1. Problem Statement

CDPH contracted the firm to help devise recommendation concerning its plan to build and operate a distribution warehouse in Salinas, California. The existing facility in Sacramento is quite outdated and incurs high shipping cost as most of demand is concentrated in Southern part. Due to these rising concerns CDPH have planned on to build and operate a new facility in Salinas. The new facility is analysed in the following grounds and would thereby help CDPH top management make better decisions.

1. 1 Demand for MMR Vaccine

1.1.1 Overview:

The first step to understand the importance of opening a new warehouse for MMR vaccine is to understand the demand for the MMR vaccines in the future. The MMR vaccine is administered for the children in the age of 1 – 5 to immunize them against measles, mumps, and rubella. By looking at the Fig-1. recent trend in the data it is seen that the demand for the vaccine has shifted downward. The forecasting the future demand would make CDPH be prepared for any surge in future demand and make wiser decision in constructing the new warehouse facility. CDPH had provided the vaccine demand data from 1990 – 2020, considering that the data has been provided over a wider window of time, it would help us capture trends and other patterns in data.

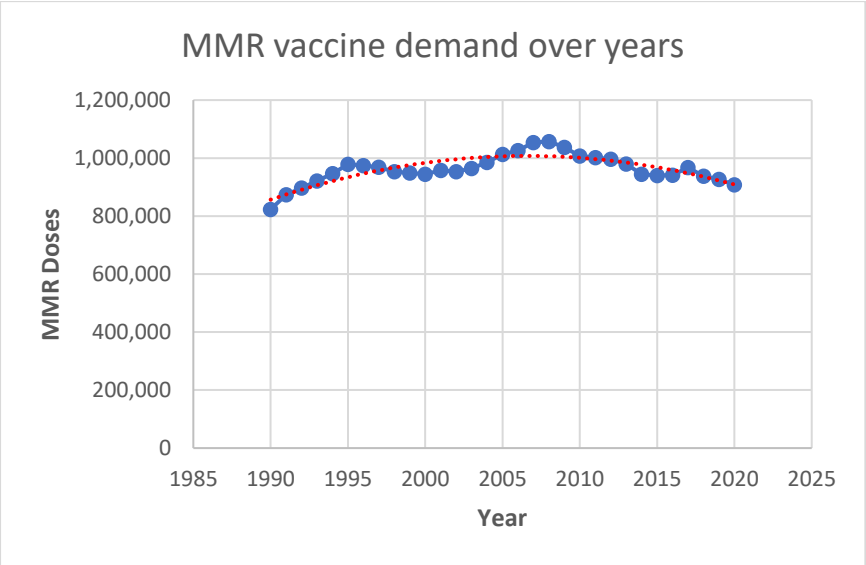

Fig-1: The polynomial trendline (Red line) shows a dip in MMR vaccine demand

1.1.2 Method of Analysis

Considering the forecast is to be done over a longer range of time, **Double exponential smoothening** turned out to be the best candidate.

Mean Absolute Error was chosen as the metric to evaluate the model. The step rate was tuned according to least MAE.

