Chapter

D Minus 1 Production Scenario: Production Model for Produced Hospital Furniture

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Abstract

Many kinds of production systems are used in medical equipment industries, one of which is through the work-in-process (WIP) buffer control system and feeding material scenarios to assure ability of the process to produce the expected throughput. The production model, known as the D minus 1 production scenario, is used to control production activities at the factory to be carried out using the day minus 1 rule. This rule is a time-based buffer production scenario in 1 day, ending at the finished goods assembly station used as the zero point (D0), from each workstation, pushed for one consecutive day to the beginning of the buffer. With the success of providing WIP buffers on D-1 and D-2 days, the product is certain to be ready on time. Production activities are modeled as Heaviside step function of the various processes involved therein. Production schedule, also production simulation, can be planned through a production dashboard provided for this purpose. Customers demand transformed to an integrated production schedule throughout the production flow, followed by production dispatching and execution. The integrated production schedule includes the supply of raw components, welding, paint, and product assembly to meet on time deliveries.

Keywords: production model, D minus 1, Heaviside step function, WIP buffer, feeding material

1. Introduction

In producing hospital beds or hospital furniture, various manufacturing practices [1–3] and production systems [4–17] are applied in medical equipment industries, one of which is through the work-in-process (WIP) buffer control system and feeding material scenarios so that the process can run normally and produce the expected throughput. The WIP buffer control system and material feed scenario at the factory are known as the D (day) minus 1 production scenario.

Operational production activities are carried out through WIP buffer control and the material stock scenario at the factory using the day minus 1 rule. This rule is a time-based buffer production scenario in 1 day, ending at the finished goods assembly station used as the zero point (D0) from each workstation, pushed for 1 consecutive day to the beginning of the buffer. With the success of providing WIP buffers on D-1 and D-2 days, the product is certain to be ready on time.

Production activities are modeled using a mathematical model of the Heaviside step function [18] of the various production processes involved therein. With these mathematical equations, a production schedule model can be arranged in accordance with the specified production scenarios and it is possible to build a production simulation model in graphic and physical forms through a production dashboard provided for this purpose.

Using this production model, customer demand can be transformed into an integrated production schedule throughout the production flow, followed by production dispatching and execution. The integrated production schedule includes the supply of raw components, welding, paint, and product assembly to meet on time deliveries.

This production model was formed using two dashboards, namely, production planning and scheduling (PPS) dashboard for production planning and production execution management and production information management (PEMPIM) dashboard [19] for production management. By using this dashboard, customer orders can be integrated into the production schedule and the actual production process. In this management model, there is ease of material tracking [20–24] which is used to decide whether an expenditure schedule will be carried out or canceled.

The production dashboard is used to process customer demand data and is used as an input for creating integrated production schedules throughout the production flow, starting from the supply of raw components, welding, paint, and assembly to meet timely deliveries. The production planning schedule produced by the production dashboard is used for scheduling actual production.

Objective of D minus 1 production scenario is to solve manufacturing operation problems, which is implementing the SAP ERP software in a manufacturing company. SAP ERP is an enterprise resource planning software developed by the German company SAP SE. SAP ERP incorporates the key business functions of an organization [25]. The problem is the manufacturing operation in production floor failure to be integrated with the business in company level, and this makes a huge loss for the company [23].

The D minus 1 production scenario has been tested in a factory with actual production operation for various types of products (**Figure 1**). The actual production follows the production schedule in the D minus1 model scenario. Work-in-process buffer (WIP) and material supply scenarios at the plant are controlled using the ease of material tracking facilities. By carrying out actual production, the factory can produce products in the right amount and in time, which adhere to the production schedule so that finished goods can be delivered to customers on time.

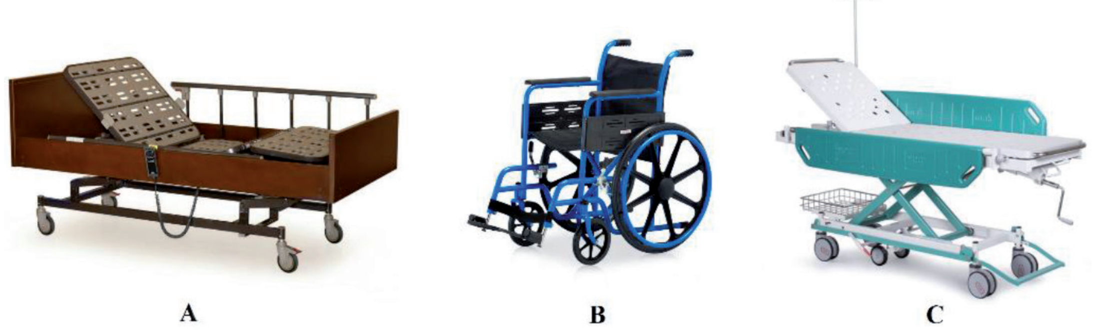

Figure 1.
Many kinds of hospital furniture. (A) Hospital bed. (B) Wheelchairs. (C) Transporting patients.

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2. D (day) minus 1 scenario

2.1 Definition of D (day) minus 1

The production model D minus 1 is a production control cycle model that uses N process stages, the planning time horizon is the delivery time of ST (days), the processing time cycle is ST-N + 1 (days) and the process period is daily. Production activities in this case use three stages process, so processing time is ST-2 (days), see **Figure 2**.

The characteristics of this model are:

1. The effective process time for Tp referral is 8 h.

2. In this model production plans can be scheduled for all stations at every stage of the process, this production schedule accommodates the possibility of holidays.

3. The number and type of products that can be scheduled to be produced are various (depending on the requirements on the production floor).

4. From the scheduled production plan, it can be simulated the possibility of delays in the completion of the process so that through this simulation it can be anticipated if a bottleneck is encountered in the process.

2.2 Model material feed scenarios in the factory

The success of the production process is influenced by the role of the material supply scenario in the factory [26, 27], and with a good scenario, it can be ensured that each station receives a timely supply and is easily handled in the production process, because each component is in a standard container rack, trolley, and box (RTB) and in a continuous range of motion so that the operator's movements are merely productive movements to produce added value, while nonproductive movements without producing added value must be kept as low as possible.

The basic principle of supply is to pull in complete quantities. This means that the supply of each process must be complete to form a one-piece flow, and after the material in the WIP buffer is finished, the supply can be withdrawn to the workstation, thus ensuring that the finished goods can be formed because each component is available.

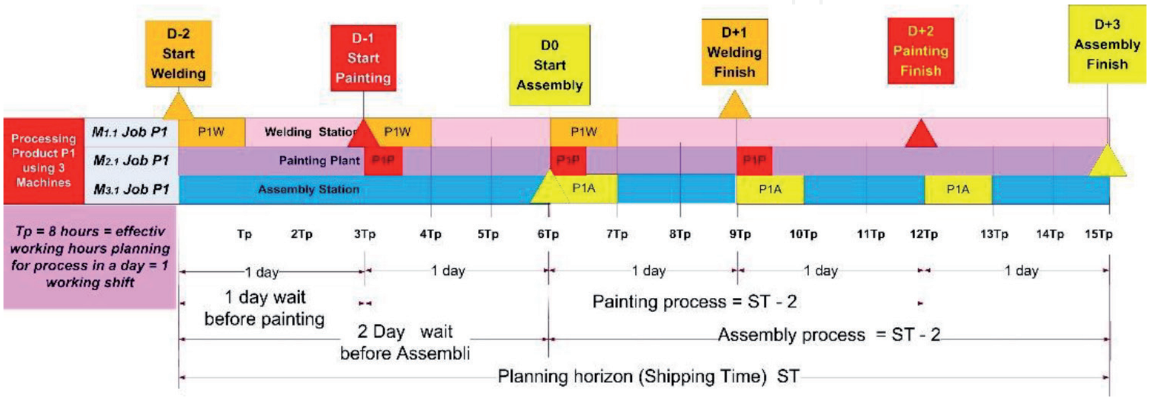

Figure 2.
Planning horizon of the production model D minus 1.

