Indian Institute of Technology Guwahati

KRITI’ 24

Tackling Food Wastage

Devising a Practical and feasible model for optimized food planning, consumption and disposal

LOHIT HOSTEL

CONTENTS

INTRODUCTION

PROBLEM

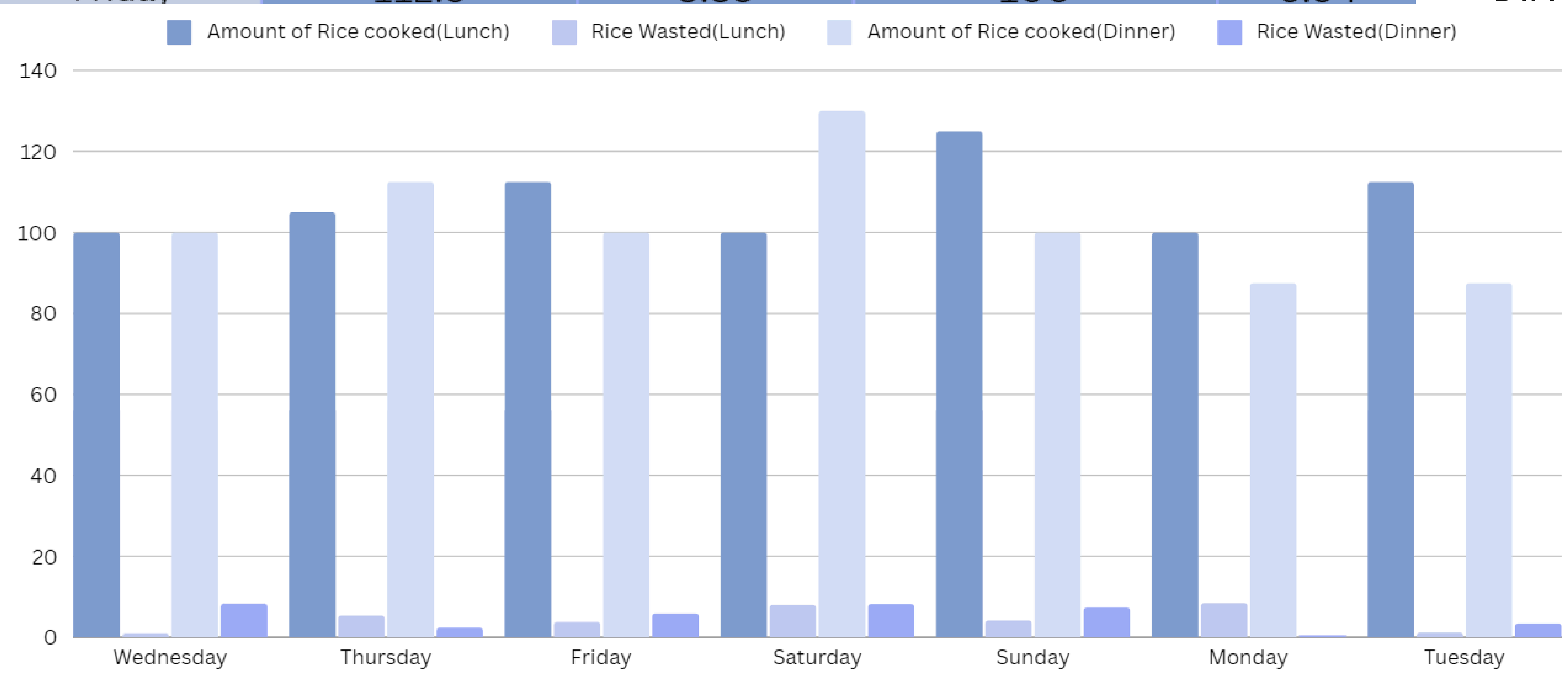
The hostel messes at IIT Guwahati are struggling with a significant problem of food wastage despite their efforts to improve meal planning processes. This issue not only affects the financial health of the messes but also raises concerns about environmental sustainability within the campus community.

