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INTEGRATING COMPREHENSIVE INDUSTRIAL RAW MATERIAL DELIVERY PLANNING AND PRODUCT-SERVICE SYSTEM INVENTORY CONTROL

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ABSTRACT

Product Service Systems (PSS) are integrated product and service offerings that provide superior customer value in industrial applications for planning, inventory control, delivery planning and a use jointly defined. Delivery planning is a particular challenge in providing personal security services. A good delivery planning is can minimize problem from great complexity subject to various constraints within a large solution space. Organizations offering PSS services or industrial services suffer from decision support to put in place robust capacity planning strategies in highly dynamic and uncertain environments. This paper presents a simulation-based approach to capacity planning. The goal of this project to identify potential routes of integration between two factors deliveries planning and PSS inventory control that could improve the delivery performance based on the raw material industry. Emphasis is placed on capacity planning for PSS inventory control and delivery planning. By using IDEFØ (Integration Definition for Function) generic modelling and Delmia Quest simulation software in this research able to achieve the time required. IDEFØ includes a well-tested language and a comprehensive system modelling technique. Meanwhile, Delmia Quest software will provide real time simulation for production process and generated report for actual operational situation. After a few general considerations on robust capacity planning for the control and delivery of technical support inventory using scenario simulations, the main elements of the agent-based simulation method are presented. The most important parameters given by company A, the control parameters and the performance indicators are discussed and the scenario planning process based on the simulation is described. This research improves the productivity rate by increasing the flexibility in time to respond towards customer needs and improve delivery performance.

INTRODUCTION

Manufacturing organisations face new troubles as competition moves toward becoming globalised. The assembling business additionally makes generation deviations underway progressively adaptable and responsive by analysing all parts of their tasks all the more completely and Product-service system (PSS) incorporates the continuum of items and administrations in a solitary framework. Little is thought about the constraints of PSS because the outside and inner components of stock control the board in a dangerous, surprising expense condition present many vulnerabilities concerning status, upkeep and substitution of item parts. The examination centres around the investigation of the esteem and legitimacy of the presentation of a PSS stock control framework. The exploration will prompt another way to deal with stock control the board, comprehend the PSS worldview in the assembling part yet besides influencing their incomes and benefits.

The operational planning of the production deals with the allocation of resources (machines, personnel) to the controls and the determination of the optimal sequence of commands and the time window of execution of the various commands. The main focuses of production planning are delivery times,

turnaround times, low stock levels and high capacity utilisation. In reasonable arranging circumstances, a portion of these goals come into clashes, for example, short due dates and low inventories [1]. The purpose of operational service delivery planning is to allow many assets to a lot of administration orders dependent on their accessibility, area, capacities and to characterize the ideal request and the beginning date of the request. As a result, the planning task rarely differs significantly from the operational planning of production. However, some specific issues make service delivery planning difficult.

The primary task in operational help conveyance arranging is to appoint a lot of assets dependent on their accessibility, zone and capacities to a lot of give occupations and to plot the best grouping and start dates of the employments. Thus the arranging adventure isn't unique from operational production planning [2]. There are a range of particular challenges which challenging the transport planning for services. Without indoor assets (e.g. issued technician, spare aspects and equipment with technical after income service, which are addresses in this context), which are now no longer managed by using capability of the company wish to be in the route of operational planning. It is now no longer workable to produce preferences on inventory and the customer has a top deal decrease tolerance for delays and geared up time. Because of the perishability of carrier and the simultaneity of company provision and consumption, carrier transport is a lot more uncovered to interior and exterior uncertainties than production route planning is a quintessential and complicated part of service transport planning because indoors and exterior assets are in special areas and opt for to be transported to the place of service delivery.

Inventory control in PSS, because of the increased scope and complexity of the supply of products and services, creates more uncertainties to be managed by the plant. Areas to consider include performance and service delivery requirements and increased reliance on the provider. In these respects, the control of stocks of products and services in PSS is less well understood than in the traditional product-centred manufacturing model. PSS inventory control sets the setting for this research by concentrating because of vulnerability. On the off chance that the manufacturer changes its manufacturing worldview into PSS, it must comprehend the execution of the procedure. Inventory is a basic factor in overseeing resources that keep up authoritative steadiness and are at the core all things considered. Inventory control assumes an urgent job in the administration, everything being equal of benefits and furthermore impacts the salary proclamation. Inventory control furnishes supervisors with helpful data, quicker choices. A fundamental inspiration driving this research is the craving to join the two regions, PSS and inventory control, which are not related. There is no standard method for executing PSS inventory control from an industrial perspective.

