



40.015 SIMULATION MODELLING AND ANALYSIS  
PROJECT

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# NUNO'S VINO

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Group 2

# Project Nuno's Vino



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# Motivation

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Our motivation is to develop a winery simulation model enabling users to optimize their in-game setups to enhance profitability without the need for time-consuming trial-and-error approaches, which could span years.



# Goal of Simulation

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**MAXIMISE PROFITS!**

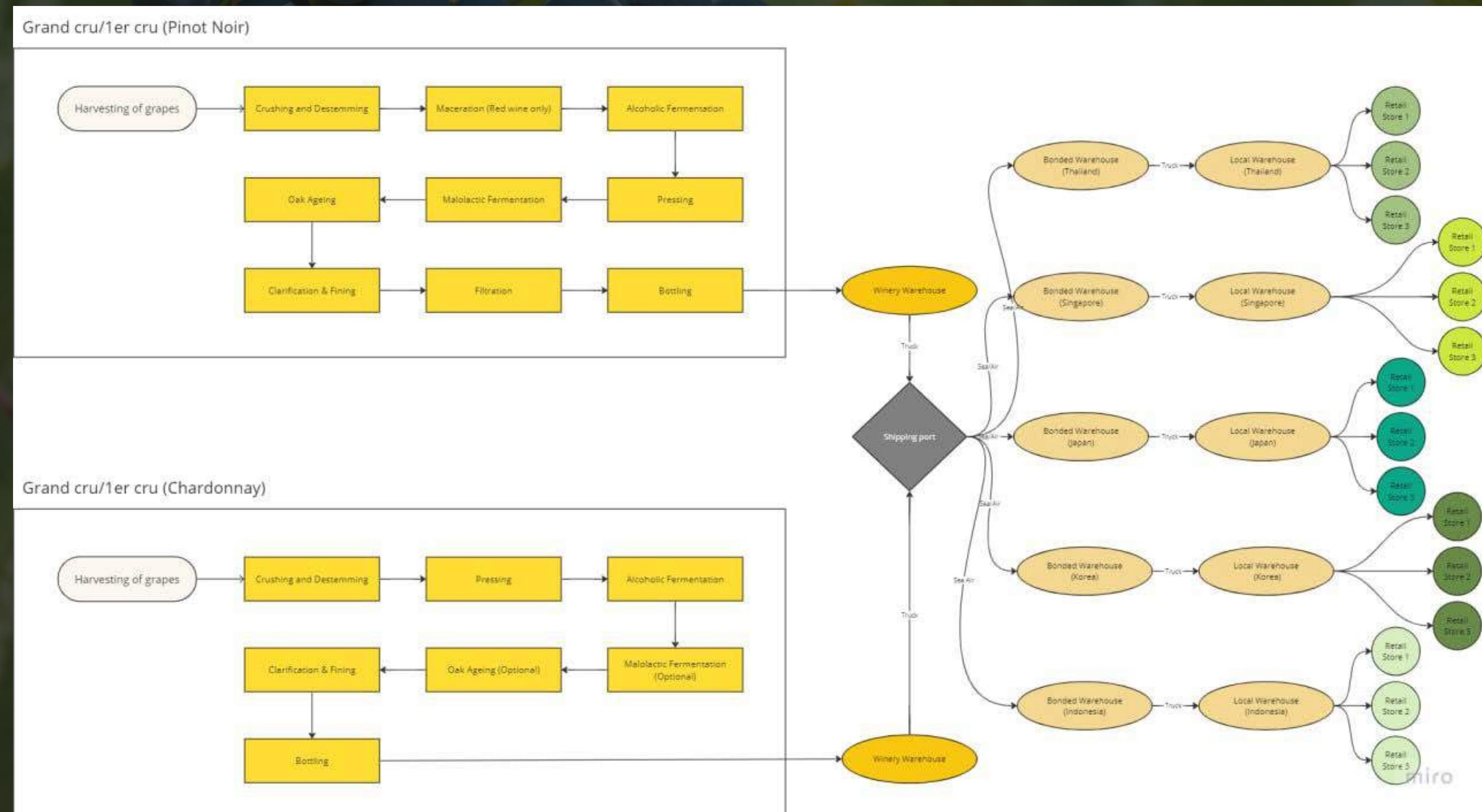
Produce and sell wines to 5 different countries

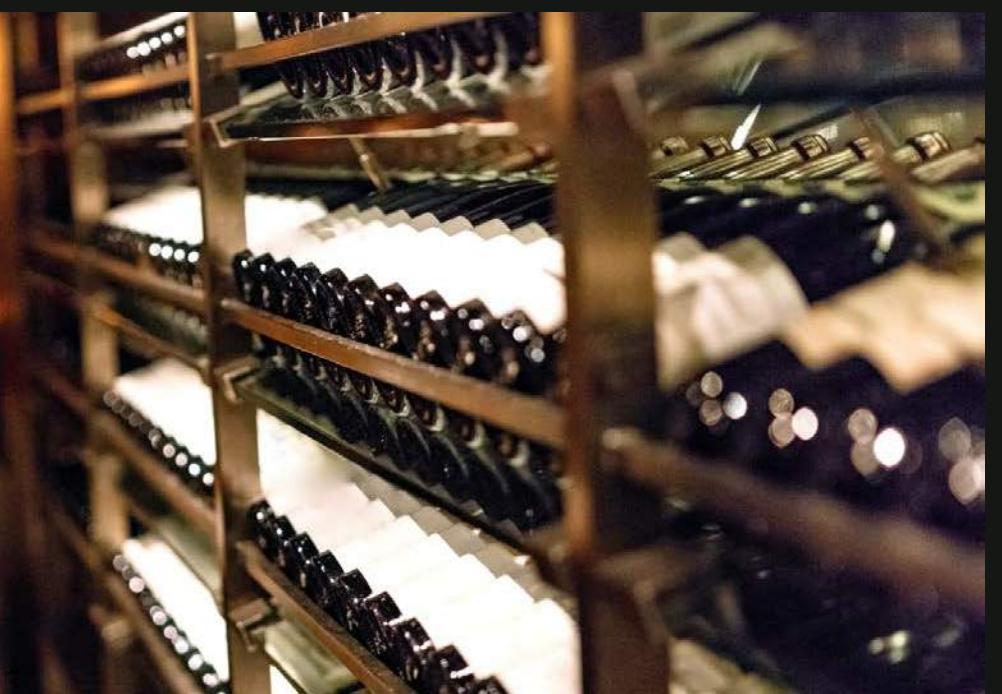
**SATISFY CONSUMER DEMAND**

# Basic Supply Chain Flow

## MAIN STAGES

- Grape Harvesting
- Production
- Distribution





# Inputs to Model

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Grapes arrive at the factory in batches where we specify:

1 batch of Char1er grapes  = 162000 bottles

1 batch of PN1er grapes  = 162000 bottles

1 batch of CharGC grapes  = 70000 bottles

1 batch of PN1er grapes  = 70000 bottles

1 oak barrel = 200 wine bottles

1 wine tank = 30 000 wine bottles

# Types of Wines We Produce

## CHARDONNAY

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- Chardonnay 1er Cru (Chardonnay1er): cheaper white wine
- Chardonnay Grand Cru (ChardonnayGC): expensive white wine

## PINOT NOIR

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- Pinot Noir 1er Cru (PinotNoir1er): cheaper red wine
- Pinot Noir Grand Cru (PinotNoirGC): expensive red wine

# *Overview on Simulations*

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We conducted 2 simulations for comparison and analysis on which one would be more profitable to our winery:

## Simulation 1

- The first simulation will focus on the winery's production of just cheap wine
- Comparison of profits between constant and linear demand

## Simulation 2

- The second simulation will consider production of both cheap(70%) and premium(30%) wines in the winery
- Comparison of profits between constant and linear demand

Given that JaamSim has a limit of only being able to run for 365 days, we adopt a ratio of **1 JaamSim day equating to 1 month in real time** for the simulation model. This approach enables us to analyze multiple years of simulation, especially crucial for examining wine production due to its lengthy timeframe.

# *Overview on Simulation*

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- Our simulation focuses on the production of both cheap(70%) and premium(30%) wines in the winery
- Comparison of profits between constant and linear demand
- Given that JaamSim has a limit of only being able to run for 365 days, we adopt a ratio of 1 JaamSim day equating to 1 month in real time for the simulation model. This approach enables us to analyze multiple years of simulation, especially crucial for examining wine production due to its lengthy timeframe.



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# JaamSim Model

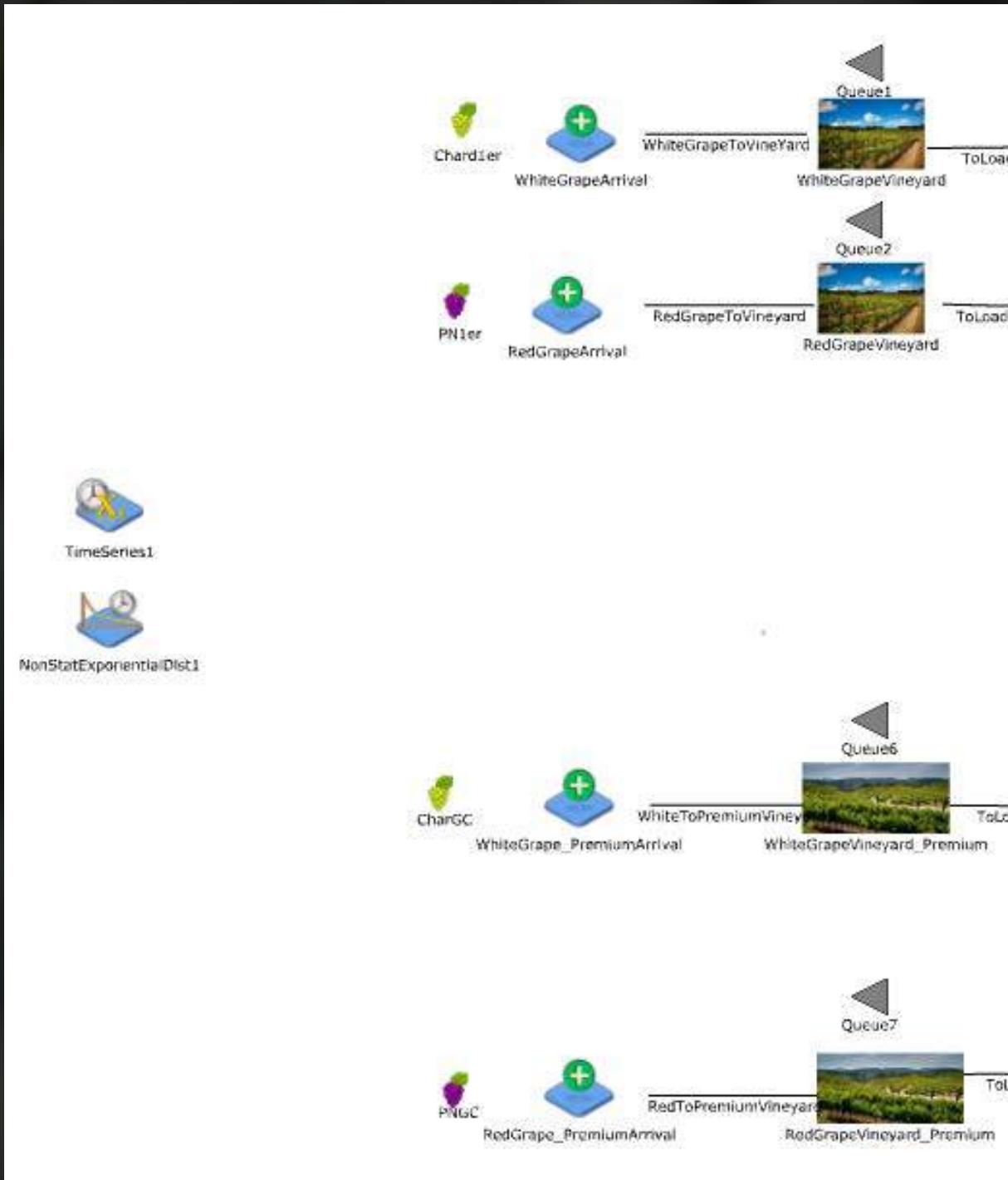
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**THE FOLLOWING SLIDES ARE EXPLANATIONS FOR OUR JAAMSIM SIMULATION 2**