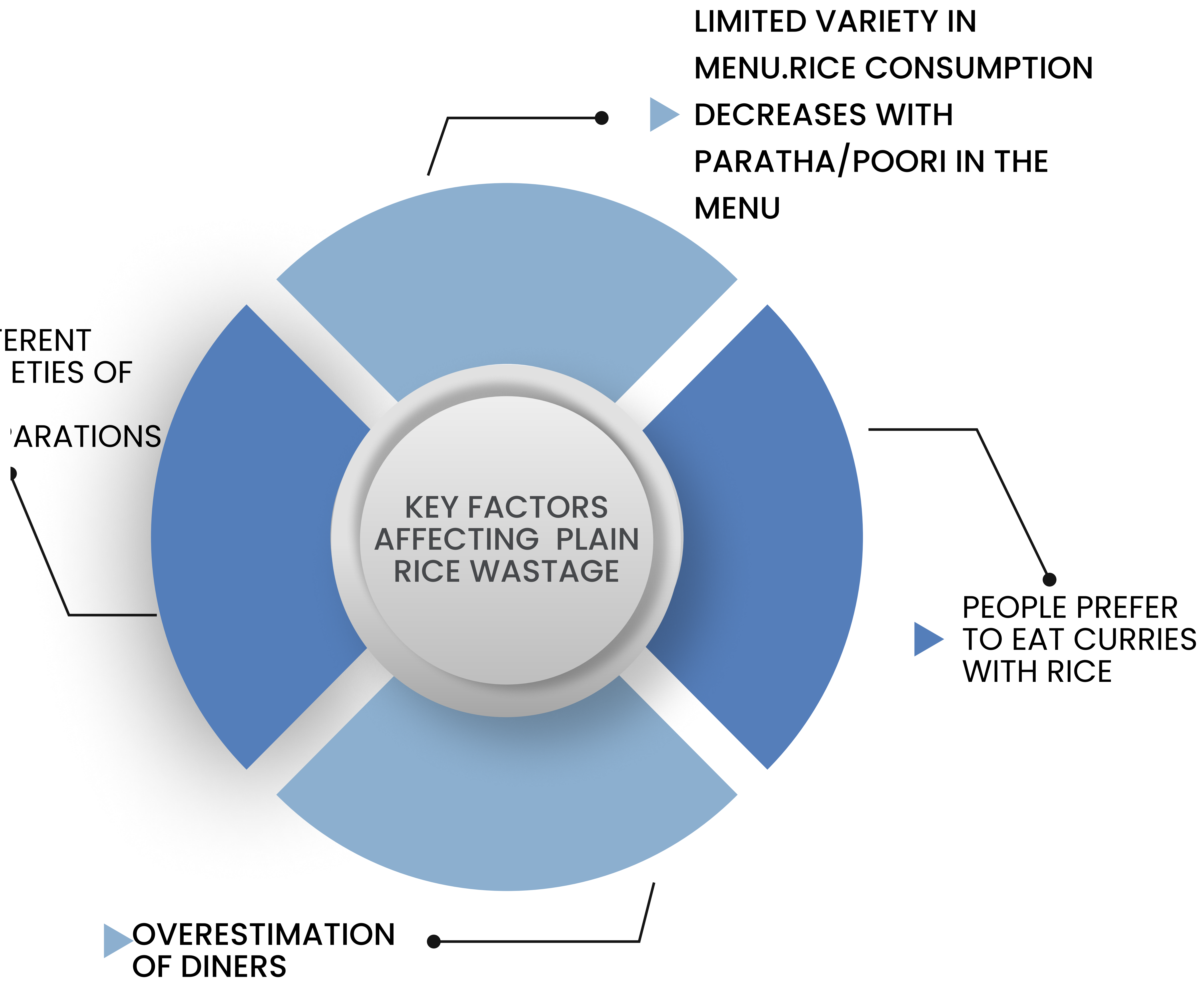
CORE OBJECTIVE

The primary aim is to devise and implement a comprehensive solution that tackles plain rice wasted per hostel resident using an inventory optimization strategy.

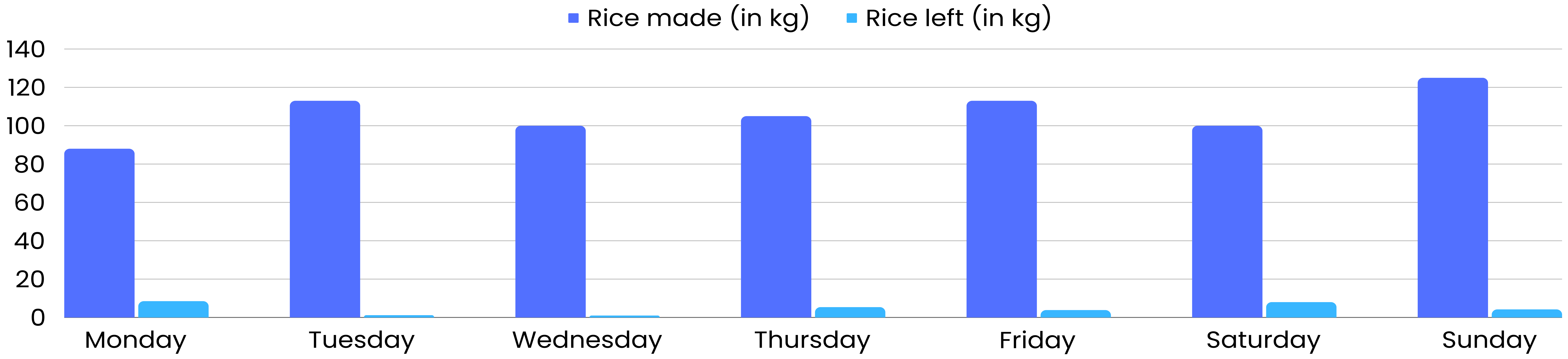
DATA INSIGHTS

Days	Amount of Rice cooked(Lunch)	Rice Wasted(Lunch)	Amount of Rice cooked(Dinner)	Rice Wasted(Dinner)
Wednesday	100	1	100	8.3
Thursday	105	5.4	112.5	2.4
Friday	112.5	3.85	100	5.94