This study focuses on integrating Product Service System (PSS) Inventory Control and raw material delivery planning. The research question requires detailed consideration how can deliver planning and Product Service System Inventory Control be integrated to contribute to the effectiveness of delivery performance? This study aims to describe and analyse the integration between delivery planning and product–service system inventory control for raw material industry, and the main objectives are summarised to propose potential routes of integration between deliveries planning and product-service system inventory control that could improve the delivery performance.

When planning PSS to the company is required to change from the “product thinking” to the “system thinking” focusing on use of the product [3]. Therefore, the PSS will be developed and implemented on a case-by-case because they are high complexity and diversity [4]. Literature offers several frameworks with measures or implementation phases of product-service systems. Most of the framework comprises three to seven steps or phases that need to be achieved in the implementation. The measures are described exactly including the tools used and the activities [5] or just shown a quick start without additional evidence [6]. Most of the value proposition meets the needs of its clients and therefore starts with the analysis of requirements can be satisfied by the PSS. Values followed by detailed product design and related services such as the real aspiration is products and services combined. Implementation of PSS that are done with evaluation and improvement.

Table 1 PSS Implementation [7].

Author	Rocchi (2005)	Yang et al. (2009)	Calminder and Carlshamre (2008)	Morelli (2003)
Amount of steps/phases	6	3	3	7
Preparation	-Exploration -Policy formulation -Idea finding	-Design Intelligent Data Units (IDUs) and embed into products	-Analyzing (internal and external) -Creating and detailing new ideas	-Definition of needs to be fulfilled -Market analysis -Architecture and main functionality of PSS
Implementation/ realization	-Strict development (design) -Realization	-Develop service enabler	-Realization of the detailed concept	-Use case analysis -Tentative architecture -Test -Final definition
Measurement of results	-Evaluation	-Transmit data to service enabler	-Evaluation included in 'realization'	——

Inventory refers to any resources that have economic value and be maintained to fill the full needs of the present and the future of company. Inventory is the stock of physical goods, businesses or production are always on hand to efficiently handle affairs on its production. Inventory is the number of good, raw materials or other resources idle. According to Gordon B. Carson, "Inventory control refers to the process whereby the investment in materials and parts carried in stock is regulated within pre-determined limits set by the inventory policy established by management". For Nobrega [8] one needs to maintain the inventory is to protect against unexpected events such as the problem of transportation, manufactured or even increasing demand.

To meet the challenges of the above-given the PSS delivery planning, an arranging issue can be separated into sub issues. Perceived arrangement as indicated by the length of arranging skyline can be found underway administration, inventory network arranging and service delivery planning [9] [10]. PSS delivery planning determine the resources necessary for the provision of PSS in terms of quantity and quality. Operational planning is short term perspective planning delivery. Resources that have been allocated to the existing delivery process specifically. In the following operational planning called resource planning. Apart from a different period, capacity planning and resource allocation has been assigned to the various stages of decision making. Though this dispatcher not allocating resources at the operating level, capacity planning is usually associated with budget management results or even rules.

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This research ends up situated inside three assortments of learning that is product service system (PSS), inventory control and delivery planning. The situating of the research our result in Figure 1.

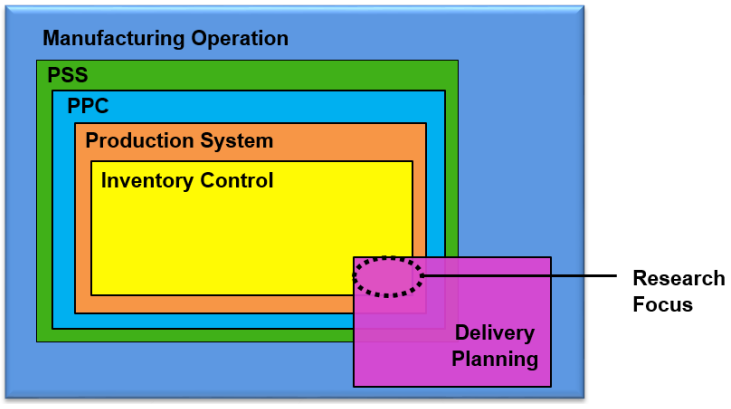

Figure 1 Positioning of the research.

