

# **Material Flow Study at Salt Processing**



IE3100R SYSTEMS DESIGN PROJECT AY23/24 | DEPARTMENT OF INDUSTRIAL & SYSTEMS ENGINEERING TEAM MEMBERS: CAI XUANXUAN | CHEN YINGLING | HUANG WANYING | LIM HUI YIN WINNIE INDUSTRY SUPERVISOR: CHAN IRENE | LEONG WAI KET | WONG KAI SIAN | SAW KEAN YAP **DEPARTMENT SUPERVISOR: DR GOH TIAN** 

## **Problem Description**

The Salt Processing area in PepsiCo plays a crucial role in manufacturing operations, handling significant amounts of material for various processing purposes. However, inefficiencies within the existing workflow have led to increasing costs and resource consumption. To address these inefficiencies, the material flow study has been conducted to optimise workflow efficiency. The project aims to achieve this by streamlining manual tasks, minimising operational resources, and ensuring cost-effectiveness. This aligns with PepsiCo's commitment to operational efficiency, emphasising continuous improvement in its manufacturing operations to meet increasing demand, thus preserving its position as a competitive and trusted global brand.

The material flow study will be guided by the following objectives:



**Constructing flowchart to** identify bottlenecks or inefficiencies within the existing material flow



Implementing a real-time monitoring system to streamline manual tasks of the sourcing officer by automating the information transmission process



Using simulation to identify the optimal workstyle between operators, thereby improving the identified key performance indicators



**Ensuring cost-effectiveness by** identifying significant factors contributing to uncertainty in the annual rejection cost, thus offering insights for risk mitigation

# **Solution 1**

## **Real-Time Rejection and Rework Monitoring System**

This monitoring system offers real-time insights into rejection weights for both single salt and 3-in-1 salt, as well as the stock value of all salt materials. Two-way communication is established between the sourcing officer and filler operators using Excel VBA. This aims to reduce the need for sourcing officers to physically visit the operational floor to gather information from filler operators. Through intuitive interfaces and automated processes, the sourcing officer will gain immediate access to crucial data, enabling swift decision-making and proactive management of stock levels.

### **User Functions**

For Single Salt

				Rejection for Combo
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**User Interface** 

		Time	Rejected Materials	Rejected Weight/kg								1				
		2/4/2024 13:27	17B38PPH	111					Dejectio	an far Camb	_					
		2/4/2024 13:28	17665PCT	34					Rejectio	on for Comb	0					
					S	AP Code	N	/later	rials	Reject Weight/kg	A	tion Time		Act	ion	
					18	80000627	17B38PPH			111	2/4	/2024 13:27	Ale	ert	Can	cel
Time	Rejected I	Materials Rejected Weig	ht/kg							1				Tin	ne	Rewo

### **Efficiency Improvement**

Tracking of rejection

				Time	Rejected Materials   Rejected Weight/kg			Time Rework Materials Rework Weight/kg		
	- E - E	Rejection for Auto X		2/4/2024 13:2 2/4/2024 13:2	5 17C09AGP 123 5 1719AIOS 223	Rejection for Single Salt	Rework	2/4/2024 13:26 17C09AGP 12 2/4/2024 13:26 17C09AGP 39	- I -	
				2/4/2024 13:2	25 17076EDT 2			2/4/2024 13:27 17C09AGP 22		
Alert		22/3/2024 9:5 Rework		2/4/2024 13:2	15 17076EDT 34	SAP Code Materials Reject Weight/kg Action Time Action	SAP Code Materials Rework Weight	ht/kg For Stock/kg Action Time Action 2/4/2024 13:27 1719AIOS 50		
Rejection for Single Salt Cancel Rejection for Combo Salt		Rework	X	2/4/2024 13:2	26 173U0CKS 11	180000656 17C09AGP 50 2/4/2024 13:25 Alert Cancel	180000656 17C09AGP 73	22 2/4/2024 13:26 Stock 2/4/2024 13:27 172H2BPT 20		
Rejection for Single Salt Rejection for Combo Salt				2/4/2024 13:2	6 17155MMA 2	180010015 1719AIOS 178 2/4/2024 13:25 Alert Cancel	180010015 1719AIOS 50 180000630 1787145K	SU Stock		Stock management
Cancel		Material Name	22/2/2024 0:57:27 PM	2/4/2024 13.2	00	180000015 1709CAA 0 Alert Cancel	180000015 17009CAA	Stock		Stock management
			22/3/2024 9:57:37 PM			180000001 17001CAF 0 Alert Cancel	180000001 17001CAF	Stock		
						180009970 176U4CMY 0 Alert Cancel	180009970 176U4CMY	Stock		
		E State Stat				180000057 17076EDT 36 <u>Alert</u> Cancel	180000057 17076EDT	Stock		
	- i - i - i - i - i - i - i - i - i - i	Reject Weight Material Name	▼			180000117 17127MAA 0 Alert Cancel	180000117 17127MAA	Stock	· · · · ·	
						180000113 1/125NAC 0 Alert Cancel	180000113 17125NAC	Stock	_	Communication
						180000153 17173SOR 0 Alert Cancel	180000153 17173SOR	Stock		
		Rework Weight				180090271 RM0004062 (Citrus Pectin) 0 Alert Cancel	180090271 RM0004062 (Citrus Pectin)	Stock		-
Devue where the standard standa		Cancel Enter				180009373 178V7CUM 0 Alert Cancel	180009373 178V7CUM	Stock		
Rework Stock						180000228 17216NHP 0 Alert Cancel	180000228 17216NHP	Stock		
						180000862 17L03TAU 0 Alert Cancel	180000862 17L03TAU	Stock		
		Cancel	Enter			180000140 17155MMA 2 Alert Cancel	180000140 17155MIMA	Stock		Polianco on physical visits
		Cancer	Enter			180009940 17286ASP 0 Alert Cancel	180009940 17286ASP	Stock		Reliance on physical visits
						180000427         175H8SCD         0         Alert         Cancel           180000285         172H2BPT         40         2/4/2024 13:26         Alert         Cancel	180000427 175H8SCD	Stock		
						180000285 172H2BPT 40 2/4/2024 13:26 Alert Cancel	180000285 172H2BPT 20	0 2/4/2024 13:27 Stock		