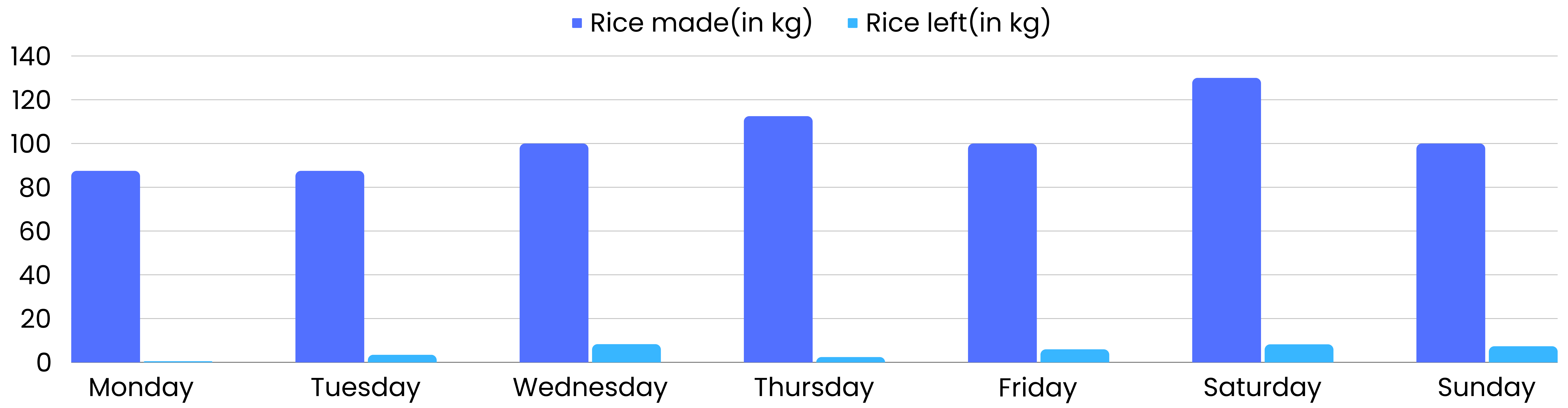


MENU ANALYSIS: LUNCH



Mess Menu	1. Corn palak 2. Rajma 3. Lemon Rice 4. Rice+ Rasam	1. Dum aloo 2. Dal makhni 3. Rice 4. Sambar	1. Aloo cabbage 2. Rajma 3. Rice 4. Roti+Rasam	1. Aloo jeera 2. Khichdi ,papad 3. Roti +Rice 4. Dal/Sambar	1. Soya Masala 2. Dal /Sambhar 3. Roti /Rice	1. Palak Puri 2. Aloo Masala 3. Roti + Rice 4. Rasam + Dal	1. Kadhi Pakoda 2. Aloo Chokha 3. Dal/sambar 4. Plain Rice
Rice made:	88kgs	113kgs	100kgs	105kgs	113kgs	100kgs	125kgs
Rice left:	8.5kgs	1.2kgs	1kgs	5.4kgs	3.85kgs	8kgs	4.2kgs
Reason	1. Lemon Rice and rajma reduced plain rice consumption.	1. No other variety of rice was made 2. People prefer Dal Makhni with rice.	1. There was no other type of Rice 2. Very less plain rice left as Rajma was made.	1. Khichdi was preferred over plain Rice.	1. Soya and Rice was prefered over other food items.	1. No other variety was made 2. palak puri was made which reduce rice consumption	1. Kadhi pakoda with Rice was prefered over other items.

MENU ANALYSIS: DINNER



Mess Menu	1. Aloo Gobi dry 2. Dal fry 3. Roti + rice 4. Sambhar	1. Chole Bhature 2. Roti + rice 3. Dal Tadka	1. Chicken/panner 2. Dal Triveni 3. Tawa Naan 4. Rice+roti 5. Rasam	1. Tawa Veg 2. Lahsuni Dal 3. Roti+rice 4. Sambhar	1. Egg curry/malai kofta 2. Jeera Rice 3. Roti +rice 4. Dal fry	1. Mix Veg korma 2. Moong Dal 3. Roti+rice 4. Sambhar	1. Chicken/ panner 1. Dal 2. Tawa Naan 3. Biryani 4. Roti+rice
Rice made	87.5 kg	87.5 kg	100 kg	112.5 kg	100 kg	130 kg	100 kg
Rice left	0.5 kg	3.45 kg	8.3 kg	2.4 kg	5.94 kg	8.22 kg	7.34 kg
Reason	1. limited variety. 2. No other rice variant.	1. People prefer eating bhature over of rice.	1. Preference of Biryani over rice.	1. Rice preferred with limited variety in menu.	1. No other variety of rice was made.	1. Jeera rice . 2. overestimation of diners.	1. Biryani was prepared. 2. Paneer with naan was preferred.

DECISION MAKING CRITERIA OF MESS

KEY DECISION FACTORS FOR THE MESS

SPECIAL DINNER
- BIRYANI FOR PEOPLE WHO PREFER RICE
- NAAN/PARATHA FOR OTHERS.
- INCREASE IN DINERS

SPECIAL EVENTS
- VISITORS DURING THE FEST AND OTHER EVENTS
- FOOD STALLS

NORMAL DINNER
- HISTORICAL DATA
- GENERAL IDEA OF DINERS
- MENU OF THE DAY

COMPARATIVE ANALYSIS OF MODELS

MODEL	DESCRIPTION	STOCK MANAGEMENT	SUPPLY CHAIN OPTIMISATION	COST OR PROFIT MODEL	HANDLES DEMAND VARIATION	KEY REASONS FOR REJECTION
Economic Order Quantity	Minimizes total inventory costs by determining the optimal order quantity to balance holding and ordering costs	✓	✗	✓	✗	• It assumes constant demands. • It focuses on holding cost (Negligible for mess).
Economic Production Quantity	The EPQ model optimizes production batch sizes to minimize total inventory and production costs by considering setup, holding, and shortage costs.	✓	✗	✓	✗	• Primarily focuses on holding costs (negligible for mess).
Just in Time	A production strategy aiming to minimize waste by supplying goods exactly when they are needed in the production process.	✗	✓	✗	✓	• It fails in the case of the uncertain demand surge. • Increased pressure on workers.
Dynamic Lot Sizing	A dynamic lot sizing model optimizes production quantities over time to minimize total costs, considering varying demand and production constraints.	✓	✗	✓	✓	• It is mainly used to reduce ordering cost and holding costs .

COMPARATIVE ANALYSIS OF MODELS

MODEL	DESCRIPTION	STOCK MANAGEMENT	SUPPLY CHAIN OPTIMISATION	COST OR PROFIT MODEL	HANDLES DEMAND VARIATION	KEY REASON FOR REJECTION
Vendor Managed Inventory	A supply chain strategy where the supplier is responsible for managing the inventory levels of their products at the customer's location.	✗	✓	✗	✗	• Inventory control shifts to supplier, increasing dependency.
Multi Echeleon Inventory Optimisation	The MEIO model optimizes across multiple levels of a supply chain to minimize costs while meeting customer service requirements.	✓	✓	✓	✗	• Applicable to Multi-Level Supply Chain • Needed for complex data and system (our system is simpler)
Continuous Review Model	Continuously monitors inventory levels to initiate reorder points when stock falls below a predetermined threshold.	✓	✗	✓	✗	• Applicable for the perishable products with lower shelf life • Rice Grains shelf life exceeds 12 months.
Stochastic Inventory Model	This model address inventory management under uncertain demand and lead times using probabilistic approaches.	✓	✗	✗	✓	• Reliance on probabilistic assumptions, which does not always accurately reflect the true variability in demand of rice.
Bullwhip Effect Mitigation	The bullwhip effect describes the amplification of demand fluctuations as they propagate upstream in a supply chain.	✗	✓	✓	✗	• Primarily focuses on improving supply chain management , not on preventing wastage of rice..