The concept used to fulfill these basic principles is to supply feeding materials to each workstation in the form of lots, batches, or kits. **Figure 3** shows the scenario scheme of the material supply to produce one type of bed. In this case, the production control area is only in the area bounded by the red line; outside of that is the supplier area, and in this case, the supplier is considered capable of meeting the supply requirements as required by his customers.

Starting from the upstream supply, suppliers for metal components in the form of raw components must supply to the welding station in the form of lots, which are placed in a standard RTB for processing at the welding station. The output of the product welding station is sub assay, and the product is placed in a standard RTB in smaller quantities, that is, batch and fed at the paint station.

Furthermore, the results of the paint station are placed in a standard RTB and forwarded to two workstations, namely, the component module station and the final assembly station. The supply of plastic components in batch form is supplied to the component module station and final assembly. The caster wheels are supplied in batches directly to the final assembly station.

The existing supply in the factory is in the form of standard module components and standard component stations. From the station module components are supplied components such as thrusters, side guards or head end foot panels in batch units. Whereas, the supply of standard components is in kit units. The management of this kit form is done in a standard component warehouse.

The production scenario starts with the planned activity at the final assembly station with the production schedule on day 0 (day zero D0) followed by the welding supply time scenario supplied on D-2 (minus 2 day) so that the production schedule is complete, and the supply at the paint station must be available on D-1 day (minus 1 day).

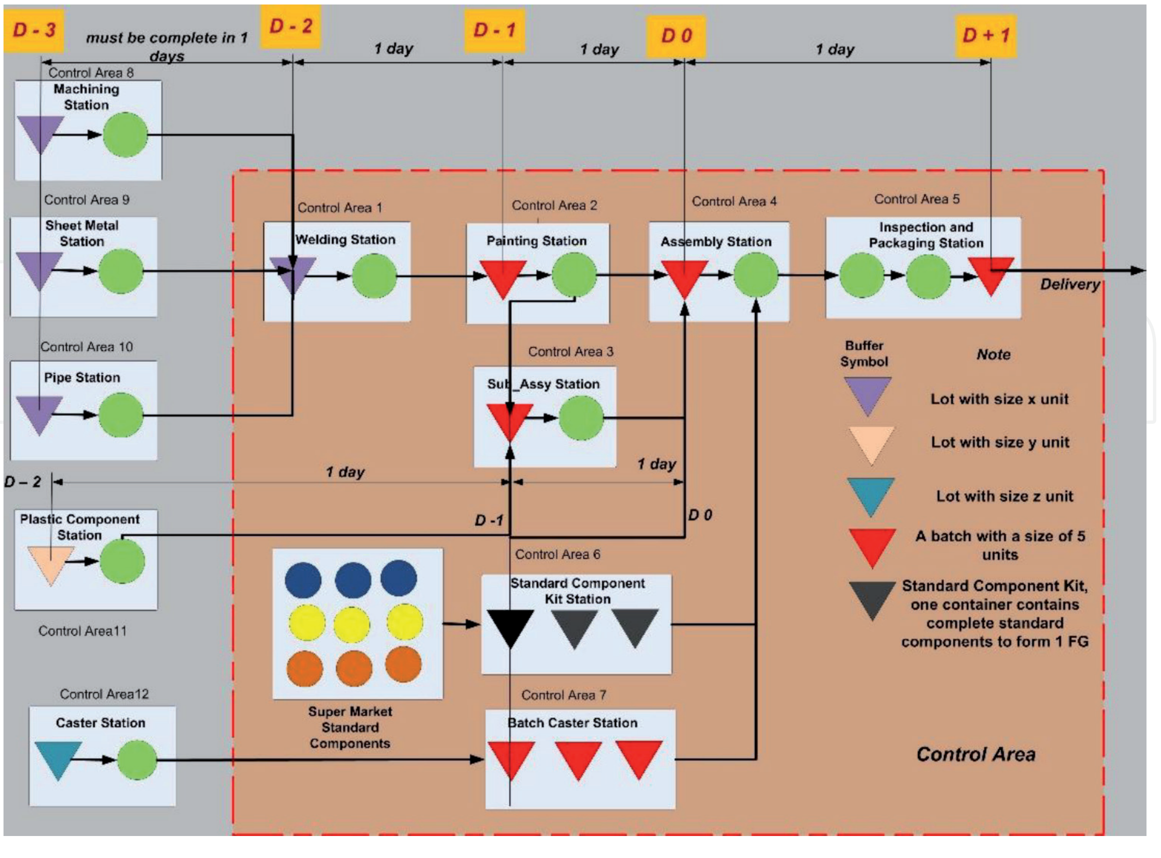

Figure 3.
Material supply scenario.

2.3 WIP buffer model

This section explains the WIP buffer model in the D minus 1 production scenario shown in **Figure 4**, which illustrates the configuration of work-in-process management (WIP) in the form of the production process of making beds for various types of bed products, and the process timing is shown in **Figure 5**.

In **Figure 4**, welding stations there are various stations from M_{11} to M_{1n}, in the paint section there is only one M_2 station, while in the assembly station various stations are available, namely, M_{31} to M_{3n}, each station produces a certain type of product.

All workstations are controlled by the WIP buffer, and the buffer configuration at the factory is from the B_{11} feeder to B_{1n} which is the WIP buffer from the M_{11} to M_{1n} welding station. While the feed in the paint section for the M_2 station is controlled by the WIP buffer continuously at buffer B_{21} to B_{2n}. The output from the paint section continues to hold the WIP buffer from B_{31} to B_{3n} and the buffer is prepared for the M_{31} to M_{3n} assembly station, and the result is the finished product in buffers B_{01} through B_{0n}.

The results of welds from various welding stations cannot be added to the paint section at once, because operations in the paint section are dependent on the hanging effortability of the components to be painted. Each component to be painted is hung on a hanger, and then through the conveyor the components are processed one by one. From the start of hanging until the first component out of the oven takes 90 min, and for a conveyor speed of 2 m/min, a set of products requires time to leave the paint section between 6 min and 12 min, depending on the complexity of the product.

The output from the paint section must be able to feed the M_{31} to M_{3n} assembly stations in accordance with the specified production schedule. If the buffer to the assembly station is done together with the painting station, the M_{31} station needs to wait 1.5 h (the first product waiting period comes out of paint station) plus 60 min (to complete one full provision of one batch of five component sets) while the

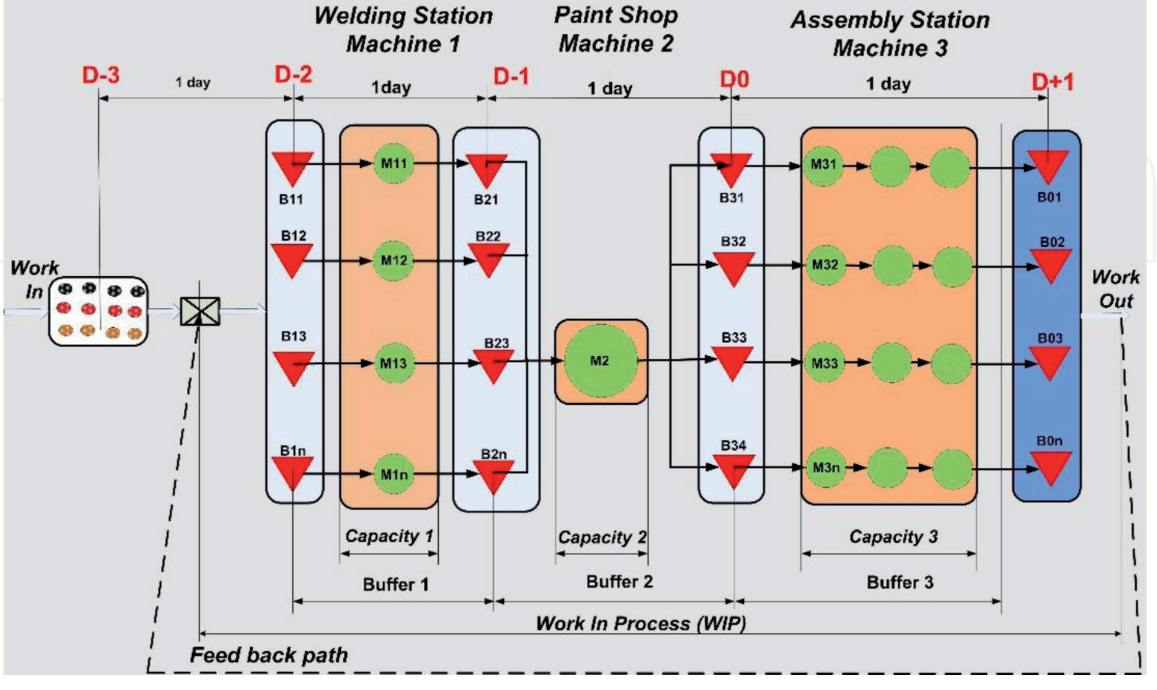

Figure 4.
Production model scenario D minus 1.

