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Line feeding downtime reduction by implementing lean material handling techniques in automotive manufacturing

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Abstract:
This paper focus on how well the connected material process flow system will bring the systematic application of the lean material handling pull principle in assembly plant and considering the multitude of different components feeding to assembly plant in a highly fluctuating customer demand is introduced in this paper. This method has been used for the in-plant logistics planning one of the leadingautomotive drive line productmanufacturing plant and shows that pull system is an efficient lean method for the in-plant logistics planning forthe mixed model assembly plant, which is mainly depends on the standardized work pattern in a highly disciplined way of managing the material flow.

Keywords: Lean material handling, Material flow, Information flow,Logistics, PFEP, Pull system, Supermarket, Kanban, Two bin system

1. Introduction:

This paperinvestigates the flow of material& information within a business unit,between internally located warehouse and assembly shop.It includes the different types of small components feeding from warehouse to the production linesupermarket on a continuous replenishment method,based on fast changing different mixed model assembly demands. Most of the automotive assembly industries use many discrete parts in the process to build a finished salable goodsare highly challenging task for the in-plant logistics team.

Transportation is a part of logistics,just a 'movement' of goods from one place to another place, Whereas the logistics is a broader term. Although this refers to the entire flow management of goods which includes not only transportation, also materials handling, cataloging & packaging of items, inventory management, transportation, and warehousing

2. Literature Review:

The focus of literature review will be on connected Material & Information flow in the manufacturing plant, which aims to bring a rhythmic uninterrupted operation at all the time

Why flow?

According to the publication of “The Toyota way field book: A practical guide for implementing Toyota’s 4P” [2], when material and information flow continuously, there is less waste in the operation. If there were a lot of waste in the system, material and information would not be flowing. Maintaining continuous flow between processes will create linkage, making each process dependent on the other.

Create a continuous process flow to bring problems to the surface

The meaning of flow is without any interruptions, watching for somebody to figure on that. Redesigning work processes to realize “flow” usually ends up in product or comes being completed in tenth of the time that was antecedently needed. the rationale to form flow isn't simply to possess material or data moving quick. it's to link processes and other people along in order that issues surface promptly [2].

Flow, Pull, Eliminating Waste

According to [2], the most common perception of lean is that it is about “Just in Time” – The right part, the right amount, the right time, the right place. The key to eliminating waste is creating flow, and the principles of pull require the production in a just in time manner.

The identification and elimination of waste is a primary philosophy of lean. Removing the first, large layer of waste generally yields significant improvements in overall performance. At this point most of the improvements are the individual process level, not at the level of flow connecting processes. Subsequently cycles through the continuous improvement spiral will connect processes and can have even larger impact and reinforce motivation to maintain the stability of individual processes [1].

Lean management

With the publication of “The Machine that Changed the World: The Story of Lean Production” [7] the advantages of lean principles have been widely recognized. The term Lean implies a series of tools and techniques to eliminate wastes (Muda), reduce non-value-added operations, improve value added processes and maximize performance [8].

Plan For Every Part

A PFEP is nothing more than a central location for containing pertinent information about purchased parts (typically created/managed with an electronic database). Its major benefit would be the elimination of wasted effort searching for this information if it were not centrally located.[9]

Kanban

Kanban is a tool in scheduling system that was mentioned for the first time by Taiichi Ohno in Lean Production and just-in-time concepts. According to its creator it is a physical information card in manufacturing plants that helps to determine what to produce, when to produce and how many units to produce [10].

Bin / Crate

Storage of items of supplies and equipment in an individual compartment or subdivision of a storage unit in less than bulk quantities, Bin is a type of container which holds the objects or components temporarily in the manufacturing floor for a particular time [11]