CHOSEN MODEL: NEWSVENDOR MODEL

01

ASSUMPTIONS

- **Demand** for newspapers is uncertain and follows a probability distribution.
- **No fixed ordering costs**: Costs incurred are unit purchase cost and potential cost associated with overstocking or under-stocking. Shortages are allowed, and unsold newspapers are considered as waste with associated costs.

02

COST COMPONENTS

Unit Purchase Cost (c): The cost incurred by the vendor for each unit of newspaper.

Selling Price (p): The price at which the vendor sells each unit of newspaper.

Shortage Cost (h): The cost incurred by the vendor for each unit of demand that is not met due to understocking.

03

DESCISION VARIABLES

Order Quantity (Q): The number of newspapers the vendor should order from the supplier.

04

OBJECTIVE FUNCTION

- The objective is to minimize expected total costs or maximize expected total profit over a given time period.
- **Total Cost** = Expected Purchase Cost + Expected Shortage Cost + Expected Holding Cost
- **Total Profit** = Expected Revenue - Total Cost

05

Optimal Order Quantity

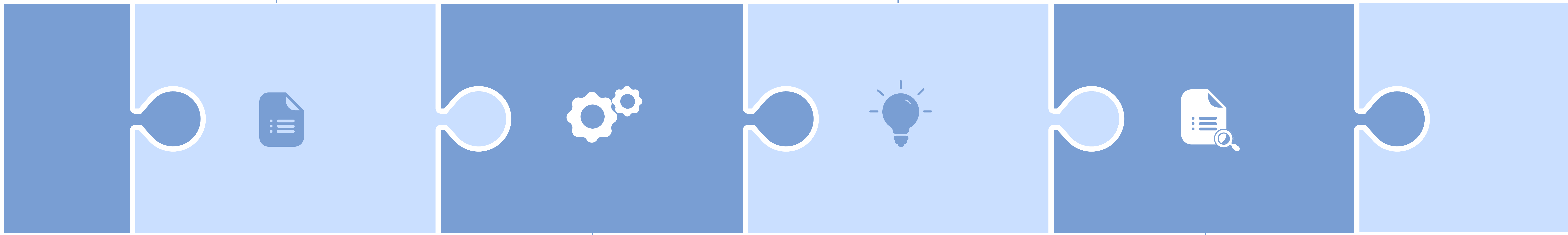
- Determines the optimal order quantity (Q), the quantity that minimizes total costs or maximizes total profit.

06

OPTION

NEWSVENDOR FORMULA

- Provides a straightforward calculation for the optimal order quantity based on the probabilities of demand and the cost parameters.
- Where F^(-1) is the inverse cumulative distribution function of demand.



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Sensitivity Analysis

- Sensitivity analysis involves evaluating how changes in key parameters (such as unit cost, selling price, shortage cost) affect the optimal order quantity.

08

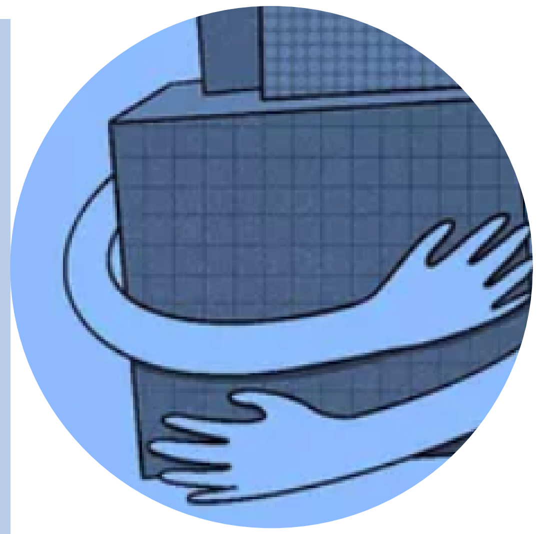
OPTION

Practical Considerations

- In practice, vendors may use historical data to estimate demand distributions, adjust parameters based on market conditions, and regularly review and revise their inventory policies.

WHY THIS MODEL?

HOLDING COST IS INSIGNIFICANT: Holding costs, while minimal after the initial investment, encompass expenses such as storage space, utilities, security, insurance, and inventory management. Ignoring these ongoing costs can lead to underestimating the true cost of maintaining inventory and may result in sub-optimal decision-making regarding stock levels and pricing.



RANDOM DEMAND: This inventory model excels in hostel messes due to its ability to handle fluctuating demand influenced by menu variations. This model's flexibility allows hostel messes to effectively manage inventory and enhance overall operational efficiency. Its adaptability allows managers to adjust stock levels based on expected meal popularity.

ALLOWS ACCURATE FORECASTING: Forecasting the quantity of rice required in advance is a proactive solution that addresses the challenges of both understocking and overstocking in hostel messes.

ADVANTAGES

MODEL ADVANTAGES

It can give an accurate estimation to optimal amount of rice to be made

minimizes understocking and overstocking of cooked rice

Variable can be changed according to our purpose of use

This model primarily focuses on quality made and less focus to inventory levels

Can upload the uncertainity in the demand of rice

Minimizes total costs associated with inventory, including holding costs and stockout costs

LIMITATIONS

Limitations of the Model

1. Looses flexibility when it comes to handling complex situations like seasonality
2. Production should in the whole units
3. The cost sensitive structure of the model get disrupted due to the change in the costs
4. Primarily focuses on quantity made overlooking the various inventory levels

Conclusions & Major Impacts

1. **Reduced Food Wastage**

By utilizing the Newsvendor Model, the hostel mess can minimize food wastage by ensuring that the amount of rice ordered is closely aligned with the actual demand.

