International Journal of Multidisciplinary Research and Growth Evaluation.

An Analysis of Operations Management Practices in Packaging Industries to Enhance Production Performance: A Case Study

Chinedu James Ujam
Department of Mechatronics Engineering, Federal University Otuoke, Bayelsa State, Nigeria

* Corresponding Author: **Chinedu James Ujam**

Article Info
ISSN (online): 2582-7138
Volume: 06
Issue: 02
March-April 2025
Received: 20-02-2025
Accepted: 18-03-2025
Page No: 1112-1124

Abstract
The worldwide beverage market, a significant aspect of the global beverage field, faces mounting pressure to enhance production methods due to heightened rivalry, shifting consumer tastes, and environmental issues. This research investigates the effects of operations management techniques on manufacturing effectiveness in the packaging sector, concentrating on vital strategies such as lean production, OEE/OPI assessment, Total Quality Management (TQM), Total Productive Maintenance (TPM), Optimal Maintenance Methods, Minimizing Production Waste, Techniques for Identifying Problems, Cleaning, Inspection, Tightening, and Lubrication (CILT), as well as Just-In-Time (JIT) production. The findings emphasize how these techniques influence production methodologies, cost efficiency, quality assurance, and general effectiveness. An examination of operations management within the packaging sector recorded downtimes over a 13-week period and analyzed them using Pareto Analysis. Taking into account the 4M (Machine, Man, Material, and Method) alongside downtimes affecting production efficiency, it was found that Material was responsible for 46% of the total downtime, while Machine Failures, Starvation, and Blocking accounted for 35%. Additionally, Man was responsible for 10%, and Method for 9%. Thus, addressing issues related to material quality, the lack of high-quality raw materials, compromised bottle quality, and engaging in Total Productive Maintenance and optimal maintenance plans could resolve over 70% of challenges in production performance, as indicated by the studies. This research enhances the understanding of the essential role operations management plays in refining production processes and underscores the advantages of optimizing systems to improve manufacturing performance, pinpointing critical practices and obstacles while offering practical suggestions for boosting production effectiveness.

Keywords: Operations Management, Total Productive Maintenance, Optimal Maintenance Methods, Waste Minimization in Production, Enhancement of Production Efficiency, Lean Production, Just-in-Time, Pareto Analysis, Fishbone Diagram, and Total Quality Management.

1. Introduction

The brewing sector is marked by intricate manufacturing methods, dependence on unprocessed agricultural inputs, and rigorous quality control measures. To stay ahead in the market, breweries need to implement management practices that boost efficiency and eliminate waste. This article delves into the impact of these practices on optimizing production, with an emphasis on lean methodologies, the use of technology, and workforce management techniques. The objective of the research is to offer a thorough insight into successful approaches for overcoming operational challenges and enhancing overall performance. In the highly competitive arena of manufacturing today, businesses are keen to attain maximum efficiency in their production operations. Operations Management (OM) plays a vital role in this aim by efficiently managing resources, processes, and systems.

It includes tactics such as lean manufacturing, Total Quality Management (TQM), and Just-In-Time (JIT), which focus on optimizing production, minimizing expenses, and elevating product quality. These practices not only boost efficiency but are also essential for achieving long-term sustainability in operations. This article provides a thorough examination of how OM practices assist in enhancing production efficiency. The intent is to investigate the connection between these practices and their impact on operational performance, specifically within production environments. According to Heineken Nederland Supply Visie (2015, 2011) [17], in a competitive marketplace, an increase in product brands is expected as consumer demands evolve, overall product demand wanes, new products enter the scene, and both fixed and variable costs are on the rise, while customers expect consistent service and quality at lower prices. Consequently, companies must focus on optimizing and continuously enhancing their production systems and maintenance approaches to fully utilize current production capabilities, lower operational costs, minimize production waste, and enhance quality to outpace competitors. The primary objective is to enhance production management to make the most of available production capacity. This can be realized by optimizing effective operations management and preventive maintenance strategies to decrease downtime while boosting performance and productivity without compromising quality, ultimately meeting production goals and customer satisfaction. A study conducted by Subramaniam, Husin, Yusop & Hamidon (2007) [30] highlights that the efficiency of industrial production systems is crucial as it leads to improved production and better use of available resources. Effective utilization of manpower and machine efficiency significantly contributes to the success of production systems. Management needs to seek out pertinent machine and production data and interpret this information correctly to pinpoint various issues at the production level and take actions to enhance efficiency. Strong operations management will reduce scheduled production halts and planned maintenance, as well as minimize starvation, blockages, short failures, and extended failures. Ineffective management of production can lead to inefficiencies within the production system and diminished production outcomes. Operations management should concentrate on areas such as improperly managed assembly lines, imbalance in production lines, issues with conveyor and buffer strategies, sensor speed difficulties, questions regarding production feasibility, inefficiencies among operators, machines operating below optimal speeds, loss occurrences, machinery failures, and a lack of effective cleaning and maintenance practices, including Cleaning, Inspection, Lubrication, and Tightening (CILT) techniques. These issues act as obstacles that hinder the efficiency of the production system. As noted by Rahman (1998) [26] in the theory of constraints, every system contains at least one limiting factor, with current constraints presenting avenues for potential improvement, while positive constraints play a crucial role in determining a system's functionality. It is essential to view these identified constraints as chances for enhancement, particularly in boosting existing production capacities that may be underused due to the constraints mentioned. Thus, these limitations should be the main focus for refining and optimizing production processes within companies, particularly concentrating on throughput. The theory also prompts researchers to uncover hidden bottlenecks, which represent further opportunities for advancement. Furthermore, Ramdeen and Pun (2005) [27] underscored the necessity for maintaining production machinery and equipment, as well as ensuring the availability of spare parts and raw materials, to make the best use of current production capacities. This aspect is vital to this research, which aims to guarantee that optimized systems have adequate supplies of raw materials and spare parts through effective operations management. Godwin and Achara (2013) [13] conducted research within the industry, revealing that manufacturers feel pressured to achieve their production goals in a competitive global market, with heavy industries facing profit losses of 30 to 40 percent annually due to unplanned downtimes caused by machine failures, breakdowns, and defects. For companies, implementing preventive maintenance strategies and refining operations management is essential for reducing downtime and enhancing current production capacities.

2. Materials

An in-depth examination was conducted regarding various processes on packaging line 1 over a span of 13 weeks, with a consistent one-shift-per-day schedule. This study aimed to document all instances of downtime, which includes machine downtime, external downtime, and planned downtime, categorizing these into four areas: Machine, Man, Materials, and Methods. Given the substantial nature of the downtime observed, a wide range of issues emerged that must be addressed to enhance production efficiency. Tackling every single problem could entail significant financial investment, so the focus shifted to resolving the most critical issues first. The objective was to identify which specific problems, when resolved, could yield a 70% improvement in overall production efficacy. To accomplish this, Pareto Analysis was utilized to prioritize potential solutions by pinpointing which issues would be alleviated by implementing these changes. This approach aids in ranking the individual adjustments that would markedly enhance the situation. The technique is based on the Pareto Principle, commonly known as the "80/20 Rule," which suggests that 20% of the causes lead to 80% of the outcomes. By addressing a mere 20% of the problems, almost identical results can be achieved as by resolving all issues. Tables 2.1 (Machine), 2.2 (Man), 2.3 (Material), and 2.4 (Method) illustrate the breakdown areas, planned, and external downtimes, while Table 2.5 provides a summary of the 4M from the 13 weeks concerning Materials, Machines, Men, and Methods, resulting in machine breakdowns, as well as external and planned downtimes. Additionally, Table 2.6 displays the contributions to machine breakdown, external downtime, and planned downtime.

Figure 2.1 shows the Pareto graph of contribution of 4M of 13 weeks studies while Figure 2.2 shows the Pareto graph of contributions of different areas.

Table 2.1: Analysis of Machine Downtime in the Packaging Line 1

The causes of downtime of machine, the external breakdown, planned breakdown along the packaging line 1 the area, minutes of downtime and frequencies per a shift of production.