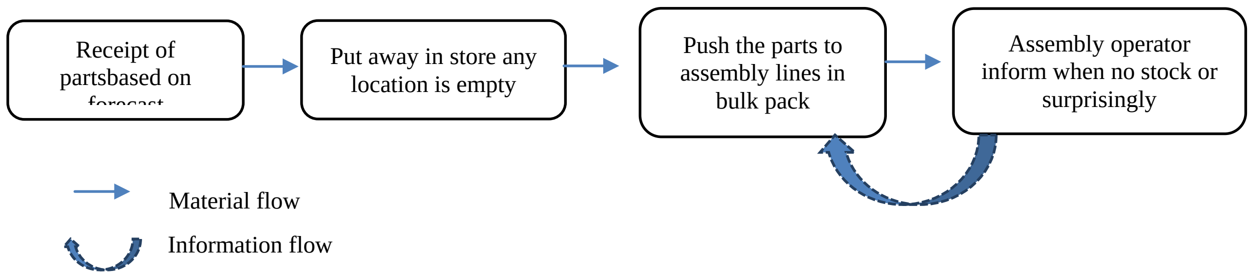
3. THE PROBLEM AND IMPLEMENTATION DETAILS

This1st section describes the situation prior to the implementation, identifying the problems that were found. The 2nddescribes opportunity available to change. The 3rd describes the changes and the situation after its completion,notwithstanding besides variables and sub-variables, customers overall satisfaction regarding the implemented changes was also evaluated.

3.1 Status prior to the implementation

This case study was conducted in the manufacturing of an automotive company. This manufacturing sector is responsible for almost all of the supply of drive line assembly, including the components that go through a sub & pre-assembly process before proceeding to final product assembly. In this sector are concentrated more of bought out components required for assembly process. The whole process runs with the aid combination of material handling equipment's like forklifts, manual carts, trolleys etc. Often, the feeding response time is equal to or higher than the time needed for parts manufacturing. Which results increased waiting time for want of material at the assembly stations more frequently, assembly operator always idle more than an hour during these time and other operating resources consumed without adding any value to the customers. The major problem found in the system is missing of integration between two places and most of the process depend on feeding operator

3.1.1 Material flow chart



3.1.2 Material flow strategy

Based on production plan material will be pushed to shop floor each line wise by hand / Trolley / Forklift / Tow truck etc. converselyon received condition as it is the boxes of parts from particular suppliers with the same pack quantities in non-standardized way.

3.2 Opportunity

Due to a mixed model assembly line, the demand variance for a large variety of small size components and final product assemblies increased. This demand growth led to speed increases and changes in how the materials were being handled and transported in order to monitor manufacturing requirements.

It encouragesthe trigger and coupling of the warehouse and assembly stations withan organized way of working, as much as possible figured out in below

- Purchase parts storage market is required
- Lot size reduction is required
- Delivery route to be designed
- Final assembly supermarket to be designed near to stations
- Trigger mechanism or Pull signal to be designed for fast response to replenish the stocks

3.3 Status after the implementation

The standardized way of material presentation method brought us the benefit of increased productivity, improved working environment, reduced traffic congestion, eliminated reverse flow, self-ordering material flow system [1]

- Significantly reduced rate of down time due to delay in material feeding to assembly lines
- Working within the planned production time to meet customer needs
- Many of wasteful activities identified and eliminated in the process
- Perfect lean or Pull system in place to utilize resources more effectively
- Workplace design is arranged properly and pleasant to work
- Predefined delivery route is created to avoid of multiple material movements between places
- Warehouse &supermarket designed in orderly manner
- Lot size & frequency is defined in line with production requirement

4. RESEARCH METHODOLOGY

Section: I- Research Approach

The analysis of this paper is based on primary data collected from the organization and secondary data, including online databases, digital libraries, books, journals, conference papers, etc.

4.1 Objectives

- To find out the deficiencies in the current material flow system
- To determine the present state and future state of material flow system
- To bring connected rhythmic flow of material between warehouseandassembly stations

4.2 Identifying Problem & prioritizing

- Breakup of total time waiting for parts in assembly linefor want of right material at right time
- Various classification of parts majorly affecting delays
- Frequency of occurrences period or time

4.3 Important attributes of lean material handling

(1) Production volume / Demand fluctuation

The production capacity is defined in annual volume for a manufacturing plant. The planned annual, monthly or daily production capacity can be furtherbroken down into capacity per working hour. Named as Takt time, defined how manyminutes required to produced one product need to go through the whole assembly line [1].

(2) Plant layout

A manufacturing plant layout with the locations of the assembly line and the warehouses is one of the prerequisites for the planning work [1].

(3) List of purchase parts and market location

Ordinarilythe purchase parts list to make one finished product is also pre-defined, which can be foundfrom the BOM (bill of material). The information of each part includes partnumber, part description, part dimension, unit of measure, part weight, and packaging information.Also, the market location of storage in warehouse, cycle stock, minimum & maximum stock levels [9].