2. **Data-Driven Decision Making:**

Implementing the Newsvendor Model necessitates collecting and analyzing data on rice consumption patterns, enabling the mess committee to make data-driven decisions regarding inventory management.

3. **Increased Hostel Satisfaction:**

By optimizing food supply and minimizing instances of food shortage or wastage, the Newsvendor Model can enhance overall satisfaction levels among hostel residents, mess committee members, and employees.

PROPOSED SOLUTIONS

Collaboration

Involve hostel staff, catering services, and other relevant stakeholders to gather insights and perspectives and employ their suggestions

Communication

Establish a system to notify the mess caterers of upcoming events or fests in advance to help them anticipate the demand and optimize food preparation accordingly.

Data Analysis

Employ historical data of rice consumption and wastage to discern patterns and trends in demand. This dataset may include meal consumption logs, leftover quantities, and other variables affecting fluctuations in demand.

Validation

Consistently verify and refine demand estimates using actual consumption data. Adjust the employed models accordingly to enhance accuracy and reliability over time.

SOLUTIONS

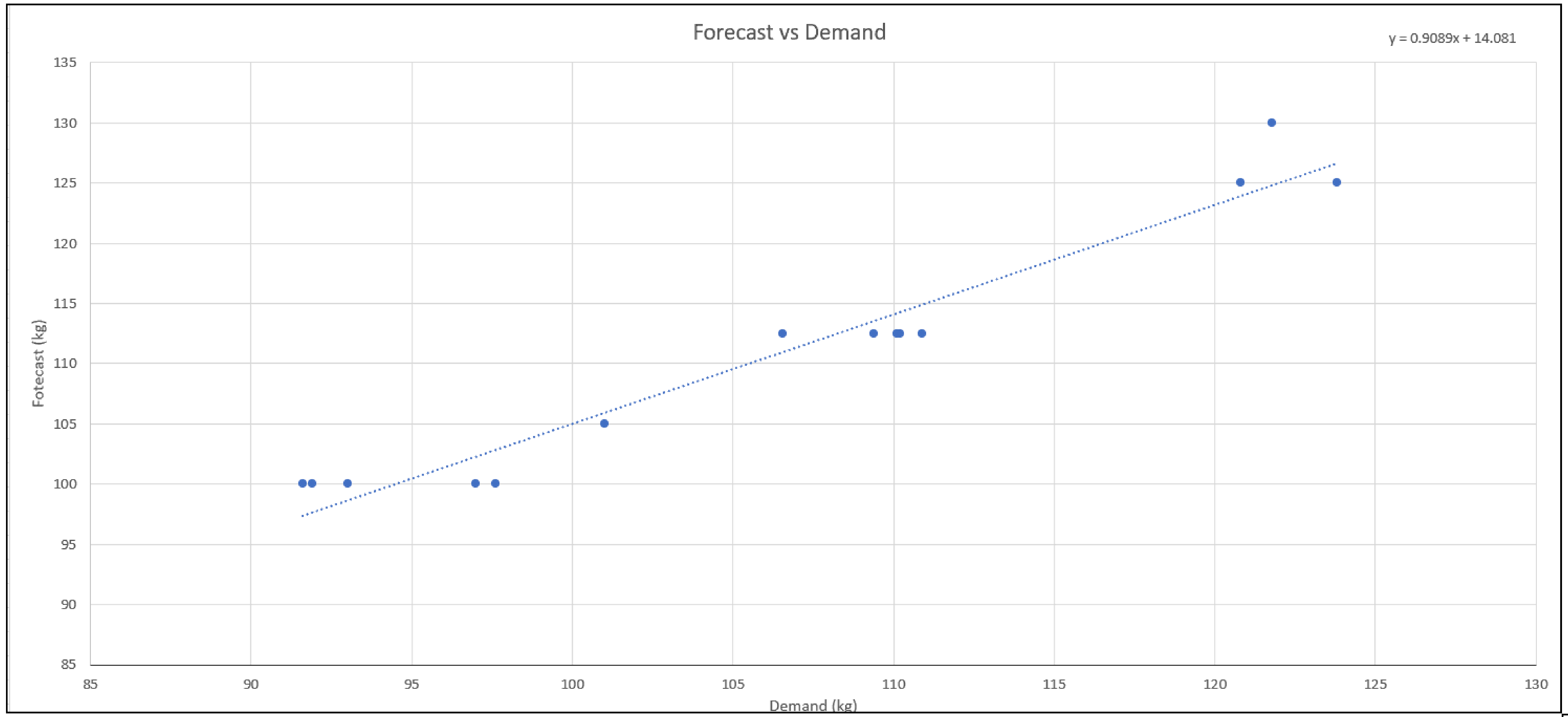
- Take advance note of fests, events, concerts etc and alter food preparation accordingly.
- Allocate appropriate time at the start of the month to assess student reactions to the new menu
- Implement a flexible menu planning system that adapts to the changing needs and preferences of residents.

PROPOSED SOLUTIONS: MODEL IMPLEMENTATTION

Date	Day	Lunch/Dinner	Forecast (kg) (RAW)	Cooked Rice (kg)	Wasted Rice (kg)	Actual Demand (kg)	Actual Demand/Forecast
31-Jan	Wednesday	Lunch	42	105	4	101	0.9619
		Dinner	40	100	8.4	91.6	0.916
01-Feb	Thursday	Lunch	50	125	1.2	123.8	0.9904
		Dinner	40	100	2.4	97.6	0.976
02-Feb	Friday	Lunch	45	112.5	2.3	110.2	0.9796
		Dinner	45	112.5	3.1	109.4	0.9724
03-Feb	Saturday	Lunch	40	100	8.1	91.9	0.919
		Dinner	52	130	8.2	121.8	0.9369
04-Feb	Sunday	Lunch	50	125	4.2	120.8	0.9664
		Dinner	45	112.5	5.94	106.56	0.9472
05-Feb	Monday	Lunch	40	100	7	93	0.93
		Dinner	45	112.5	2.4	110.1	0.9787
06-Feb	Tuesday	Lunch	45	112.5	1.6	110.9	0.9858
		Dinner	40	100	3	97	0.97
					Mean	106.1185714	0.9593
					Standard Deviation	11.11958346	0.0249
					Forecast		**110**
					Expected Demand		105.5236
					St. Dev. of Demand		2.7426
					Final Decision		**105.5236 ± 2.7426**