## Solution 2

For 3-in-1 Sal

## **FlexSim Simulation Model**



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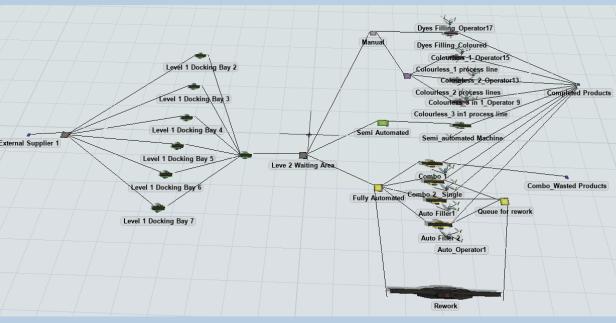
### **Data Collection & Processing**

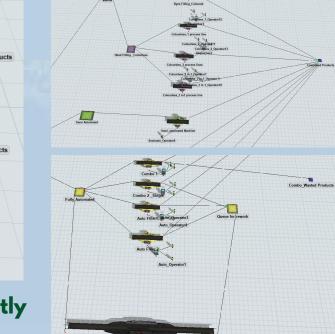
**Rejection Rates (%)** Unloading Time (Sec/kg) **Rework Process Time (Sec/kg)** 

Transportation Time (Sec/kg) **Repacking Process Time (Sec/kg)** Fully Automated machine Setup Time (Sec/kg)

Data are collected to capture the entire repacking process, from salt arrival to completion. Critical analysis focuses on comparing two work styles at Auto Fillers.

### **Simulation Model Development**





Simulated annual performance of Style A & B independently to analyse the optimal work style.

## Simulation Model Result Insights

Total Auto Filler Output Comparison

Total Auto Filler Rework Comparison -16561.00 kg

## **Solution 3**

## **Cost Analysis**

## **Analytic Hierarchy Process (AHP)**

AHP offers insights into the perspectives of PepsiCo's supervisors on the relative significance of factors contributing to annual rework costs for both single salt and 3-in-1 salt.

Geometric Mean Method (AHP Ranking for Single Salt)											
	Manpower cost for operator	Manpower cost for rework	Utility cost	Product	Geometric Mean	AHP Priority	Rank				
Manpower cost for operator	0.230769231	0.2	0.428571429	0.01978022	0.270443805	0.280833111	2				
Manpower cost for rework	0.692307692	0.6	0.428571429	0.178021978	0.562545784	0.584156411	1				
Utility cost	0.076923077	0.2	0.142857143	0.002197802	0.130015821	0.135010478	3				

		Geo	metric Mean Method	(AHP Ranking for 3-in-	1 Salt)			
	Manpower cost for operator	Material cost/sold price	Utility cost	Wasted salt treatment cost	Product	Geometric Mean	AHP Priority	Rank
Manpower cost for operator	0.154411765	0.132352941	0.326086957	0.318181818	0.002120424	0.214588129	0.227169866	2
Material cost/sold price	0.772058824	0.661764706	0.543478261	0.409090909	0.113594158	0.580549158	0.614587932	1
Utility cost	0.051470588	0.132352941	0.108695652	0.227272727	0.000168288	0.113897202	0.120575226	3
Wasted salt treatment cost	0.022058824	0.073529412	0.02173913	0.045454545	1.60274E-06	0.035580802	0.037666976	4

Total Annual Rejection Co

Total Annual Rejection Cost

#### For Single Salt: .Manpower cost for rework . Manpower cost for operator .Utility cost r 3-in-1 Salt: **1. Material cost** 2. Manpower cost for operator **3.Utility cost** 4. Wasted salt treatment cost