LINE	DOWNTIME	ISSUES	4M	AREA	MINUTES	FREQ.
1	BOTTLE CONV,TRIPPED OFF(ELECTRICAL RESET)	Breakdown	MACHINE	Conveyors	25	1
1	AUTOMATION REPAIR @ EBI	Breakdown	MACHINE	EBI	30	1
1	EBI MALFUNCTION/ELECTRICAL REPAIR	Breakdown	MACHINE	EBI	75	3
1	EBI REJECTION/CLEANING	Breakdown	MACHINE	EBI	30	2
1	POWER FAILURE	External	MACHINE	Power failure	45	1
1	ELECTRICAL REPAIR @ EBI DISCH, CONV.	Breakdown	MACHINE	EBI	15	1
1	INCESSANT JAM @ EBI	Breakdown	MACHINE	EBI	40	2
1	POWER/AIR PRESSURE FAILURE	External	MACHINE	Power failure	60	1
1	LABEL CARRY OVER	External	MACHINE	Weathered bottles	140	5
1	COUNTER PRESSURE TRIP REPAIR	Breakdown	MACHINE	Filler	35	1
1	FILLER DISCH, CONV, HOOKED	Breakdown	MACHINE	Filler	25	1
1	LABEL CARRY OVER	External	MACHINE	Weathered bottles	70	4
1	LIFT CYLINDER REPAIR	Breakdown	MACHINE	Filler	15	1
1	PACKER INFEED CONV, DERAIL	Breakdown	MACHINE	Packer	40	1
1	SPEED LOSSES	Planned	MACHINE	Speed losses	126	1
1	REPAIR @ PACKER INFEED CONV,	Breakdown	MACHINE	Packer	40	1
1	ELECTRICAL REPAIR @ PASTEURIZER ZONE 4 PUMP	Breakdown	MACHINE	Pasteurizer	105	2
1	UNPACKER DISCHARGE FALLEN BOTTLES	Breakdown	MACHINE	Unpacker	25	1
1	ATTENDING TO SODA LEAKAGE @ WASHER COMPT 1 VALVE	Breakdown	MACHINE	Washer	60	2
1	FALLEN BOTTLES @ WASHER INFEED CONVERYOR	Breakdown	MACHINE	Washer	55	2
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	40	2
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	20	1
1	UNPACKER DISCHARGE CONV, DELAY	Breakdown	MACHINE	Unpacker	20	1
1	WASHER INFEED DISCH,JAM	Breakdown	MACHINE	Washer	15	1
1	EBI TRIPPED OFF	Breakdown	MACHINE	EBI	15	1
1	PACKER JAM	Breakdown	MACHINE	Packer	30	1
1	WORK @ FILLER WATER INJECTOR	Breakdown	MACHINE	Filler	45	2
1	WASHER JAM	Breakdown	MACHINE	Washer	25	1
1	PACKER GRAB ASSY	Breakdown	MACHINE	Packer	20	1
1	EX- UNPACKER DISCH CONV,DELAY	Breakdown	MACHINE	Unpacker	15	1
1	POWER FAILURE	External	MACHINE	Power Failure	30	1
1	JAM @ WASHER INFEED	Breakdown	MACHINE	Washer	50	2
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	75	3
1	POWER FAILURE	External	MACHINE	General	20	1
1	REPAIR UNPACKER BOTTLE SENSOR	Breakdown	MACHINE	Unpacker	25	1
1	EBI MALFUNCTION	Breakdown	MACHINE	EBI	50	1
1	UNPACKER DISCHARGE CONV, MALFUNCTION	Breakdown	MACHINE	Unpacker	20	1
1	PACKER GRAB ASSY,ADJ,	Breakdown	MACHINE	Packer	25	1
1	CONSTANT JAM @ WASHER DISCHARGE	Breakdown	MACHINE	Washer	30	2
1	ELECTRICAL REPAIR @ EBI	Breakdown	MACHINE	EBI	290	6
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	15	1
1	REPAIR @ FILLER DISCHARGE CONV,	Breakdown	MACHINE	Filler	20	1
1	PASTURIZER THERMAL OVERLOAD	Breakdown	MACHINE	Pasteurizer	40	1
1	PASTEURIZER ZONE 6 BURNT/REPAIR	Breakdown	MACHINE	Pasteurizer	240	4
1	PASTEURIZER THERMAL OVERLOAD	Breakdown	MACHINE	Pasteurizer	25	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	20	1
1	EBI MALFUNCTION REPAIR	Breakdown	MACHINE	EBI	65	2
1	ELECTRICAL REPAIR FILLER BOTTLE STOPPER	Breakdown	MACHINE	Filler	30	1
1	REPAIR @ FILLER DISCHARGE CONV.	Breakdown	MACHINE	Bottle Conveyor	15	1
1	ELECTRICAL REPAIR @ UNPACKER CRATE STOPPER	Breakdown	MACHINE	Unpacker	40	1
1	WORK ON HIGH PRESSURE PUMP HOSE @ WASHER	Breakdown	MACHINE	Washer	40	1
1	CONSANTANT JAM @ EBI OUT FEED	Breakdown	MACHINE	EBI	25	1
1	EBI JAM @ DISCHARGE	Breakdown	MACHINE	EBI	20	1
1	WASHER JAM @ DISCHARGE	Breakdown	MACHINE	Washer	20	1
1	WASHER OUT FEED JAM	Breakdown	MACHINE	Washer	35	1
1	ELECTRICAL REPAIR @ UNPACKER DISCH,ZONE CONV.	Breakdown	MACHINE	Unpacker	20	1
1	WORK @ UNDERFILLING VALVE	Breakdown	MACHINE	Filler	15	1
1	EBI CONSTANT JAM @ INFEED	Breakdown	MACHINE	EBI	15	1
1	CONSTANT JAM @ EBI/ELECTRICAL REPAIR	Breakdown	MACHINE	EBI	40	1
1	BOTTLE CONV, TRIPPED OFF	Breakdown	MACHINE	Bottle Conveyor	20	1
1	EBI MALFUNCTION/ELECT,REPAI	Breakdown	MACHINE	EBI	35	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	55	2

1	FULL BOTTLE CONV,TRIPPED OFF	Breakdown	MACHINE	Bottle Conveyor	20	1
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	30	2
1	WELDING OF BROKEN PACKER GRAB HEAD	Breakdown	MACHINE	Packer	25	1
1	LABELLER DISCHARGE CONV, TRIPPED OFF (ELECTRICAL)	Breakdown	MACHINE	Bottle Conveyor	100	2
1	LABELLER GRIPPER ADJUSTMENT	Breakdown	MACHINE	Labeller	15	1
1	LABELLER INFEED CONV, SENSOR	Breakdown	MACHINE	Labeller	50	3
1	MALFUNCTION OF ELECT, SWITCH @ LABELLER	Breakdown	MACHINE	Labeller	20	1
1	ELECTRICAL WORK @ LASER JET	Breakdown	MACHINE	Laser Jet	40	2
1	WASHER FREQUENT JAM	Breakdown	MACHINE	Washer	80	4
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	20	1
1	UNPACKER DISCHARGE CONV, DELAY	Breakdown	MACHINE	Unpacker	40	2
1	EBI INFEED JAM/CLEANING	Breakdown	MACHINE	EBI	15	0
1	EBI MALFUNCTION ELECTRICAL REPAIR	Breakdown	MACHINE	EBI	75	3
1	UNPACKER DISCH, CONV, DELAY	Breakdown	MACHINE	Crate Conveyor	20	1
1	PACKER GRAB ASSY, ADJUSTMENT	Breakdown	MACHINE	Packer	30	1
1	ELECTRICAL REPAIR @ UNPACKER INDEXING CONN,	Breakdown	MACHINE	Unpacker	25	1
1	LASER JET OVER HEATING/ELECT,REPAIR	Breakdown	MACHINE	Laser Jet	105	5
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	90	3
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	20	1
1	EBI BOTTLE JAM	Breakdown	MACHINE	EBI	20	1
1	WASHER JAM @ DISCHARGE	Breakdown	MACHINE	Washer	25	1
1	CONSTANT JAM @ INLINER	Breakdown	MACHINE	Inliner	15	1
1	WASHER JAM @ INFEED	Breakdown	MACHINE	Washer	15	1
1	LABELLER INLINER JAM	Breakdown	MACHINE	Labeller	15	1
1	EBI JAM	Breakdown	MACHINE	EBI	15	1
1	POOR LUBRICATION	Breakdown	MACHINE	Lubrication Failure	25	1
1	WASHER JAM @ DISCHARGE	Breakdown	MACHINE	Washer	25	1
1	FAULTY COUNTER	Breakdown	MACHINE	Filler	35	1
1	EBI MALFUNCTION(|ELECTRICAL)	Breakdown	MACHINE	EBI	15	1
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	30	1
1	WASHER DISCHARGE JAM/WASHER SLOW SPEED	Breakdown	MACHINE	Washer	90	4
1	WASHER DISCARGE JAM	Breakdown	MACHINE	Washer	35	2
1	WASHER INFEED FINGER DELAY	Breakdown	MACHINE	Washer	25	1
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	55	2
1	ELECTRICAL REPAIR @ EBI	Breakdown	MACHINE	EBI	40	2
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	70	3
1	CROWNER DISCHARGE GUIDE REPAIR	Breakdown	MACHINE	Crowner	50	1
1	ELECTRICAL WORK 2 LASER JET	Breakdown	MACHINE	Laser Jet	40	1
1	CHANGE OF BAD CENTRING HEAD	Breakdown	MACHINE	Labeller	35	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	90	3
1	ELECTRICAL REPAIR @ EBI	Breakdown	MACHINE	EBI	25	1
1	EBI MALFUNCTION	Breakdown	MACHINE	EBI	15	1
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	45	2
1	EBI HIGH REJECTION	Breakdown	MACHINE	EBI	15	1
1	REPAIR ON CROWNER THROAT	Breakdown	MACHINE	Crowner	20	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	60	3
1	WASHER SLOW SPEED RUN	Breakdown	MACHINE	Washer	45	2
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	95	3
1	PACKER GRAB REPAIR	Breakdown	MACHINE	Packer	40	2
1	WORK ON CLOSING PLUNGER	Breakdown	MACHINE	Filler	20	1
1	PACKER GRAB DELAY	Breakdown	MACHINE	Packer	35	2
1	LABELLER TRIP OFF BY CODING SYSTEM	Breakdown	MACHINE	Labeller	15	1
1	LASER JET OVERHEATING (ELECTRICAL	Breakdown	MACHINE	Laser Jet	30	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	15	1
1	REPAIR LOADERS CONVERYOR	Breakdown	MACHINE	Crate Conveyor	35	2
1	FILLER INFEED CONV, REPAIRS	Breakdown	MACHINE	Filler	85	2
1	REPLACEMENT OF FILLER INFEED CONV,CHAIN	Breakdown	MACHINE	Filler	60	1
1	WASHER DISCH,JAM	Breakdown	MACHINE	Washer	30	2
1	PACKER BOTTLE LANE DELAY	Breakdown	MACHINE	Packer	25	2
1	EBI FINE TURNING	Breakdown	MACHINE	EBI	50	2
1	ELECTRICAL REPAIR @ EBI	Breakdown	MACHINE	EBI	40	2
1	WORK ON FILLER INFEED CONV, DRIVE	Breakdown	MACHINE	Filler	40	1
1	EBI CONSTANT JAM @ EBI	Breakdown	MACHINE	EBI	20	1
1	FINE TURNING OF EBI	Breakdown	MACHINE	EBI	50	3
1	WASHER SLOW SPEED RUN	Breakdown	MACHINE	Washer	65	4
1	FAULTY BOTTLE CONV, SENSOR TO LABELLER	Breakdown	MACHINE	Labeller	30	1
1	ELECTRICAL WORK ON LASER JET	Breakdown	MACHINE	Laser Jet	45	1

