Non Value Added Time Reduction and Process Cycle Efficiency Improvement by Implementing Inventory Management System

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***Abstract*—This paper depicts how Inventory Management System was used to eliminate Non Value Added Time in a manufacturing plant. A current Process Cycle Efficiency was measured and data for constructing the present Process Cycle Efficiency was collected through production line visits, interviews of employees and observation of machine's function at different production stages. Different causes of Non Value Added Time was determined. Regression analysis with the help of Minitab software were applied to evaluate most affected causes of Non Value Added Time. At present, Process Cycle Efficiency was found 63.47%. In order to improve Process Cycle Efficiency and to Reduce Non Value Added Time it was proposed to implement Inventory Management System, it was evaluated that future state Process Cycle Efficiency would be improved to 67.78% at initial stage.**

Index Terms*-Process Cycle Efficiency, Non Value Added Time, Inventory Management System(key words)*

I. INTRODUCTION

Development of project consists of many complications. All the parts of project is very sensitive and accurate. So for the development of project highly accurate instruments are used. The accuracy required for all the parts should be greater than 3σ (Sigma). Project is developed by passing through different processes known as Process Cycle. Process Cycle allows the specification of task dependencies and their inter-relationship and then controls the execution of that process specification.
Current Process Cycle takes more time than estimated time, in which Non Value Added Time (NVAT) takes more time than estimated time. So, to reduce Non Value Added Time (NVAT) and to Improve Process Cycle Inventory Management System (IMS) was Implemented.
Inventory Management System (IMS) is software application that helps to maintain the details of tools, instruments, materials etc. Software provides the details of inventories like who is responsible person, what he/she is using, for what purpose and also time duration to return inventory.
By implementing Inventory Management System (IMS), existing process will be simplified, decrease in Non-Value Added Time (NVAT) and reduction in loss of data. This results into increase in overall efficiency and output.

II. LITERATURE SURVEY

To identify the causes of non-value added times and manufacturing waste, to reduce the lead time and to improve the process cycle efficiency. Throughout this study the existing manufacturing line was assayed by using Value Stream Mapping, where current cycle time, lead time, and non-value added time were found; thereby the present process cycle efficiency to reduce total manufacturing cycle time [1].
This paper presented with some specific objectives which were -to identify, quantify and to reduce the non-value added (NVAT) activities and time towards the improved Process Cycle Efficiency (PCE) and therefore to reduce the total manufacturing cycle time. Cycle time is the required time to complete one manufacturing process in the value stream. Change over time is the NVD time required to convert a setup from one product line to another product line. This concept implies that go there instantly where a problem is occurred; check out the problem; take a temporary measure on spot; find out the main causes beyond the problem [2].
This paper depicts how Process Cycle Efficiency was used to eliminate the manufacturing waste in a litchi juice production plant of Y food and beverage industry in Bangladesh. A current data of litchi juice production line was constructed. Different causes of non-value adding (NVAT) activities were find out and try to improve process cycle efficiency [3].
The production flow was optimized thus minimizing several non-value added activities/times such as bottlenecking time, waiting time, material handling time, etc. In general, the various components associated with the lead time of any production process are (i) Waiting time before process (ii) Setup time (iii) Process time (iv) Waiting time after process (v) Transfer time. It focuses the revamp of operations by eliminating non value-added time and improving cycle efficiency [4].
An automated warehousing system provides less resources effort, more efficient, and reliable results compared to manual handle system. Warehousing management system (WMS) is a necessary approach for every warehouse. WMS is designed to help reduce costs through effective warehouse processes. The goal of this work is to automate the warehouse management system, along with implementing a mini-size production line for product labeling within warehouse. Ultimately, a software program must be chosen depending on the needs of the warehouse. In this case, one of the most important requirements was that the software program must be able to withstand large capacity of data and it also has to be able to sort out the serial numbers

according to expiry, receiving, and activation date then releasing it to the dealer. ERP is a business management software that a company can use to collect, store, manage and interpret data from many business activities [5].