### **Sensitivity Analysis**

#### Formulas used to calculate base input value

Manpower Cost for	2 workers * 2 shifts * 8 hrs * 252 days * Hourly pay * Rejection rate
Operator	
Manpower Cost for Rework	(0.8 * 12 hrs + 0.2 * 8.5 hrs) * 252 days * Hourly pay
Material Cost/KG	Annual amount of BB salt used by the company * Combo filler 1 rejection
	rate * cost of BB salt
Utility Cost	50% * Total plant utility cost * Proportion of respective salt filler in the
	whole salt plant * Rejection rate
Wasted Salt Treatment	80%* Total plant wasted salt treatment cost
Cost	

#### **Result Discussion**

From the sensitivity analysis, it can concluded that the upper limit for annual rejection cost for 3-in-1 salts is approximately 1.5 times higher than single salts. PepsiCo should prioritise lowering annual rejection costs for 3-in-1 salts to achieve maximum cost savings.

#### For 3-in-1 Salt:

Despite PepsiCo's belief that wasted salt costs are minimal, data shows they significantly impact annual rework costs. To reduce annual rejection cost, it's advisable for PepsiCo to reassess and address this discrepancy to reduce expenses.

Style A excel in repackaging

Single Salt (Auto filler)

Single Salt (Combo filler 2)

3-in-1 Salt (Combo filler 1)

Material Cost/KG

Wasted Salt Treatment Cos

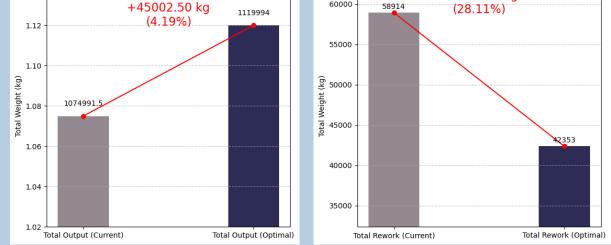
Manpower Cost for Operato

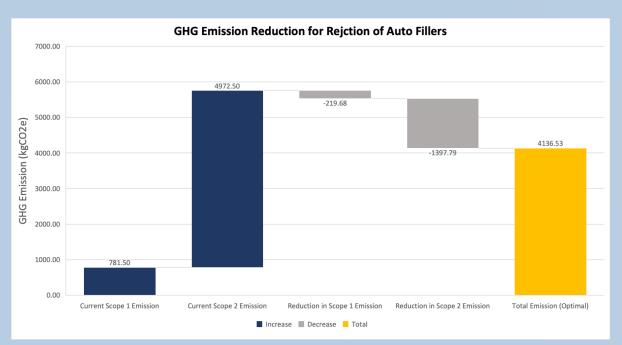
Itility Cost (assume 50% for salt

Manpower Cost for Rewor

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Itility Cost (assume 50% for salt





#### technique which results in **lower Rejected Products** (-47.13%) and higher Completed Products (+0.53%).

• Style B performs better in setup technique, with higher efficiency (+24.57%).

• An optimal scenario model is developed to suggest potential annual improvements for PepsiCo:

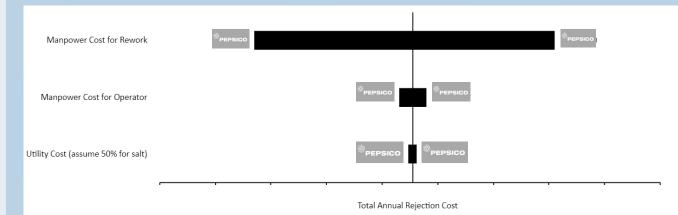
> **1. Rejection Rate** (-28.11%) **2.**Completed Products (+4.19%) 3. GHG Emissions (-1617.48kgCO2eq)

Actionable insights for enhancing operator training are provided by targeting the identified inefficient techniques.



**Simulation Modelling & Analytics Excel VBA Programming** Sensitivity Analysis

**Corporate GHG Accounting Stakeholder Management Project Management** 



## Recommendations

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Implemented real-time monitoring system using Excel VBA Userform for sourcing officer to oversee salt demand and supply. This interface offers updated insights into rejected salt quantities and stock volume. In addition, individual rework entries provide managers with insights into rework processes, enabling better scheduling and manpower allocation.



Using FlexSim simulation, the optimal workstyle that minimises processing time and rejection rate is to adopt Style A's repackaging technique, where the operators manually adjust weight in case of rejection for low weight packages, and to incorporate Style B's setup technique, where two operators collaborate with one inputting tablet information and one adjusting the machine.



Based on the cost analysis for single salt, it is important to mitigate the impact of manpower costs, especially manpower cost for rework, through adopting optimal workstyle and training programs. For 3-in-1 salt, it is important to mitigate the impact of material costs and wasted salt treatment costs for operators through efficient sourcing and training programs.

#### For Single Salt:

Data supports PepsiCo's sentiment, suggesting they can continue monitoring and exploring ways to reduce rework manpower costs, which would significantly lower annual expenses.