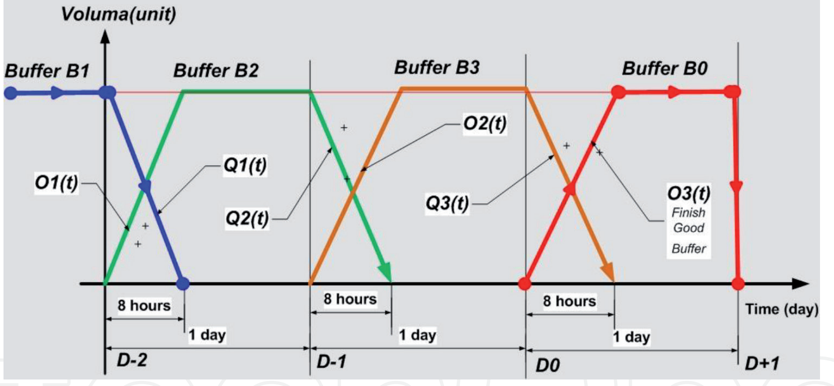

Figure 5.
Timing process in production model scenario D minus 1.

other station waits because there is no buffer. This is a situation where the buffer is not sufficient to supply an assembly station that is designed to operate at a certain capacity.

To overcome this, a buffer scenario is created on day D--2, where sufficient buffers must be available from B_{11} to B_{1n} to be fed to the welding station. Meanwhile, to be fed to the paint part, there must be enough buffers B_{21} to B_{2n} available. Furthermore, to be fed to the assembly station, B_{31} to B_{3n} buffers must also be available in sufficient quantities.

The buffer that needs to be provided is work in. This buffer must be ensured on day D-3 already available, while through the WIP controller the input entered into the system must be controlled, the input is work released, while the throughput is work out provided from the WIP buffer of finished goods B_{01} to B_{0n}.

Through this model, it can be stated that the controlled parameter is WIP in the system, while the manipulated parameter is the upstream buffer in each machine system of the three processing machines. By using the principles of control, of course by controlling WIP through the manipulation of parameters of the production process, it is expected to succeed.

2.4 Scenario of three-stage production dispatch and manufacturing execution process

The production scenario D minus 1 for the production process of one type of product with three stages of successive process, namely, welding, paint, and assembly are depicted in the production dispatching and manufacturing execution scheme shown in **Figure 6**.

On the first day (day 1; **Figure 6**), starting from the welding station, after making sure that the buffer material in front of the welding station (B_1; **Figure 5**) is complete, the production dispatcher releases the B_1 buffer for the welding process dispatch and the production executor at the welding station executes the welding process, while on this first day, the paint station and the second assembly is idle, waiting for the results of manufacturing execution at the welding station buffered on B_2 (**Figure 5**) to be fed to the paint station the next day (the second day).

On the second day (day 2; **Figure 6**), the welding station repeats the welding process as done on the first day, while on the second day, the paint station has available buffer material for processing. After checking that the buffer material in front of the paint station is complete, the production dispatcher releases the buffer for the paint processing dispatch and the paint station production executor executes by carrying out the painting process, while on this second day, the assembly station is still idle, awaiting the results of manufacturing execution at

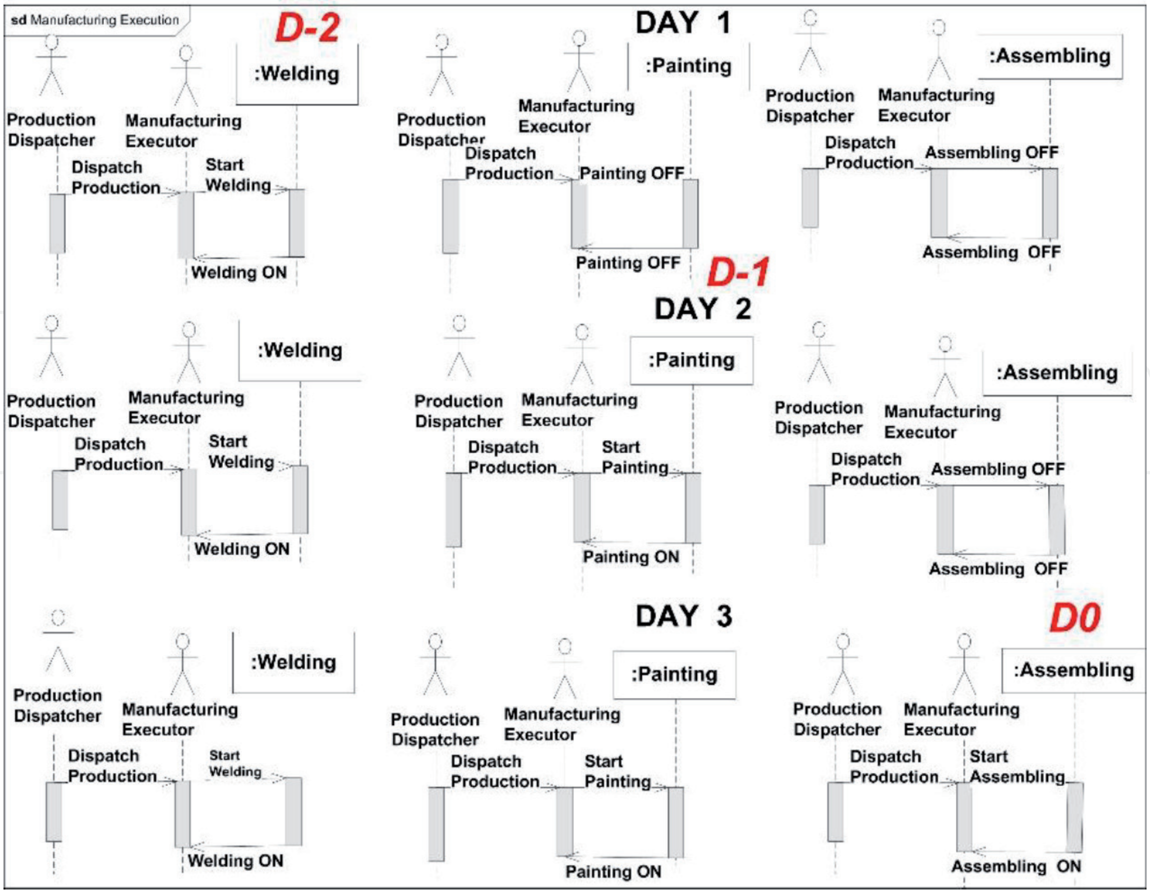

Figure 6.
Production dispatch and manufacturing execution scenarios.

the painting station buffered on B_3 (**Figure 5**) to be fed to the assembly station the next day (the third day).

On the third day (day 3; **Figure 6**), the welding station and the paint station repeat the welding process as done on the second day, while on the third day, the assembly station has a ready component buffer available for assembly. After checking that the finished component buffer in front of the assembly station is complete, the production dispatcher releases the buffer for the dispatch assembly and the production executor at the assembly station carries out the manufacturing execution by carrying out the assembly process to produce finished goods buffered at B_0. On the third day, all three workstations carry out manufacturing executions simultaneously, and this process is repeated in the following days until the specified shipping time is found.