(4) Details of workstations

The line information is predominant for in plant logistics planning. This informationincludes how many line types in the plant, what kind of working stations in eachline, and what to do in each workstation.

(5) Delivery routes / lot size

How the parts are fed to line workstations by which route, method, frequency of trips, lot size [9].

(6) Pull signal / Trigger

How the warehouse operator getting the next trigger from the production workstations and replenishing stocks at each workstation [1].

Section: II- Research Tools

Choice of tools used as follows,Bar chart [18], Pareto chart [16], case study [14], OEE [6], PDCA [3], Cause and Effect diagram [3], 5S [13], Seven type of deadly waste [13], ABC inventory classification [15].

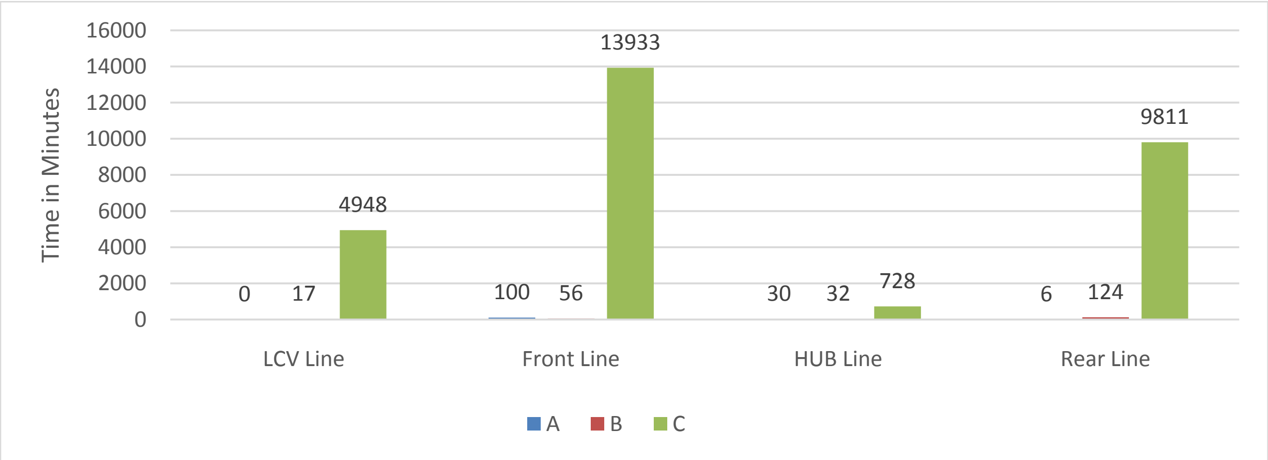
5. CASE STUDYAND ANALYSIS

The entire model of all parts put together comes around 900 parts in all category information has been consolidated to further study [14]