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**THE JAAMSIM MODEL FOR SIMULATION 1 IS DONE THE SAME WAY BUT  
WITHOUT THE EXTRA PROCEDURE FOR EXPENSIVE WINE**

# Grape Harvesting



- Red and White Grapes are received according to a Time Series and NonStatExponential Distribution, with each new batch arriving in September.
- Following their arrival, the grapes are retained at the vineyard for a service time of 30 days, until October when they reach peak ripeness.
- This practice aligns with research indicating that winemakers typically harvest grapes in September to achieve optimal flavor.
- The first 2 grape types are used for the production of cheap wine while the second 2 grape types, comes from a more fertile land and is used for the production of more expensive wine

# Grape Harvesting

Input Builder

```
'' {} | this sub Sim null Entity  
  
{ 0 d 0 }  
{ 8 d 0 }  
{ 9 d 1 }  
{ 20 d 1 }  
{ 21 d 2 }  
{ 32 d 2 }  
{ 33 d 3 }  
{ 44 d 3 }  
{ 45 d 4 }  
{ 56 d 4 }  
{ 57 d 5 }  
{ 68 d 5 }  
{ 69 d 6 }  
{ 80 d 6 }  
{ 81 d 7 }  
{ 92 d 7 }  
{ 93 d 8 }  
{ 104 d 8 }  
{ 105 d 9 }  
{ 116 d 9 }  
{ 117 d 10 }  
{ 128 d 10 }  
{ 129 d 11 }  
{ 140 d 11 }  
{ 141 d 12 }  
{ 152 d 12 }
```

Input Editor - WhiteGrapeArrival

Key Inputs	Options	Thresholds	Maintenance	Format	Graphics
<b>Keyword</b>	<b>Default</b>	<b>Value</b>			
Description	<i>None</i>				
NextComponent	<i>None</i>	WhiteGrapeToVineYard			
FirstArrivalTime	0.0 h	9 d			
InterArrivalTime	2.777777777777777	NonStatExponentialDist1			
EntitiesPerArrival	1				
PrototypeEntity	<i>None</i>	Chard1er			
BaseName	<i>Generator Name</i>				
MaxNumber	<i>Infinity</i>				

Grape Arrival Inputs

Input Editor - WhiteGrapeVineyard

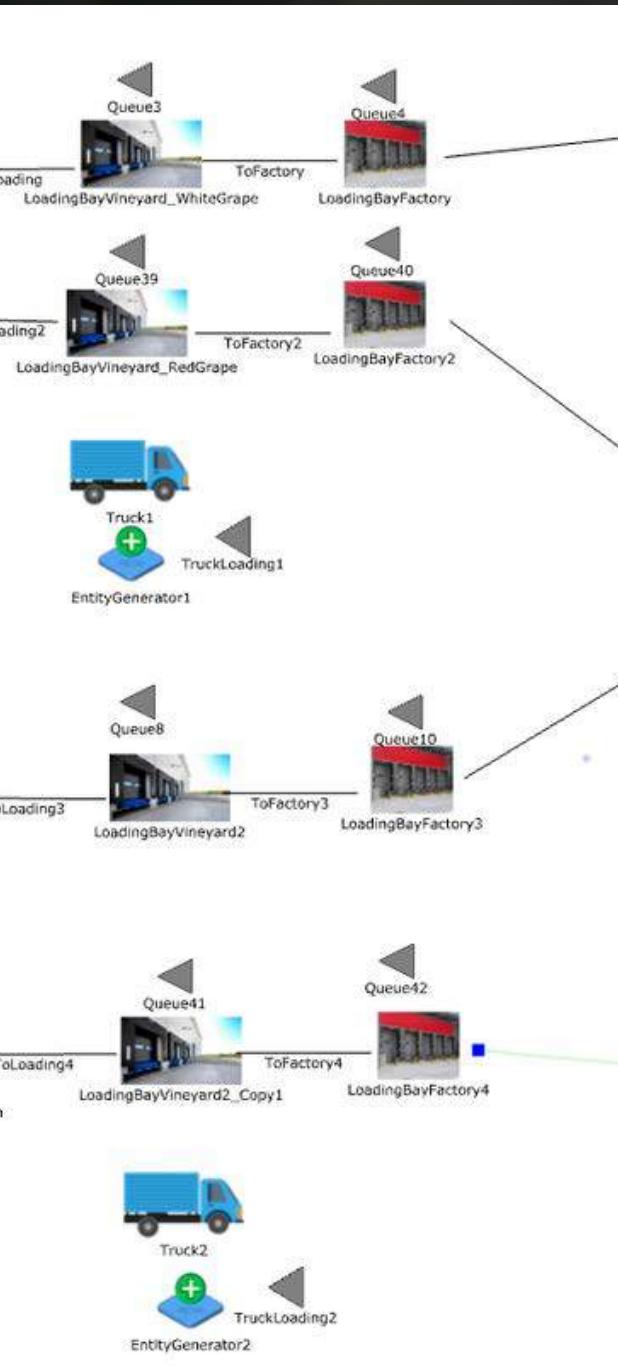
Key Inputs	Options	Thresholds	Maintenance	Format	Graphics
<b>Keyword</b>	<b>Default</b>	<b>Value</b>			
Description	<i>None</i>				
NextComponent	<i>None</i>	ToLoading			
WaitQueue	<i>None</i>	Queue1			
Match	<i>None</i>				
SelectionCondition	<i>None</i>				
NextEntity	<i>None</i>				
WatchList	<i>None</i>				
ServiceTime	0.0 h	1 d			

Vineyard Inputs

Snippet of Time Series  
Batch Arrivals

# Transport to Factory

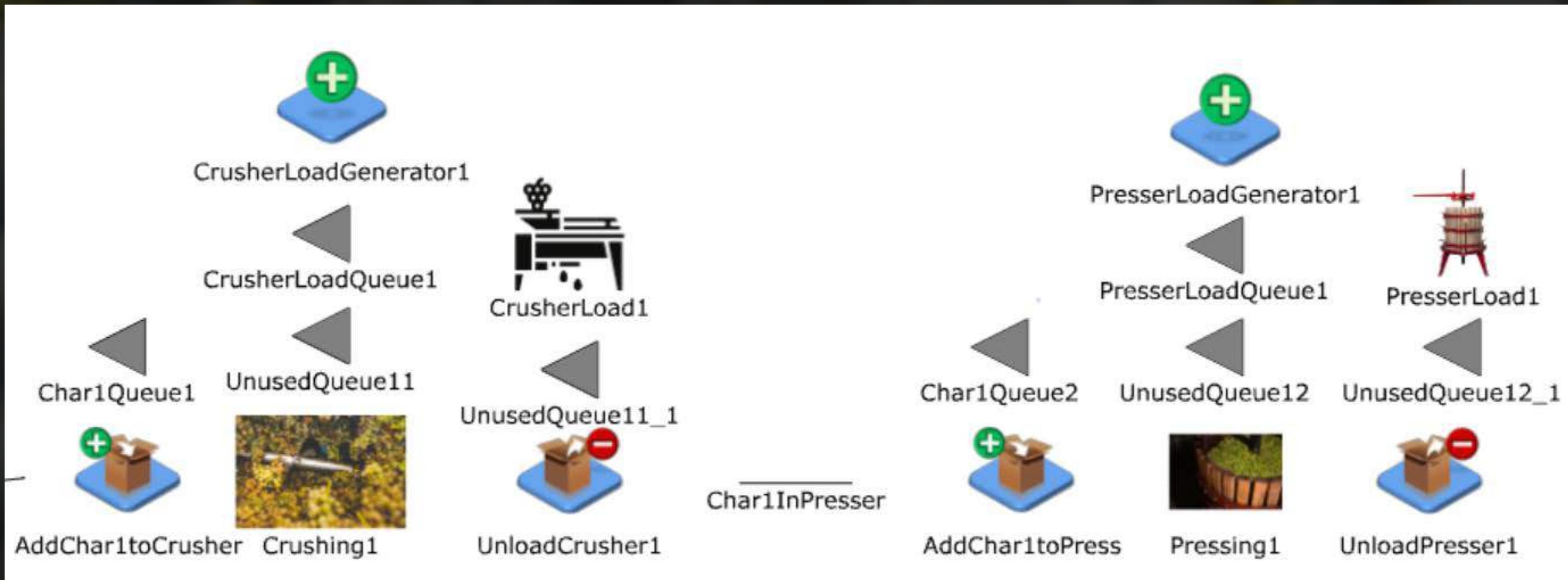
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- Trucks serve as containers capable of carrying up to 2 batches of grapes per truck per trip, from the Vineyard Loading Bay to the Factory Loading Facility.
- Upon arrival at the Factory Loading Bay, the grapes are offloaded from the trucks and continues to travel through separate Entity Conveyors for Red and White grapes(cheap and expensive), facilitating their respective factory processes.

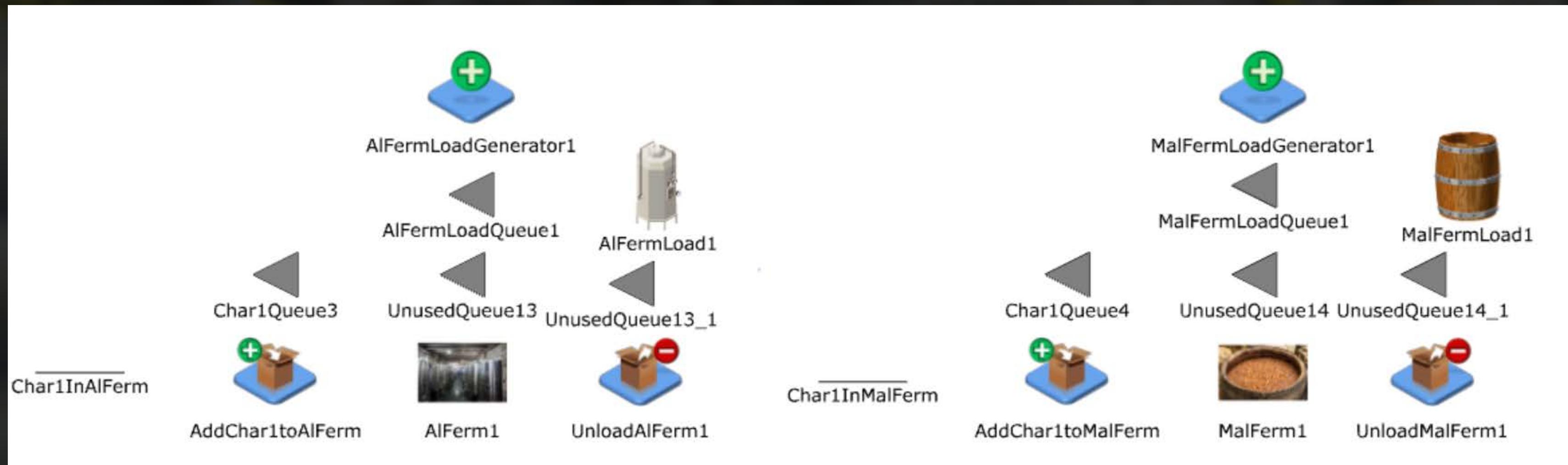
# Winemaking Process (White)