2.5 Planning horizon of the production model D minus 1

The production model scenario D minus 1 use the planning time horizon based on shipping time (ST). This time is described in relation from the beginning of the production process to the completion process (finished goods are sent or stored in warehouses), for all stages of the production process shown previously in **Figure 2**. The work reference is on day 0 (D0), which is the day when the assembly process starts (start assembly), for that on day D-1 (start painting) the painting process must be sure to run, and on day D-2 (start welding) welding process must also be sure to run.

The processing time in the case of three process steps for the welding, paint, and assembly processes is the same as the ST-2 days. While the waiting time to be able to start the painting process is 1 day, while the waiting time for the assembly process is 2 days.

The complete planning horizon for D minus 1 production scenario is illustrated in **Figure 7**. In this figure, the total amount produced during the ST period is expressed in Dt (units), the amount produced daily is Dp (units), and the daily processing time for one shift is Tp = 8 h.

The D minus 1 scenario will be able to be effectively applied to a hospital furniture factory with a daily production plan of more than one type of product (n types of products), because the obstacle is that, at a painting station, one painting station will get feed n buffer components from B_{21} to B_{2n} and must produce finished components which are buffered into n buffers in B_{31} through B_{3n} which will be fed to n assembly stations.

The painting process model is multi-buffer input, single machine, and multi-buffer output, where the buffer output cannot be received immediately even though the input buffer has been fed to the paint station, and the product can only be received at the buffer output after the paint station completes one rotation cycle, and the waiting time for waiting for the first output out of the painting plant is about 90 min.

The results of this paint will later be placed in buffers B_{31} through B_{3n} to be fed to n assembly stations, so if the bait scenario uses the *hot from the oven* method, the waiting time constraints on each assembly station will be a waste, and to overcome this, use the production model D minus 1 with prepared component buffer on minus 1 day before the component is assembled into finished goods. Examples of scenarios for managing four types of products are shown in **Figure 8**.

2.6 Production schedule and example of D minus 1 operation

Production schedule is setup used mathematical Heaviside step function $H(t)$ [18]:

$$H(t)=\begin{cases} 0 \overset{for}{\rightarrow} t \le 0 \\ 1 \overset{for}{\rightarrow} t > 0 \end{cases} \tag{1}$$

Using D_{di} as the stimulus and ST is total planning horizon. General time respond Dp at time t for every number of period k of time period T_d which is time period of a process to finish D_{di} product in a day can be determine as:

$$Dp(t,k)=D_{di}\left(H\left(t-kT_d\right)-H\left(t-kT_d-T_d\right)\right) \tag{2}$$

k = 1, 2, 3, ST

With Eq. (2) can be determined day-to-day production schedule in each workstations as seen in Eqs. (3)–(5); each is respectively scheduled for welding, painting, and assembly.

$$Dpk(t,k)=D_{di}\left(H\left(t-(k-1)T_d\right)-H\left(t-(k-1)T_d-T_d\right)\right) \tag{3}$$

$$Dpc(t,k)=D_{di}\left(H\left(t-kT_d\right)-H\left(t-kT_d-Td\right)\right) \tag{4}$$

$$Dpa(t,k)=D_{di}\left(H\left(t-(k+1)T_d\right)-H\left(t-(k+1)T_d-T_d\right)\right) \tag{5}$$

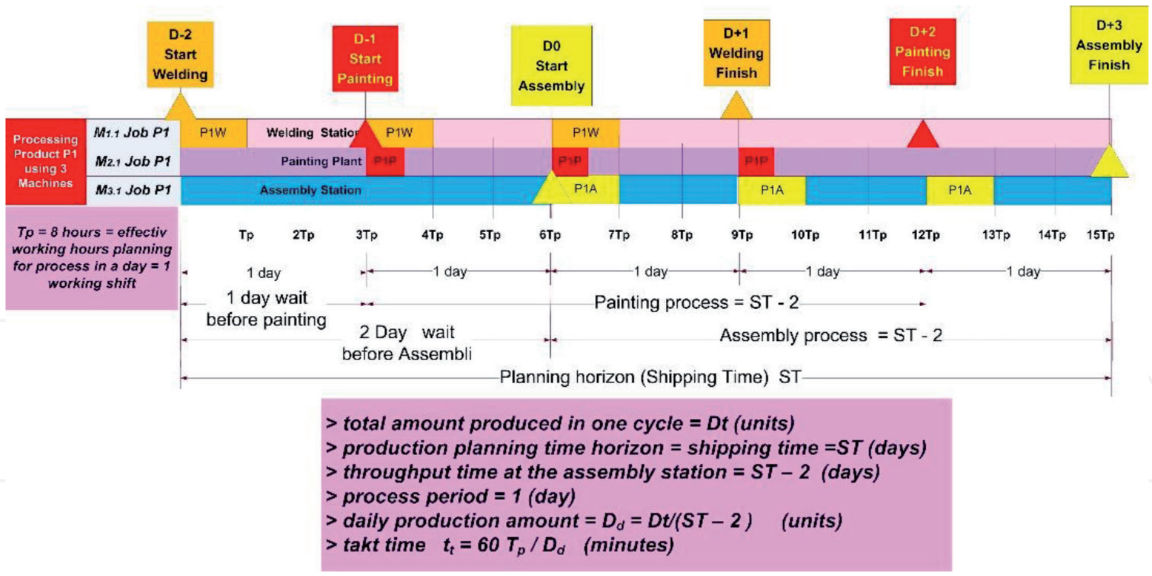

Figure 7.
Scheme of the complete planning horizon of D minus 1 production planning scenario.

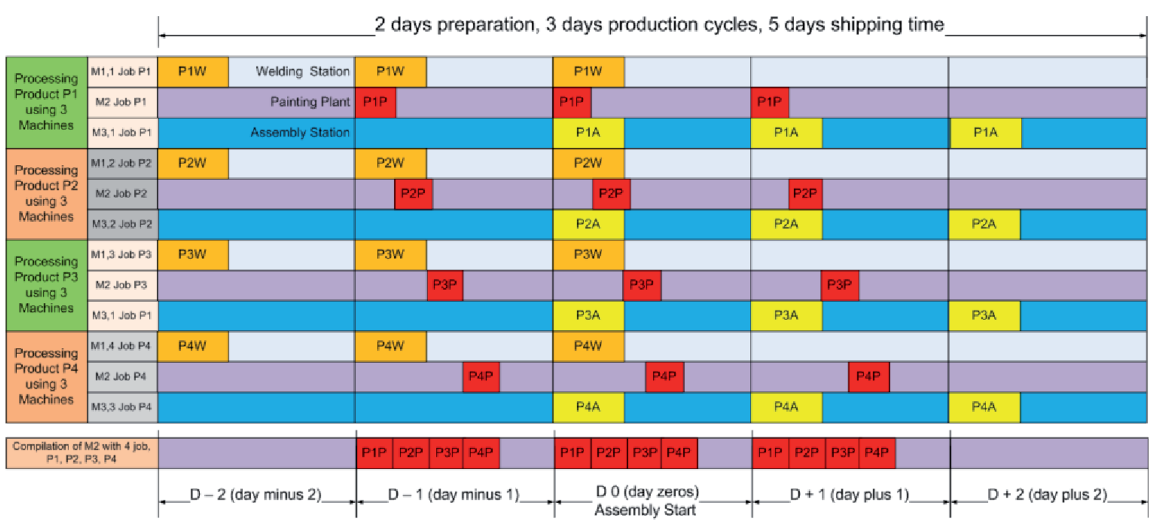

Figure 8.
The planning horizon scenario for the production model D is minus 1 to produce four types of products.

