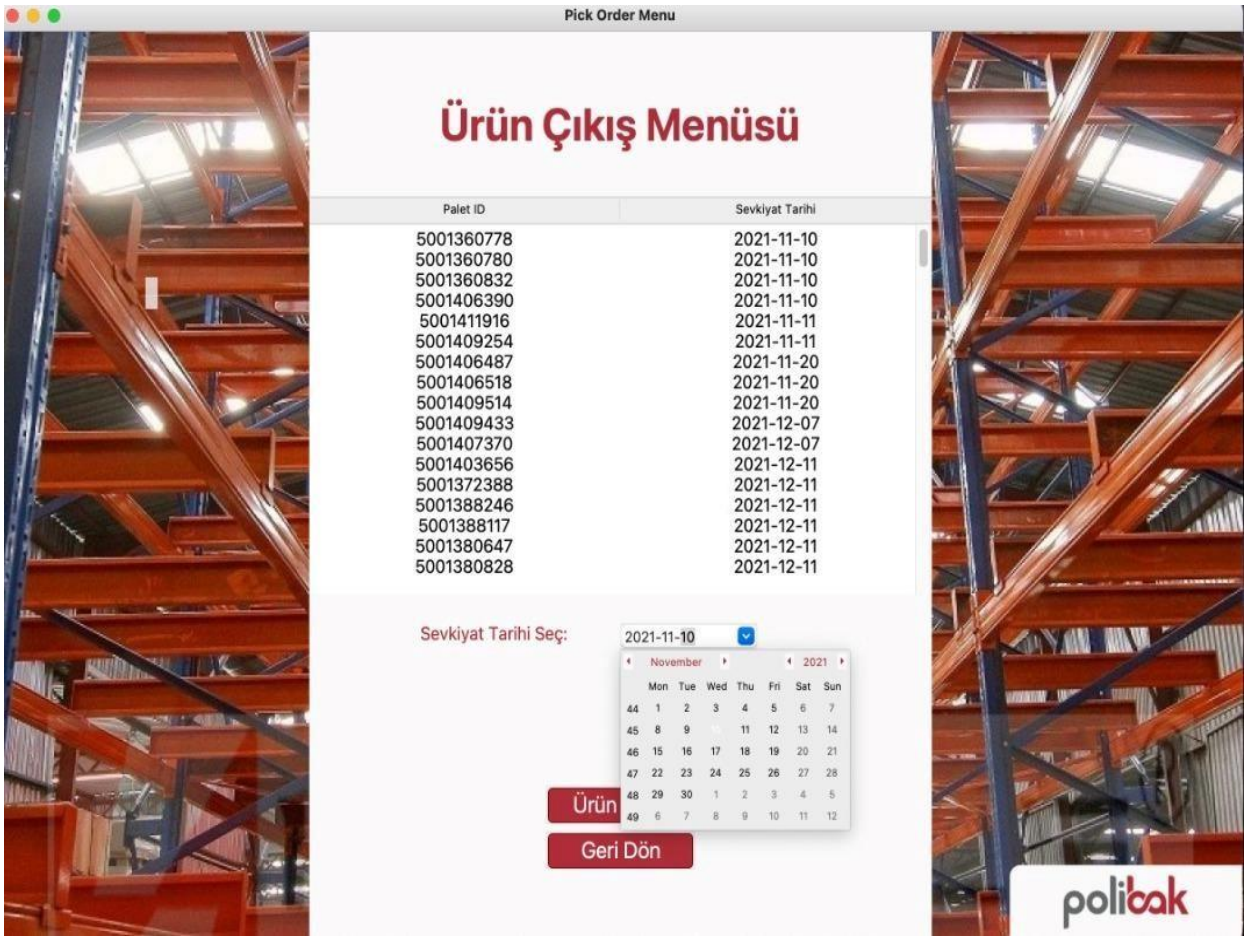

Figure 7: Product Selection Window

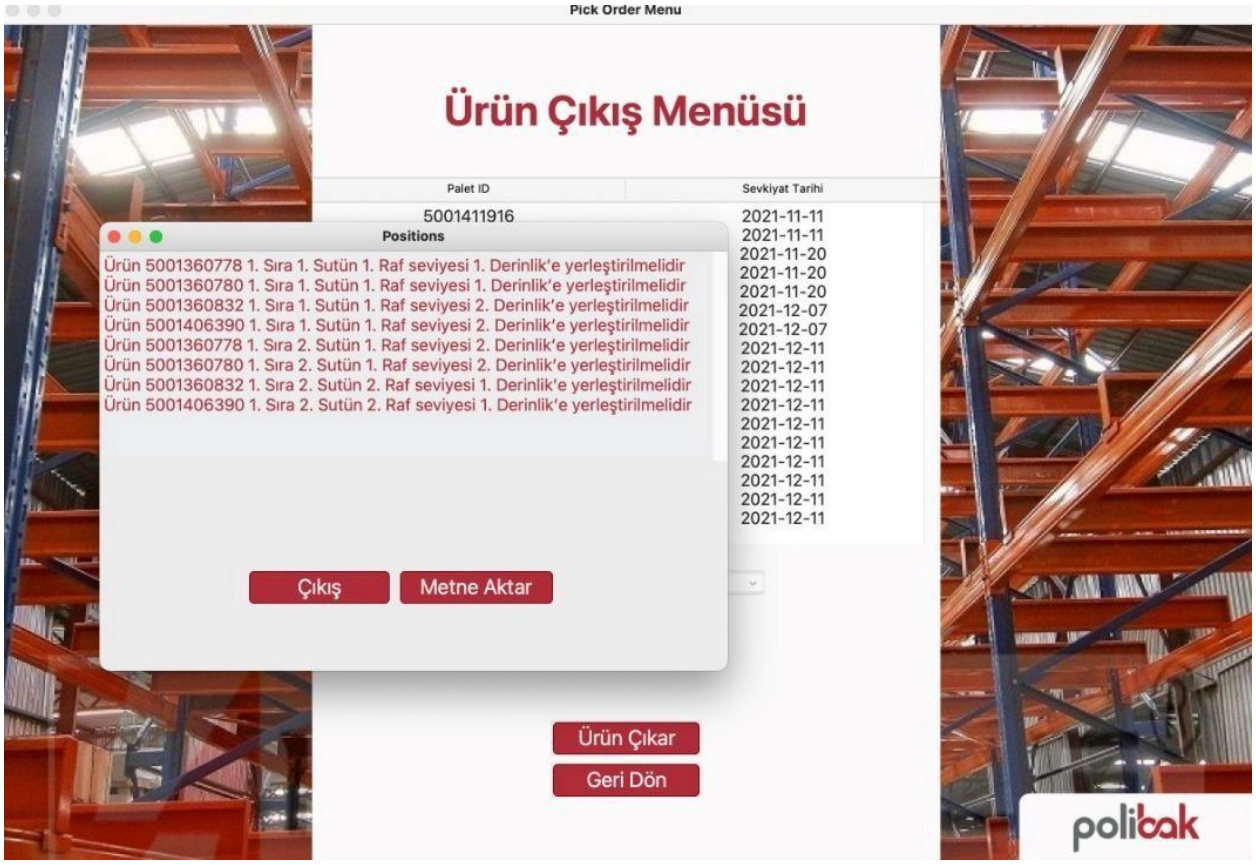

Figure 8: Product Selection Output

2.4 Changing the Warehouse Layout

To modify cell dimensions or the maximum number of products that can be allocated to a cell:

1. Enter the desired cell length and product limit.
2. Click on the **Update** button.

To reset to default settings, click **Revert**, restoring cell length to 290 cm and the product limit to 3 per cell.