1	BROKEN PLUNGERS REPAIR	Breakdown	MACHINE	Filler	30	2
1	WEATHERED BOTTLES/REJECTION	External	MACHINE	Weathered Bottles	50	2
1	ELECTRICAL WORK ON LASER JET	Breakdown	MACHINE	Laser Jet	45	1
1	BROKEN PLUNGERS REPAIR	Breakdown	MACHINE	Filler	30	2
1	EBI MALFUNCTION/ELECTRICAL REPAIRS	Breakdown	MACHINE	EBI	40	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	35	1
1	EX- FILLER CONV, TRIPPED OFF	Breakdown	MACHINE	Filler	45	2
1	EBI HIGH REJECTION	Breakdown	MACHINE	EBI	30	2
1	EBI DISCH JAM	Breakdown	MACHINE	EBI	15	1
1	FILLER INFEED CONVERYOR PULL OUT / BAD LINK/REPAIR	Breakdown	MACHINE	Filler	40	2
1	WASHER SLOW SPEED RUN	Breakdown	MACHINE	Washer	40	2
1	EBI HIGH REJECTION	Breakdown	MACHINE	EBI	30	2
1	ELECTRICAL WORK @ LASER JET	Breakdown	MACHINE	Laser Jet	50	1
1	WASHER INFEED JAM	Breakdown	MACHINE	Washer	50	3
1	LIFT CYLINDER HOSE PULLED OUT /REPAIR	Breakdown	MACHINE	Filler	35	1
1	ELECT, REPAIR @ EBI	Breakdown	MACHINE	EBI	50	1
1	CONSTANT TRIPPING OFF FBI	Breakdown	MACHINE	FBI	90	2
1	FILLER DISCH , CONV,/GUIDE REPAIRS	Breakdown	MACHINE	Bottle Conveyor	30	1
1	WASHER DISCH, JAM	Breakdown	MACHINE	Washer	35	1
1	ELECT, REPAIR PAST,TEMPERATURE	Breakdown	MACHINE	Pasteurizer	30	2
1	ELECTRICAL REPAIR @ EBI	Breakdown	MACHINE	EBI	50	1
1	ALL CONVERYOR TRIP OFF	Breakdown	MACHINE	Bottle Conveyor	30	1
1	REPAIR @ CYLINDER NO 25	Breakdown	MACHINE	Filler	80	2
1	REPAIR @ CYLINDER NO 60	Breakdown	MACHINE	Filler	60	1
1	ELECTRICAL REPAIRS @ EBI	Breakdown	MACHINE	EBI	80	2
1	REPAIR LOADERS CONV,	Breakdown	MACHINE	Crate Conveyor	45	1
1	UNPACKER CRATE CONV, REPAIR	Breakdown	MACHINE	Unpacker	20	1
1	EBI REJECTIN /ELECTRICAL REPAIR	Breakdown	MACHINE	EBI	65	3
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	45	2
1	PASTEURIZER TRIPPED OFF	Breakdown	MACHINE	Pasteurizer	50	1
1	EBI HIGH REJECTION	External	MACHINE	Weathered Bottles	35	2
1	LOADER CONVERYOR REPAIRS	Breakdown	MACHINE	Crate Conveyor	60	1
1	EBI MALFUNCTION/ELECTRICAL REPAIRS	Breakdown	MACHINE	EBI	30	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	90	4
1	LIFT CYLINDER PRESSURE HOSE PULL OFF	Breakdown	MACHINE	Filler	15	1
1	EBI HIGH REJECTION	Breakdown	MACHINE	EBI	15	1
1	LABELLER INFEED CONV, SPEED DROP (ELECT).	Breakdown	MACHINE	Labeller	15	1
1	LASER JET TRIPPED OFF	Breakdown	MACHINE	Laser Jet	60	1
1	WASHER DISCH, JAM	Breakdown	MACHINE	Washer	65	4
1	WASHER SLOW SPEED RUN	Breakdown	MACHINE	Washer	25	1
1	REPAIR @ FILLER DISCH, BOTTLE GUIDE	Breakdown	MACHINE	Filler	20	1
1	FILLER TRIPPED OFF	Breakdown	MACHINE	Filler	25	1
1	ELETRICAL REPAIR @ EBI	Breakdown	MACHINE	EBI	80	2
1	CONSTANT JAM @ EBI	Breakdown	MACHINE	EBI	30	2
1	EBI CONSTANT JAM	Breakdown	MACHINE	EBI	50	4
1	EBI TRIPPED OFF	Breakdown	MACHINE	EBI	20	1
1	FREQUENT JAM @ EBI	Breakdown	MACHINE	EBI	55	1
1	ELECTRICAL REPAIR @ PACKER CRATE STOPPER	Breakdown	MACHINE	Packer	190	6
1	ELECTRICAL REPAIR @ PACKER	Breakdown	MACHINE	Packer	25	1
1	PACKER MALFUNCTIONING(ELECT	Breakdown	MACHINE	Packer	30	2
1	WORK @ PACKER CRATE STPPER	Breakdown	MACHINE	Packer	60	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	20	1
1	LASER JET REPAUR(ELECT)	Breakdown	MACHINE	Laser Jet	15	1
1	ELECT, REPAIR @ PACKER CRATE STOPPER	Breakdown	MACHINE	Packer	40	1
1	WASHER JAM	Breakdown	MACHINE	Washer	20	1
1	EBI REJECTION	Breakdown	MACHINE	EBI	40	4
1	EBI INFEED JAM	Breakdown	MACHINE	EBI	30	3
1	ELECTRICAL REPAIR @ PACKER CRATE STOPPER	Breakdown	MACHINE	Packer	25	1
1	ELECTRICAL WORK @ PACKER	Breakdown	MACHINE	Packer	20	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	25	2
1	CONSTANT JAM @ EBI INFEED	Breakdown	MACHINE	EBI	15	1
1	EBI MALFUNCTION/ELECTRICAL ADJ	Breakdown	MACHINE	EBI	60	1
1	EBI TRIPPED OFF/ELECTRICAL REPAIRS	Breakdown	MACHINE	EBI	50	1
1	WELDING @ PACKER CENTRING RACK	Breakdown	MACHINE	Packer	50	1
1	PAST, NO 5 MOTOR TRIPPED OFF	Breakdown	MACHINE	Pasteurizer	110	3
1	EBI TRIPPED OFF	Breakdown	MACHINE	EBI	70	2
1	EBI MALFUNCTION	Breakdown	MACHINE	EBI	30	1