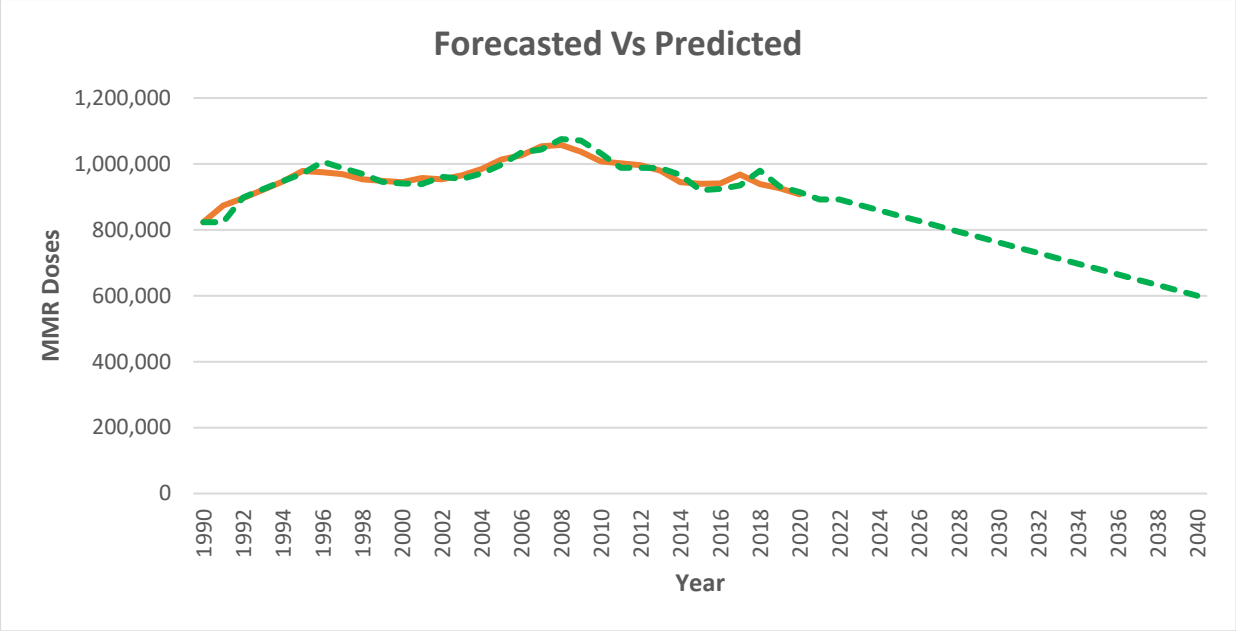

Fig-1.1: The forecasts in the green dotted line and actual in red.

Optimal α value	0.75
Mean Absolute error in the forecast	15245 Doses
Forecasted MMR doses in 2040	600,048
Adjusted forecast for 2040	
Upper limit forecast	615,293
Lower limit forecast	584,803

Table-1: The table summarizes the key results from forecasting model.

1.1.3 Recommendations and Findings:

The data is a trended data plunging downward and the demand for MMR vaccines in the future looks downward. The demand for the vaccines is in decreasing trend year after year. CDPH can look to build the warehouse that can accommodate the decreasing demand by building a warehouse that can be smaller than existing facility in Sacramento. The maximum yearly demand in the future is going to much lesser than current demand for MMR vaccines.

1.2 Construction Time

1.2.1 Overview:

The various steps or activities involved in building the vaccine warehouse facility were provided along with three estimates for each construction activity – an optimistic scenario (minimum time required if the weather is good, deliveries are received on time, and all goes according to plan), a most likely scenario, and a pessimistic scenario (maximum time required if there is bad weather and/or other problems occur).

We understand the requirement from CDPH is to possibly start the project by 1 June 2022 and the deadline within which the project is expected to be completed is set to 31st October 2022.

1.2.2 Analysis Method:

The completion of the project of setting up this new distribution facility at Salinas has been analysed by considering the various estimates of Optimistic, Most Likely and Pessimistic scenarios that were provided.

We have adopted an analysis technique called **PERT - Project Evaluation Review Technique,** where we assume the duration of each activity is uncertain and have estimated that the successful completion time will take 150 days, which is 28th October 2022.

While analysing we considered the fact on how most of the tasks are interdependent on each other. Certain activities can be started only upon the completion of other activities for instance, "Lay Foundation" activity can only begin after the completion of activities such as "Building Design" and "Site Preparation". For every activity we derived at a possible **duration** that could take to complete it, we did this by considering the Optimistic, Pessimistic and the Most Likely values that were provided by CDPH. Furthermore, we also computed the **earliest** that each activity can start and finish and the **latest** they could start and finish.

Out of all the activities in the project that needs to carry out, we have identified certain activities to be **"Critical"**. Critical tasks are those for which its slack is **0**, a slack is defined as the difference between the earliest a task can occur with the latest it can occur. The critical activities in the construction of warehouse:

- Site Preparation
- Lay Foundation
- Build Frame
- Install Siding
- Electrical
- Finish Interior
- Furnishings

Among all the activities, it is identified that the activity which possess the maximum duration is "Electrical" which takes 26 days to complete, followed by "Install Siding" & "Finish Interior" which takes about 25 days each. The activity that takes the least amount of time is "Building Design" which takes 9 days.

We have also identified that certain activities are very sensitive such that a small impact on them will cause a maximum variability in the completion of the project.

To achieve a nearer completion of a project, there should be a reduction in the duration time of certain activities. This reduction of duration will result in an increase in cost. And so, we propose that additional investment be made on those activities so that the completion of the project is achieved sooner.

1.2.3 Findings and Recommendation:

Therefore, based upon all the computation we can arrive at a fact that the likelihood of meeting the project deadline is at 68%.

We have estimated that the successful completion time will take 150 days, which is 29th October 2022.

Below is the summary of the tasks that can be shortened and the amount of additional investment that is needed for doing that

Activity	Crashing days	Crashing cost
Furnishing	5	$10,000.00
Finish Interior	5	$10,500.00
Install Sliding	4	$9,200.00
Electrical	2	$5,000.00
Build frame	5	$20,000.00
Site preparation	5	$40,000.00
Lay foundation	5	$60,000.00
No. of days cashed	31	days
Total cost for crashing	$154,700.00	

Table-1.2: The table summarizes the possible reduction in duration of activities that can cause an increase in their cost.

Since the probability of completing the project within the stipulated deadline is 63%, we recommend that the duration of certain tasks can be reduced, so that the probability can be increased. Having said that, to reduce the duration of activities, more funding is needed, so that the increase in costs of each activity can be compensated.