## Pre-Fermentation



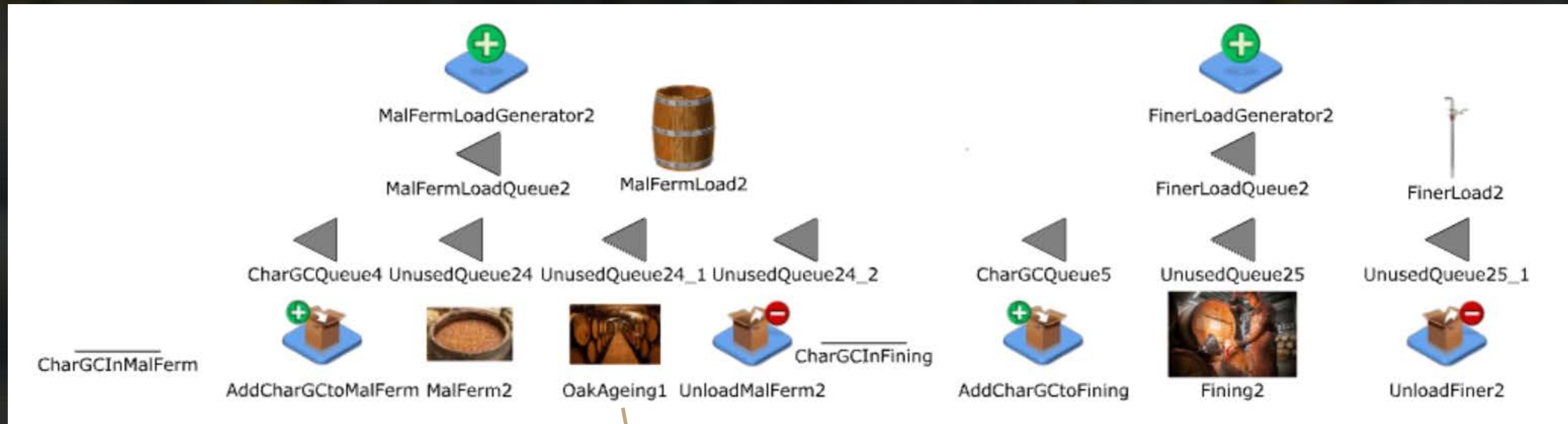
# Winemaking Process (White)

## During Fermentation (1er Cru)



# Winemaking Process (White)

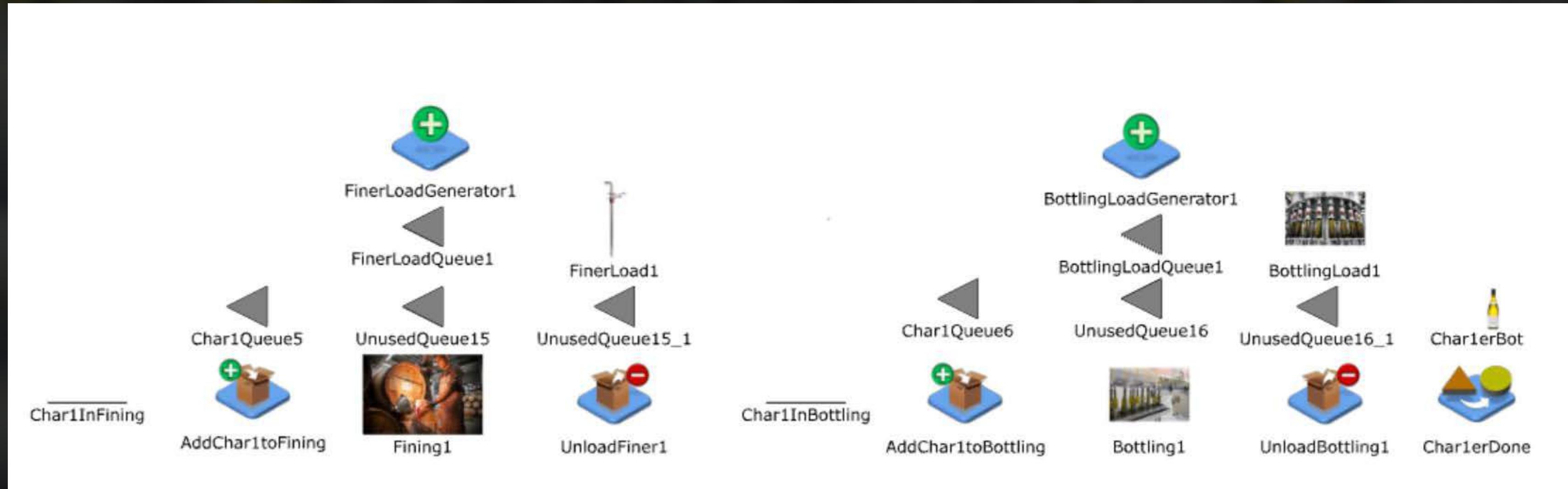
## During Fermentation (Grand Cru)



Additional Oak Ageing Process

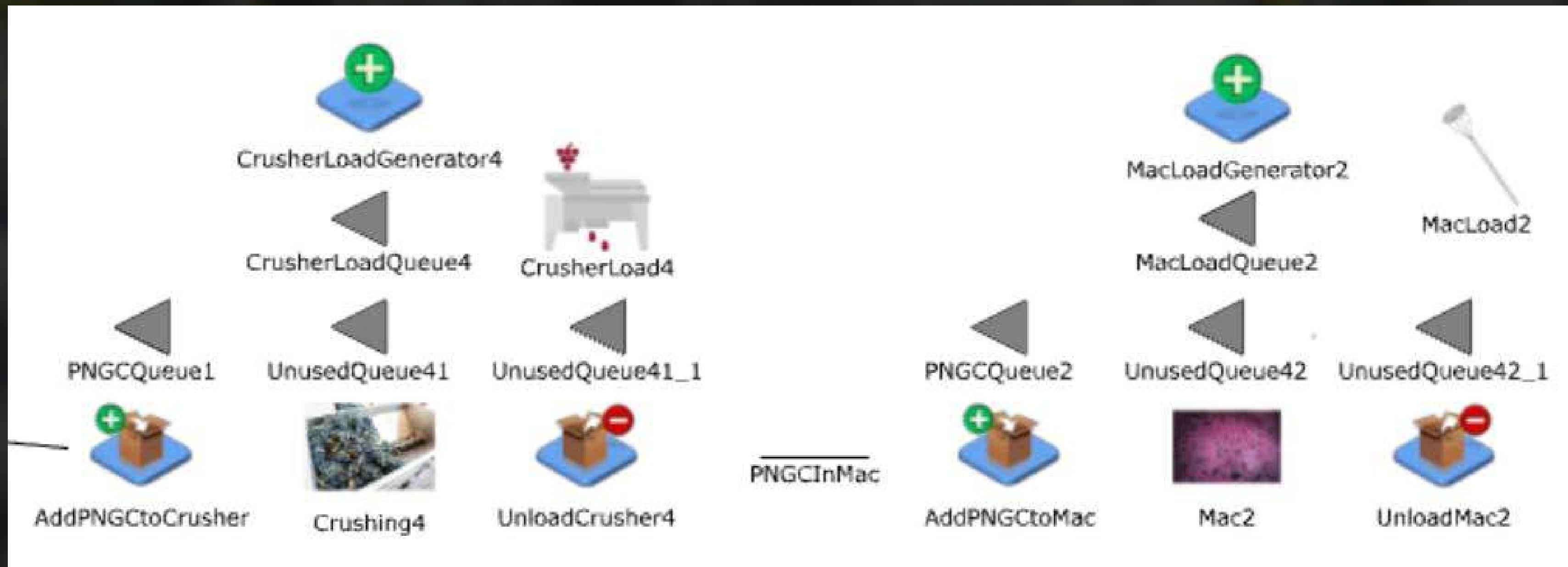
# Winemaking Process (White)

## Post-Fermentation



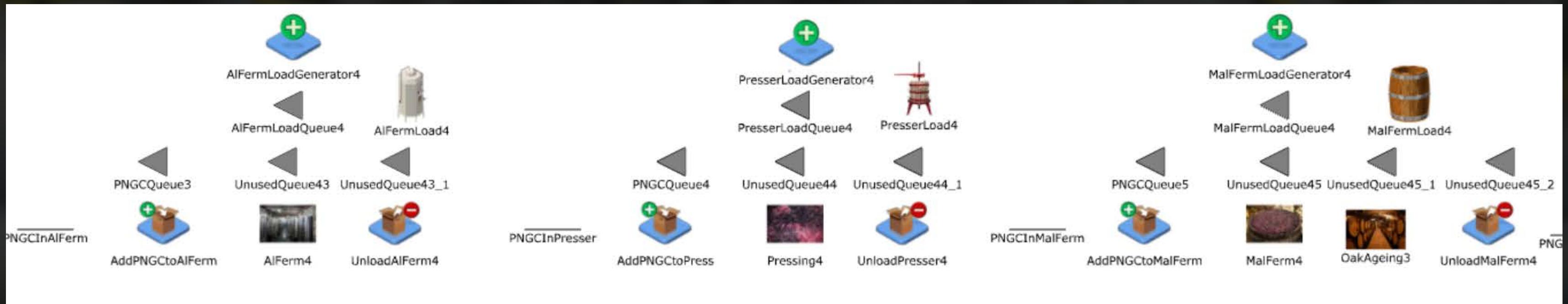
# Winemaking Process (Red)

## Pre-Fermentation



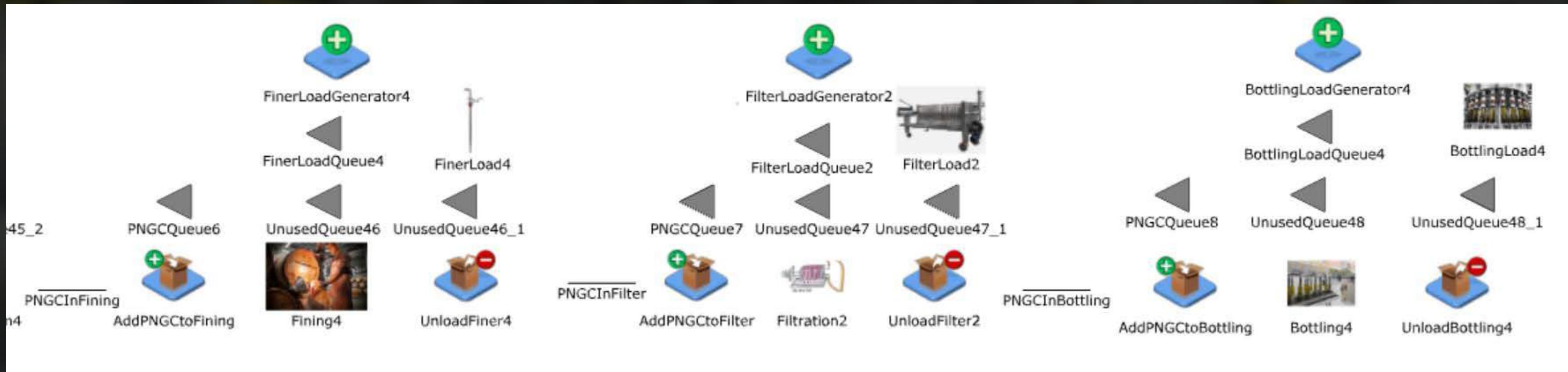
# Winemaking Process (Red)