1	WORK @ INLINER CONV, (ELECTRICAL|)	Breakdown	MACHINE	EBI	70	2
1	REPAIR @ INFEED PHOTO CELL	Breakdown	MACHINE	Packer	40	1
1	UNPACKER DISCH CONV, DELAY	Breakdown	MACHINE	Unpacker	35	2
1	BEER PUMP TRIPPED (ELECTRICAL|)	Breakdown	MACHINE	Filler	25	1
1	WASHER JAM @ INFEED	Breakdown	MACHINE	Washer	30	2
1	ELECTRICAL REPAIRS @ LASER JET	Breakdown	MACHINE	Laser jet	30	1
1	EBI HIGH REJECTION	External	MACHINE	Weather Bottles	20	1
1	OPENING PLUNGER PULLED OUT	Breakdown	MACHINE	Filler	45	3
1	REPAIR @ FILLER INFEED CONV,	Breakdown	MACHINE	Filler	100	2
1	REPAIR @ LABELLER OIL PUMP	Breakdown	MACHINE	Labeller	90	2
1	PACKER GRAB ASSY,	Breakdown	MACHINE	Packer	30	1
1	ELECTRICAL REPAIR @ EBI	Breakdown	MACHINE	EBI	105	3
1	WORK ON FILLER DIX TRANSFER PLATE	Breakdown	MACHINE	Filler	15	1
1	EBI BOTTLE DETECTOR	Breakdown	MACHINE	EBI	25	1
1	EBI MALFUCTION/ELECT.REPAIR	Breakdown	MACHINE	EBI	70	2
1	WORK ON LIFT CYLINDER	Breakdown	MACHINE	Filler	80	2
1	WORK ON PACKER BOTTLE LANE	Breakdown	MACHINE	Packer	40	1
1	WASHER DISCHARGE JAM	Breakdown	MACHINE	Washer	20	1
1	ELECTRICAL REPAIR @ EBI	Breakdown	MACHINE	EBI	25	1
1	CONSTANT BOTTLE JAM @ INFEED EBI	Breakdown	MACHINE	EBI	20	1
1	CONSTANT BOTTLE JAM @ DISCH EBI	Breakdown	MACHINE	EBI	30	1
1	UNPACKER DISCH BOTTLE GUIDE PULLED OFF	Breakdown	MACHINE	Unpacker	40	2
1	ELECTRICAL REPAIR @ EBI	Breakdown	MACHINE	EBI	150	3
1	ELECTRICAL REPAIRS UNPACKER CRATES STOPPER	Breakdown	MACHINE	Unpacker	60	1
1	WASHER SODA HOSE PULL OUT	Breakdown	MACHINE	Washer	20	1
1	EBI CONSTANT TRIPPED OFF	Breakdown	MACHINE	EBI	60	1
1	PACKER MAIN DRIVE TRIPPED OFF	Breakdown	MACHINE	Packer	15	1
1	INLINER CONV, TRIPPED OFF	Breakdown	MACHINE	EBI	30	1
1	ELECTRICAL WORK ON EBI	Breakdown	MACHINE	EBI	410	6
1	EBI HIGH REJECTION	Breakdown	MACHINE	EBI	90	5
1	ELECT, REPAIR @ EBI	Breakdown	MACHINE	EBI	65	3
1	QUALITY CONTROL CHECK @ WASHER	Breakdown	MACHINE	Washer	30	1
1	SODA ADDITION/FLUSHING OF ROTARY DRUMS @ WASHER	Breakdown	MACHINE	Washer	25	1
1	EBI REJECTION	Breakdown	MACHINE	EBI	15	1
1	RING TANK DRYING	Breakdown	MACHINE	Filler	35	2
1	LABEL CARRY OVER/EBI REJECTION	Breakdown	MACHINE	EBI	40	3
1	WASHER MAIN DRIVE CHAIN REPAIR	Breakdown	MACHINE	Washer	50	1
1	DRYING OF RING TANK	Breakdown	MACHINE	Filler	20	2
1	JAM @ WASHER INFEED	Breakdown	MACHINE	Washer	30	2
1	EBI HIGH REJECTION	Breakdown	MACHINE	EBI	30	2
1	PACKER GRAB ASSY, ADJ.	Breakdown	MACHINE	Packer	50	2
1	EBI INFEED CONSTANT JAM	Breakdown	MACHINE	EBI	70	2
1	WASHER JAM INFEED	Breakdown	MACHINE	Washer	75	3
1	UNPACKER GRAB ASSY ADJ.	Breakdown	MACHINE	Unpacker	55	2
1	BOTTLE JAM @ EBI(ELECTRICAL)	Breakdown	MACHINE	EBI	60	2
1	EBI MALFUNCTION (ELECTRICAL)	Breakdown	MACHINE	EBI	60	3
1	CONSTANT JAM @ WASHER DISCH	Breakdown	MACHINE	Washer	80	4
1	GAP FOR PERIOD END ACCONUT	Plan Stop	MACHINE	Period end account	45	1
1	EBI MASSIVE REJECTION	Breakdown	MACHINE	EBI	45	2
1	UNPACKER INDEXIING CONV, REPAIR	Breakdown	MACHINE	Unpacker	35	2
1	EBI MASSIVE REJECTION	Breakdown	MACHINE	EBI	25	1
1	ELECT WORK @ EBI	Breakdown	MACHINE	EBI	25	1
1	INLINER CONV,MALFUNCTION	Breakdown	MACHINE	Inliner	45	2
1	REPAIR @ UNPACKER GRAB ASSY	Breakdown	MACHINE	Unpacker	75	2
1	WASHER DISCH GUIDE HOOKED	Breakdown	MACHINE	Washer	20	1
1	REPAIR @ UNPACKER DISCH CONV,	Breakdown	MACHINE	Unpacker	40	1
1	EBI DISCHARGE CONV, CONSTANT JAM	Breakdown	MACHINE	EBI	40	1
1	EBI ELECTRICAL REPAIR	Breakdown	MACHINE	EBI	50	1
1	EBI HIGH REJECTION	Breakdown	MACHINE	EBI	60	3

Table 2.2: Analysis of Downtime Due to Man's Activities in the Packaging Line 1

The causes of breakdown, planned stops, the external breakdown, planned breakdown along the packaging line 1 the area, minutes of downtime and frequencies per a shift of production.

LINE	DOWNTIME	ISSUES	4M	AREA	MINUTES	FREQ.
1	FORKLIFT DELAY (GAS)	External	MAN	Forklift Delay	105	4
1	GENERAL LINE CLEANING	Planned	MAN	Cleaning	45	1
1	GENERAL LINE CLEANING	Planned	MAN	Cleaning	45	1

1	GENERAL LINE CLEANING	Planned	MAN	Cleaning	45	1
1	GENERAL LINE CLEANING	Planned	MAN	Cleaning	25	1
1	WORK ON WASHER MAIN DRIVE CHAIN	Breakdown	MAN	Washer	20	1
1	SPEED LOSSES	Planned	MAN	Speed losses	126	1
1	SPEED LOSSES	Planned	MAN	Speed losses	126	1
1	SPEED LOSSES	Planned	MAN	Speed losses	126	1
1	SPEED LOSSES	Planned	MAN	Speed losses	126	1
1	SPEED LOSSES	Planned	MAN	Speed losses	126	1
1	START UP	Planned	MAN	Start up	60	0
1	START UP	Planned	MAN	Start up	60	1
1	CLEANING	Plan Stops	MAN	Cleaning	60	1
1	PLANNED STOP FOR WORK ON AIR LINE	Plan Stops	MAN	Air Line Modification	85	2
1	CLEANING	Plan Stops	MAN	Cleaning	60	1
1	CHANGE OF BBT/CLOUDY/FLUSHING	Plan Stops	MAN	BBT	60	1
1	CLEANING	Plan Stops	MAN	Cleaning	60	3
1	CHANGE OVER TO PEAR	Plan Stop	MAN	Change Over	60	1
1	LINE CLEANING	Plan Stop	MAN	Cleaning	45	1
1	WORK ON STIFFED CROWNER THROAT	Breakdown	MAN	Crowner	15	1
1	CRMPT TEST	Plan Stop	MAN	Quality Check	15	1
1	PLANNED STOP	Plan Stop	MAN	Cleaning	25	1
1	CHANGE OVER TO FAYROUZ	Plan Stop	MAN	Change Over	60	1
1	CHANGE OVER TO FAYROUZ	Plan Stop	MAN	Change Over	120	2
1	CHANGE OVER TO MALTINA	Plan Stop	MAN	Change Over	60	1
1	CHANGE OF FILLING TUBES	Plan Stop	MAN	Change Over	35	1
1	CHANGE OF FILLING TUBES	Plan Stop	MAN	Change Over	35	1
1	CHANGE OVER TO MALTINA	Plan Stop	MAN	Change Over	60	1
1	RELOADING OF WASHER	Plan Stop	MAN	Washer	70	2
1	FORKLIFT DELAY	External	MAN	Forklift	25	1
1	RUNING OUT	Plan Stop	MAN	Runing Out	0	0
1	EBI DISCH, JAM/CLEANING	Breakdown	MAN	EBI	35	2
1	MORNING CLEANING	Plan Stop	MAN	Cleaning	60	1
1	PLANNED MAINTENANCE	Plan Stop	MAN	Maintenance	540	1
1	START UP	Plan Stop	MAN	Start Up	60	1
1	MORNING CLEANING	Plan Stop	MAN	Cleaning	35	1
1	MORNING CLEANING	Plan Stop	MAN	Cleaning	55	2
1	FINAL RINSE CLEANING	Plan Stop	MAN	Cleaning	20	1
1	LINE CLEANING	Plan Stop	MAN	Cleaning	20	1
1	LINE CLEANING	Plan Stop	MAN	Cleaning	30	1
1	CHANGE OVER TO MALTINA	Plan Stop	MAN	Change over	120	1
1	LINE CLEANING	Plan Stop	MAN	Cleaning	30	1
1	GENERAL CLEANING	Plan Stop	MAN	Cleaning	30	1
1	RING TANK DRYING/GAFF FILTER CLEANING	External	MAN	Powder Carry Over	20	1
1	GENERAL CLEANING	Plan stop	MAN	Cleaning	30	1
1	GENERAL CLEANING	Plan stop	MAN	Cleaning	60	1
1	EBI REJECTION /CLEANING	Breakdown	MAN	EBI	75	5
1	GENERAL LINE CLEANING	Plan Stop	MAN	Cleaning	40	1