METHODOLOGY

The methodology used in this research to achieve all targeted objectives and answering the research questions. The overall methodology is recapitulated in Figure 2.

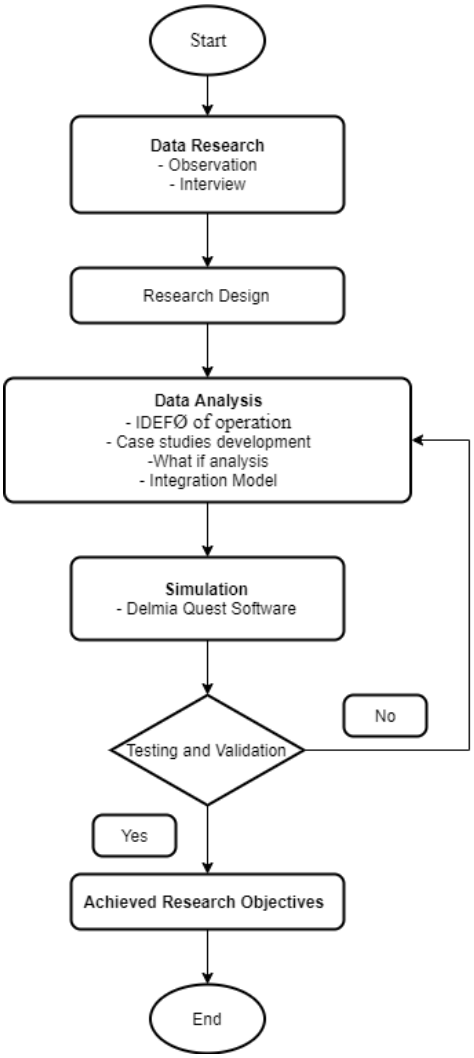

Figure 2 Process flow.

The development of automated simulation modeling technologies, three components of the structure must be defined: data models with definitions based on production data, simulation control scripts for simulation modeling, and system interfaces for monitor software simulation [11]. Process for generating simulation models in three main stages as shown in Figure 3, while a study is underway on the simulation method to predict production productivity. In step 1, the problems to be identified or resolved are planned, the project plans for the generation of the system are created and the objectives of the system are defined. In step 2, the input data required for the simulation model is collected and the collected input data is analyzed to determine the data definition for the simulation and the simulation model based on the analyzed data. In step 3, the simulation model for productivity prediction is implemented, followed by validation and validation. Information about the simulation targets defined in step 1 is extracted using the integrated simulation model. Simulation models are generated by following several processes and sub-processes. Since the time required in step 1 to format the problem and determine the objectives of the simulation model is inevitable, the time required in steps 2 and 3 to collect the input data and generate The simulation models based on the collected and analyzed data will be reduced if the system can be separated and the iterative process can be supported. This can be achieved by reducing the procedure for creating and managing simulation models and creating standard models.

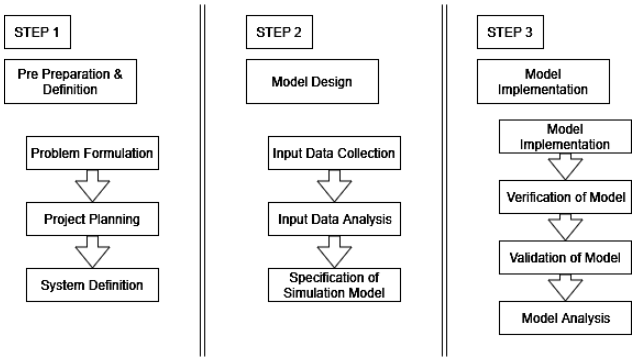

Figure 3 Model building procedure for production simulation

Delmia Quest was chosen to install configure and run a simulation for the project. Quest is discrete object-oriented object simulation software with virtual visualization that includes pre-defined machine elements, components and technicians that users can use to create simulation models. Quest model users can also design factory layouts, process flows, motor designs, machine layouts, and sectional designs. An interface with Excel can provide data with which model information is updated. For more complex production processes, the simulation control language (SCL) or the batch control language (BCL) can be integrated into the simulation model [12].