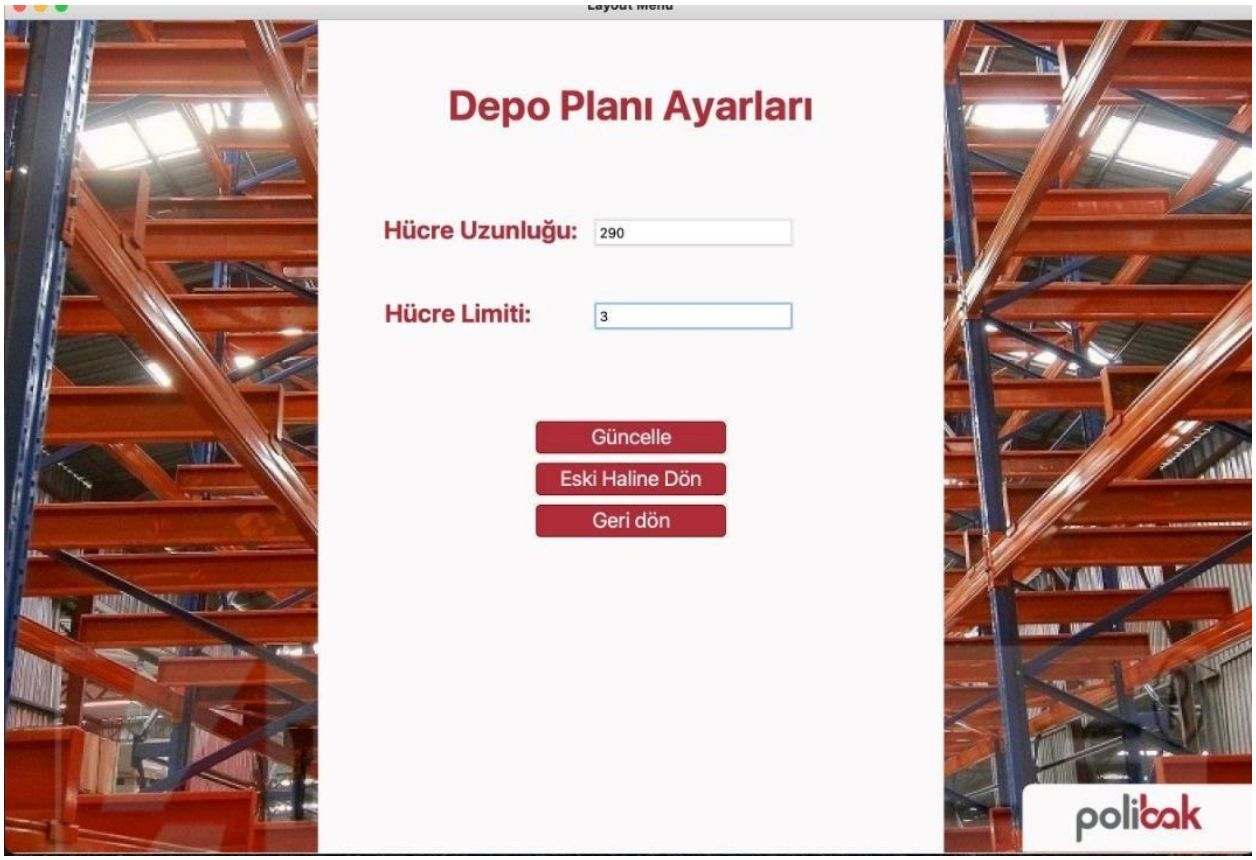

Figure 9: Warehouse Layout Change Window

3. Vehicle Loading Optimization

Click on the **Vehicle Loading Optimization** button from the main menu to access this functionality.