Table 2.3: Analysis of Downtime Due to Materials in the Packaging Line 1

The causes of breakdown, the external breakdown, along the packaging line 1 the area, minutes of downtime and frequencies per a shift of production.

LINE	DOWNTIME	ISSUES	4M	AREA	MINUTES	FREQ.
1	NO PALLET	External	MATERIAL	No pallet	35	2
1	LABEL CARRY OVER	External	MATERIAL	Weathered bottles	70	3
1	LABEL CARRY OVER/EVACUATION	External	MATERIAL	Weathered bottles	255	7
1	LABEL CARRY OVER/REJECTION	External	MATERIAL	Weathered bottles	125	4
1	WEATHERED BOTTLES/EVACUATION	External	MATERIAL	Weathered bottles	60	3
1	WEATHERED BOTTLES/REJECTION/EVACUATION	External	MATERIAL	Weathered bottles	95	3
1	LABEL CARRY OVER/HIGH REJECTION	External	MATERIAL	Weathered Bottles	80	4
1	WEATHERED BOTTLES/EVACUATION	External	MATERIAL	Weathered Bottles	210	7
1	EVACUATION OF WEATHERED BOTTLES	External	MATERIAL	Weathered Bottles	265	4
1	LABEL CARRY OVER	External	MATERIAL	Weathered Bottles	60	2
1	LABEL CARRY OVER /EBI REJECTION	External	MATERIAL	Weathered Bottles	143	3
1	EBI HIGH REJECTION	External	MATERIAL	EBI	45	2
1	EVACUATION OF WEATHERED BOTTLES	External	MATERIAL	Weathered Bottles	75	3
1	EBI REJECTION	Breakdown	MATERIAL	EBI	25	1
1	FAULTY BOTTLE COUNTER	Breakdown	MATERIAL	Filler	25	1
1	NO AIR	External	MATERIAL	Low Air Pressure	25	1
1	NO POWER	External	MATERIAL	Power Failure	40	1

1	LABEL CARRY OVER	External	MATERIAL	Weathered Bottles	70	3
1	FREQUENT FALLEN BOTTLE @ EBI INFEED	Breakdown	MATERIAL	EBI	80	3
1	LABEL CARRY OVER/EVACUATION/REJECTION	External	MATERIAL	Weathered Bottles	260	8
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	80	4
1	WEATHERED BOTTLES/EBI JAM	External	MATERIAL	Weathered Bottles	220	9
1	LABEL CARRY OVER/HIGH REJECTION	External	MATERIAL	Weathered Bottles	55	2
1	EVACUATION OF WEATHERED BOTTLES	External	MATERIAL	Weathered Bottles	55	2
1	NEW BBT FOAM CONTRL	Breakdown	MATERIAL	Foam Control	15	1
1	LABEL CAYY OVER/EVACUATION/HIGH REJECTION	External	MATERIAL	Weathered Bottles	160	6
1	NEW BBT/FOAM CONTROL	Breakdown	MATERIAL	Foam Control	20	1
1	EVACUATION OF DIRTY BOTTLES	External	MATERIAL	Weathered Bottles	50	2
1	LABEL CARRY OVER /EBI HIGH REJECTION	External	MATERIAL	Weathered Bottles	175	7
1	LOW AIR PRESSURE	External	MATERIAL	Low Air Pressure	15	1
1	WEATHERED BOTTLES /REJECTION	External	MATERIAL	Weathered Bottles	65	3
1	WEATHERED BOTTLES/EVACUATION	External	MATERIAL	Weathered Bottles	50	3
1	LABEL CARRY OVER	External	MATERIAL	Weathered Bottles	20	1
1	FOAM CONTROL	Breakdown	MATERIAL	Foam Control	65	5
1	POWER FAILURE	External	MATERIAL	Power Failure	15	1
1	WEATHERED BOTTLES /REJECTION	External	MATERIAL	Weathered Bottles	30	1
1	WEATHERED BOTTLES /REJECTION	External	MATERIAL	Weathered Bottles	170	5
1	NO READY FAYROUZ	External	MATERIAL	No Ready Product	360	6
1	NO READY FAYROUZ	External	MATERIAL	No Ready Product	360	1
1	LABEL CARRY OVER	External	MATERIAL	Weathered Bottles	65	3
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	70	3
1	LABEL CARRY OVER/HIGH REJECTION	External	MATERIAL	Weathered Bottles	155	5
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	90	3
1	LABEL CARRY OVER/REJECTION	External	MATERIAL	Weathered Bottles	105	5
1	AIR PRESSURE FAILURE @ UTILITIES	External	MATERIAL	Low Air Pressure	20	1
1	NO AIR	External	MATERIAL	Low Air Pressure	20	1
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	40	2
1	LABEL CARRY OVER /REJECTION	External	MATERIAL	Weathered Bottles	95	3
1	NO READY MALTINA	External	MATERIAL	No Ready Product	105	3
1	EVACUATION OF DIRTY BOTTLES	External	MATERIAL	Weathered Bottles	40	1
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	15	1
1	NO READY MALTINA	External	MATERIAL	No Ready Product	1440	0
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	40	2
1	LABEL CARRY OVER /EBI REJECTION	External	MATERIAL	Weathered Bottles	170	6
1	LOW AIR PRESSURE	External	MATERIAL	Low Air Pressure	25	1
1	LABEL CARRY OVER /EBI REJECTION	External	MATERIAL	Weathered Bottles	125	5
1	CHECKS CARRIED OUT ON FILLER	Breakdown	MATERIAL	Filler	50	1
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	50	2
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	225	10
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	205	7
1	FOAM CONTROL	External	MATERIAL	Foam Control	50	2
1	NO AIR PRESSURE	External	MATERIAL	Low Air Pressure	20	1
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	40	2
1	LABEL CARRY /EVACUATION	External	MATERIAL	Weathered Bottles	125	5
1	LABEL CARRY OVER/EVACUATION	External	MATERIAL	Weathered Bottles	50	2
1	WEATHERED BOTTLES/EVACUATION	External	MATERIAL	Weathered Bottles	425	8
1	LABEL CARRY OVER	External	MATERIAL	Weathered Bottles	20	1
1	WEATHERED BOTTLES/REJECTION	External	MATERIAL	Weathered Bottles	80	4
1	NO BLOW OFF PLUNGER	Breakdown	MATERIAL	Filler	60	2
1	PRODUCT HIGH FOAMING/CONTROL	External	MATERIAL	High Temp	60	2
1	WEATHERED BOTTLES /REJECTION	External	MATERIAL	Weather bottle	85	3
1	LABEL CARRY OVER	Breakdown	MATERIAL	Labeller	130	4
1	WEATHERED BOTTLES /REJECTION	External	MATERIAL	Weather bottle	90	4
1	WEATHERED BOTTLES /REJECTION	External	MATERIAL	Weather bottle	90	3
1	NO READY MALTINA	External	MATERIAL	No Ready Product	420	7
1	RING TANK DRYING	External	MATERIAL	Poweder Carry Over	20	1
1	LABEL CARRY OVER /HIGH REJECTION	External	MATERIAL	Weather Bottle	50	2
1	WEATHERED BOTTLES/HIGH REJECTION	External	MATERIAL	Weather Bottle	30	3
1	EVACUATION OF DIRTY BOTTLES FROM WASHER	External	MATERIAL	Weather Bottle	25	1
1	WEATHERED BOTTLES/EVACUATION	External	MATERIAL	Weather Bottle	290	13
1	WEATHERED BOTTLES/HIGH REJECTION	External	MATERIAL	Weather Bottle	50	3
1	PRODUCT HIGH FOAMING /CONTROL	External	MATERIAL	High Temp	145	6
1	WEATHERED BOTTLES/HIGH REJECTION	External	MATERIAL	Weather Bottle	65	3
1	EBI MASSIVE REJECTION	External	MATERIAL	Weather Bottles	115	4
1	FALLEN BOTTLE @ UNPACKER DISCH CONV.	Breakdown	MATERIAL	Unpacker	50	2
1	WEATHERED BOTTLES/EBI REJECTION	External	MATERIAL	Weather Bottles	105	4
1	WEATHERED BOTTLES/EBI REJECTION	External	MATERIAL	Weather Bottles	185	10
1	GENERAL POWER FAILURE	External	MATERIAL	Power Failure	80	2