Resources, technicians and processes are modelled in the Quest software based on the presentation and its logical relationships as simulation elements. Once the simulation models have been created, the model check is performed by checking the functionality of the selected model. Quest Trace is used to find and eliminate all errors through an interactive process. The intermediate results of the simulation are graphically displayed on modules and statistically tested.

RESULT AND DISCUSSION

The preliminary result for this project was conducted through simulation by using software Delmia Quest that has been implemented of complete digitalization of desired environments and applications in manufacturing, from the process planning stage on this project to implementing plan layout, this enables researchers in manufacturing to provide desire and the latest product design data benefits and to expect and optimize production processes and requirements under certain condition. Contrary, on this project has been focus on delivery planning and PSS inventory control by identification potential routes of integration between both factors that could improve the delivery performance

This project was conducted by using data for 5 customers from the company that been through the generic model from A1 until A6. The customer has been identified as A, B, C, D, and E. The detail about the customers has been lit out on the Table 2.

Table 2 Customer Data for Company A.

Customer	Cycle Time	Travelling Time	Product
A	2 hours	30 min	Slab High Grade
B	1 hour 45 min	30 min	Slab Medium Grade
C	1 hour 15 min	30 min	Slab Low Grade
D	1 hour 30 min	30 min	Slab Low Grade
E	1 hour 45 min	30 min	Slab Medium Grade

The cycle time taken from process to output is 2 hours and 25 minutes for travelling time, data has been given from company A are representing for all the process to output for Customer A, B, C, D and E. The Figure 4 below has been show through flow chart the process from Input until Output in company A. The slab size is 200×1400×8000 in unit mm has been set constant for all customers.

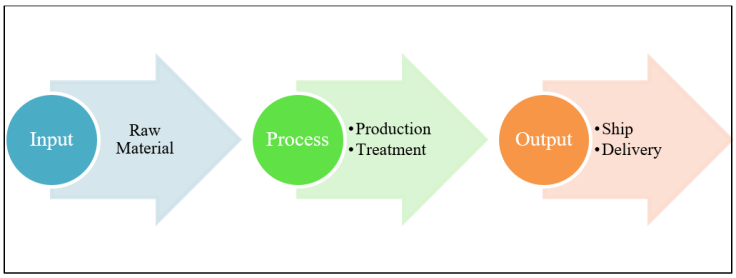

Figure 4 General flow chart for production in Company A.

Simulation Company A (one of examples)

Based on Table 4 Customer A product has been provided it is a slab with high grade quality in the end of delivery activities of production. The simulation using Delmia Quest has been conducted based on data given by company A. There is 3 station on the simulation there is Source as Input, Machine as Process and Sink as Output. The process section act as PSS inventory control before the product going out for delivery activity.

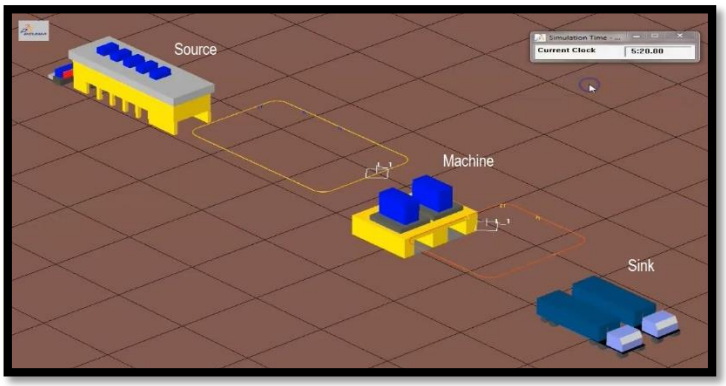

Figure 5 Simulation Set-Up in Delmia Quest for Customer A.

After the set-up for simulation is complete, then the simulation has been run for 24 hours, the value for simulation time on Delmia Quest is 86,400 seconds and the report was generated in minutes.