This paper based on the present development situation of the most enterprises material inventory management system. Aiming at the existed problems and deficiency of the materials inventory management system, combined with the actual needs of modern inventory management and advanced technology of computer software development technology, and designed a scientific and practical materials inventory management process. The process can monitor the order information of the materials, and provide some functions the real-time querying, etc. [6].

Unified Modelling Language (UML) enables the visualization, specification, construction, and documentation of software-intensive system. Wholesale management system is developed aim to improve the efficiency and performance of daily business activity of the wholesaler. Unified Modelling Language (UML) is used at initial phases of software development because of having a reasonable support of diagrams and notations but has not proved sufficient for the complete modelling of functional and non-functional requirements of a system [7].

Inventory control is not a just an advantage but also a necessity. Proper raw material inventory control promotes firm profitability and sustainability in a business environment. The paper presents a new approach for Inventory Management System utilized by firms in the Tool and Die industry operating in a distributed manufacturing framework. The system will aid in the proper control of raw material inventory used in the sector thus improving the efficiency [8].

This paper deals with development of inventory management system for a manufacturing Industry. The developed software System is easy to use, less time consuming & all detail about the inventory items & transaction status. Enterprise Resource Planning (ERP) software presents a frame work for organizations to better utilize their processes. The Backend used is SQL server database that ensures total security and no data loss or corruption. The database management systems are warehouses of information, where large amount of data can be stored. The main idea of this paper is to handle the all details of inventory management system. In this software package has been developed to smoothen the processing of item transaction in inventory such as item receive, item issue, etc. [9].

Inventory management is the process of efficiency overseeing the constant flow of units into and out of an existing stock of goods. The system is protected from unauthorized user. This research has designed a Computerized Inventory Management System to ascertain stock level of a supermarket [10].