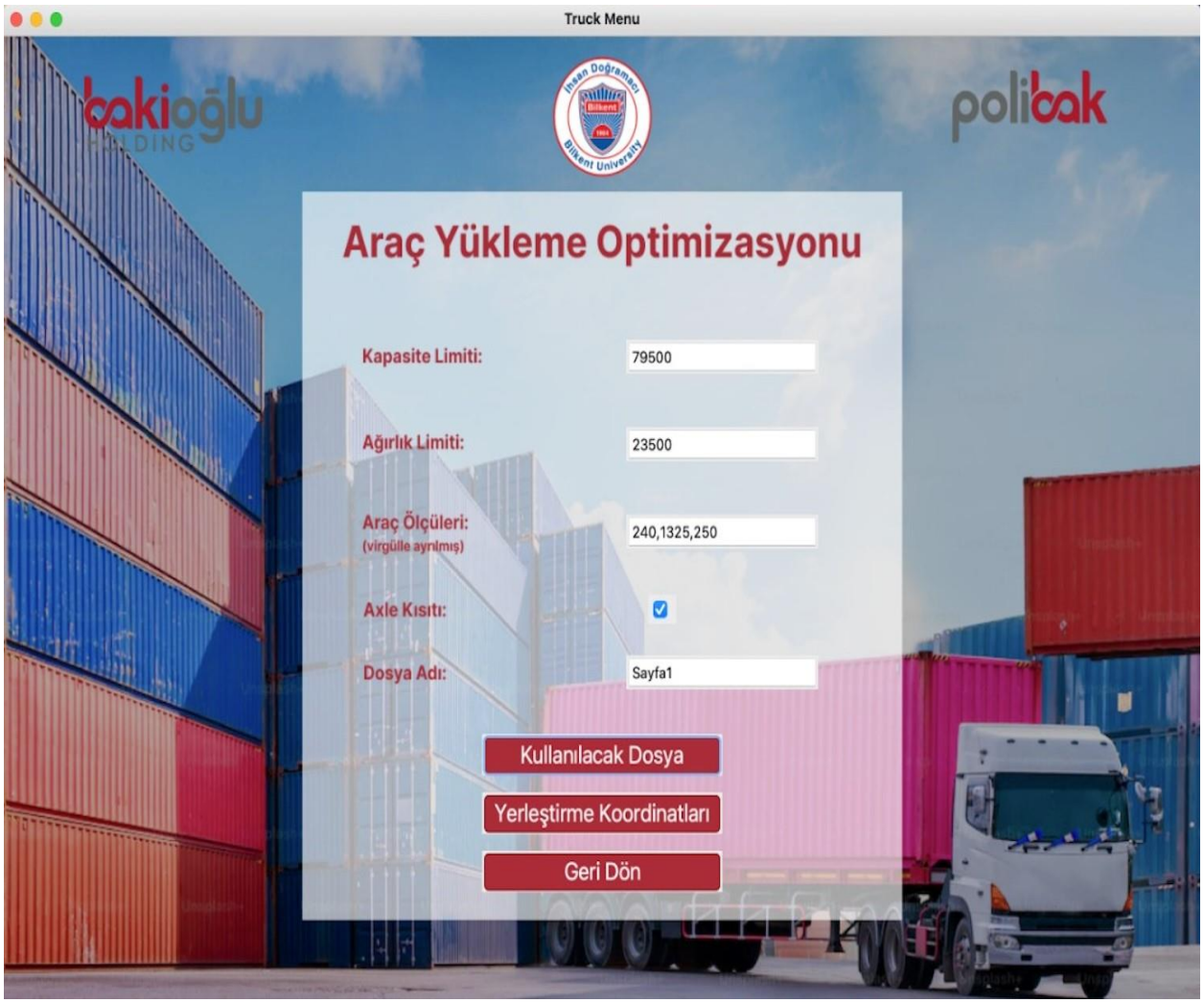

Figure 10: Vehicle Loading Optimization Screen

3.1 Loading Products onto Vehicles

1. Fill in the required fields:
    - Volume limit
    - Weight limit
    - Vehicle dimensions
    - Axle constraints
    - Excel sheet name
2. Upload the product data using the **Select File** button.