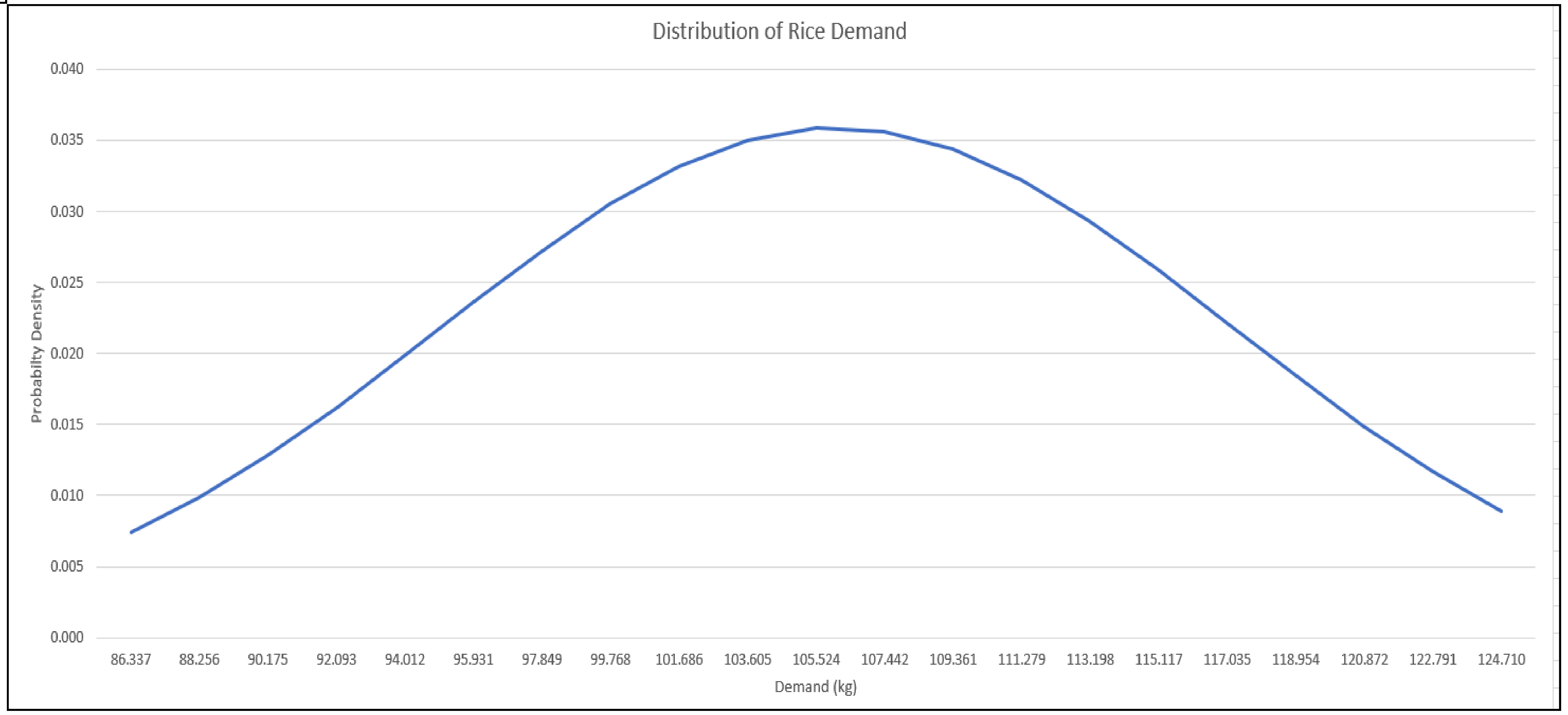
- Forecast based on sample data collected from the Mess Workers
- Standard Deviation accounts for the fluctuation in the proposed demand