III. WORKING METHODOLOGY OF THE STUDY

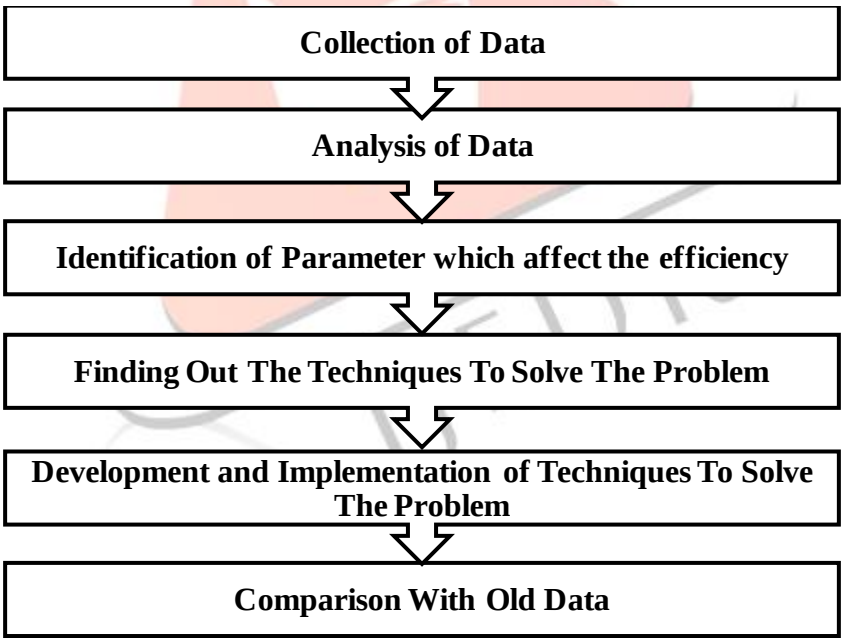

Fig. 1: Complete Methodology of the study

A. Basic Project Development Cycle:

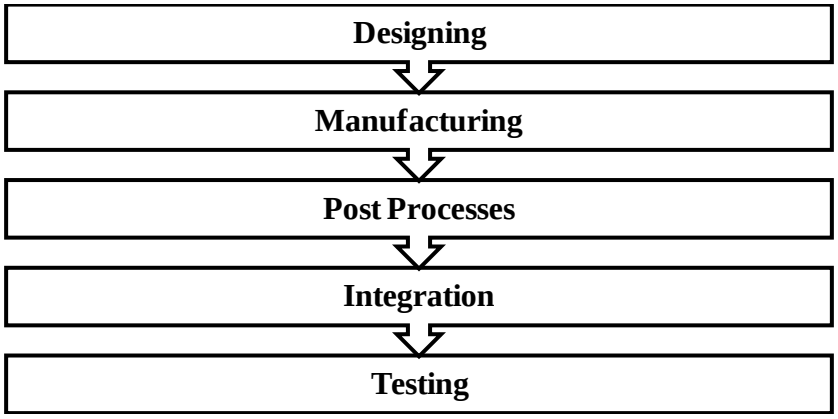

Fig. 2: Sample Basic Project Development Cycle

B. Evaluation of Time Study for Project Processes:

As project consists of large numbers of parts and theses large number of parts are developed by different processes. So, to find out and improve the efficiency of Project Development Cycle one method is followed known as Process Cycle Efficiency.

I. Cycle Time (CT):

Cycle time is the total time from the beginning to the end of process. Cycle time includes process time, setup time, part loading time, part unloading time, move time of part and delay time.

$$CT = PT + ST + LT + UT + MT + DT$$

Also,

$$CT = VAT + NVAT$$

Where,
CT = Cycle Time
PT = Process Time
ST = Setup Time
LT = Loading Time
UT = Unloading Time
MT = Move Time
DT = Delay Time
VAT = Value Added Time
NVAT = Non-Value Added Time

II. Value Added Time (VAT):

This is the amount of time it takes to actually produce the product. Obviously, production time is a value added time because it creates a product from raw materials.

$$VAT = PT$$

III. Non-Value Added Time (NVAT):

Non-value added time is amount of the production cycle time that does not directly produce product or part. The non-value added time is the sum of setup time, loading time, Unloading time, Move time and Delay time.

$$NVAT = ST + LT + UT + MT + DT$$

IV. Process Cycle Efficiency (PCE):

Process Cycle Efficiency is a metric useful for prioritizing improvement opportunities. Calculating process cycle efficiency begins with identifying those areas that do not contribute to the value of the product. This typically can be done using a value stream map.
Process Cycle Efficiency helps to formulate an action plan to eliminate the Non-Value added time. It also helps to identify the causes of unexpected Non-Value added time that results in the long lead time and lower Process Cycle Efficiency.
The Process Cycle Efficiency can be defined as the percentage ratio of Value added time and cycle time (Zhen, 2011; Rajenthirakumar et al., 2011). Mathematically it is denoted as following –

$$\text{PCE } (\eta) = \frac{VAT}{CT} X\ 100\ \%$$

Where,
VAT = Value Added Time
CT = Cycle Time
However, to improve the PCE, the Non-value added time should be reduced, which is the objective of this study.
Project which is consider or choose for study consists of total 184 parts or components.
From that 18 components are carried out for detail study due to limitation of time.

Table 1: Selected component's time duration table

Sample Part No.	Process Time (Min.)	Setup Time (Min.)	Move Time (Min.)	Loading Time (Min.)	Unloading Time (Min.)	Delay Time (Min.)	Total Cycle Time (Min.)
SBP117	9173	132	39	11.5	9.5	1919	11284
SBP120	8956	105	48	9	8.5	4164	13290.5
SBP136	504	40	29	7.5	7.5	2461	3049
SBP141	7976	91	52	14	13	7315	15461
SBP146	8235	122	55	10.5	9.5	2158	10590
SBP149	8838	113	33	11	9	4623	13627
SBP151	8989	94	31	7.5	7	4302	13430.5
SBP153	8934	78	47	12	11	1675	10757
SBP155	8907	75	34	10	9	4956	13991
SBP158	8368	69	42	9.5	8	4632	13128.5
SBP160	2295	95	31	9	8	6569	9007
SBP164	8371	117	50	11	10	3907	12466
SBP167	8871	99	54	12	10.5	5796	14842.5
SBP178	8355	86	44	11.5	9.5	4200	12706
SBP179	8975	108	38	11.5	10	4620	13762.5
SBP181	9248	127	43	11.5	9.5	3814	13253
SBP183	8259	126	57	10.5	9.5	4359	12821
SBP184	9104	76	50	12	11	3286	12539
Total Time (Min)	142358	1753	777	191.5	170	74756	220005.5