## During Fermentation

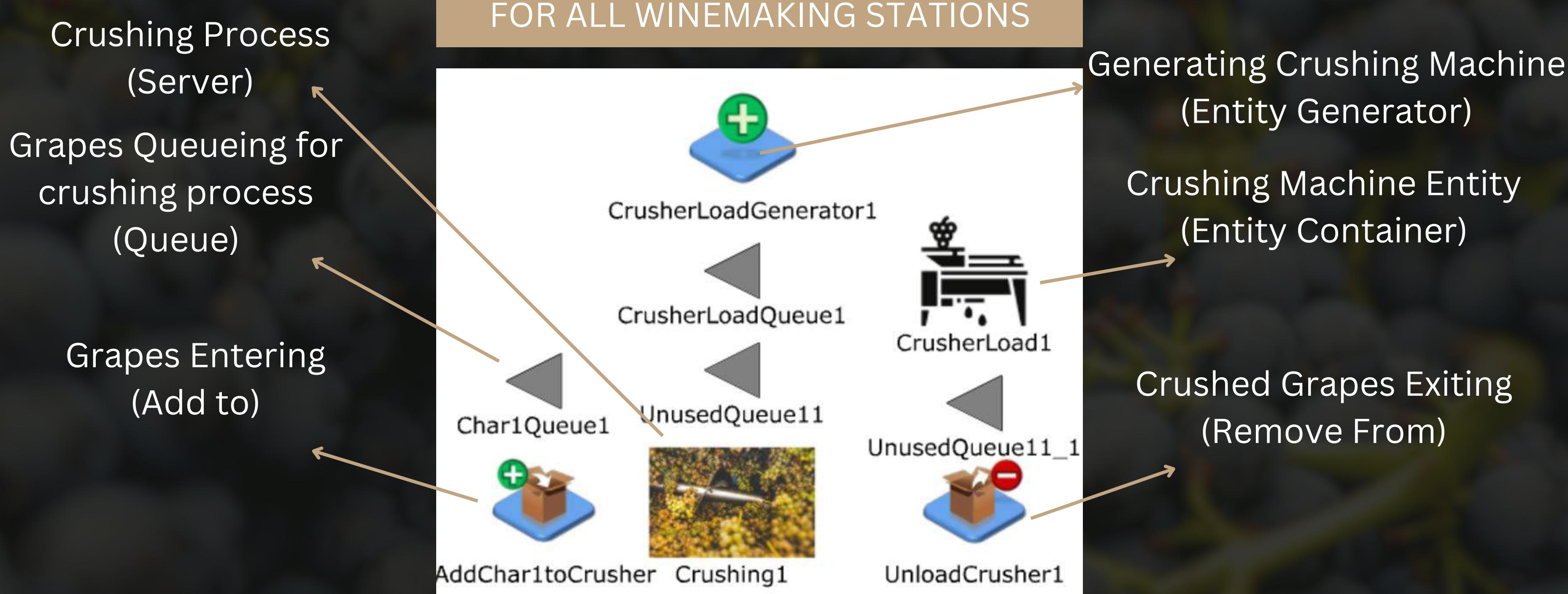


# Winemaking Process (Red)

## Post-Fermentation



# JaamSim Elements Example



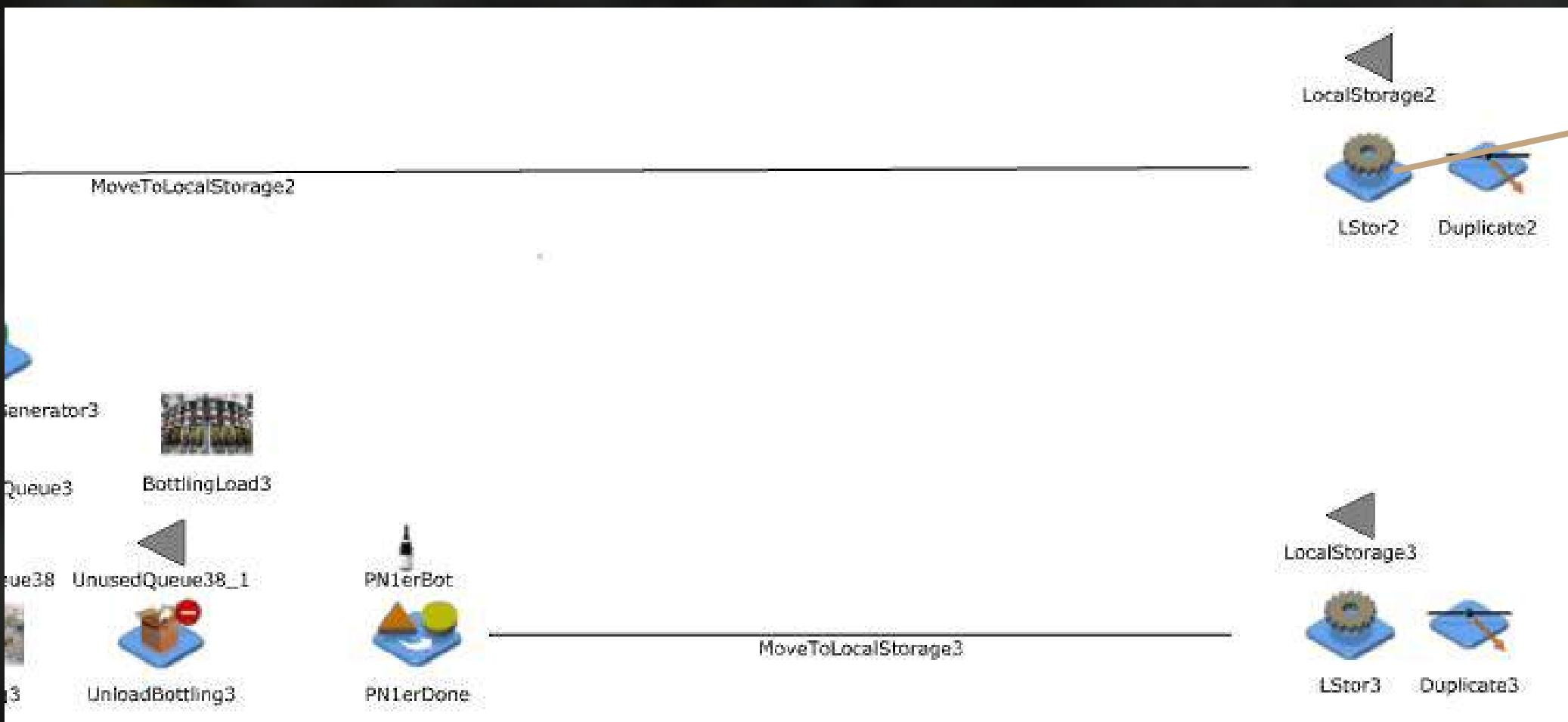
# Winemaking Service Times (Red)

Process	Service Time
Crushing and Destemming	3 hours
Maceration	4 weeks
Alcoholic Fermentation	2 weeks
Pressing	4 hours
Malolactic Fermentation	2 months
Oak Ageing	15 months (1er Cru) / 24 months (Grand Cru)
Clarification & Fining	5 days
Filtration	3 hours
Bottling	0.5 day
<b>Total Production Time</b>	<b>~ 18 - 27 months</b>

# Winemaking Service Times (White)

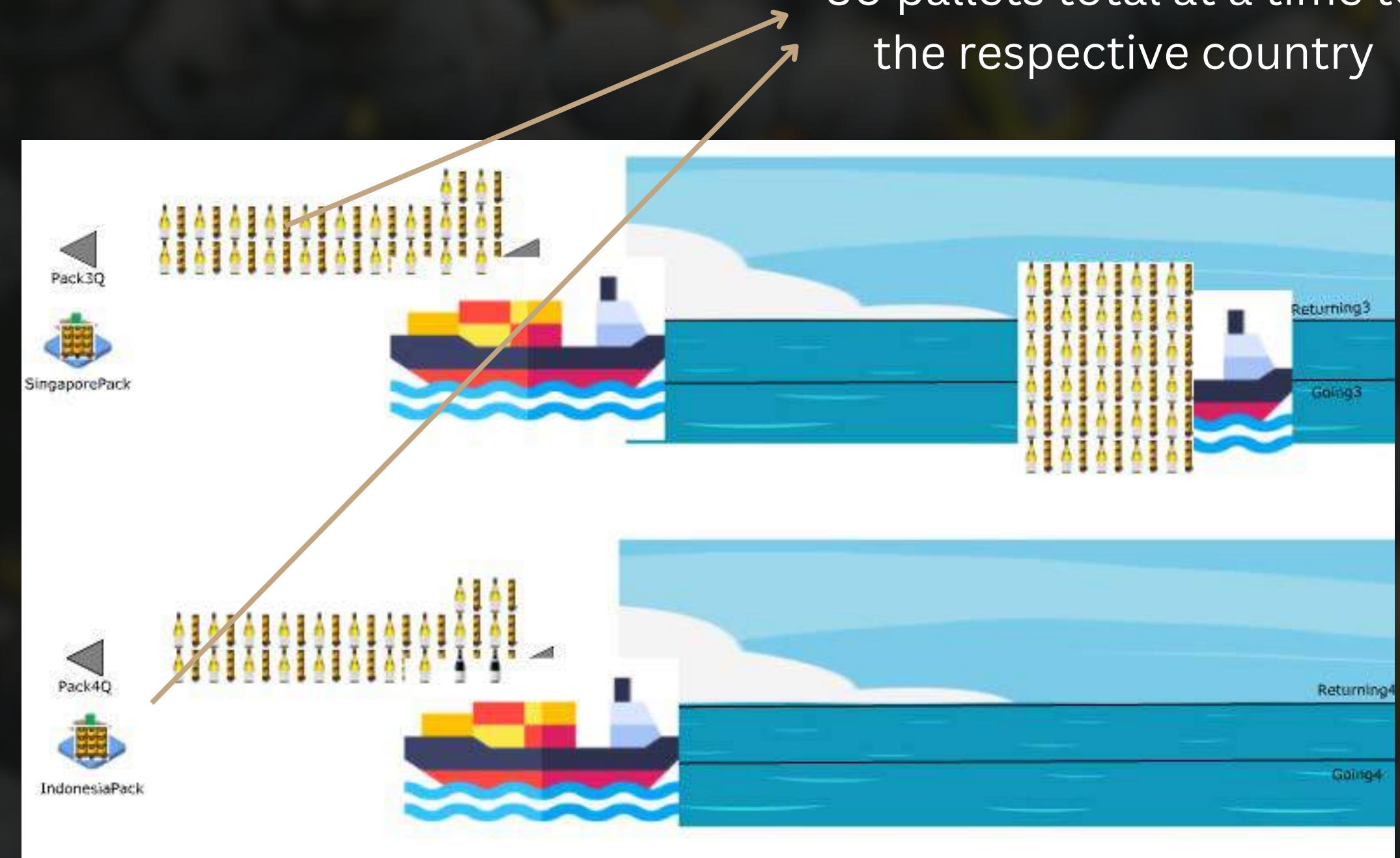
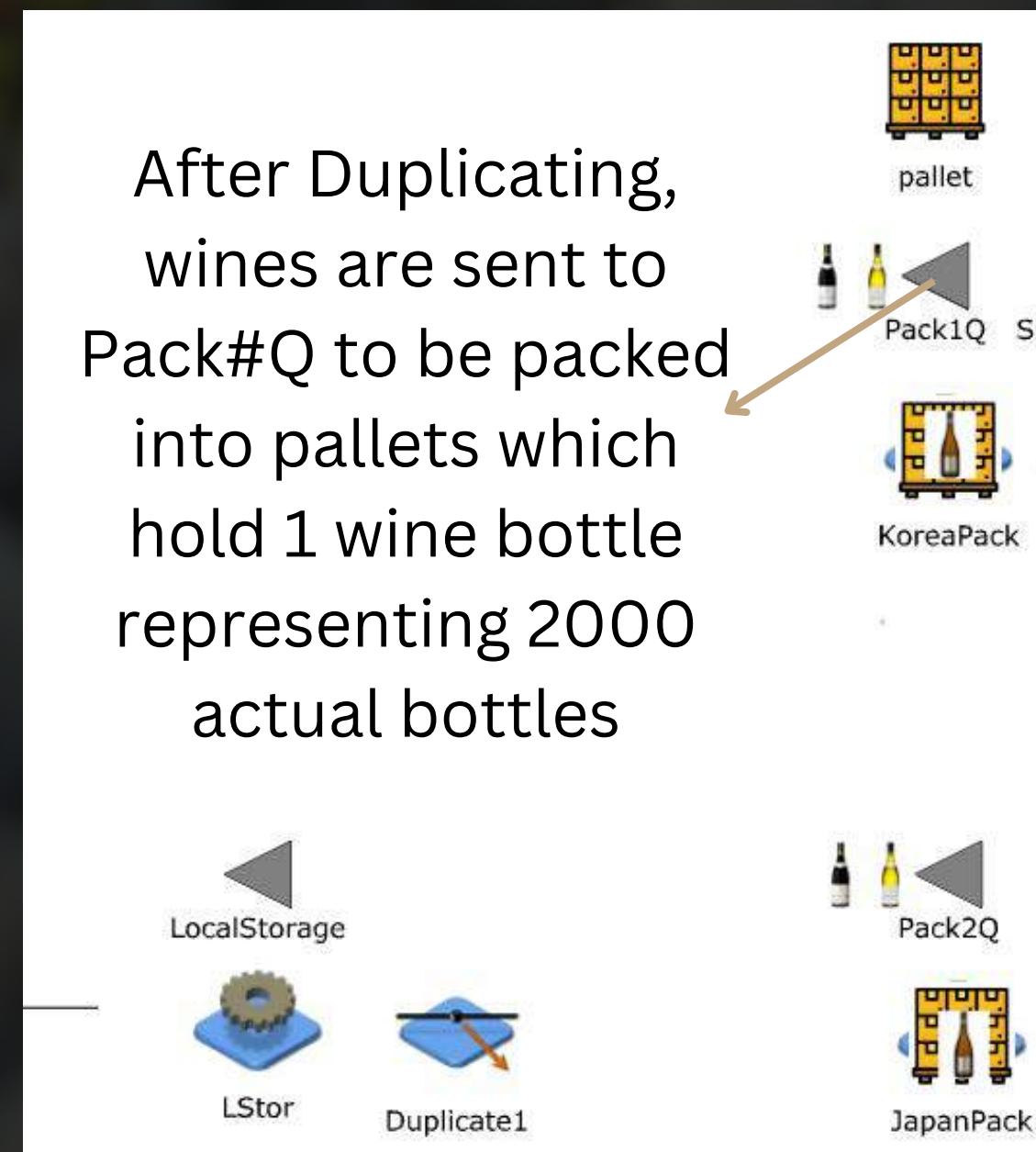
Process	Service Time
Crushing and Destemming	3 hours
Pressing	4 hours
Alcoholic Fermentation	2 weeks
Malolactic Fermentation	2 months
Oak Ageing	12 months (Grand Cru ONLY)
Clarification & Fining	5 days
Bottling	0.5 day
<b>Total Production Time</b>	<b>~ 3 - 15 months</b>