1.3 Construction Cost

1.3.1 Overview

The CDPH would like to build a facility that will be fully capable of handling demand until 2040. The inflow amount is provided for the project right from the fixed cost and variable cost which is to be computed based on the doses predicted up to 2040 by giving a buffer of 110% for the monthly demand from 2023 to 2040, which can be tuned in light to inventory optimization. 20% of fixed cost to be paid up front and other 20% at end of the projects. The rest 60% to be paid in equal monthly instalments. Furter hefty penalties have been fired such as 15000 fines for each week delay in project. In addition to it CDPH pay a fine of 6000/week for delay in opening the facility. This data analysis report is to estimate the **total discounted cost** involved with building the new vaccine warehouse.

1.3.2 Method of Analysis

Discounted cash Flow Method

Discounted cash flow (DCF) is a valuation method used to estimate the value of an investment based on its expected future cash flows. DCF analysis attempts to figure out the value of an investment today, based on projections of how much money it will generate in the future. This applies to the decisions of investors in companies or securities, such as acquiring a

company or buying a stock, and for business owners and managers looking to make capital budgeting or operating expenditures decisions.

1.3.3 Recommendations and Findings:

Discount rate/Yr.	**4.50%**
Discount rate/Month	**0.38%**
Fixed cost for warehouse	**$35,00,000**
Variable cost per 10,000 doses	**$1,00,000**
Initial payment %	**20%**
Final payment%	**20%**
Buffer in demand	**110%**
Weekly penalty for delay	**$15,000**
Additional cost incurred by CDPH/Week	**$6,000**
Max. monthly demand	**72,960**
Max. monthly demand after buffer	**80,256**
Variable cost based on Max. demand	**$8,02,557**
Total cost (Fixed cost + Variable Cost)	**$4,302,557**

It is found that the discounted value involved in building the new warehouse with a capacity for the maximum demand of **dose 72,960 which is then summed up to 80,256 with the buffer limit of 110%** has been estimated **as $ 42,62,569.27**

The NPV value that has been estimated is $ 42,62,569.27 < $43,02,557 which is the total cost (Fixed cost + Variable cost)

Month	01 June 2022	30 June 2022	31 July 2022	31 August 2022	30 September 2022	31 October 2022	30 November 2022
Cash inflow	$700,000	$725,639	$725,639	$725,639	$725,639	$700,000	$0
Cash outflow	$0	$0	$0	$0	$0	$0	$0
Net cash flow	-$700,000	-$725,639	-$725,639	-$725,639	-$725,639	-$700,000	$0

Net Present Value(NPV)	$4,262,569.27

The objective is to investigate the total discounted cost of building the vaccine warehouse.

It has been found that the **NPV value < the total cost (fixed + Variable),**

Although, since it is a construction site project which has no relative details in terms of benefits there is no room for hurdle rate to conclude this at this stage.

1.4 Inventory Operating Costs

1.4.1 Overview:

The objective of this model to find the inventory operating costs for the year 2023 and 2040. To find the **Economic Order Quantity (EOQ)** and **Optimal time between deliveries(T)**. Prices in the future are expected to increase by 2.5% per annum. For simplicity, demand (which you will need to forecast) should be broken down by year and should be assumed to be constant within a given year.

1.4.2 Method of Analysis:

The capacity per lorry is given to be 1000doses with climate control, The fixed order cost is given to be $1,200 plus $600/truck and additionally $500/truck above 5 trucks. Fixed holding costs $10,000 and variable cost per 10,000 doses is $16,000, This is demand based and varies according to the demand(D). All these costs were estimated in the year 2018.
The demand is estimated from the forecasting exercise using **Double Exponential Smoothening.** The future value of the money is calculated based on rate provided **(Future value of money).** The inventory cost is cumulative of **total holding cost** and **total order cost.** The total inventory cost is the function of **Order Quantity(Q).** Excel based solver is used to find the optimal value of Order Quantity(Q) such that the Inventory Cost is the least. **GRR Non-Linear** solver was used. To compliment the solver solution **Excel Data table** was built to find Inventory costs for a series of Q (Order Quantity) and Least Inventory Cost was found using the MIN () in Excel. Inventory Costs was computed for 2023 and 2040, first and last year of our analysis.

1.4.3 Recommendations and Findings:

The optimal size of the warehouse is determined using the order quantity(Q).