IV. REGRESSION

Regression analysis is a way of mathematically sorting out which of the variables does indeed have an impact. Regression attempts to determine the strength of the relationship between one responder (usually denoted by Y) and a series of other changing variables.
Regression analysis is a form of predictive modelling technique which investigates the relationship between responder and continues predictor. This technique is used for forecasting, time series modelling and finding the causal effect relationship between the variables.
There are multiple benefits of using regression analysis. They are as follows:
It indicates the significant relationships between dependent variable and independent variable. It indicates the strength of impact of multiple independent variables on a dependent variable.
Regression is carried out on Minitab 17. Fit Regression is carried out because fit regression model relationship between one responder and nos. of continuous predictors:

Regression Analysis: Efficiency versus Process Time, Setup Time (, Move Time (M, ...

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	6	4723.34	787.22	59.50	0.000
Process Time (Min.)	1	1784.93	1784.93	134.92	0.000
Setup Time (Min.)	1	12.49	12.49	0.94	0.352
Move Time (Min.)	1	2.67	2.67	0.20	0.662
Loading Time (Min.)	1	1.10	1.10	0.08	0.778
Unloading Time (Min.)	1	0.16	0.16	0.01	0.914
Delay Time (Min.)	1	583.29	583.29	44.09	0.000
Error	11	145.53	13.23		
Total	17	4868.86			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
3.63727	97.01%	95.38%	79.38%

Regression Equation

Efficiency = 22.65 + 0.005741 Process Time (Min.) + 0.0467 Setup Time (Min.)
+ 0.068 Move Time (Min.) + 0.59 Loading Time (Min.) - 0.27 Unloading Time (Min.)
- 0.004017 Delay Time (Min.)

Figure 3: Regression analysis result

From result it can be found out that the most affected time in payload development cycle is process time and delay time also found out that by modification in delay time, efficiency will be increased.
Analysis of Variance (ANNOVA):

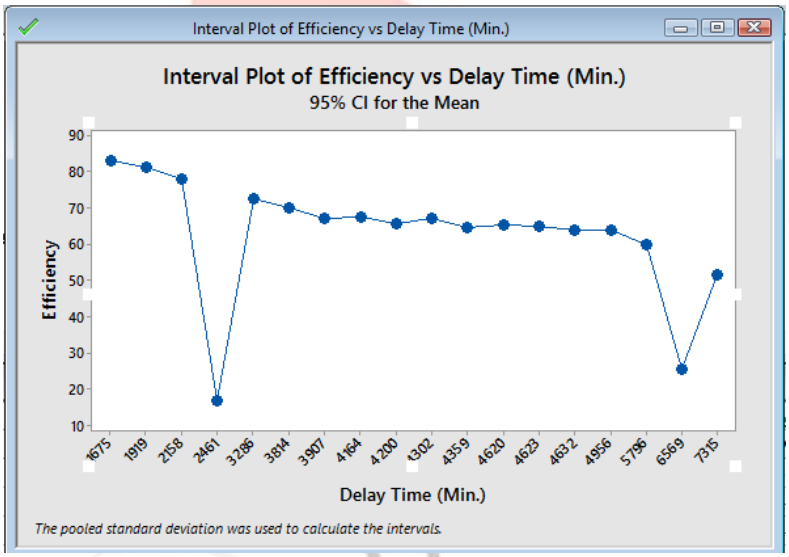

Figure 4: Interval plot of efficiency vs delay time

One way analysis of variance (ANNOVA), is carried out to get response of continuous responder on particular predictor. Here responder is Efficiency and factor (continuous predictor) is Delay Time.