# Distribution



After Production,  
wines are sent to the  
Local Storage (Lstor)  
where they are  
duplicated (1 grape  
batch produces 5  
bottles = 1000L)

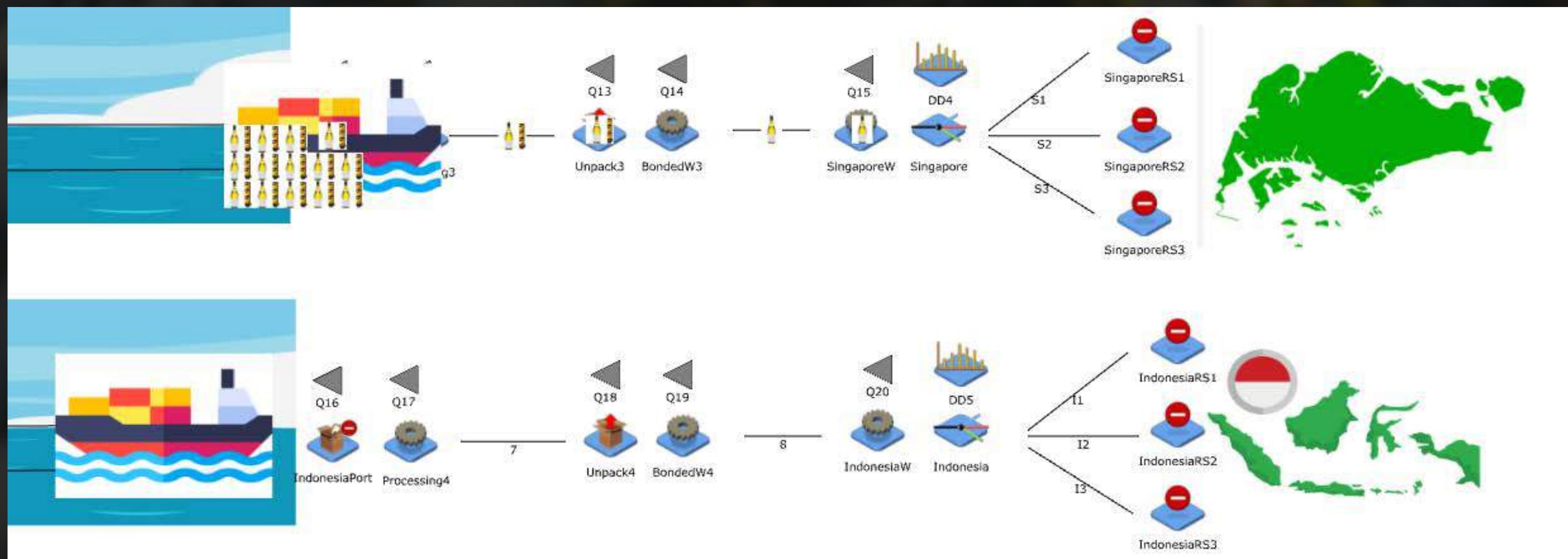
# Distribution



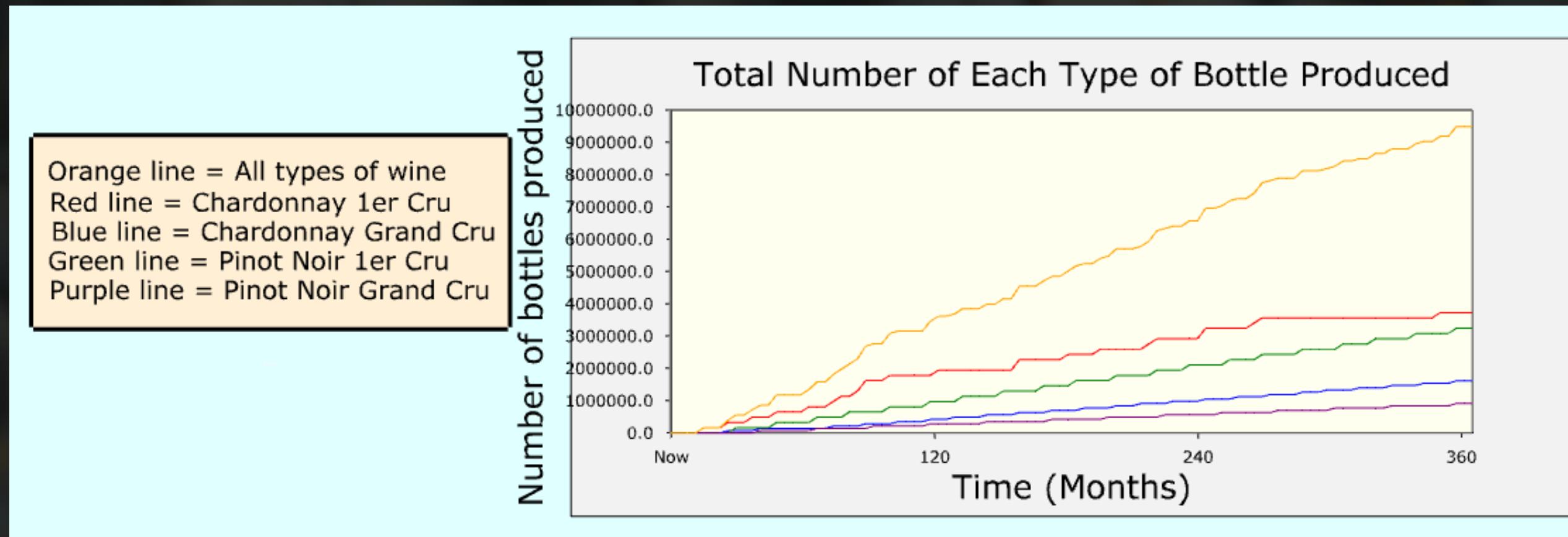
The pallet is then added to a cargo ship which transports 30 pallets total at a time to the respective country

# Distribution

Finally the ship lands at the destination country port and after unloading is sent back to the ShipQ  
The wines are then unpacked at the bonded warehouse, sent to the local warehouse and then for distribution into 3 major retail stores.

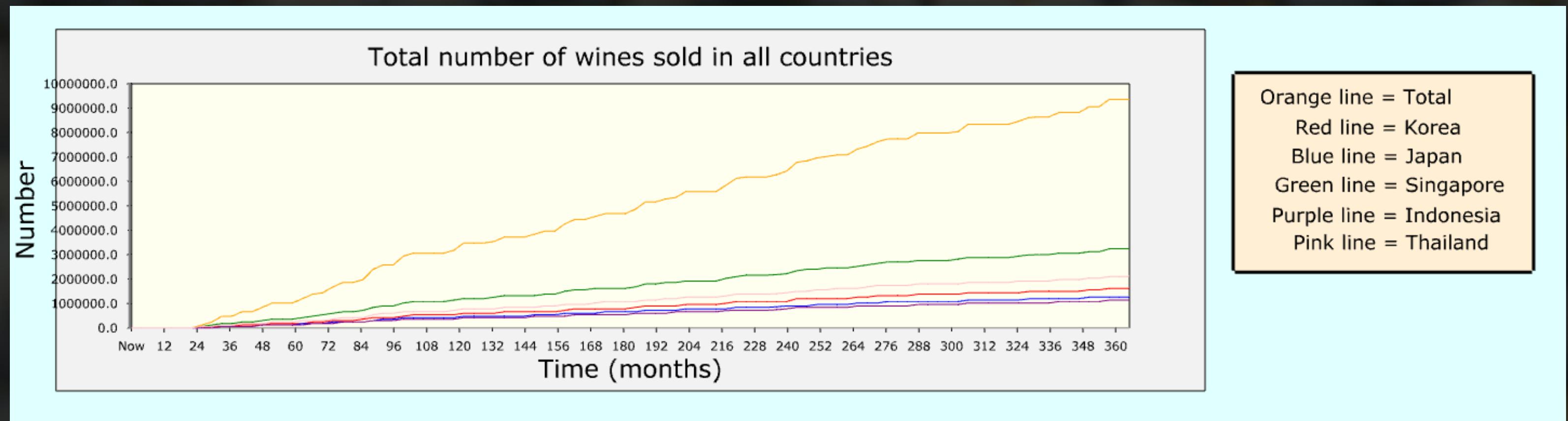


# Output Analysis



Production of Cheaper wines was greater than Premium wines as usually customers have a higher quantity of cheaper wines in their stores compared to premium wines.

# Output Analysis



Singapore had the highest demand for wines followed by Thailand, Korea, Japan and lastly Indonesia.

# Output Analysis



\*We assumed that other transport costs such as trucks are negligible.

After backtracking, we found we needed 2320 oak barrels and 18 Wine tanks to satisfy demand which cost 1500€ and 28000€ respectively for 1 unit.

Transport by ship is estimated to be 2.5€ per bottle.

**Profit = Revenue - Fixed Costs - Transport Costs**



A dark, atmospheric photograph of a wine cellar. The scene is filled with numerous large wooden barrels stacked in rows, their heads pointing towards the viewer. The lighting is low, creating deep shadows and highlighting the texture of the barrels. In the background, a person wearing a white apron and a hat is visible, though slightly out of focus, adding to the authenticity of the setting.