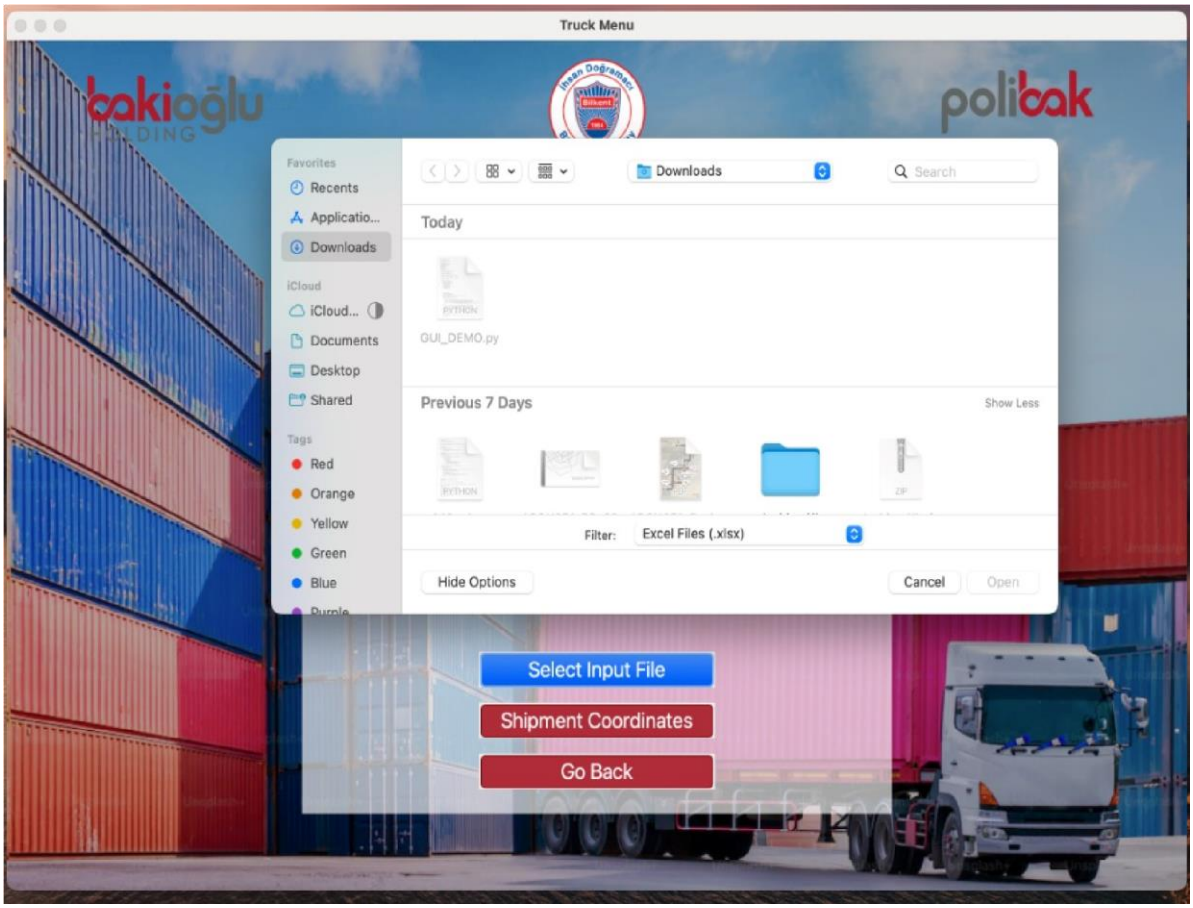

Figure 11: File Selection Window

If the total product weight exceeds the vehicle capacity, the excess weight will be displayed. Remove products as required and retry the process with the updated Excel file.