PROPOSED SOLUTIONS: MODEL PREDICTION



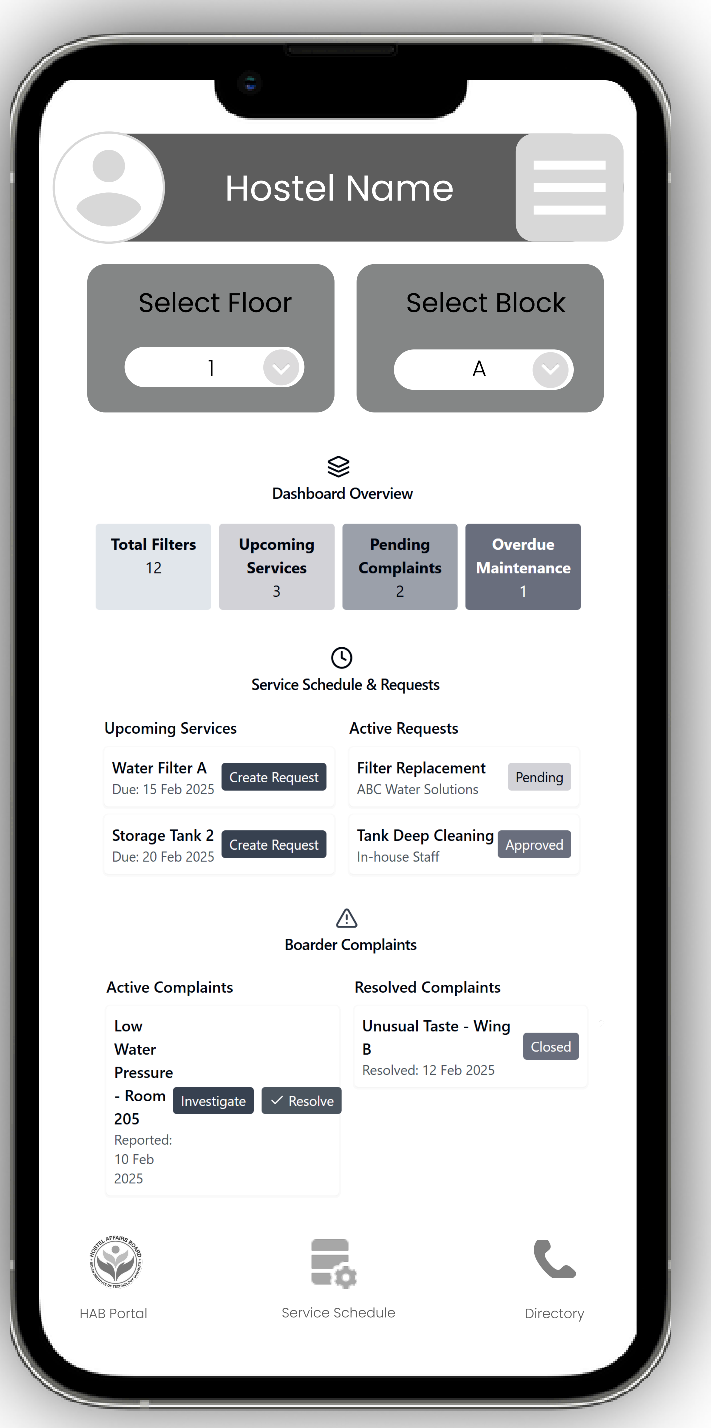
DEMAND FORECAST CURVE

NORMAL DISTRIBUTION OF RICE DEMAND



PROPOSED SOLUTIONS: P-Rice App

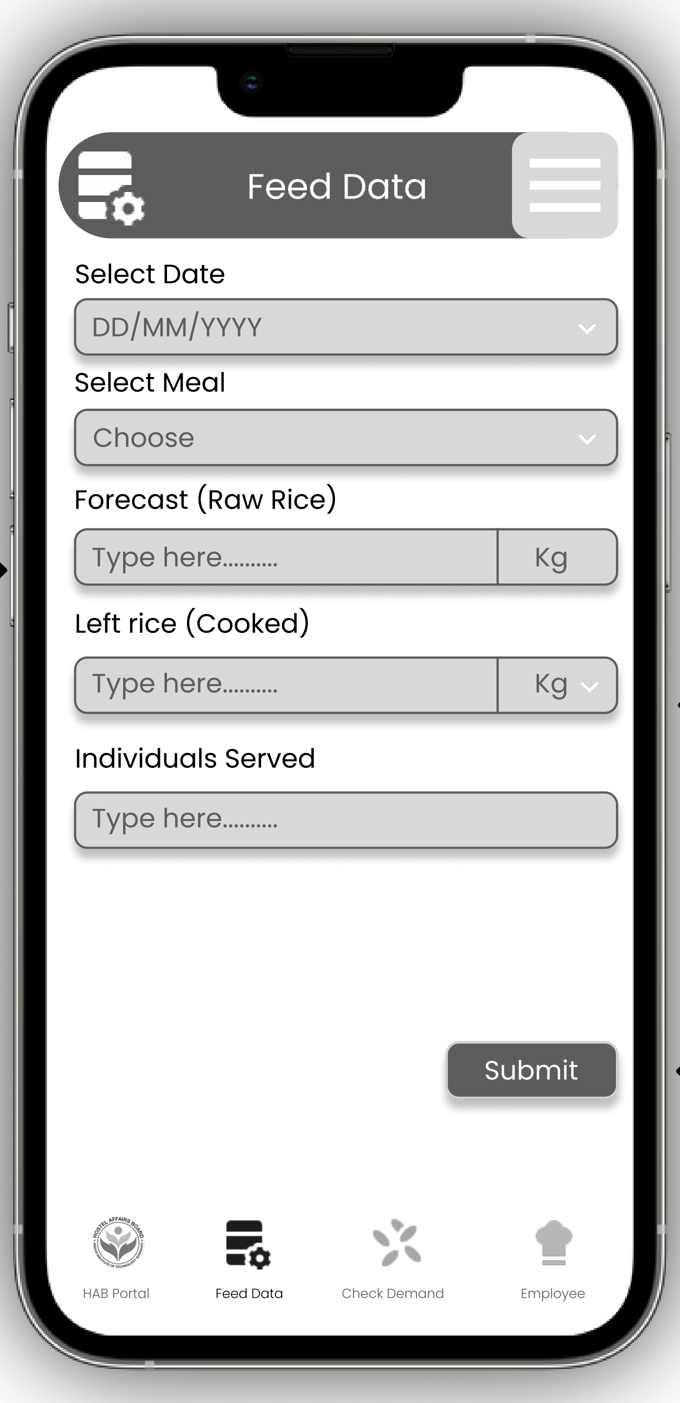
User Profile



Model Predictions

1

Feed Forecasted Estimation

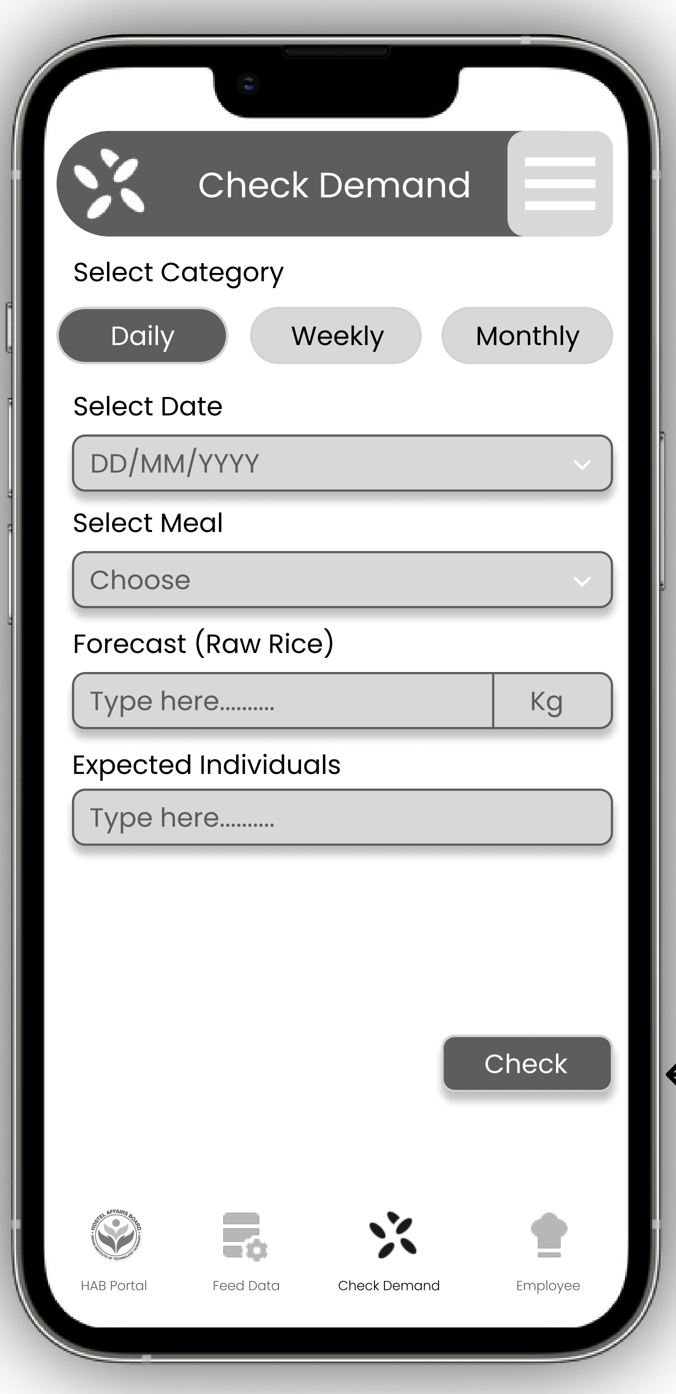


Enter Amount of Rice left in Kg/Scoops

This Data will update the Mean and Standard Deviation of the model to give better predictions of Demand

2

Check Daily/Weekly/Monthly Estimate of Rice Demand

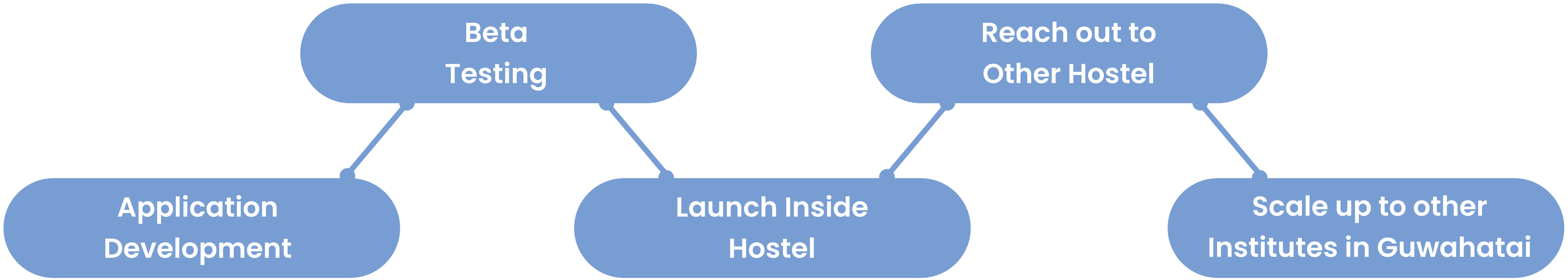


This will show the predicted Demand and Fluctuation for the given Time frame

3

TIMELINE

Gantt Chart	FEB			MAR				APR		
TASK	W 2	W 3	W 4	W 1	W 2	W 3	W 4	W 1	W 2	W 3
Application Development										
Beta Testing										
Launch Inside Hostel										
Reach out to Other Hostels										
Scale up to other Institutes in Guwahati										



FEASIBILTY ANALYSIS

S No.	Activity	Hourly Rate (INR)	Time Required	Cost
1	**App Development Cost**			**244500**
1a	UI/UX Design	800	45	36000
1b	Frontend Dvelopment	1500	40	60000
1c	Backend Development	1500	40	60000
1d	Testing & Debugging	1100	35	38500
1e	Deployment	-	-	50000