V. INVENTORY MANAGEMENT SYSTEM (IMS)

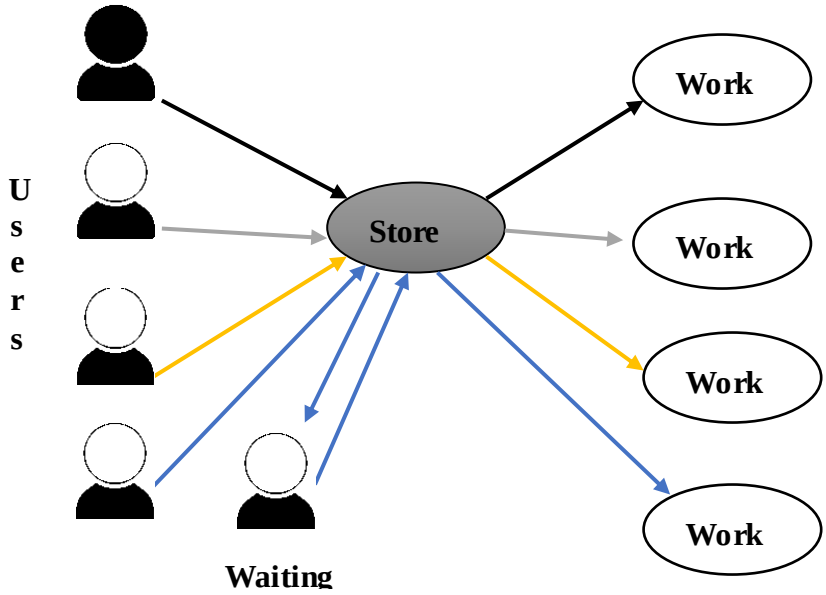

Figure 5: Existing Situation

Inventory control is not a just an advantage but also a necessity.Inventory management system (IMS) is a necessary approach for every warehouse. An Inventory Management System provides less effort, more efficient, and reliable results compared to manual handled system.

Inventory management system is developed aim to improve the efficiency and performance of daily activity of development cycle of Project.Proper control is crucial for the profitability of the organization. Enables the visualization of inventories like tools, instruments, materials etc. Software provides the details of inventories like who is responsible person, what he/she is using, for what purpose and also time duration to return inventory.