For planning production activity used Eq. (3), Eqs. (4) and (5). Base on those equation be developed application module using Matlab software for setup production schedule. Sample of production schedule is shown in **Table 1**. This is the table of production activity for delivering order of 96 unit products of hospital bed, Supramak 73,006, with daily production of 32 units, with shipping time 5 days; production period is 2÷7 February 2017, in this period at date of 5 February (holidays) production activity is off.

The following will show the scenario D minus 1 of production schedule of **Table 1** to produce products with a total volume of Dt = 96 units, lead time ST = 5 days, daily production plan Dd = Dt/(ST-2) = 96/3 = 32. From this production plan, the production process scenario for the welding cycle time t_{weld} = 18 min as shown in **Figure 9**.

This is a daily production scheme for welding stations using a daily process period of one shift is Tp = 8 h, 1 day is 24 h, so the 24th hour represents the first day, the 48th hour indicates the second day, the 72th hour denotes the third day and so on.

Process	01-Feb	02-Feb	03-Feb	04-Feb	05-Feb	06-Feb	07-Feb
Supply	32	32	32	0	0	0	0
Welding	0	32	32	32	0	0	0
Painting	0	0	32	32	0	32	0
Assembly	0	0	0	32	0	32	32

Table 1.
73,006 Supramak bed production schedule.

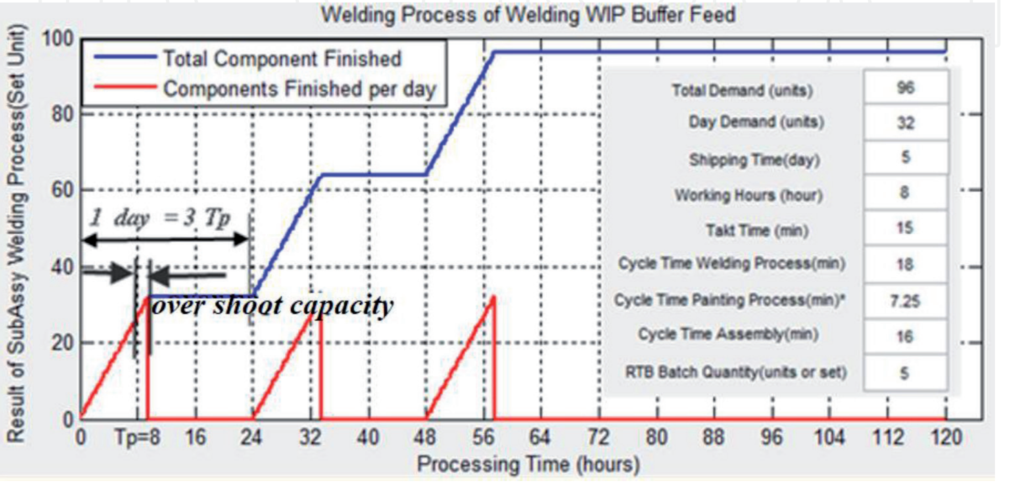

Figure 9.
Example scenario at a welding station. Total production of 96 units, ST = 5 days.

From **Figure 9** at eighth hour, the welding process to finish 32 products should have been completed, but the process was still running (overshoot capacity $T_d > Tp$) to completing the process through extra time (overtime). The occurrence of overtime is due to the available daily production capacity is lower than demand, the indicator is weld cycle time > takt time (18 > 15 min), in this case the overtime that needs to be provided is (18–15) 32 = 96 min.

To avoid overtime in the welding process, in planning the production process, it must be ensured that takt time ≥ cycle time, because takt time indicates the production capacity is associated with workload (number of requests).

The semifinished component buffer for the painting station provided by the welding station the day before was in complete condition, then the component was painted with the process scenario as shown in **Figure 10**.

The complete component supply before leaving the painting station as a finished component, is first circulated throughout the paint station track using a conveyor, so there is a delay in processing time to start the painting process waiting for the finished component to be the first to leave the paint station. In **Figure 10** shown at 24 h.

This delay will reduce the time available for the Tp process to Tp-waiting time, and act as potential to cause a delay in the process of completing the workload (overtime) and this will occur if the number of complete components forming the finished product requires the same cycle time or greater than takt time. But if the paint cycle time is far less than the takt time, then before the process runs out the workload has been completed so that there is still available remaining time and capacity (**Figure 10**), this remaining time can be used to process other types of products.

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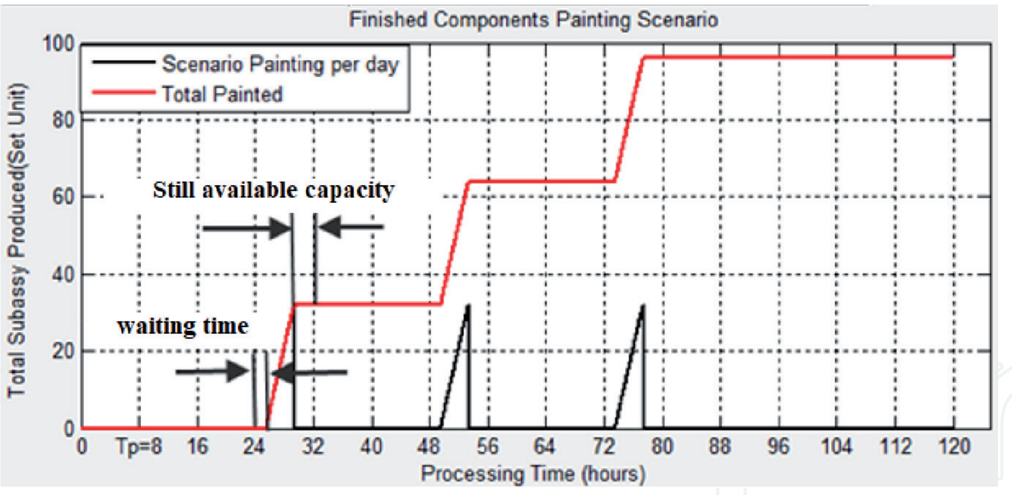

Figure 10.
Example scenario at the paint station. Total production of 96 units, ST = 5 days.

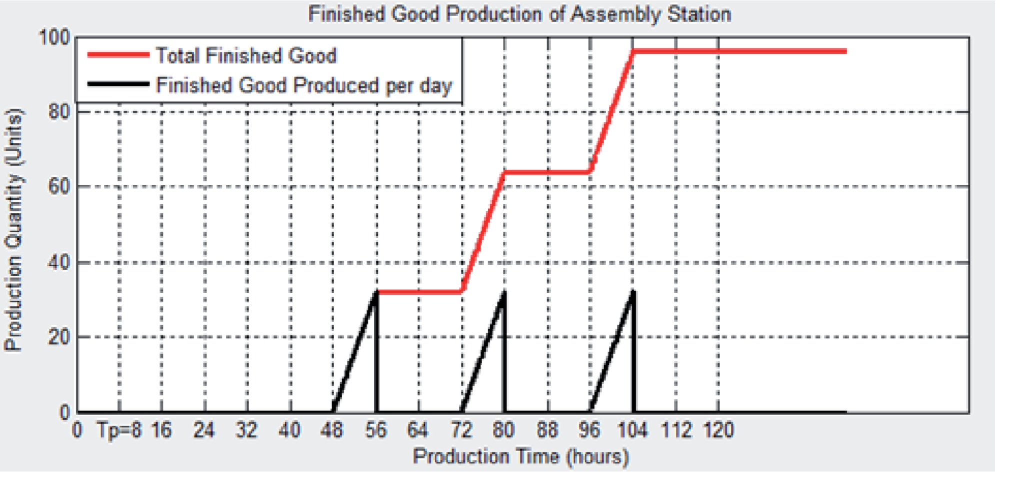

Figure 11.
Example scenario at an assembly station. Total production of 96 units, ST = 5 days.

The finished component buffer for the assembly station provided by the welding station 1 day before is available in complete condition, then the component is assembled with the assembly process scenario as shown in **Figure 11**.

At the assembly station, the process of assembling finished goods can be directly carried out without any waiting time, if the time of the assembly cycle (ta) of the finished product is close to the takt time price then the possibility of overtime can be reduced. **Figure 11** shows that Tp processing time can be utilized maximally, and in this case, overtime does not occur or the process is finished faster than the available processing time.