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# Analysis

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# Analysis 1: Constant Demand with Seasonal Fluctuations

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## BACKTRACKING PROCESS

- 2 Simulations for only cheap wine and for both cheap and expensive
- Determine the demand for each type of wine for each year:
  - Assuming that our winery is responsible for:
    - 1% of demand in Singapore
    - 0.1% of demand in Thailand
    - 0.01% of demand in Japan
    - 0.01% of demand in Korea
    - 0.1% of demand in Indonesia

# Analysis 1: Constant Demand with Seasonal Fluctuations

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## BACKTRACKING FLOW

- Given that the harvesting only starts in September 2024, we can say that the first batch of red wine will be ready is **March 2026** given the 18 months for production and 1 month until optimal ripeness
- Hence the demand that 1 batch of grapes need to statify = Sum of all wine demand from April 2026 to March 2027(when next batch can be produced)
- This will be the same for all other wine types (Chardonnay: Cheap and Expensive, Pinot Noir: Cheap and Expensive)

# Analysis 1: Constant Demand with Seasonal Fluctuations

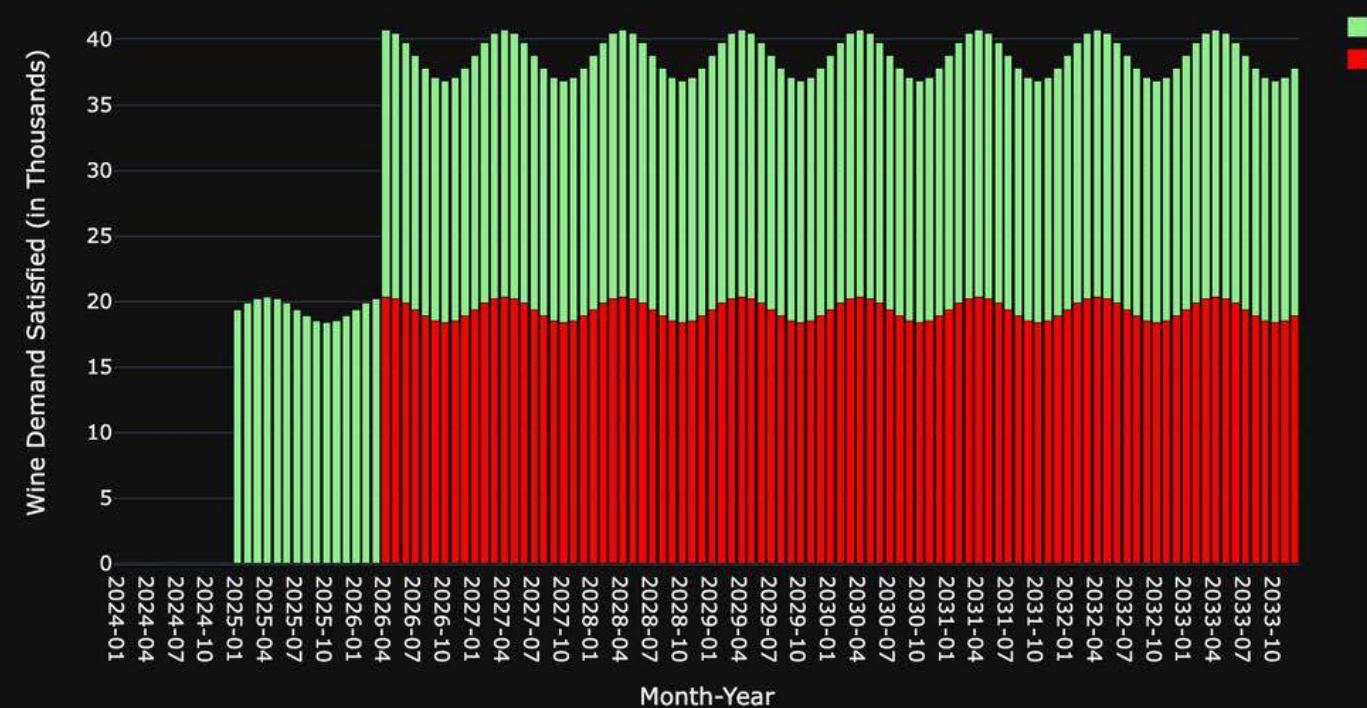
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## BACKTRACKING PROCESS

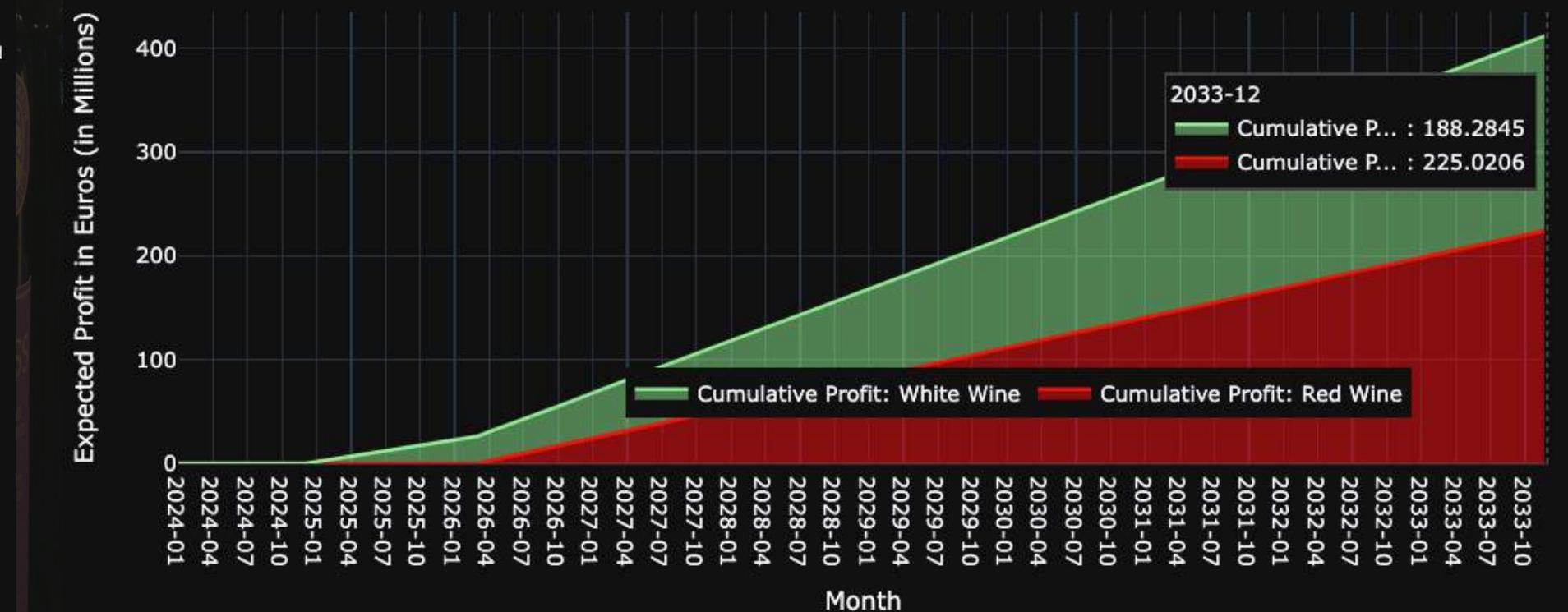
- Backtrack the number of oak barrels required to satisfy the projected demand
  - Only considering Cheap Wine with 1% demand
    - Pinot Noir: 1163
    - Chardonnay: 1163
  - Considering Cheap and Expensive wine with demand 0.7% and 0.3% respectively:
    - Cheap Pinot Noir: 814
    - Expensive Pinot Noir: 349
    - Cheap Chardonnay: 814
    - Expensive Chardonnay: 349
  - 581.5 Tonnes of Red and White Grapes are required to be harvested each year.

# Analysis 1: Constant Demand with Seasonal Fluctuations

CONSIDERING ONLY CHEAP WINES (SIMULATION 1):



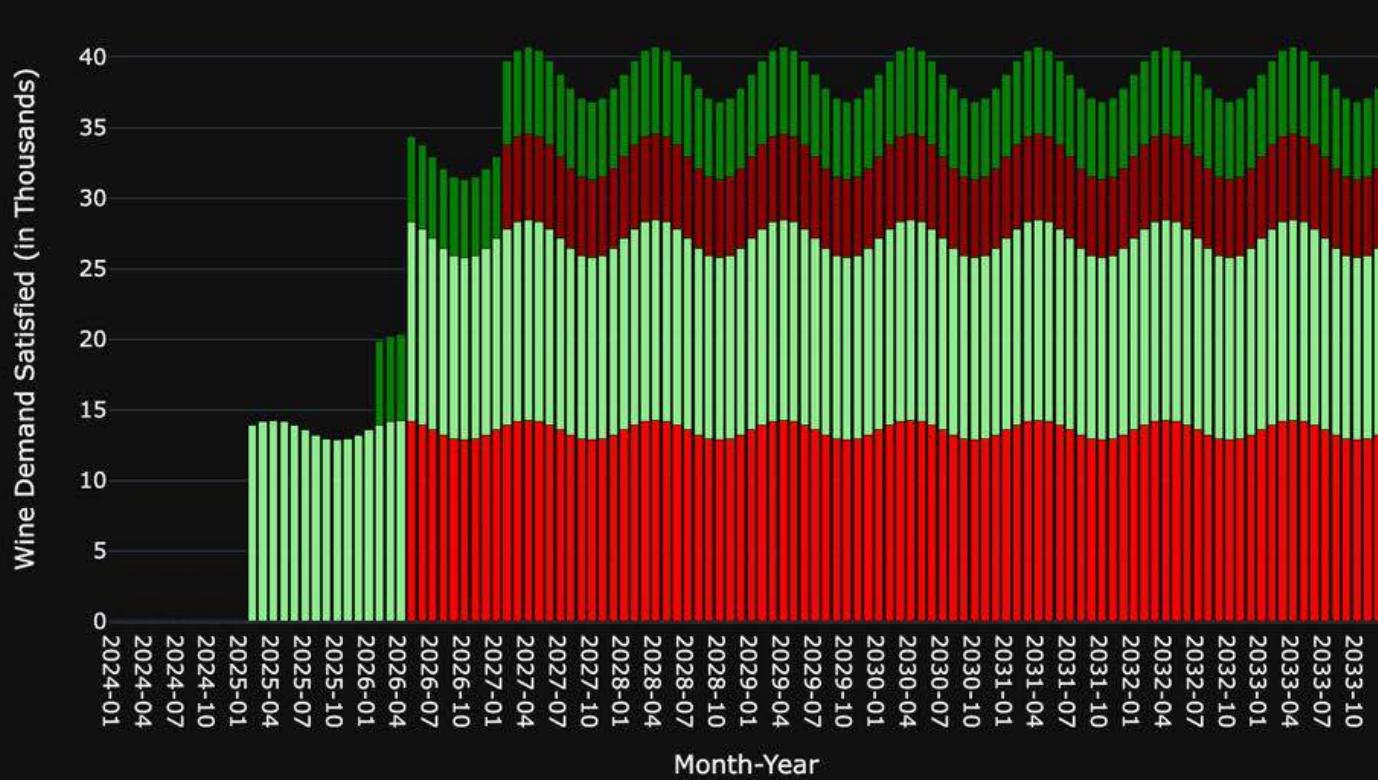
Wine Demand Satisfied



Expected Profits

# Analysis 1: Constant Demand with Seasonal Fluctuations

CONSIDERING BOTH CHEAP AND EXPENSIVE WINES  
(SIMULATION 2):



# Analysis 1: Constant Demand with Seasonal Fluctuations

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BY COMPARING BOTH SIMULATIONS WE CAN CONCLUDE THAT SIMULATION 2 IS ABLE TO GENERATE MORE PROFITS FOR THE WINERY

# Analysis 2: Linear Demand

- We wanted to do a second analysis on linear demand as it is more realistic
- 2 simulations will be done for this analysis as well to compare profitability when only cheap wine is produced with when both cheap and expensive is produced