Step:1 Basis data collection

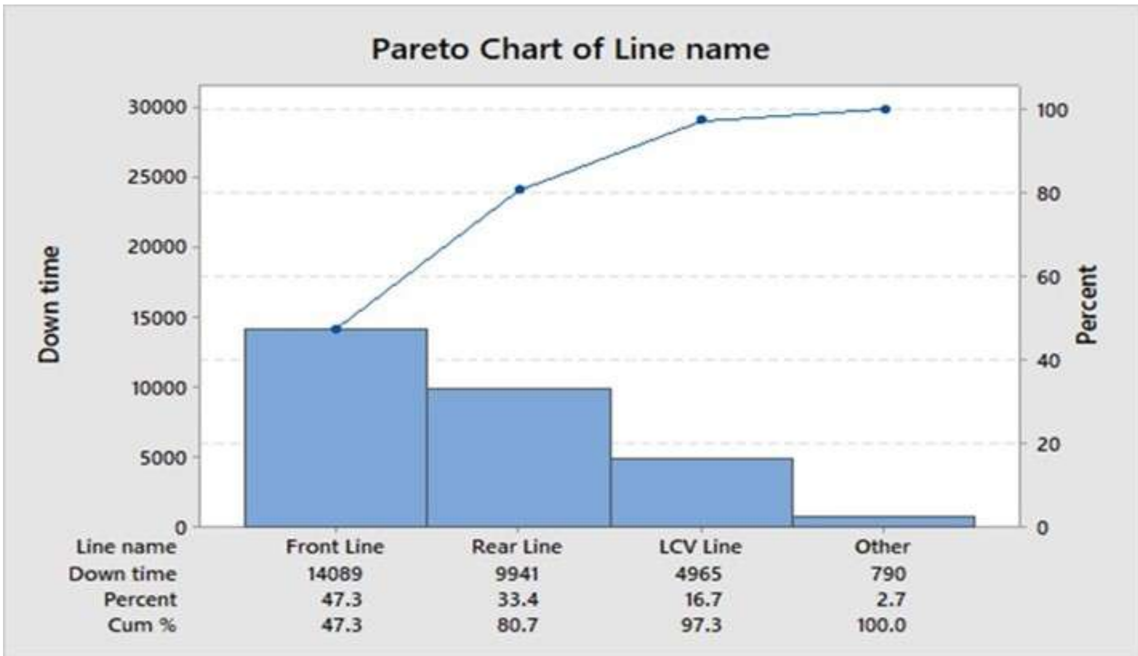
- The information about parts (Part #, Description, UOM, Weight, shapes, packages, dimensions, peak daily and hourly usage, storage location, usage location workstation, models, classification, traffics in feeding route, frequency, interval between two replenishment, type of containers used, trigger flow, supplier transit lead time etc. [9]
- Down time details like assembly line wise and type of loss wise collected majorly affected area and prioritizing the implementation [6].

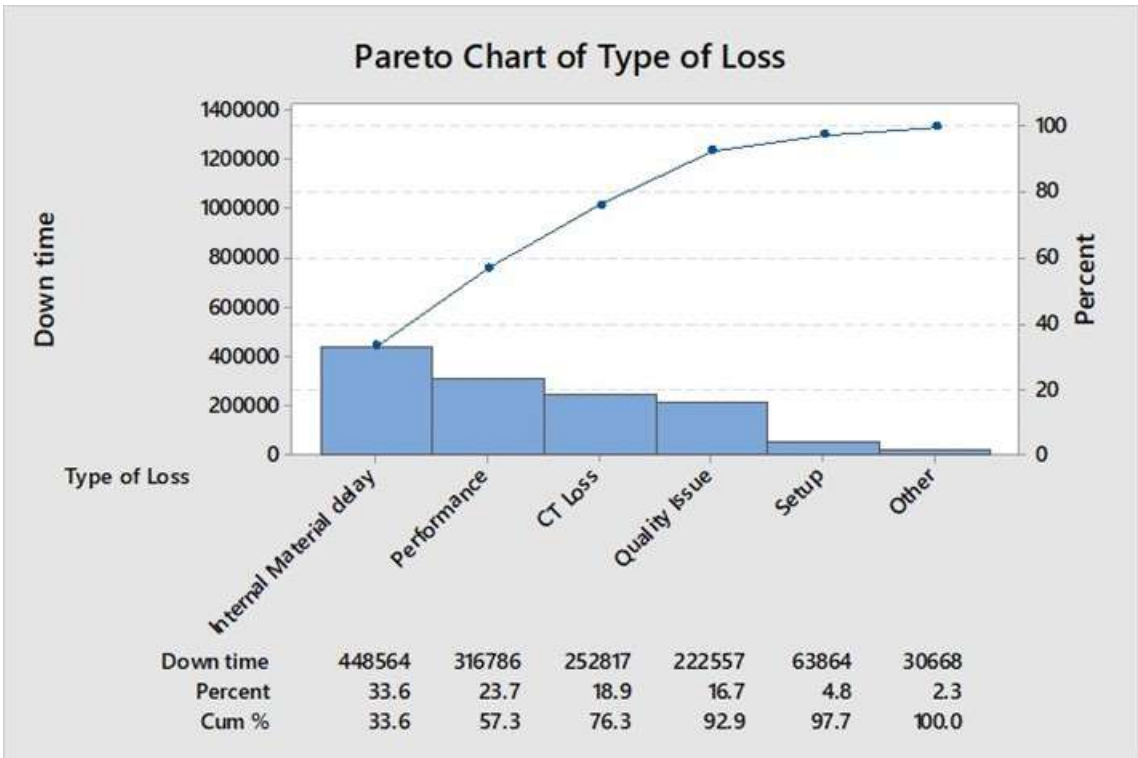
ABC Classification wise down time prior implementation



Consequentlyobserved major cause in class of parts falls under "C" and need more attention and further study to reduce or eliminate down time occurrences [15].