2.7 Production dashboard

2.7.1 Production planning and scheduling (PPS) dashboard

Operational model of D minus 1 production scenario can be managed using a production dashboard [19]. Starting with production schedules, buffering at each production station and production simulation to total product demand can be demonstrated using this dashboard. Also, daily production activity and calculating the time delay when production cannot be met the target can be demonstrated too. This dashboard besides to simulate production activities based on cycle time and takt time also provides applications to show the response of the production system as a dynamic system.

This dashboard to display production simulation with scenario D minus 1 is called the production planning and scheduling (PPS) dashboard. The PPS dashboard display is shown in **Figure 12**.

Production planning and scheduling can be setup on the dashboard. Before production, event schedule executed the schedule simulated using relevant parameter of production control. If by simulation target of production can be achieved, the scheduled plan decided to be used as production schedule in production floor. But if schedule failure, must be set up new production parameter to control and optimization the process, and with the new parameter once again the production event must be simulated. If the process objective can be fulfilled by this parameter, then the parameter is used in the production schedule.

Control parameter provides in the prototype PPS dashboard, and the parameters used to simulate production process are takt time and cycle time. Cycle time, which is higher than takt time, means capacity of production is lower than the customer demand. For this case the production system is multistage production it is mean all cycle time in each production stage must be equal or lower than takt time. If one of cycle time higher than the takt time, production output will not full fill the customer demand, also there is a bottleneck in one of production stage certainly. If the difference of the takt time and cycle time relatively small, the solution is using extra time in the production floor. But if the difference significantly high the production system must add production time shift.

Control parameter can be directly input to the dashboard use block *Input Parameter* as shown in **Figure 12**. Also using facility provide in the windows dashboard system is with push menu *Input Production Parameter* which is prompt input dialog for input control parameter, the result also displayed in block Input Parameter. For simulate the process must be push each process menu, *Welding*

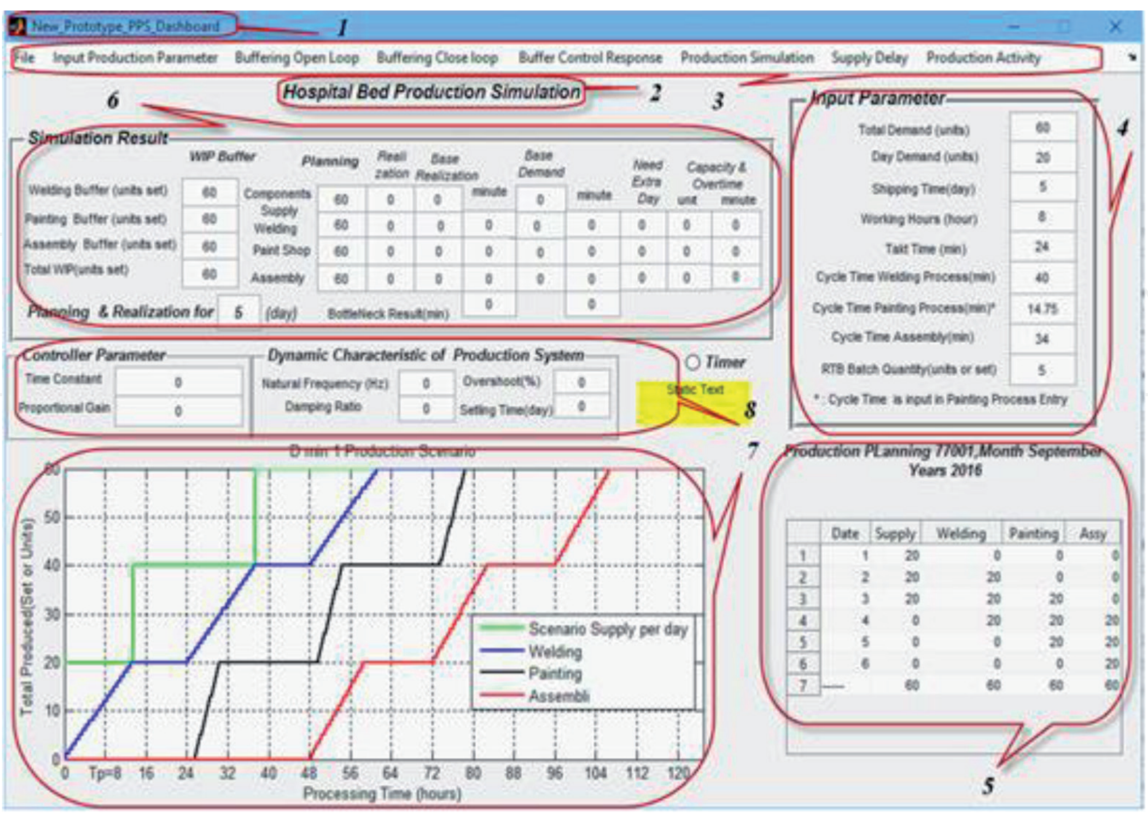

Figure 12.
Production planning and scheduling (PPS) dashboard. The dashboard consists of: 1.Dashboard name, 2. Simulation Title, 3. Dashboard Menu, 4. Input parameters, 5. Product name and production schedule, 6. Simulation Results, 7. Graph Display, and 8. Dynamic system display.

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Buffer, *Paint Shop Buffer* or *Assembly Buffer*. To show all process must be push menu *Display result*.

The simulation sample shown in **Figure 12** is simulation of production to produce total customer demand 120 units hospital bed, for shipping time 5 days and day demand is 40 units. Takt time 12 min, cycle time in welding station is 13 min, in paint shop is 7.25 min and in assembly 12 min. Simulation result is shown in *Simulation Result* block.

The dashboard also provide compare between target and realization for any day of production, if there is any difference between target and realization the dashboard will show bottleneck time also need of extra time to finishing the task. If the differences can be accepted use menu in Input parameter to save the production planning.

2.7.2 Production execution management and production information management dashboard

To control production process provide production execution management (PEM) dashboard and production information managements (PIM) dashboard, both dashboard bundle in a single dashboard call as PEMPIM dashboard [19].

The architecture of the dashboard is shown in **Figure 13**, and the windows dashboard is equipped with menu:

1. File menu: For operating file among other open file, save file and close windows.

2. Bill of Materials (BOM) information and status of components supply menu: It is for manufacturing control purposes, consist information of supply components to ensure that supply is complete.

3. Outstanding orders menu: It is for execution purpose of production. This consists of menu for give information of the order status, status finish good in ware house and product delivery to customers.

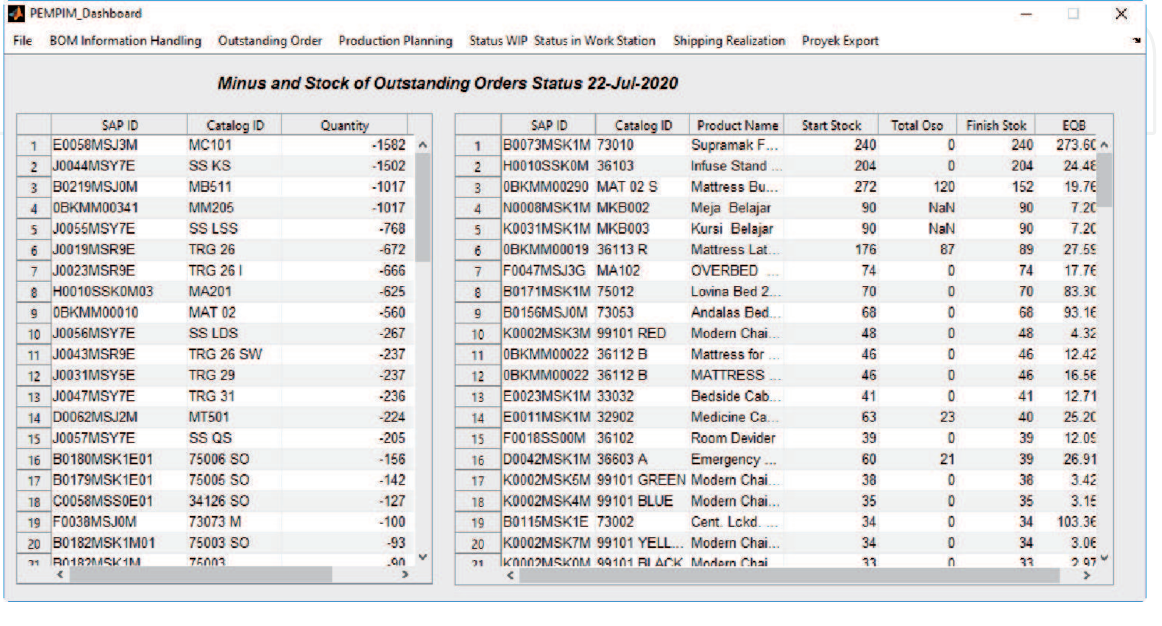


Figure 13.
Production execution management and production information management dashboard.