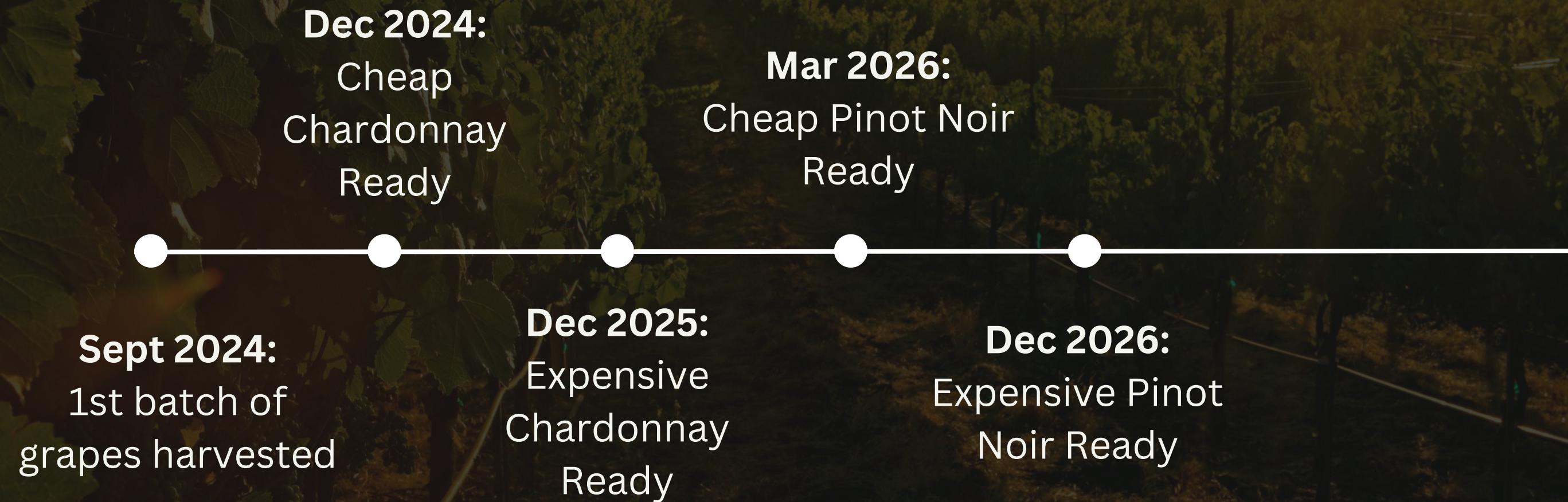


Source: <https://asiabeverage.group/singapore-wine-market-report/>

# Analysis 2: Linear Demand

## BACKTRACKING FLOW

- The flow is backtracked the same way as Analysis 1(explained in Slides 21 and 23)
- The production times for the 4 types of wine as illustrated below:



# Analysis 2: Linear Demand

## BACKTRACKING FLOW

- This analysis shows the number of oak barrels required increasing every year as shown in the following tables
- **Simulation 1**-only cheap wine(assuming we satisfy 1% of wine demand):



# Analysis 2: Linear Demand

## BACKTRACKING FLOW

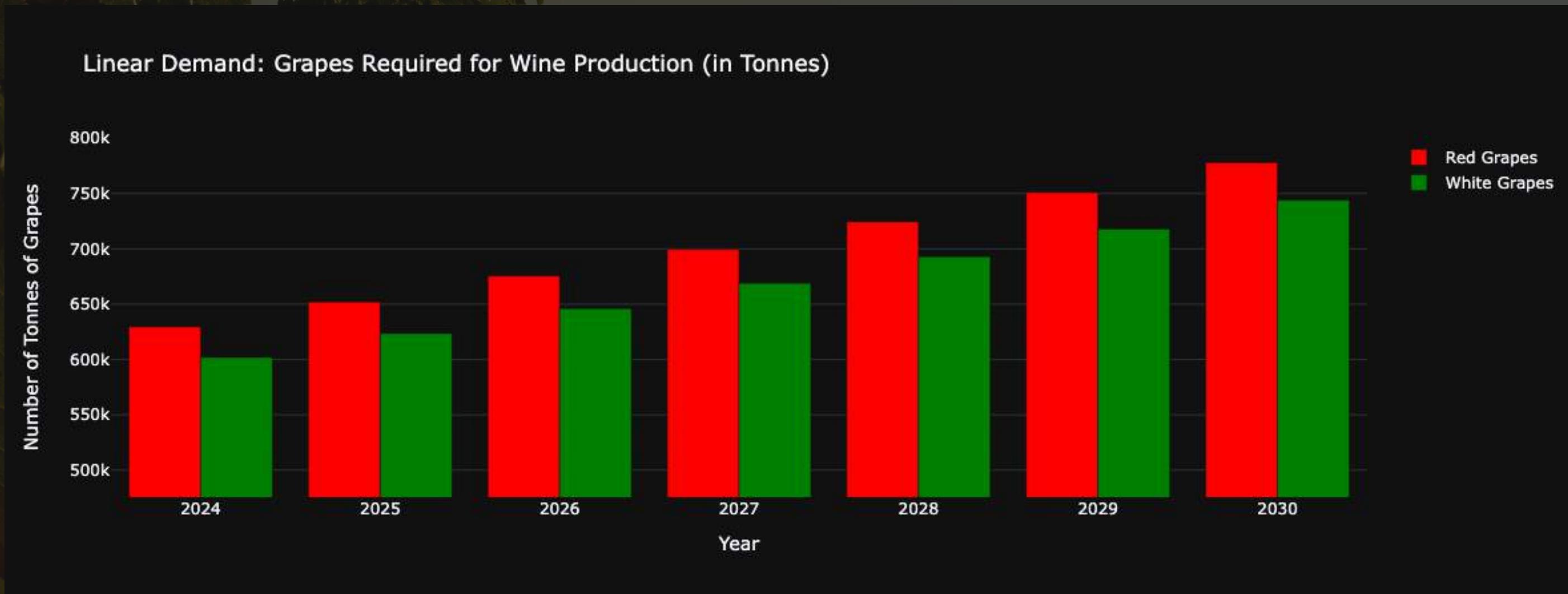
- **Simulation 2-** both cheap (assuming we satisfy 0.7% of wine demand) and expensive wines(0.3% of wine demand):



# Analysis 2: Linear Demand

## BACKTRACKING FLOW

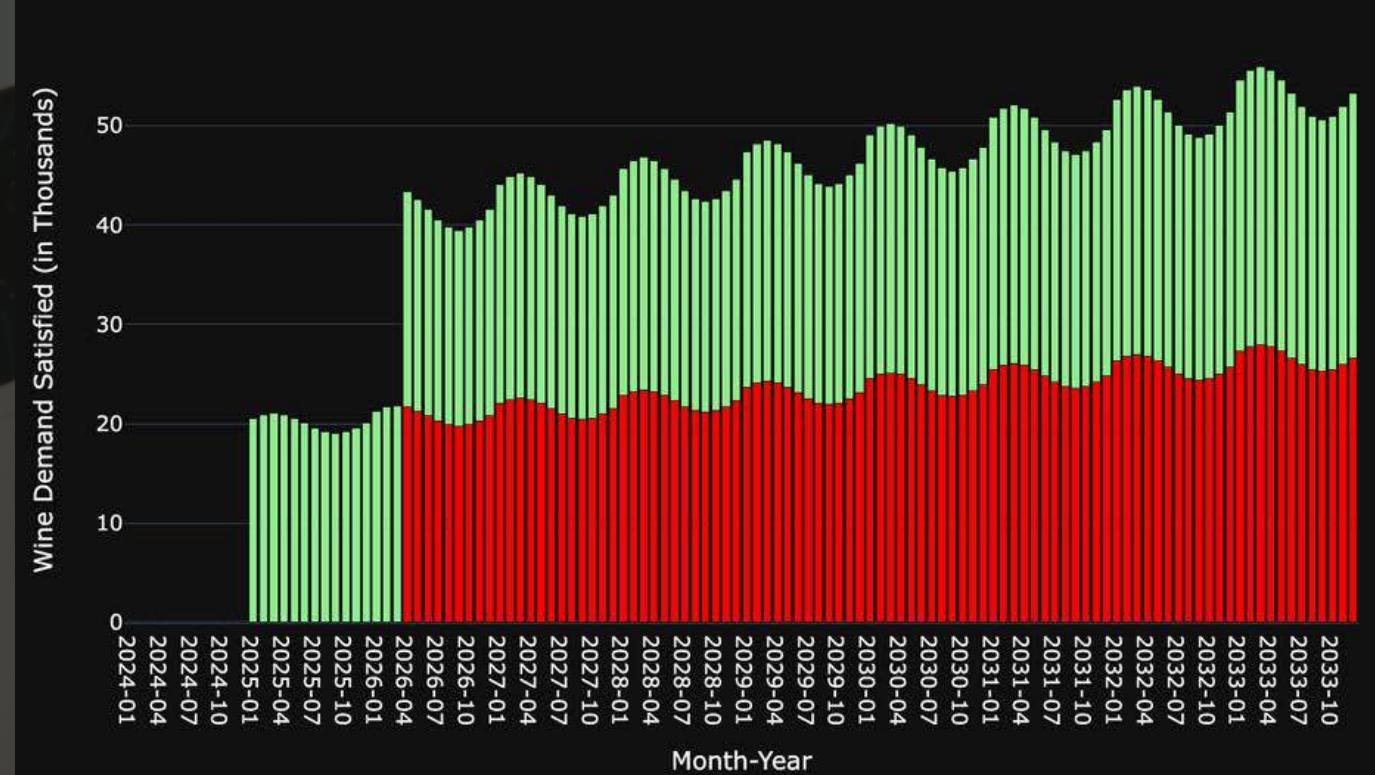
- Simulation-Grape Demand



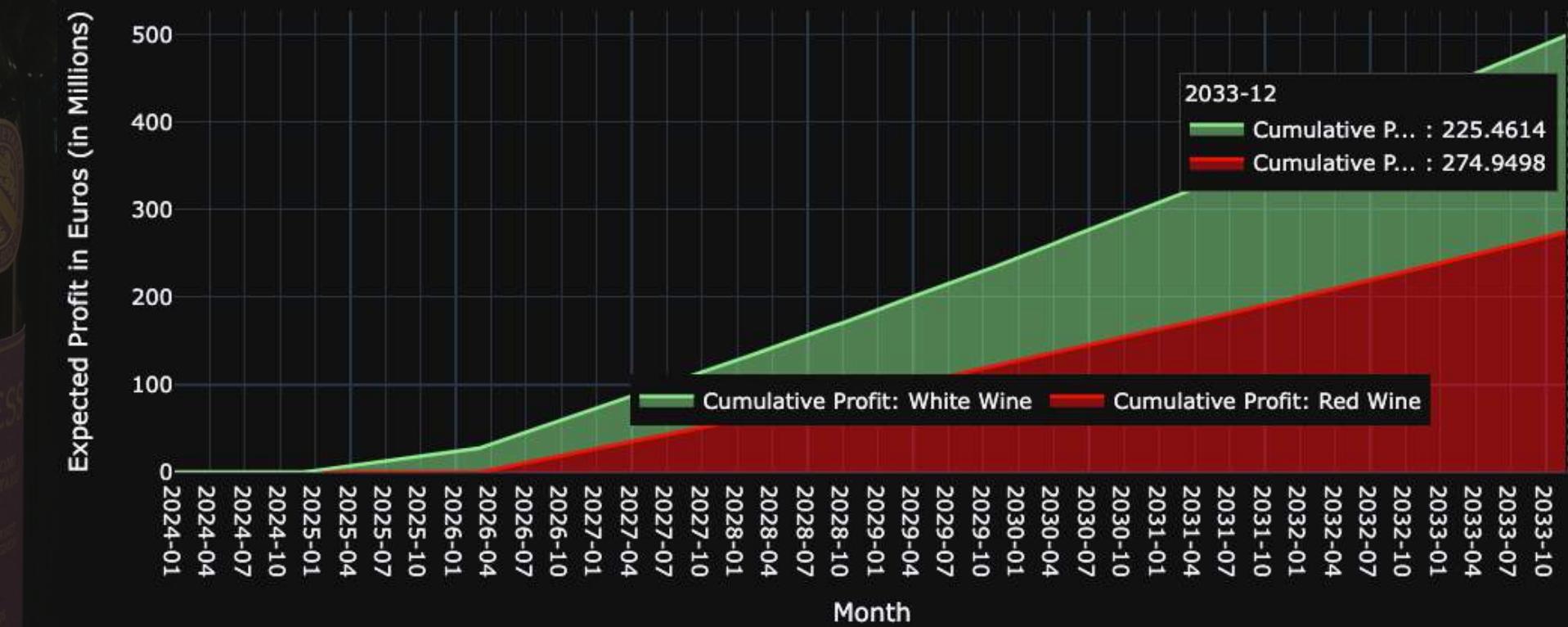
Notice how more red grapes need to be harvested than white grapes because it takes longer for Pinot Noir production compared to Chardonnay. Hence there is more Pinot Noir each batch than Chardonnay

# Analysis 2: Linear Demand

CONSIDERING ONLY CHEAP WINES (SIMULATION 1):