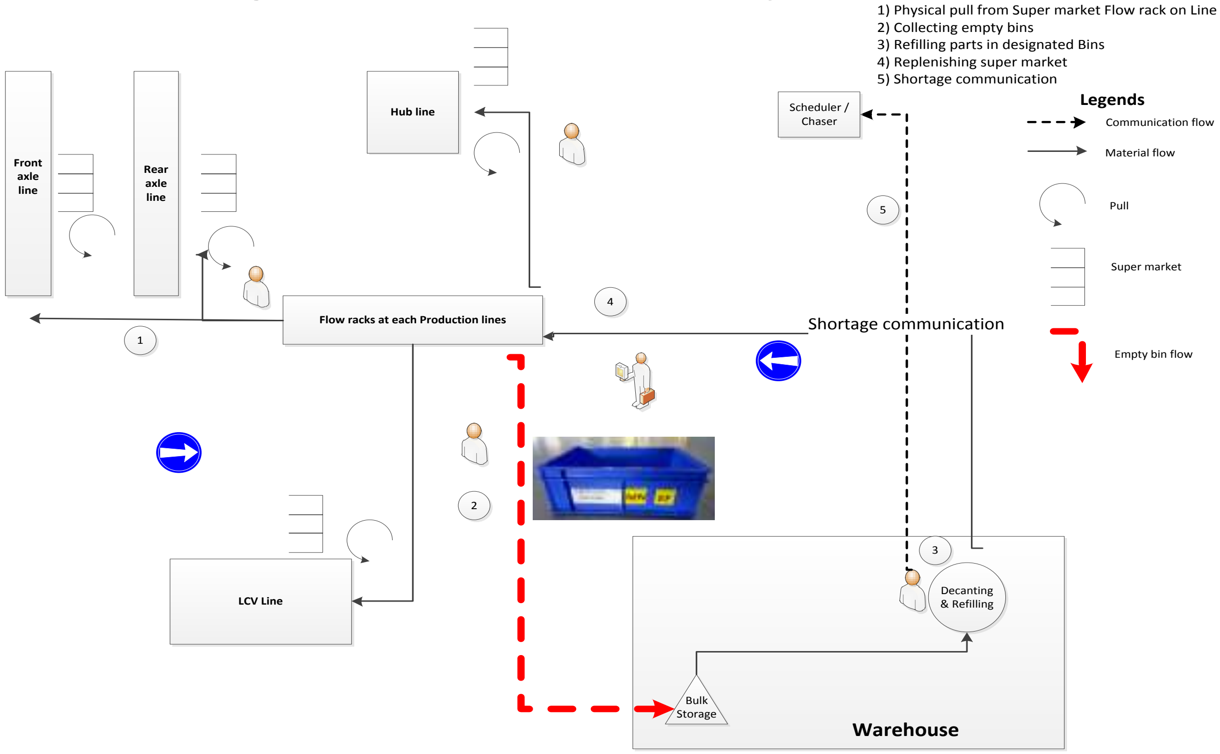
Moreover,pareto chart is to highlight the most important among a (typically large) set of factors [16].





Step:2 Design of material flow strategy

Pull signal between Warehouse to Assy Lines



Step:3Developing the PFEP

- All necessary data has been collected and filled the PFEP only relevant to in plant logistics prepared

Part #	Number used to identify the material in the facility
Description	Material name (e.g., frame, bolt, nut, yoke)
Daily Usage	Maximum amount of material used in a day through the entire plant
Usage Location	Process/areas where the material is used (e.g., Cell 14)
Storage Location	Address (location) where the material is stored
Order Frequency	Frequency that the material is ordered from the supplier (e.g., daily, weekly, monthly, as required)
Supplier	Name of the material supplier
Supplier City	City where the supplier is located
Supplier State	(State, province, region, district) where the supplier is located
SupplierCountry	Country where the supplier is located