Part Classes

Name	Max. Residence	Min. Residence	Avg. Residence	Created Parts	Destroyed Parts	Parts in System
Slab High Grade	205.948	204.502	205.155	12	11	1

Source

Name	State Times	Created Parts	Creation Rate
	Idle		
Input Raw Material 1	1440.00	12	0.008

Sink

Name	State Times	Finished Parts
	Idle	
Sink1_1	1440.00	12

Machine

Name	State Times		Utilization (%)	Avg. Process Time	Parts Added	Parts Rejected	No. of Products	Avg. Cycle Time	Avg. Reqmt Time	Production Rate	Avg. Part Residence Time	Final Context
	Idle	Busy Processing										
Production Treatment 1	49.934	1390.066	96.532	124.539	12	0	11	120.00	4.161	0.008	120.00	1

Figure 6 Report generated by Delmia Quest for Customer A.

As shown in report on Figure 6 above the Source (input) produced 12 slab high grade for 24 hours production time for customer A requirement. The size for slab in simulation is set with same dimension as mention 200×1400×8000 in mm but in simulation has been set in unit feet 0.7×4.6×26.3 as a requirement for a software system. The finish product recorded at Sink (output) is 11 slab high grade ready to be delivery. The report show that Machine (process) processing 12 slab high grade from input and produce 11 number of product for 24 hours period. Average cycle time per product is 120 minutes is equal to 2 hours based on data given by company A. Before run the simulation, the constant time has been set up based on requirement given by company A regarding to cycle time for production starting from input until output. Figure 7 below show the constant value of 7200 seconds has been set up at Source (input) before transfer to process section for production or treatment activities. The IAT term is reference to Inter-Arrival Time and functional as a setting for cycle time on Source entities. There are several distributions function on IAT setting, but on this simulation according to data fixed given by company A constant function is used. The cycle time at process section has been set up with constant 7200 seconds (2 hours) show at Figure 8 below based on data given. The cycle time set up is same for all customer A, B, C, D, and E requirement.

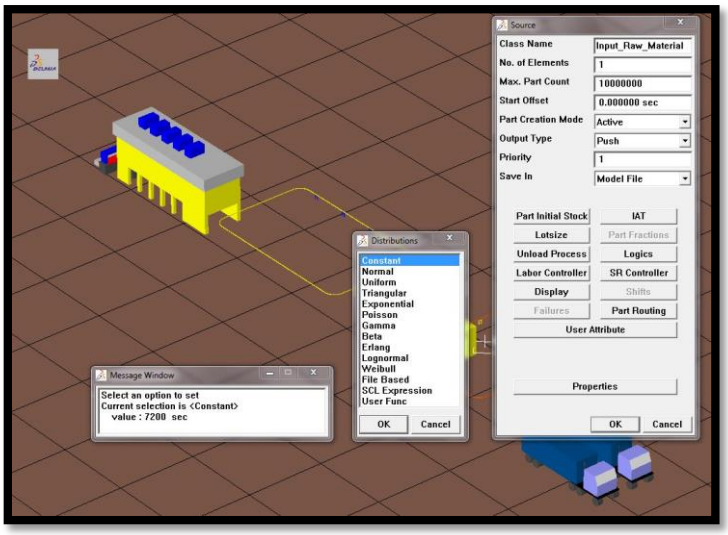

Figure 7 Input processing time set up for Customer A in Delmia Quest.