1	WEATHERED BOTTLES/ EBI REJECTION	External	MATERIAL	Weather Bottles	120	5
1	WEATHERED BOTTLES/ EBI REJECTION	External	MATERIAL	Weather Bottles	90	5
1	EBI MASSIVE REJECTION	External	MATERIAL	Weather Bottles	25	2
1	NO READY MALTINA	External	MATERIAL	No Ready Product	390	7
1	EBI HIGH REJECTION	External	MATERIAL	Weather Bottles	50	5
1	NO READY FAYROUZ	External	MATERIAL	No Ready Product	960	16
1	WEATHERED BOTTLES EVACUATION	External	MATERIAL	Weathered Bottles	25	1
1	WEATHERED BOTTLES/EBI REJECTION	External	MATERIAL	Weathered Bottles	350	13
1	LABEL CARRY OVER EBI HIGH REJECTION	External	MATERIAL	Weathered Bottles	50	2
1	NO READY FAYROUZ	External	MATERIAL	No Ready Product	165	3
1	WEATHERED BOTTLES EBI REJECTION	External	MATERIAL	Weathered Bottles	110	5
1	EBI MASSIVE REJECTION	External	MATERIAL	Weathered Bottles	45	3
1	NO READY MALTINA	External	MATERIAL	No Ready Product	300	5
1	WEATHERED BOTTLES /EBI REJECTION	External	MATERIAL	Weathered Bottles	105	4
1	FOAM CONTROL	External	MATERIAL	Foaming	40	1
1	PRODUCT HIGH TEMPERATURE	External	MATERIAL	High Temp	35	2
1	NO READY MALTINA	External	MATERIAL	No Ready Product	30	1
1	WEATHERED BOTTLES/EBI REJECTION	External	MATERIAL	Weathered Bottles	45	2
1	NO POWER	External	MATERIAL	Power	40	1
1	LABEL CARRY OVER	Breakdown	MATERIAL	Washer	50	2
1	VERY DIRTY BOTTLES WASHER DISCH	Breakdown	MATERIAL	Washer	95	2
1	WEATHERED BOTTLES/EBI HIGH REJECTION	External	MATERIAL	Weathered Bottles	50	2
1	PRODUCT HIGH FOAMING CONTROL	Breakdown	MATERIAL	Filler	30	2
1	WEATHERED BOTTLES,EBI REJECTION	External	MATERIAL	Weathered Bottles	50	3
1	PRODUCT HIGH TEMPERATURE	External	MATERIAL	Temperature	110	7
1	NO READY MALTINA	External	MATERIAL	No Ready Beer	195	4
1	PRODUCT TEMPERATURE	External	MATERIAL	Temperature	45	3
1	EVACUATION OF WEATHERED	External	MATERIAL	Weathered Bottles	35	2
1	FOAM CONTROL	Breakdown	MATERIAL	Filler	25	2
1	WEATHERED BOTTLES EVACUATION	External	MATERIAL	Weathered Bottles	130	5
1	NO READY MALTINA	Plan stop	MATERIAL	No Ready Beer	60	1
1	PRODUCT HIGH TEMPERATURE	External	MATERIAL	Temperature	105	6
1	NEW BBT /PRODUCT HIGH TEMPERATURE	External	MATERIAL	Temperature	40	2
1	WEATHERED BOTTLES/EBI REJECTION	External	MATERIAL	Weathered Bottles	85	5
1	NO READY FAYROUZ	External	MATERIAL	No Fayrouz	60	1
1	LOW HOT WATER TEMPERATURE	Breakdown	MATERIAL	Pasteurizer	120	2
1	PARTICULES IN PRODUCT @ BBT	External	MATERIAL	Particle	60	1
1	PRODUCT HIGH TEMPERATURE FROM B/H	External	MATERIAL	Temperature	50	3
1	WEATHERED BOTTLES @ WASHER	External	MATERIAL	Weather Bottles	80	4
1	LABEL CARRY OVER SLOW SPEED RUN	Breakdown	MATERIAL	Labeller	40	2
1	RUNING OUT OF FAYROUZ APPLE	Plan Stop	MATERIAL	No Fayrouz	40	1
1	FOAM CONTROL	Breakdown	MATERIAL	Filler	25	1
1	WEATHERED BOTTLES/EBI HIGH REJECTION	External	MATERIAL	Weather Bottles	90	3
1	FOAM CONTROL /SLOW SPEED	Breakdown	MATERIAL	Filler	30	3
1	MASSIVE BOTTLE FALL @ WASHER INFEED	External	MATERIAL	Weather Bottles	25	1

Table 2.4: Analysis of Breakdown Due to Method in the Packaging Line 1

The causes of breakdown, along the packaging line 1 the area, minutes of downtime and frequencies per a shift of production.

LINE	DOWNTIME	ISSUES	4M	AREA	MINUTES	FREQ.
1	EBI Electrical Adjustment	Breakdown	METHOD	EBI	20	1
1	Product High Temp	External	METHOD	BBT	30	2
1	Electrical Adjustmemt @ EBI	Breakdown	METHOD	EBI	50	2
1	Adjustment of Lift Cylinder	Breakdown	METHOD	Filler	15	1
1	Change Of Broken Pulled Down Cam	Breakdown	METHOD	Filler	120	3
1	CHANG OVER TO PEAR	Planned	METHOD	Change over	60	1
1	LIFT CYLINDER HOSE PULLED OFF	Breakdown	METHOD	Filler	20	1
1	LABELLER GRIPPER CYLINDER ADJUSTMENT	Breakdown	METHOD	Labeler	25	1
1	LABELLER MAGAZINE ADJUSTMENT	Breakdown	METHOD	Labeler	60	2
1	ADJUSMENT @ PACKER GRAB ASSY	Breakdown	METHOD	Packer	60	1
1	ADJUSTMENT OF PACKER GRAB	Breakdown	METHOD	Packer	20	4
1	ALIGHMENT OF PACKER INFEED CONV,	Breakdown	METHOD	Packer	20	1
1	PACKER GRAB ASSY	Breakdown	METHOD	Packer	25	1
1	FILLING PLUNGER ADJUSTMENT	Breakdown	METHOD	Filler	15	1
1	ELECTRICAL ADJUSTMENT @ EBI TRIGGER	Breakdown	METHOD	EBI	50	2
1	ADJUSTMENT LABELLER MAGAZINE	Breakdown	METHOD	Labeller	15	1
1	WORK @ PULLED OUT COUNTER PRESSURE HOSE	Breakdown	METHOD	Washer	20	1
1	WORK ON COMPT, 3 SODA HOSE	Breakdown	METHOD	Washer	25	1
1	WORK @ PACKER CENTRING RACK	Breakdown	METHOD	Packer	70	2