Container Type	Packaging type of the container (e.g., cardboard box, reusable tote, wire basket)
Container Weight	Weight of an empty container
1 Part Weight	Weight of 1 unit of material
Total Package Weight	Weight of a full container of material
Container Length	Length or depth of the container
Container Width	Width of the container
Container Height	Height of the container
Usage Per Assembly	Number of parts required for 1 finished product
Hourly Usage	Maximum number of pieces used per hour
Standard Container Quantity	Piece count of material in one container
Containers Used Per Hour	Maximum number of containers required per hour
Shipment Size	Size of a standard shipment in days (1-week shipment = 5 days)
Carrier	Company providing parts-transportation services
Transit Time	Travel time required from the supplier to the facility (in days)
# of Cards / Bin in Loop	Number of pull signals that are in the system
Supplier Performance	Supplier performance rating that includes on-time delivery, quality, etc.

Source: *Making Materials Flow* workbook, Lean Enterprise Institute, www.lean.org [4].

Step:4 Design of purchased parts market location

- Arranged warehouse with specific line usage in common bay to avoid multiple movements and reduce to motion of operator to collect parts
- All the parts locations are fixed with identification bar code labels with visual photograph in the particular shelfs to identify it easily during replenishment

- Fast moving parts located in nearest warehouse approach, after that medium moving parts and accordingly in last slow-moving parts which will reduce the operator movement drastically in a daily basis [17].

Step:5 Design of trigger mechanism / pull signals

- KANBAN introduced by implementing Two bin system with part identifications for all the parts, it will have all necessary details purchased part market location, Part details, Workstation super marker location, usage, frequency, loop / lot size, standard pack qty etc.

Step:6 Design of delivery route / Supermarket feeding method

- Based on daily demand and traffic congestion points identified at all routes, decided to feed the parts in a standard route for each line with delivery window time and empty returnable bin collection for refilling at purchased parts market
- Flow racks been installed near to the workstations to grab the required parts by assembly operator easily without searching

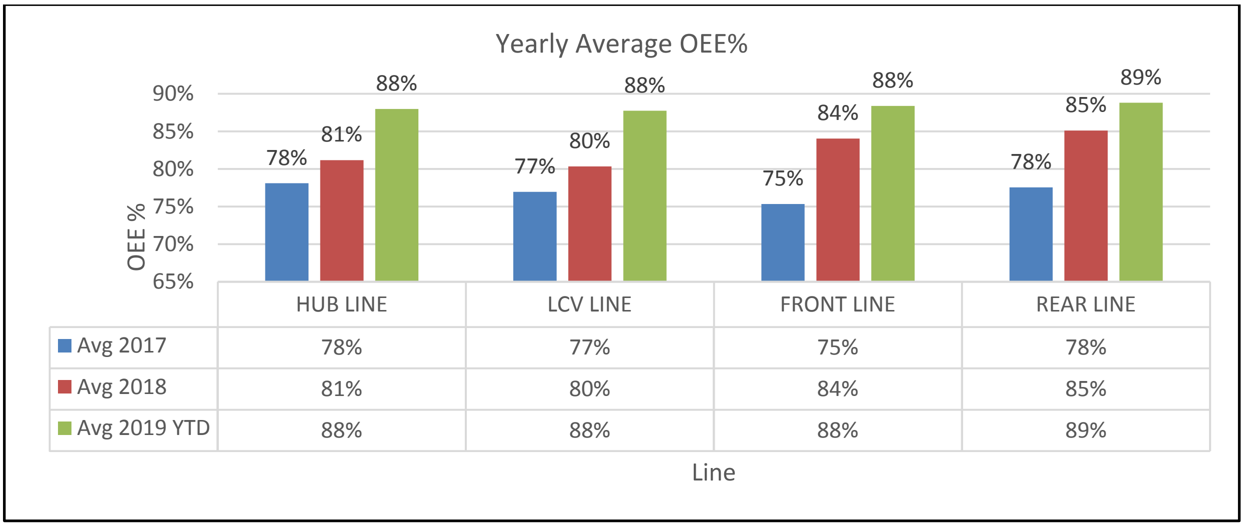
Step: 7 Design of shortage / excess parts communication method