2	**Maintainance Costs**			**5400000**
2a	Software Engineer	1000000	3 years	3000000
2b	Product Managers	800000	3 years	2400000
3	**Promotional Expenses**			**500000**
4	**Business Overheads**			**1200000**
4a	Customer Executives	300000	3 years	900000
4b	Other Expenses	100000	3 years	300000
	Total Expenses		**3 years**	**7344500**

Appendix

Mess Survey Visuals Link

Rice Survey Form Link

Survey Data Analysis Sheet Link

Other References

- https://www.gep.com/blog/strategy/multi-echelon-inventory-optimization-transforming-supply-chain#:~:text=A%20multi%2Dechelon%20inventory%20system%20is%20an%20efficient%20means%20of,levels%20in%20a%20supply%20chain
- https://www.netsuite.com/portal/resource/articles/inventory-management/just-in-time-inventory.shtml
- https://www.techtarget.com/searcherp/definition/bullwhip-effect
- https://collectionperformance.com/continuous-review-system-real-time-inventory-control/
- https://www.techtarget.com/searcherp/definition/vendor-managed-inventory-VMI
- https://en.m.wikipedia.org/wiki/Dynamic_lot-size_model#:~:text=The%20dynamic%20lot%2Dsize%20model,Whitin%20in%201958
- https://www.techtarget.com/searcherp/definition/bullwhip-effect