1	ADJ, COUNTER PRESSURE PLUNGER	Breakdown	METHOD	Filler	25	1
1	WELDING OF PACKER CENTRING RACK	Breakdown	METHOD	Packer	30	1
1	EBI REPLACEMENT OF BROKEN BASE INSPECTION GLASS	Breakdown	METHOD	EBI	30	1
1	CHANGE OF COMPT, 3 SODA HOSE	Breakdown	METHOD	Washer	25	1
1	ELECT, ADJUSTMENT @ EBI	Breakdown	METHOD	EBI	15	1
1	CHANGE OF FILLING VALVE NO 39	Breakdown	METHOD	Filler	25	1
1	WORK ON PACKER INDEXING CONV, REFLECTOR	Breakdown	METHOD	Packer	15	1
1	LASER JET ELECTRICAL ADJUSTMENT	Breakdown	METHOD	Laser Jet	80	2
1	PACKER GRAB ADJUSTMENT	Breakdown	METHOD	Packer	15	1
1	BLOW OFF PLUNGER ADJUSTMENT	Breakdown	METHOD	Filler	25	1
1	ADJUSTMENT @ PACKER	Breakdown	METHOD	Packer	25	1
1	PACKER GRAB ADJUSTMENT	Breakdown	METHOD	Packer	40	2
1	CHANGE OF FILLER PRESSURE HOSE PULLED	Breakdown	METHOD	Filler	30	1
1	TIGHTENING OF WORK LOOSED CROWNER HEAD	Breakdown	METHOD	Crowner	30	1
1	TIGHTENING OF STIFF CROWNER THROAT	Breakdown	METHOD	Crowner	25	1
1	FILLER INFEED WORM ALIGNED	Breakdown	METHOD	Filler	20	1
1	TIGHTENING OF WORK LOOSED CROWNER HEAD	Breakdown	METHOD	Crowner	15	1
1	WORM OUT PLUNGER ADJUSTMENT	Breakdown	METHOD	Filler	30	2
1	LABELLER DISCH , STARWHEEL ALIGNED	Breakdown	METHOD	Labeller	15	1
1	WORM OUT PLUNGER ADJUSTMENT	Breakdown	METHOD	Filler	30	2
1	CHECKS CARRIED OUT ON FILLER	Breakdown	METHOD	Filler	50	1
1	LABELLER DISCH , STARWHEEL ALIGNED	Breakdown	METHOD	Labeller	15	1
1	TIGHTENING OF WORK LOOSED CROWNER HEAD	Breakdown	METHOD	Filler	25	1
1	FILLER PLUNGER ADJUSTMENT	Breakdown	METHOD	Filler	15	1
1	QUALITY CHECK ON THE PRODUCT	External	METHOD	Quality Checks	125	3
1	WORK @ OPENING PLUNGER	Breakdown	METHOD	Filler	25	1
1	FILLER DISCH, GUIDE /TRANSFER PLATE ADJUSTMENT	Breakdown	METHOD	Filler	105	3
1	WORK @ OPENING PLUNGER	Breakdown	METHOD	Filler	20	1
1	SODA HOSE PULLED OUT @ WASHER /SODA ADDITION	Breakdown	METHOD	Washer	60	1
1	WORK ON BROKEN PULL DOWN CAM SUPPORT	Breakdown	METHOD	Filler	60	1
1	TIGHTENING OF WORK LOOSED LIFT CYLINDER	Breakdown	METHOD	Filler	60	1
1	UNPACKER GRAB ADJ,	Breakdown	METHOD	Unpacker	20	1
1	LOADING BELT HOOKED/ REPAIR	Breakdown	METHOD	Crate Conveyor	25	1
1	REPLACEMENT OF PULL DOWN CAM SUPPORT	Breakdown	METHOD	Filler	120	2
1	LABELLER GRIPPER CYLINDER ADJ,	Breakdown	METHOD	Labeller	20	1
1	FILLER DISCH, GUIDE ADJUSTMENT	Breakdown	METHOD	Filler	20	1
1	FILLER INFEED WORM ADJUSTMENT	Breakdown	METHOD	Filler	30	1
1	LASER JET ADJ,	Breakdown	METHOD	Laser Jet	20	1
1	PACKER CRATE ADJUSTMENT	Breakdown	METHOD	Packer	85	3
1	FILER HEIGHT ADJUSTMENT	Plan Stop	METHOD	Change Over	90	2
1	WORK ON CROWNER DISCH, TRANSPORT PLATE	Breakdown	METHOD	Crowner	60	1
1	WORK ON CROWNER HEAD NO 8	Breakdown	METHOD	Crowner	60	1
1	TRANSFER OF CENTRING BELL NO 2	Breakdown	METHOD	Filler	40	1
1	PACKER GRAB ADJUSTMENT	Breakdown	METHOD	Packer	50	4
1	PACKER GRAB ASSY ADJ,	Breakdown	METHOD	Packer	30	3
1	PACKER GRAB ASSY ADJ,	Breakdown	METHOD	Packer	60	2
1	ELECT, ADJUSTMENT @ LASER JET	Breakdown	METHOD	Laser jet	80	2
1	WEATHERED BOTTLES/REJECTION	External	METHOD	Weather Bottles	70	5
1	RUNNING OUT	Plan Stop	METHOD	Discharge	90	1
1	START UP	Plan stop	METHOD	Start Up	60	1
1	LABELLER INFEED ADJUSTMENT	Breakdown	METHOD	Labeller	25	1
1	EBI MALFUNCTION ELECT ADJ,	Breakdown	METHOD	EBI	60	2
1	PACKER GRAB ADJ/	Breakdown	METHOD	Packer	40	2

The table shows the total downtime of each of the 4M and the individual contributions.

Table 2.5: Summary of 4(M) Downtime of Packaging Line 1

13 Weeks of 4M of Packaging Line 1				
S/N	**4M**	**Total Downtime in Minutes**	**% Contribution**	**% Cumulative Contribution**
3	Material	14,828	46%	46%
1	Machine	11,456	35%	81%
2	Man	3,245	10%	91%
4	Method	2,980	9%	100%
	Total	**32,509**	**100%**	

From the graph, it is observed that Material and Machine contributed more the 70% of the total downtime.

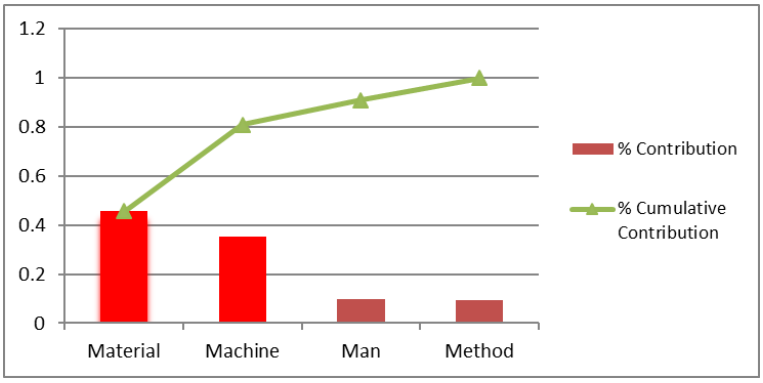

Fig 2.1: The Pareto Analysis of the 4M of 13 weeks studies

The table shows the total downtime of each of the 4M and the individual contributions. From the observation, Weathered Bottle, No Ready Product, Empty Bottle Inspector, Washer, Filler and Packer contributed more than 70% of the downtime.

Table 2.6: Summary Analysis of each area's contributions to downtime within the 13 weeks shifts of packaging line 1

S/N	Area	Minutes	% Contribution	% Cumulative Contribution
1	Weathered Bottle	8253	26.90%	26.90%
2	NO READY PRODUCT	4920	16.03%	42.93%
3	EBI (Empty Bottle Inspector)	4230	13.79%	56.72%
4	WASHER	2805	9.14%	65.86%
5	FILLER	2295	7.48%	73.34%
6	PACKER	1720	5.61%	78.94%
7	SPEED LOSSES	756	2.46%	81.41%
8	PASTEURIZER	720	2.35%	83.75%
9	CHANGE OVER	700	2.28%	86.04%
10	UNPACKER	660	2.15%	88.19%
11	LASER JET	640	2.09%	90.27%
12	LABELLER	630	2.05%	92.32%
13	PLANNED DOWNTIME	540	1.76%	94.08%
14	CONVEYOR	425	1.39%	95.47%
15	TEMPERATURE	350	1.14%	96.61%
16	POWER FAILURE	310	1.01%	97.62%
17	CROWNER	275	0.90%	98.52%
18	START UP	240	0.78%	99.30%
19	LOW PRESSURE	125	0.41%	99.71%
20	FBI	90	0.29%	100.00%
	Total	30684	100.00%	

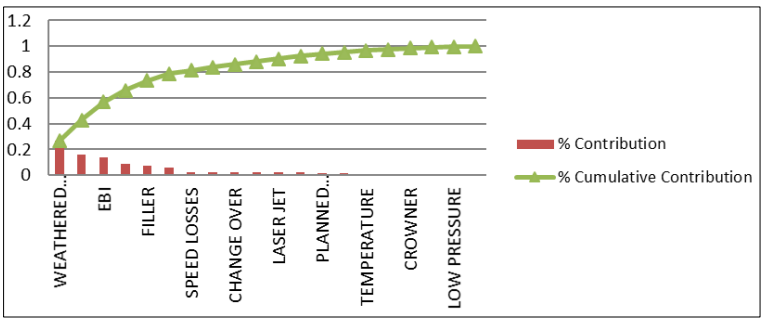

Fig 2.2: Pareto Analysis of downtime component of packaging line 1

3. Result, Conclusion and Recommendation

3.1 Result

The examination of case studies and performance indicators uncovers several crucial insights concerning how Operations Management techniques influence the enhancement of production performance.