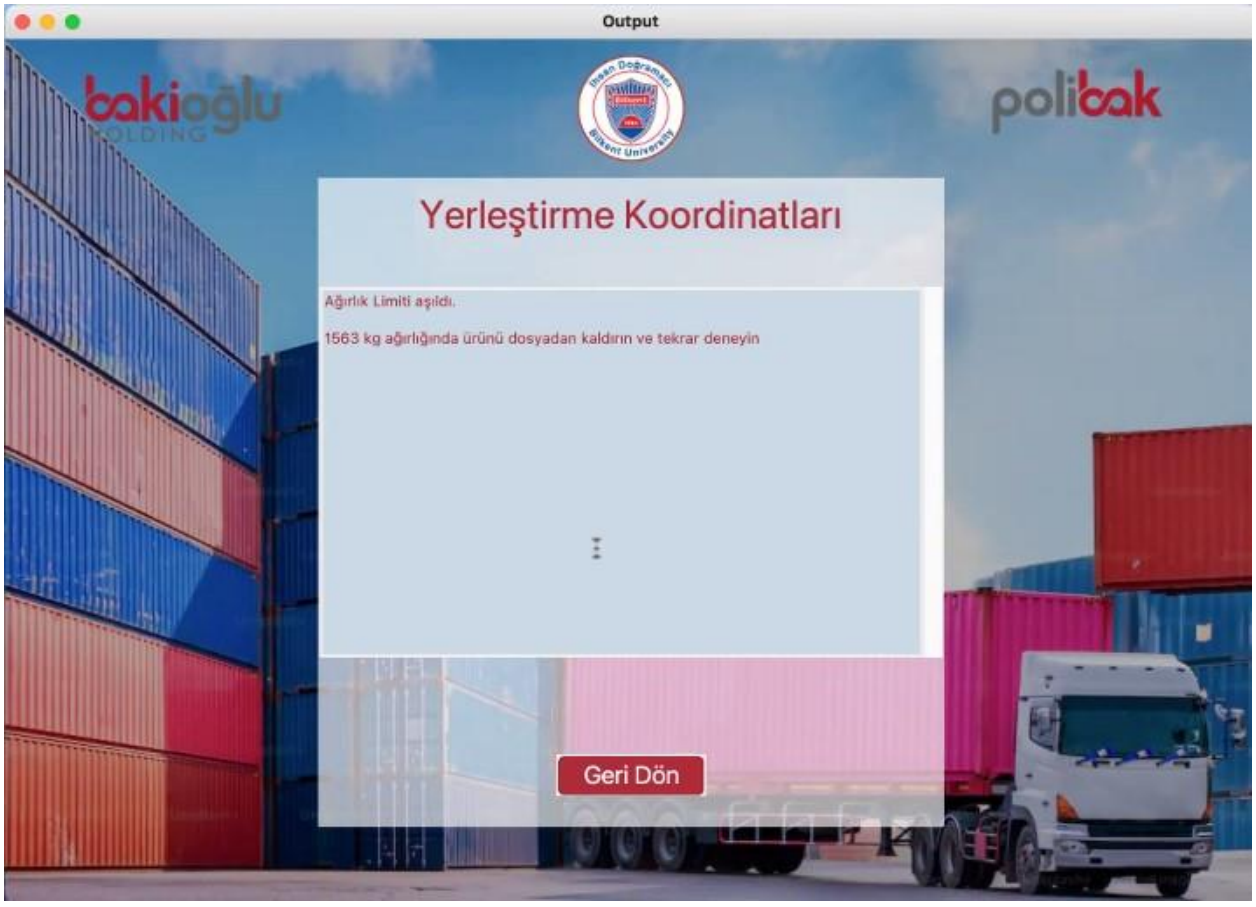

Figure 12: Weight Constraint error

3.2 Placement Coordinates

The output will display the coordinates of the pallets as shown below:

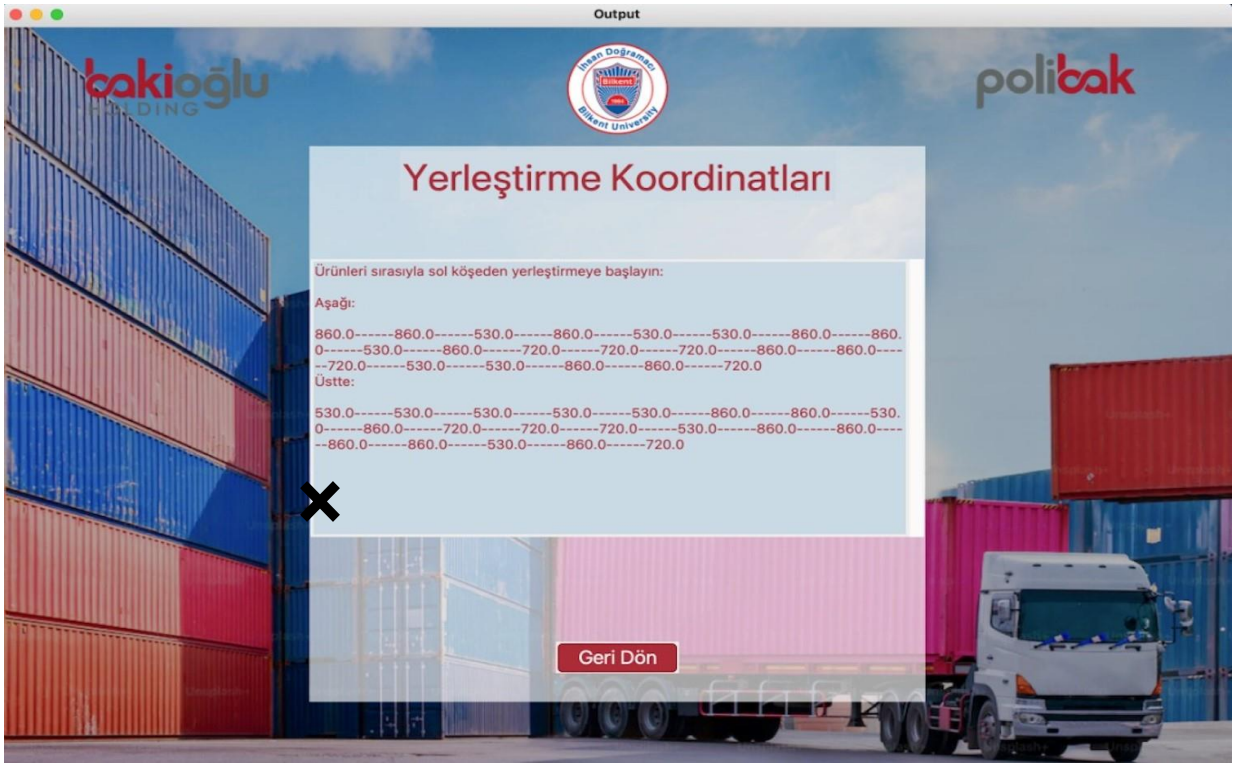

Figure 13: Placement Coordinates Screen

3.3 Two- and Three-Dimensional Output Graphs

Refer to the guides below to interpret 3D and 2D outputs correctly:

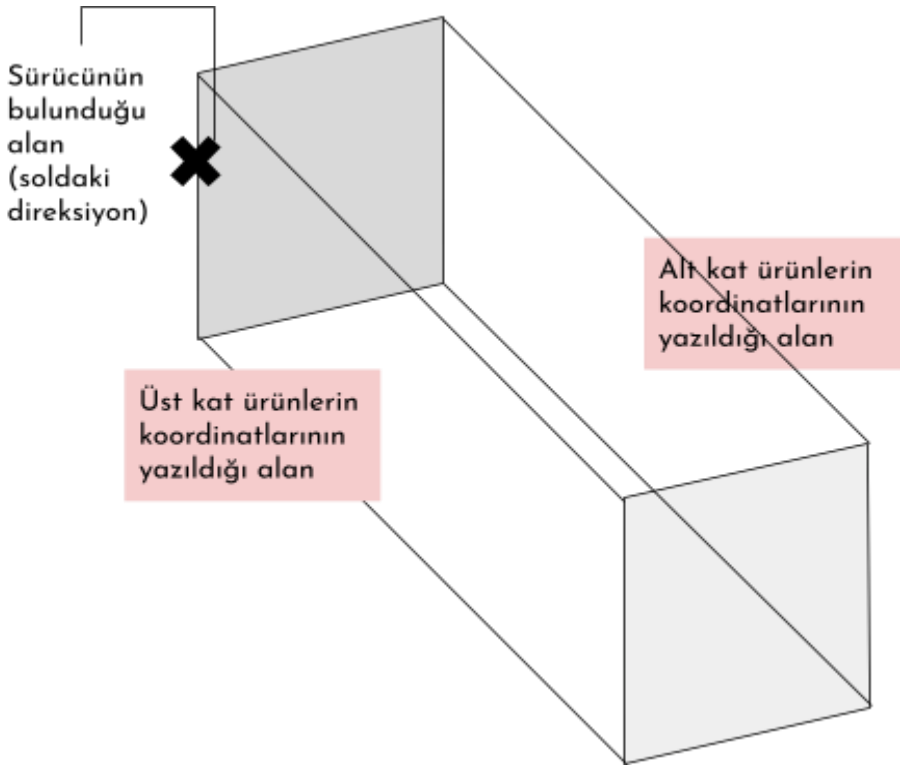

Figure 14: 3D Output Guide

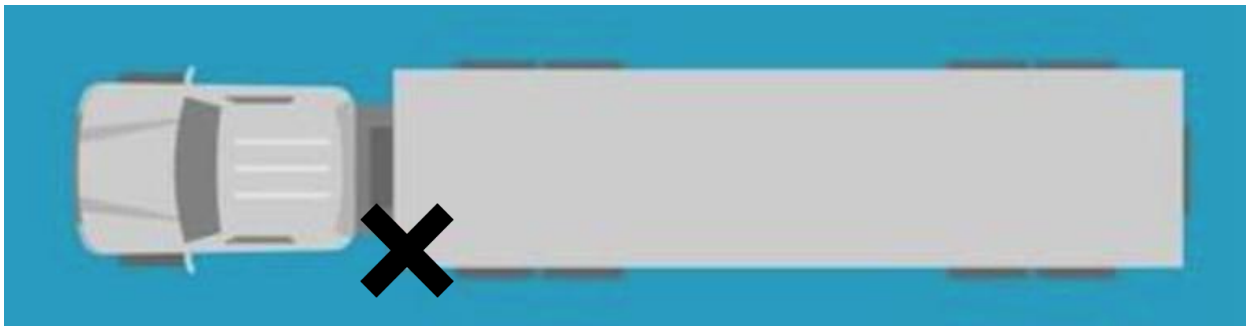

Figure 15: 2D Output Guide

The images highlight important sections:

- The black "x" marks the driver's seat.
- The coordinate system's origin (0,0,0) is the bottom-left-front corner of the vehicle.