4. Production WIP menu: It is for manufacturing control purposes, consists information of WIP buffer of supply from internal supplier, welding station WIP buffers, paint shop WIP buffer, and assembly WIP buffer.

5. Target and production realization menu: It is for manufacturing control purposes to show target of production and realization.

6. Machine loading simulation menu: It is additional tool for simulating loading of the machine to forecasting capacity of the workstation.

7. Tool for input components supply menu: It is additional menu for input components supply for special case.

The design of the manufacturing control dashboard is still limited capability as integrated tool for integrating production information from welding station,

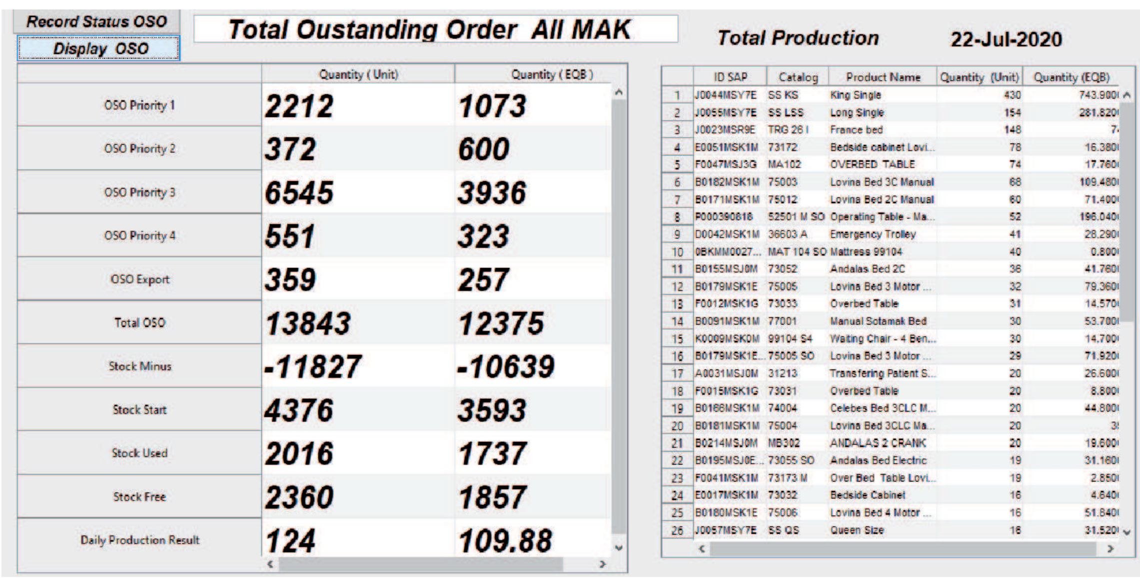


Figure 14.
Snapshot information of outstanding orders status.

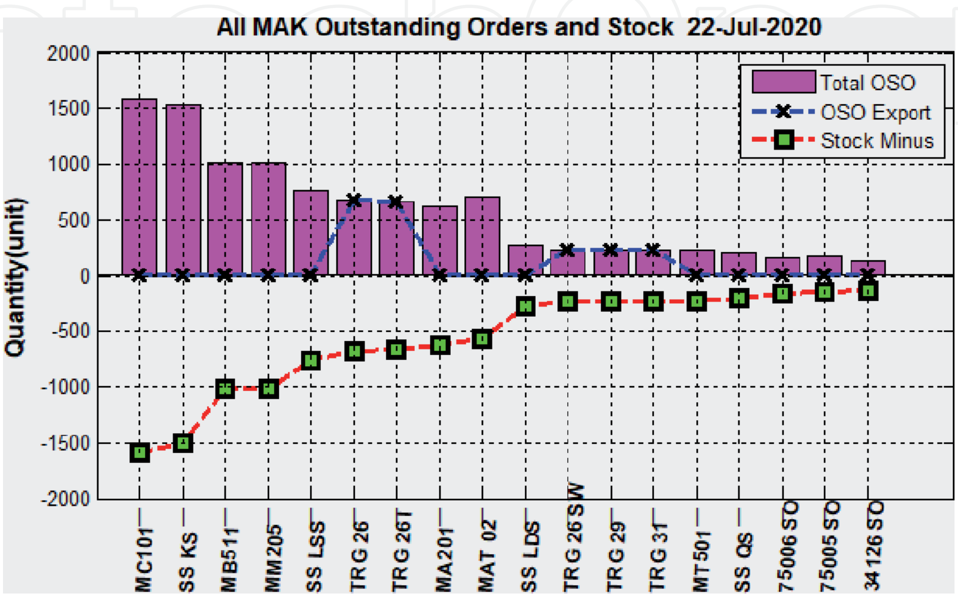


Figure 15.
Snapshot information of outstanding orders and stock.

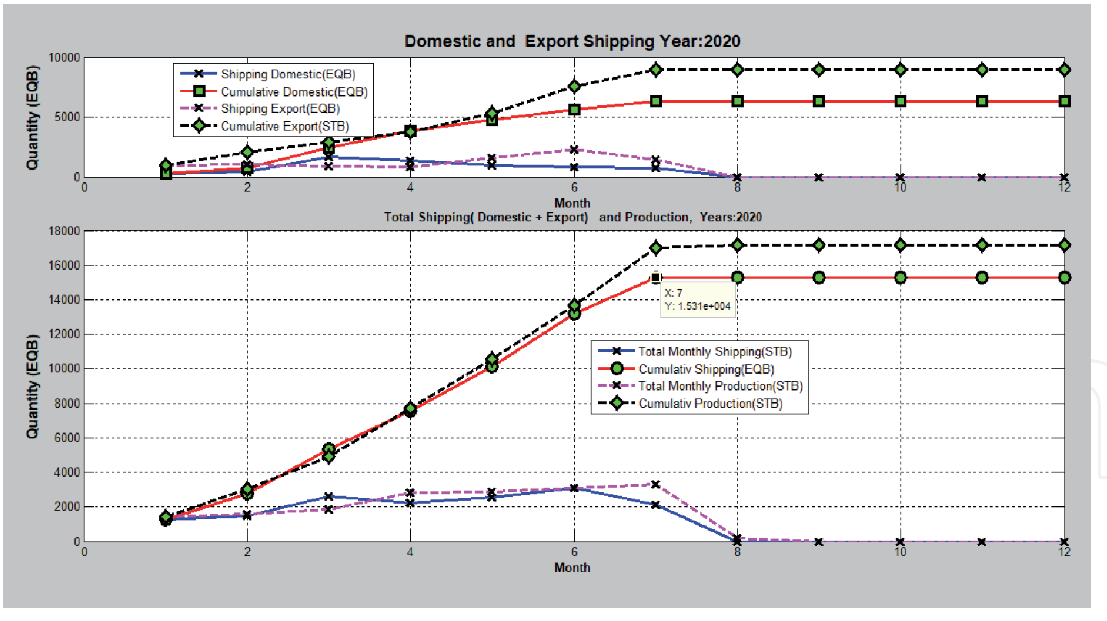


Figure 16.
Snapshot information of production and shipping.

paint shop, assembly also supply of components to be integrated with SAP ERP. The dashboard is a stand-alone dashboard, and not an interface yet to the SAP system.