- Enhanced Production Efficiency: Decreasing machine downtime resulting from factors such as personnel, equipment, materials, and procedures by utilizing various Operations Management approaches, including Total Quality Management, Total Productive Maintenance, and Optimal Maintenance strategies, Lean Management, and CILT, can lead to significant gains in production efficiency. Research indicates that addressing issues related to materials and machines can result in a 70% improvement in production effectiveness.
- Expense Decrease: The combination of quality management practices, Just-In-Time production, and lean manufacturing guarantees access to high-quality raw materials, skilled labor, and superior spare parts, leading to considerable cost savings through reduced waste and lower inventory expenses. Findings suggest that quality-related problems with Weather bottles contribute to 27% of overall downtime.
- Improved Quality Oversight: Applying Total Quality Management principles has led to better product quality and uniformity. Research demonstrates that implementing TQM and Total Productive Maintenance can achieve a 30% decline in defect rates, which simultaneously enhances customer satisfaction by 20%.
- Reduction of Waste: Lean manufacturing techniques have proven particularly successful in minimizing waste throughout different production stages. In the food processing sector, eliminating activities that do not add value, such as lack of available products and insufficient raw materials, along with streamlining production processes, can enhance performance by 18%.

3.2 Conclusion

To summarize, enhancing operational performance, reducing costs, improving quality control, and minimizing waste can be accomplished through effective operations management within packaging industries.

3.3 Recommendation

Alongside implementing a preventive maintenance approach incorporating CILT, Lean principles, Total Productive Maintenance, Kaizen Sheet Development, and Quality Deployment to enhance production performance and maintenance practices, additional inefficiencies or potential improvements were identified during this analysis. Below are the summaries of the suggestions:

- Shift the focus towards conveyors/lines. The current emphasis across all packaging lines is primarily on the machines. Various teams concentrate on enhancing the efficiencies of these machines. The prevalent belief within the company is that line performance hinges on the performance of individual machines, which is a reasonable assumption. However, the significance of conveyors and buffers in influencing line performance cannot be overlooked. The conveyors that connect the machines can be regarded as machines in their own right. The implementation of the findings from this analysis may seem minimal, yet the impact is quite substantial.
- Develop a comprehensive overview of how sensors operate on the production line. To boost efficiency between machines, a precise comprehension of the sensors' roles is essential. This understanding will enable immediate resolution of superficial inefficiencies. Additionally, it would be beneficial to visualize the functioning of the production line.
- Employ an additional Process Automation/Process Instrumentation engineer. When employees notice inefficiencies, they need to document them on a label. These labels can address various concerns ranging from safety to machine issues. Technical issues that arise are directed to a PA/PI engineer. Some labels remain unaddressed for up to six months, leading to a slow response. This slow reaction time discourages operators from contributing to the enhancement of line performance.
- Enhance the record-keeping regarding the replacement of small items. The maintenance department fails to document the exchange of small parts (e.g., Teflon cylinders, glue sprayers) and their respective locations. While the number of spare parts replaced is known, their final disposition is not tracked. Consequently, it is impossible to ascertain the frequency and quantity of small items replaced across parallel machines.
- Display inefficiencies for operators. Currently, each machine features its own 'light' to indicate its operational status. However, not all issues are visually indicated. For instance, if several fallen bottles obstruct the entrance of the bottle washer, no signal shows up. These fallen bottles can lead to a machine inefficiency of 11.5% (6 out of 52 empty pockets). Therefore, operators should be informed of any fallen bottles at the entrance of the bottle washer. This could be accomplished with an additional light indicating 'fallen bottles at entrance' to mitigate machine inefficiencies.
- Closely monitor the labeller and crowner; if a defective crown cork obstructs the rectifier and hinders the crowner from capping the bottles, delays in removing the faulty crown cork by the operator may result in rejecting up to 10 bottles with extracts. This situation can be rectified by installing a separate crowner on the production floor, detached from the filler, to ensure that only functional crowners are used and do not obstruct the rectifier located at the top of the filler.
- The standard of raw materials entering the system must be closely examined; poor-quality crown cork can lead to significant interruptions on the Filler and result in elevated extract losses. Evaluating the supplier's ability is crucial to guarantee that the organization receives high-quality raw materials and replacement components.

4. References

1. ADLER PS, BORYS B. Two types of bureaucracy: enabling and coercive. Adm Sci Q. 1996;41:61–89.
2. AHUJA IP. Manufacturing excellence through total productive maintenance paradigm. Int J Technol Policy Manag. 2011.
3. ARLBJØRN JS, FREYTAG PV. Evidence of lean: a review of international peer-reviewed journal articles. Eur Bus Rev. 2013;25(2):174–205.
4. BENDELL T. A review and comparison of Six Sigma and the Lean organizations. TQM J. 2006;18(3):255–262. doi:10.1108/09544780610659989
5. CHAN F, LAU H, IP R, CHAN H, KONG S.

Implementation of total productive maintenance: a case study. Int J Prod Econ. 2005;95:71–94.
6. DE RON A, ROODA J. OEE and equipment effectiveness: OEE revisited. IEEE Trans Semicond Manuf. 2006;18(1):190–196.
7. DEMING WE. Out of the Crisis. Cambridge, MA: Massachusetts Institute of Technology; 1986.
8. FARRIS JA, VAN AKEN EM, DOOLEN TL, WORLEY J. Critical success factors for human resource outcomes in Kaizen events: an empirical study. Int J Prod Econ. 2009;117(1):42–65.
9. FORZA C, CHOO AS. Work organization in lean production and traditional plants: what are the differences? Int J Oper Prod Manag. 1996;16(2):42–62.
10. FUJIMOTO T. The Evolution of a Manufacturing System at Toyota. New York: Oxford Univ Press; 1999.
11. FROST AC, HUXLEY C, ROBERTSON D. Just another car factory? Lean production and its discontents. J Labor Res. 2000;21(1):181–185. doi:10.1007/s12122-000-1012
12. GODWIN E, ACHARA A. Development of vehicles preventive maintenance and replacement schemes for Anambra State Transport Service. Research Repository. 2013.
13. GODWIN E, et al. Optimum maintenance strategy for paint manufacturing industries: a case study. Int J Adv Eng Technol. 2013.
14. HACKMAN JR, WAGEMAN R. Total quality management: empirical, conceptual, and practical issues. Adm Sci Q. 1995;40(2):309–342.
15. HANDFIELD R. A resource dependence perspective of Just-in-Time purchasing. J Oper Manag. 1993;11(3):289–311.
16. HÄRTE FL. Efficiency Analysis of Packaging Lines. Delft: Delft Univ Press; 1997.
17. HNS visie 2015. HNS nieuws special. Zoeterwoude: Heineken Nederland Supply; 2011. p.1–12.
18. HAYES M, TOMES A. Practical Operations Management. Oxford: Philip Allan; 1988.
19. MONDEN Y. Toyota Production System. Norcross, GA: Ind Eng Manag Press; 1983.
20. NAKAJIMA S. Introduction to TPM: Total Productive Maintenance. Cambridge, MA: Productivity Press; 1988.
21. NAKAJIMA S. Continuous Improvement in Operations. Cambridge, MA: Productivity Press; 1991.
22. NEELY AD. The performance measurement revolution: why now and what next? Int J Oper Prod Manag. 2005;19(2):205–228.
23. PANDE PS, NEUMAN RP, CAVANAGH RR. The Six Sigma Way. New York: McGraw-Hill; 2000.
24. PARMENTER D. Key Performance Indicators (KPI): Developing, Implementing, and Using Winning KPIs. Hoboken: John Wiley & Sons; 2010.
25. PEPPER MPJ, SPEDDING TA. The evolution of lean Six Sigma. Int J Qual Reliab Manag. 2010;27(2):138–155.
26. RAHMAN S. Theory of Constraints: a review of the philosophy and its applications. Int J Oper Prod Manag. 1998;18(4):336–355.
27. RAMDEEN A, PUN KF. Development of a computerized maintenance stores system in distiller manufacturer: a case study. J Assoc Prof Eng Trinidad Tobago. 2005;36(1):27–31.
28. ROLFSEN M, LANGELAND C. Successful maintenance practice through team autonomy. Employee Relat. 2012;34(3):306–321.
29. SHAH R, WARD PT. Lean manufacturing: context, practice bundles, and performance. J Oper Manag. 2003;21(2):129–149.
30. SUBRAMANIAM SK, HUSIN SH, YUSOP Y, HAMIDON AH. Machine efficiency and manpower utilization on production lines. Proc 6th WSEAS Int Conf Circ Syst Electron Control Signal Process (CSECS'07). 2007 Dec 29–31:185–90.
31. WOMACK JP, JONES DT. Lean Thinking: Banish Waste and Create Wealth in Your Corporation. New York: Simon & Schuster; 1996.