- Using the barcode label with reference to minimum and maximum stock levels pre-defined at all parts location in the individual shelf
- Barcode to be scanned at the time of receipt of parts at purchase part storage and at the time of line feeding replenishments to generate real time stock alerts to the material scheduler/ planner to restock the inventory in a periodic
- Warehouse management software package implemented to communicate real time alerts through electronic mail

6. CONCLUSION AND RESULTS

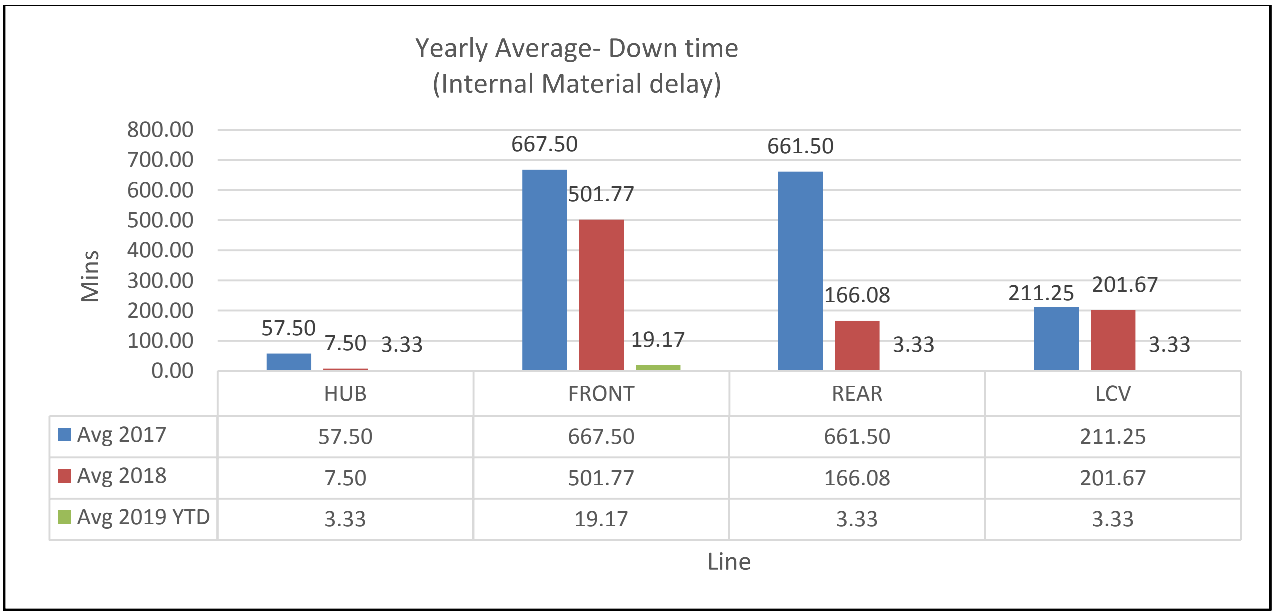
During the planning phase of in-plant logistics all internal / external suppliers and customers requirements should be considered, PFEP is one of the efficient tools,which integrate the business process from supplier to customer in a central location [17].

6.1 Improvement trend year wise of OEE past to present



Therefore,OEE Trend got improved average of 5% to 8% as overall from year on year past to present as on date and consistently maintaining its trend during stabilization period [6] [12].

6.2 Decrease trend in down time past to present



6.3 Challenges faced during implementation:

Nevertheless, of implementation results important lessons learned as mentioned

- Encountered the significant amount of Training requirement to maintain consistency in the material flow for the SCM & Non SCM team members

- During KANBAN signal (Bins) Implementation afterwards some of the bins were misused by other team members for other than material loading purpose and it was given as to spread awareness to all companywide the importance of Bins is the signal card for next reorder materials
- During the transition phase we observed new people joined in our organization and they are not aware of the material system followed in our organization and suggested the same to be included in human resource induction training to improve the system
- Maintenance of Material handling Equipment's like Racks, BINS, Trolley, Good lift, tow truck required budget and effective frequent audit check list is required and it was prepared
- Frequent audit of Location labels, BIN labels, Delivery route condition, BIN loop size system not in place and the same implemented later
- Shortage reporting mobile application is used to scan and communicate to buyer and noticed, if it is a standard professional industrial scanner will give good result and improve the efficiency of operator and faster is response the same initiated to buy newly in the next budget.

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