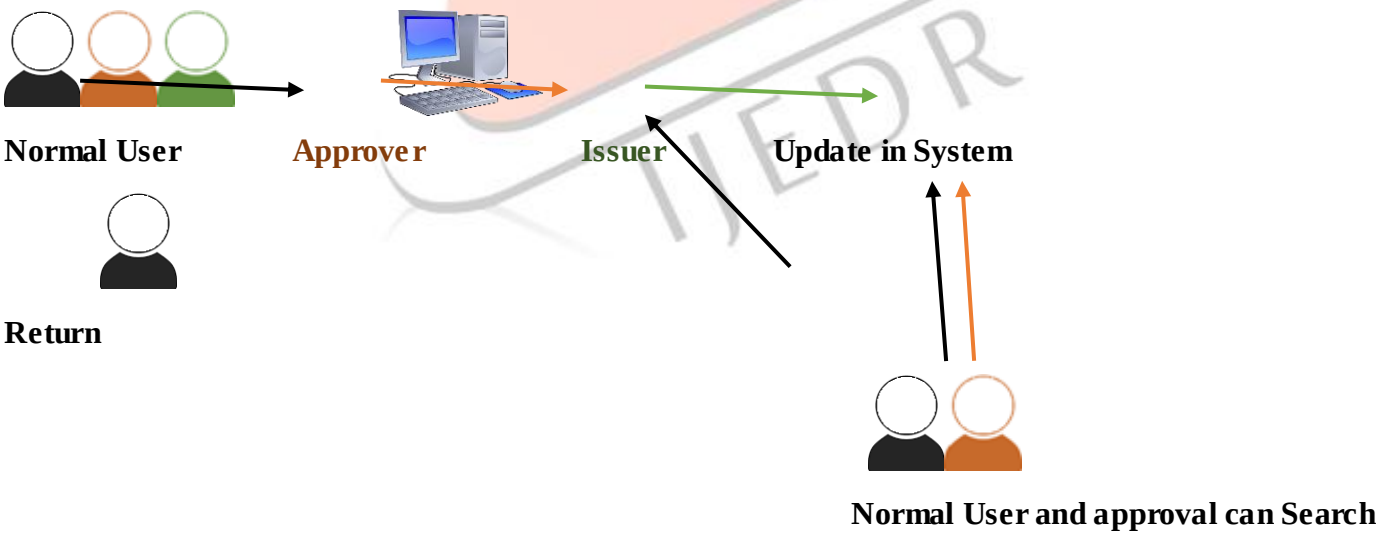

Figure 6: IMS Design database model

A. How Inventory Management Software (IMS) Works:

Inventory Management System (IMS) helps to manage inventories like tools, fasteners, materials etc.

In order to get required inventory, user have to raise the job card request, then it has to be approved by approver. Approver has the rights to approve/reject the job-card request sent by user. If approved, then it can be issued by issuer to the user, else user cannot issue the inventory. If the issued inventories are of returnable type, then it can be returned by user to the system, through the issuer. This track of all inventories is managed by Barcode System i.e. all inventories are having unique barcode attached with it. Also during the issue of inventory mail is sent to the user and approver regarding issue and probable return date, if the

inventory is returnable and also reminder mail regarding to return of inventory is sent to same if user fail to return inventory in definite time duration.