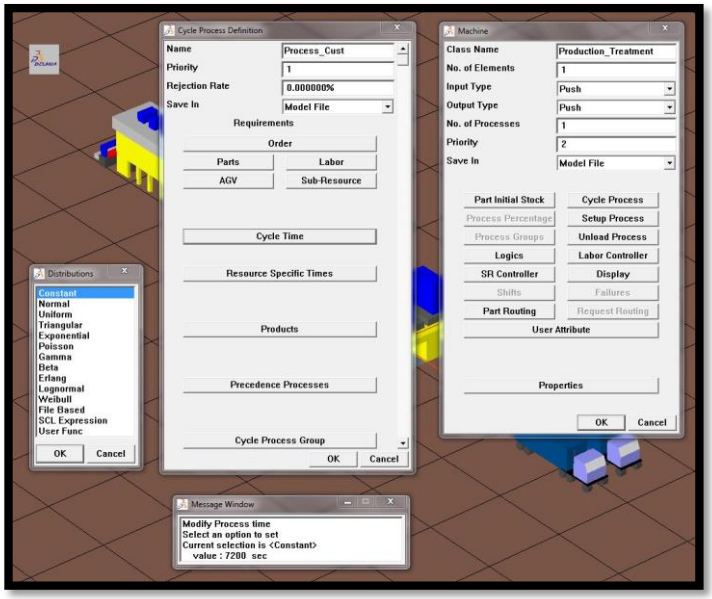

Figure 8 Process cycle time set up in Delmia Quest software

There are several conclusions that can be conclude based on simulation conducted by using Delmia Quest software. To summarize number of products produced based on simulation report from Delmia Quest software, Table 4.3 below has been construct. First, the input number of products is different in value for each of the customers except for customer B and customer E with 14 units slab medium grade quality. Both section process and output recorded with the same number of products, 11 units of slab with different grade. It is because the cycle time for process section given by company A is 2 hours per product before transfer it to delivery section. Even though the input section produced a high productivity number, still at the output section there is just able to deliver a constant number of product per day. Instead of set up constant processing time each of the process, the company be able to improve the productivity number by increasing the flexibility in processing time to respond to customer needs.

Table 3 Number of products produced each section based on simulation report.

	Number of Products		
Customer	Source (Input)	Machine (Process)	Sink (Output)
A	12	11	11
B	14	11	11
C	20	11	11
D	16	11	11
E	14	11	11

There is solution towards this problem using simulation in Delmia Quest software by changing the distributions function for cycle time at process section from constant function to exponential function. The exponential distribution is the probability distribution of the time between events in a Poisson point process, a process in which events occur continuously and independently at a constant average rate. The setting for distributions has been change to exponential with 7200 seconds equal to 2 hours cycle time for process section. The process will be continuously and independently processing at a constant range without fixed the processing time at constant distributions.

Table 4 Number of products produced each section in the simulation with exponential distributions functions.

	Number of Products		
Customer	Source (Input)	Machine (Process)	Sink (Output)
A	12	11	11
B	14	11	11
C	20	13	13
D	16	12	11
E	14	11	11

Table 4 above shows the increment value at process from 11 to 13 and sink section also from 11 to 13 for customer C requirement. There also an increment value at process section for customer D from 11 to 12 units of slab. The result proves that the process act as PSS inventory control had a significant factor when the processing time change from constant to exponential distributions functions. Hence, it will improve the productivity rate by increasing the flexibility in time to respond towards customer needs and improve delivery performance.

CONCLUSIONS

This research has successfully answered the objective and research question when refer the data from Table 2 show that the number of products produced at process and output section are same for all customer A, B, C, D and E when running simulation using Delmia Quest. The company's personnel from case study validated the simulation results and provided suggestions for optimization parameters. From Table 2 also show different number of products produced at input section because of difference value of input processing time based on different requirement each customer except for customer B and E that share same processing time and grade of product.

After the data alteration for process cycle time was conducted from constant distributions to exponential distributions functions, the results show the significant improvement for delivery performance. Table 3 show the proof that the process act as PSS inventory control had a significant factor when the processing time change from constant to exponential distributions functions. The increment value for customer C at process section and sink section are increased from 11 to 13. Besides that, there also an increment value at process section for customer D from 11 to 12 units of slab. From that, conclude the improvement happen to the productivity rate by increasing the flexibility in time to respond towards customer needs and improve delivery performance.

As a conclusion, a productive system exists in which the forces of production merged into the production process. Constituent parts of the productive system such as labor power, production methods and methods of production are divided into the structure of possession and control of gainful exercises and social and political system wherein generation taking care of procedure. Here the project discovers the flexibility towards processing time taken during production line activity. Contextual analyses on PSS will be directed in large organisations, and the information and exercises gained from these investigations are exceptionally private and seldom distributed, making this undertaking troublesome. Comprehend the intricacy and execution of the PSS arrangement as an assembling worldview. “Production Planning and Control (PPC) Systems are crucial tools for meeting high customer demands and expectations in the present competitive manufacturing climate,” [13]. Today, business customers challenging and they expect a timely delivery, short lead time, high quality and reasonable prices.

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