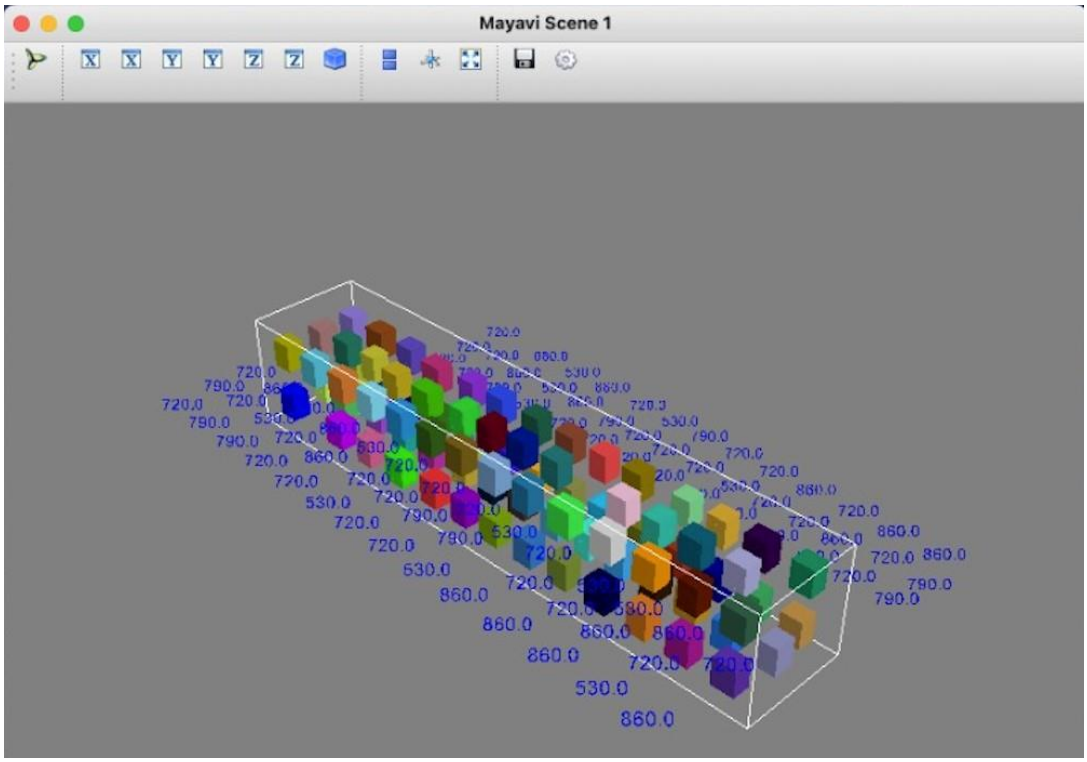

Figure 16: 3D Output

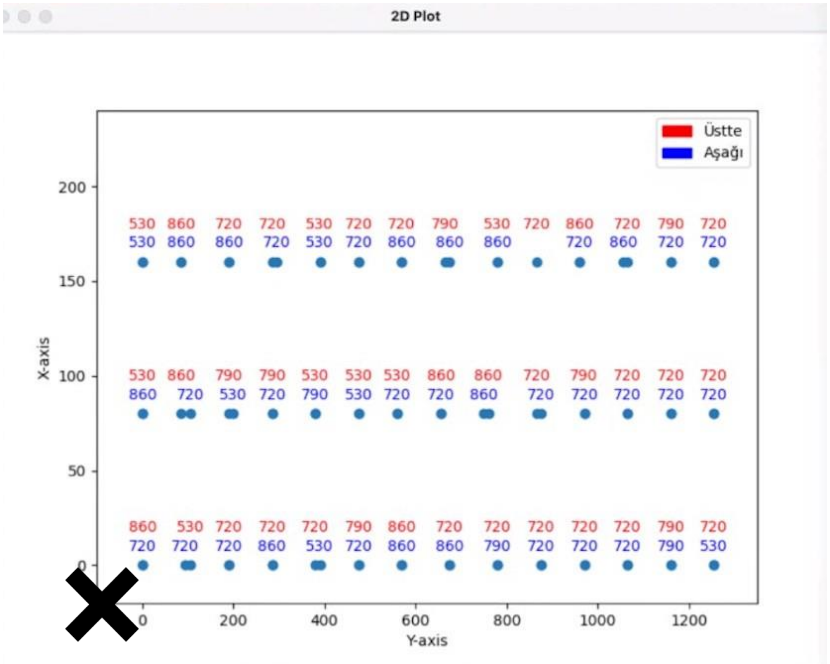

Figure 17: 2D Output