DATA TABLE		GRR Solver
2023		**2023**
Min. Inventory cost	$771,608.66	$784,642.74
	13	
Q*	12,000	17,000
Optimal time bet deliveries	0.014	0.019
Optimal days between deliveries	5	7

Table 1.4 – Summary for 2023

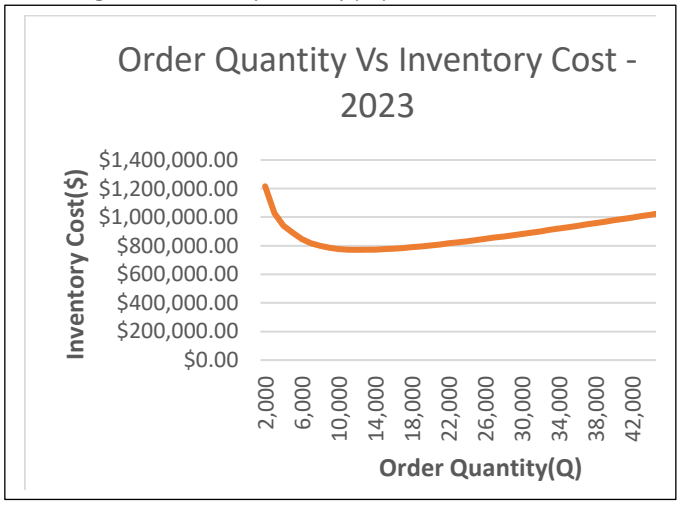

Fig- 1.4: Inventory Cost Vs Order Quantity - 2023

The table and graph-1.4 tell us the EOQ and Optimal days between deliveries for 2023. The optimal Inventory Cost $771,608.66 (Excel data table) and $784,642.74(Solver).

Demand Scenarios	
600,048	$904,286.05
1,075,396	$1,549,662.13
880,771	$1,285,421.32

Table 1.4.2 – Max Min Average demand scenarios

The Table 1.4.2 shows us how based on maximum, minimum and average from the CDPH historical data the inventory cost changes

Data Table		GRR Solver
2040		2040
Min. Inventory cost	$866,005.30	$875,661.06
	11	
Q*	10000	12,982
Optimal time bet deliveries	0.017	0.022
Optimal days between deliveries	6	8

Table 1.4.3 – Summary for 2040

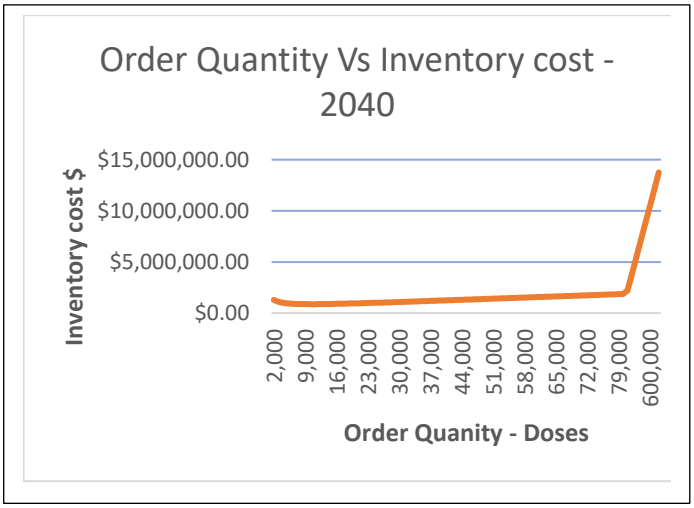

Fig- 1.4.1: Inventory Cost Vs Order Quantity

Similarly for the year 2040 the Table 1.4.3 and graph-1.4.1 shows us the EOQ and Optimal days between deliveries. The optimal Inventory Cost $875,661.06(Solver) and $866,005.30 (Excel data table).
The recommendation to CDPH would be the inventory cost will see an increase from the year 2023 to 2040 by 10% for a decrease in demand.
The optimal size of the warehouse should be able to accommodate the maximum optimal order quantity which is 17,000 doses. The warehouse should be capable of accommodating 17,000 doses.

2.Overall findings and Recommendations:

The new warehouse in Salinas would be constructed in the market where the MMR vaccine demand will see a fall in the next 3 decades => **52.2% decline** compared to 2020. The forecasts were predicted with an uncertainty of 15,000 doses per year.
The total construction cost for the facility would be **$4.2 million**, which depends on the maximum forecast for the term 2023-2040. Might be subject to change.
Additionally, the operating cost varies between **$875,662 to $784,642** per annum for keeping the facility up and running. Even these numbers have come up with a level of uncertainty based on % increase, forecasts.
The facility would take around 150 days to complete with a probability of **68%**.
The construction time for the warehouse can be reduced by **31days** by pumping in additional investments of **$154,700**.
Based on the max, min and average we observed that the inventory cost varied between $ **900,000 to $1.2Mil per annum**.
With the drop in the discounting rates the total discounted cash flow was seeing a dip.
The inventory cost is increasing year upon year with demand for the MMR vaccine decreasing in tandem.
CDPH must reconsider the plan of building the new facility in Salinas on the grounds of shipping costs incurred from the facility in Sacramento and as well refurbishing the existing facility.