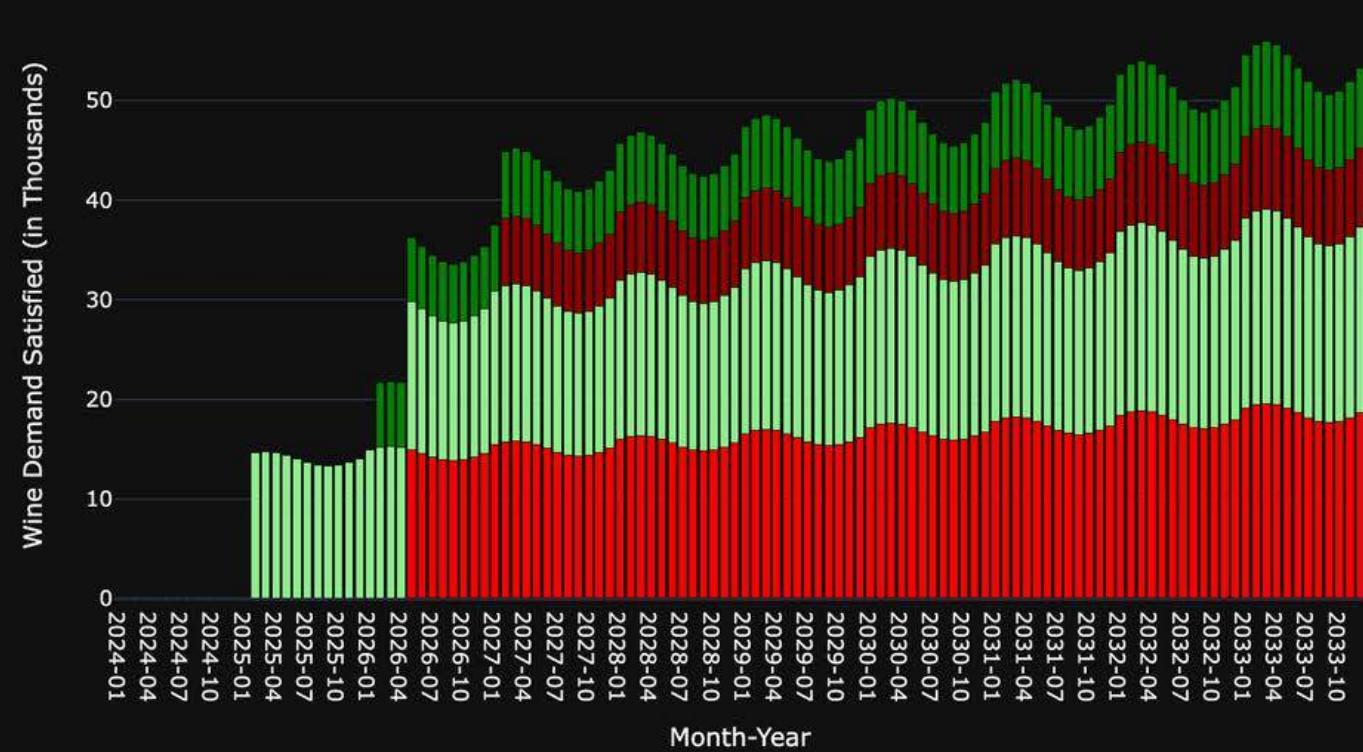
Wine Demand Satisfied



Expected Profits

# Analysis 2: Linear Demand

CONSIDERING BOTH CHEAP AND EXPENSIVE WINES  
(SIMULATION 2):



# Analysis 2: Linear Demand

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BY COMPARING BOTH SIMULATIONS WE CAN CONCLUDE THAT SIMILARLY TO ANALYSIS 1, SIMULATION 2 IS ABLE TO GENERATE MORE PROFITS FOR THE WINERY IN ANALYSIS 2 AS WELL

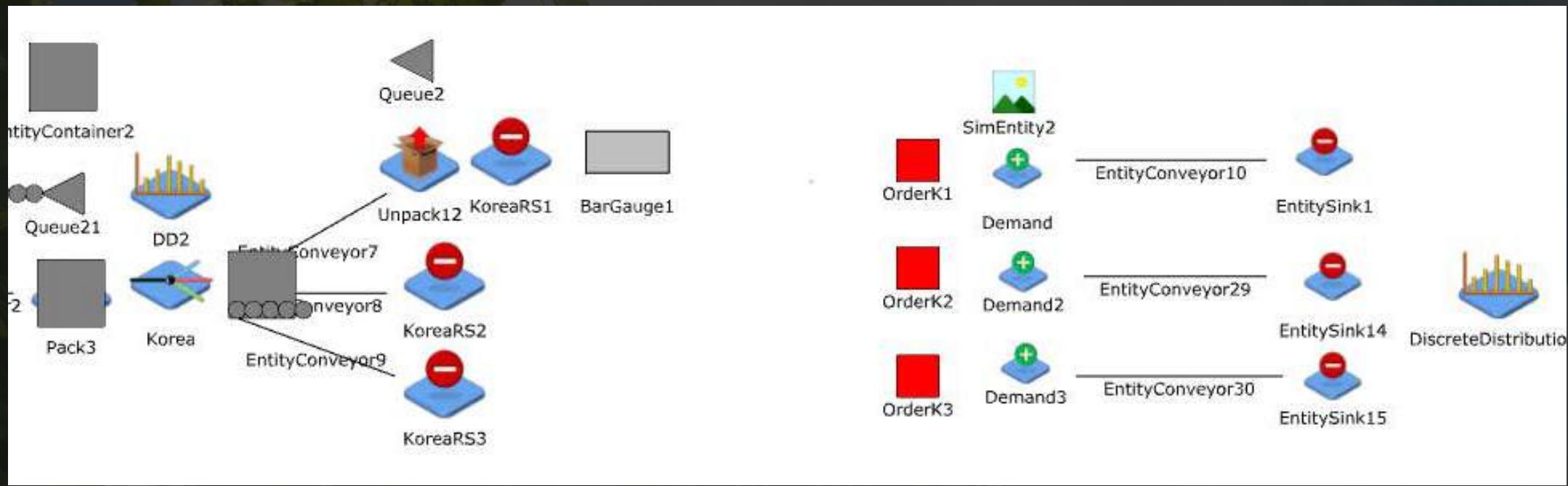


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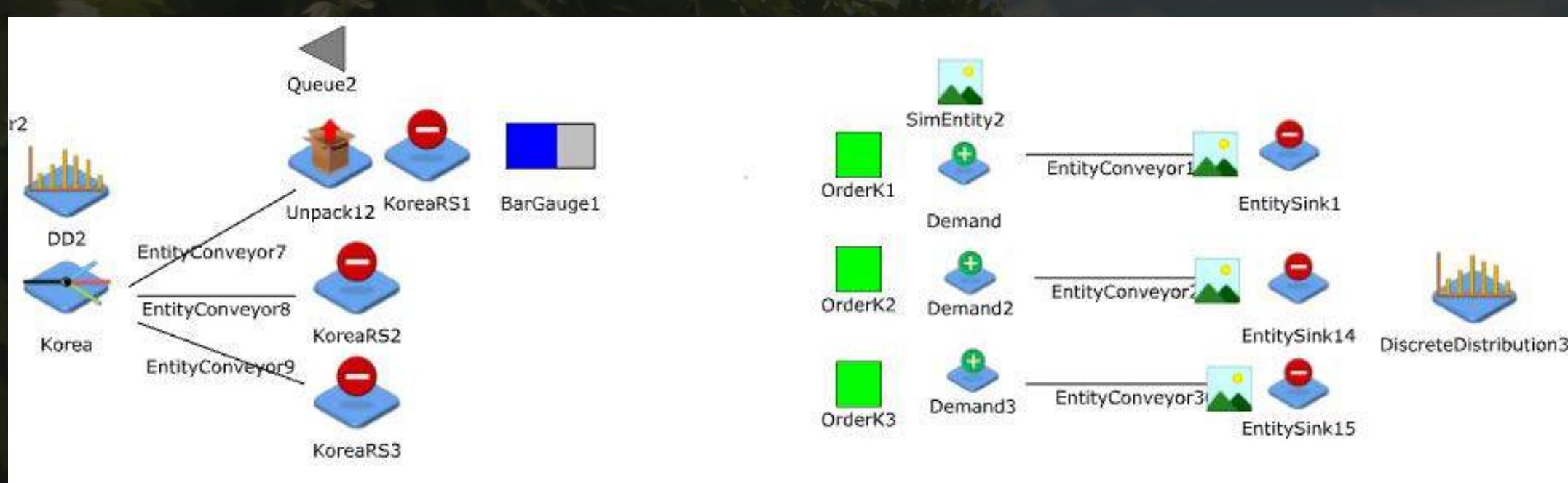
Failed Attempts :(

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# Generating Demand for Stores



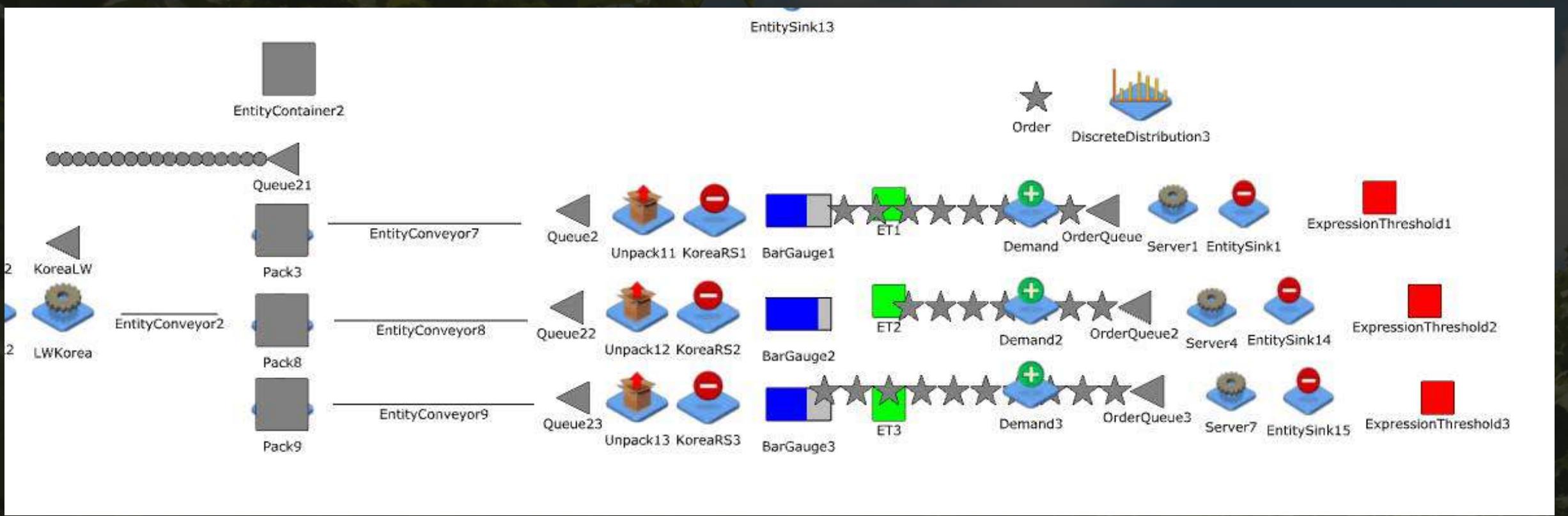
We tried to simulate demand for the retail stores but quickly realised its complexity as there are 4 types of wines being sent to the retail stores



Jaamsim also does not have a Count function for the different types of entities sent to the sink.

In this example, the road to the retail store will only be open if there is an order placed and is travelling on the conveyor.

# Generating Demand for Stores



We also tried “satisfying orders” and having a bar guage which represents how much of the demand has been met for each store, but this as well did not work and we were met with many errors.

Even though there was only 1 type of wine in the testing stage, there were already 2-3 expression thresholds and many other entities. After adding 4 types of wines, this would have been even more complicated especially since we would have to replicate this 15 times for all retail stores.

# Generating Demand for Stores

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Hence, we decided not to include an Order generator for the stores as using our intial python analysis, we could already find out what was the demand for each country and then simulate wines for exactly that amount.



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*The End*

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