Examples of output information of the dashboard are: information outstanding orders (**Figure 14**), information of outstanding orders and stock (**Figure 15**), information of production and shipping (**Figure 16**), etc.

3. Verification and validation of the D minus 1 production system

To verify the implementation of this production system, a manufacturing execution system (MES) is used which refers to the ANSI/ISA 95 Part 3 Activity Models of Manufacturing Operations [22, 28]. The manufacturing operations functions are shown in **Figure 17**.

Verification of D minus 1 system is intended to ensure that the functions of manufacturing operations can be operated by providing properly prepared information from the PPS and PEMPIM dashboards, so the production of each workstation normally run and capable to show good production performance.

The verification process begins with processing the product orders into a production schedule and is detailed at all workstations following scenario D minus 1 for the shipping period ST and the detailed schedule must be available at each workstation. This detailed schedule information is then passed on to the production tracking function to ensure that all materials to be used in the process at each workstation are available. For this purpose, the information is provided on the dashboard in the material tracking function.

To ensure that the process can be carried out, the production resources must be available, and for that, the availability of production resources as schedule is verified by using the information on resource requirements at the workstation using the dashboard of available source information.

The verification process is accepted if the system can provide information about the availability of production materials and resources to the dispatcher for each production plan in each workstation according to the production schedule.

To validate the production system is done by validating the dispatcher function and manufacturing execution. This validation process is intended to ensure that the

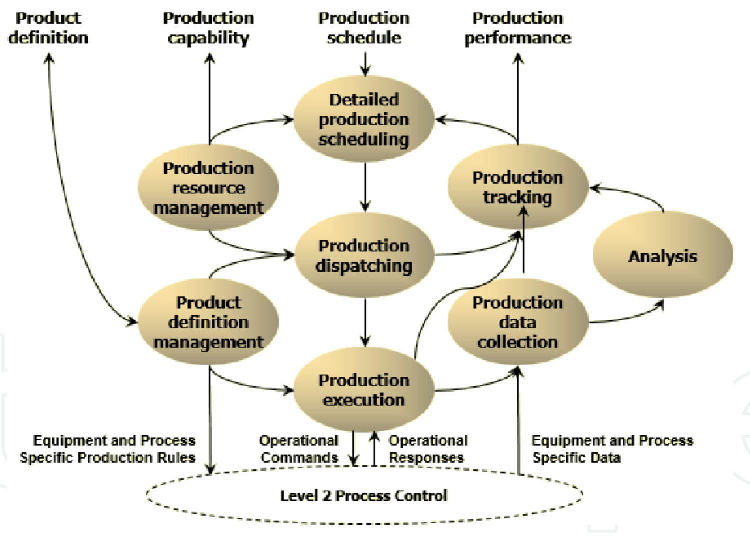
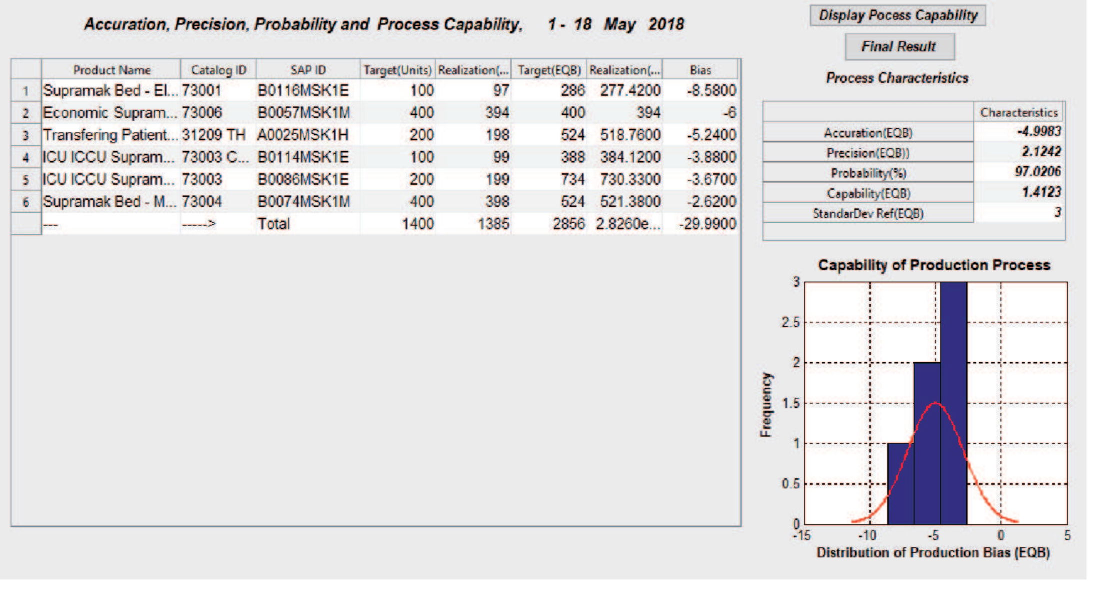


Figure 17.
Manufacturing operation function.



	Product Name	Catalog ID	SAP ID	Target(Units)	Realization(...	Target(EQB)	Realization(...	Bias
1	Supramak Bed - El...	73001	B0116MSK1E	100	97	286	277.4200	-8.5800
2	Economic Supram...	73006	B0057MSK1M	400	394	400	394	-6
3	Transfering Patient...	31209 TH	A0025MSK1H	200	198	524	518.7600	-5.2400
4	ICU ICCU Supram...	73003 C...	B0114MSK1E	100	99	388	384.1200	-3.8800
5	ICU ICCU Supram...	73003	B0086MSK1E	200	199	734	730.3300	-3.6700
6	Supramak Bed - M...	73004	B0074MSK1M	400	398	524	521.3800	-2.6200
	---	----->	Total	1400	1385	2856	2.8260e...	-29.9900

	Characteristics
Accuration(EQB)	-4.9983
Precision(EQB))	2.1242
Probability(%)	97.0206
Capability(EQB)	1.4123
StandarDev Ref(EQB)	3

Figure 18.
System validation using capability process.

production process can run and production targets can be achieved. Information on the completeness of resources and the availability of materials must be processed by the dispatcher to determine that the manufacturing execution in each workstation can be carried out.

The process is declared valid if the process accuracy is ±5 equivalent to bed (EQB), precision <= 5 EQB, probability > 90% and process capability > 0.7, it is used as indicators performance for process validation.

The system has been validated on18 May 2018 (**Figure 18**) in production floor, the result all process performance (as process characteristics) indicate fulfilled performance requirement given, it is mean the system is valid.

4. Conclusions

The purpose of D minus 1 production scenario is to produce a management model on the production floor of the assembly plant of hospital furniture through

WIP buffer control and feeding material scenarios to ensure the process runs normally and produces the expected throughput.

The D minus 1 production scenario is an alternative production management model for production scheduling and assembly management from a manufacturing plant of hospital furniture. It also ensures that the production process runs normally and produces a high level of production.

Managing of production activities is done through the control of WIP buffer and material supply scenario in the factory using method D minus 1. This method is a production scenario based on a 1-day buffering period, ending at assembly station as zero point, and then pushed in 1 consecutive day to the beginning of the buffer from each production station. The success of setting buffers at D-1 and D-2 is main factor for the product to be delivered on time.

This production model is built using two dashboards, namely, the PPS dashboard for production planning and the PEMPIM dashboard for production management. By using this dashboard, orders from customers can be integrated into the production schedule and actual production process. Also provided is material tracking facility, which is used to decide whether a production schedule will be implemented or canceled.

The model has been tested in a factory with actual production activity for various types of products. By implementing D minus 1 in the factory, production activity runs normally and is capable to produce products in the right quantity and in a time that complies with the production schedule, so the goods can be delivered on time.

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