B. Detail View of Inventory Management System (IMS):

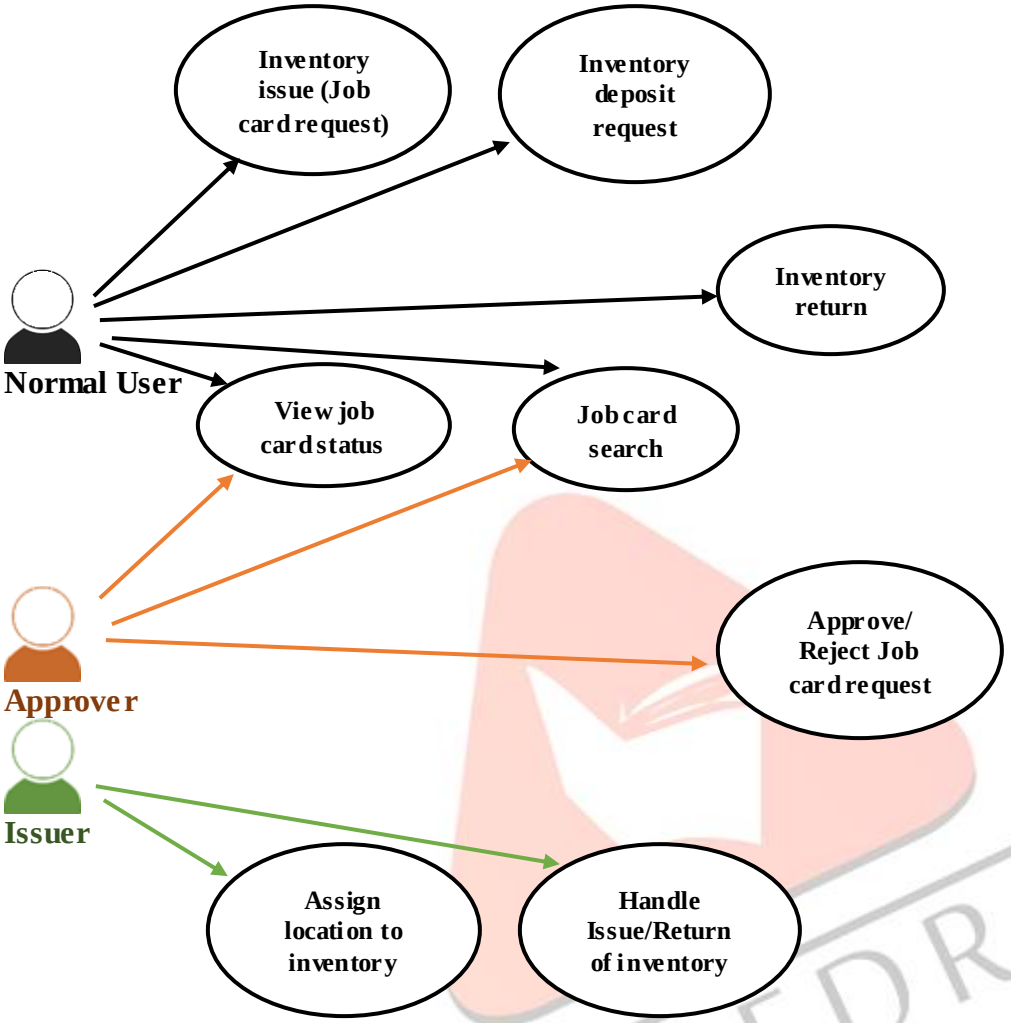

Figure 7: Use case diagram

Inventory Management System (IMS) consists of mainly four activities:

1. Request New Job-Card
2. Approve Job-Card
3. Issue/Return requested Inventory
4. Administration module

1. Request New Job-Card:

Normal user by means of secure login request new job-card also view job-card status, Deposit new inventory, Search Job-card, view/change profile etc.

2. Approve Job-Card:

Approver by secure login, approve or reject the requested job-card fully or can approve the partial amount of quantity of inventory.

Also Approver can perform the other normal user functionalities like view job-card status, Deposit new inventory, Search Job-card, View/change profile etc.

3. Issue/Return requested inventory:

After approval, issuer issue the requested inventory to user. Also same inventory can be returned, after use. This process is engaged with the Barcode system i.e. unique barcode is attached with each inventory.
Issuer can also assign location to respective inventory organized with barcode. This is useful for tracking the inventory corresponding to location.

4. Administration module:

Admin can add Project, Category, Sub- Category and location in the system. Also, admin has the rights of User Management i.e. admin can edit the user details or can remove the user from the system.

Effective inventory management is all about knowing what is on hand and where it is in use. Accurately maintaining records of fasteners, tools and materials makes it possible to quickly convey information as to what is available at any given time.
Inventory management software is a computer based network applications that track, manage and organize fasteners, tools and materials. Gone are the days of tracking inventory with pencil and paper. Organization can now use systems based on barcodes to see where the inventories are? And if it is returnable then when it is returned? By using inventory management software, businesses reduce the time and efforts previously put into basic tracking, and instead focus on analyzing, finding and reducing inefficiencies.
Inaccurate inventory records create a higher lead time (the time between the initiation and execution of a process), which means a slower response to demand. This, in turn, can create employees disapproval when inventories aren't available as needed.

VI. TESTING AND IMPLEMENTATION OF INVENTORY MANAGEMENT SYSTEM

I. Software Requirements:

- Windows 7 or higher version
- Intranet Facility
- Platform: java
- Database: My SQL

II. Hardware Requirement:

- Workstation with Plantium 4 or higher version
- Barcode Scanner
- Barcode Printer
- Barcode Tapes

A. Pre-test the database:

The project team should practice in the test database to confirm that all information is accurate and working correctly. Use a full week of real transaction data to push through the system to validate output. Make sure all necessary interfaces are designed and integration issues are resolved to ensure the software works appropriately.

B. Final Testing:

Make sure the actual Standard Operating Procedures works properly or not and determine whether modifications need to make. The project team needs to perform a final test on the data and make any needed adjustments.

C. Implementation:

Software implementation is the process of realizing design as a system. Organizations are increasingly implementing Inventory Management System (IMS) software solutions to improve operations and provide faster response. Choosing anIMS that meets specific business requirements will enable to have a smoother implementation. A well designed implementation plan is the key to success. For Implementation training was given to employees regarding awareness about Inventory Management System.

VII. RESULT AND CONCLUSION

After Implementation of Inventory Management System at initial stage it was found that mostly affected parameter i.e. Delay Time of selected components were reduced from 74756 min. to 64751 min. So, Process Cycle Efficiency was increased from 63.47% to 67.78%.

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