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EMPLOYING A SIMULATION MODEL TO EVALUATE THE PERFORMANCE OF THE PRODUCTION SYSTEM DIVISION IN THE MATERIAL REQUIREMENTS PLANNING (MRP) SYSTEM

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Abstract

The research aims to investigate the strategy for allocating mechanics of the production system consisting of materials subjected to Material Requirements Planning (MRP) system control byperformance evaluations whose components are: inventory costs, late order costs and the level of services. The research problem is mainly centred ondetermining the best model that achieves MRP based on its peculiarities as a model with complex requirements. This is because figuring out the optimal production technique and breaking the production system down into its component parts are necessary steps in the planning process. Similarly, the strategy applies to thecombinations of machines available for both types of materials. Likewise, the simulation model can equally be used on the developable production plan, which was prepared by determining the landmarks of the specific database without specific work execution by the model. On the high preparation times anda low number of elements, the research found that whenever the production system utilization is higher, the policy of fragmentation or division of the production system will be better. However, the The optimal machine combinations for medium and low utilisation levels are accessible across all versions. Additional research in operations management benefits from the scalable simulation model for many production system types.

Introduction

Studies on manufacturing systems find that defining parameters of production planning and methods of control significantly impactthe cost of inventory and delay simultaneously with service tiers. Production Material Requirements Planning (MRP) has been extensively researched and used in operations management, according to published literature (Axsater, 2005:459), (Altendorfer & Minner, 2011:135). Thus, engineering technologies show that kanban, JIT, Lean, and Assembly line are other methods of control in producing (push or pull) as it can be a technique that can replace , in certain cases, the conventional MRP approach to manufacturing. Such conditionsinclude an instance where the variation time in the production processing batch is not very high (Ben et al., 2022: 2750). Since consumer demand for a wide variety of items is relatively stable, this is the result (Jodlbauer & Huber, 2008: 2180). On the other hand, the traditional MRP methodcan handle any complex processing time as well as variation in customer demand (Hopp & Spearman, 2008:22). In addition, one of the advantages of (kanban, JIT, assembly line) since inventory control systems are self-regulating, they need less planning effort than MRP (Jodlbauer, 2007:83). Manufacturers in the area often use both methods in the same workplace for various materials, thanks to the unique properties of MRP. There is some writing that contrasts the organisational frameworks of various production systems with MRP (kanban, JIT, etc.). (Jodlbauer & Huber, 2008: 2181). Although there is literature that combines kanban, JIT (or pull methods) and MRP (or push methods), there is, however, no effect of mixing kanban, JIT (MRP) materials on the same manufacturing machines. Motivated by previous empirical research, the research analyses both production systems for materials produced for storage and those produced on demand. (Smet & de 1998:111).

1. Research methodology:

The research adopts case research methodology in the formulation of the simulation model and in measurement and evaluation to reach the desired results. Simulation is a feature of scientific research methodologies based on the particular technical field that reveals a condition at the starting state,inputs, parameters. The preferred method for a complex system is when analytical solutions to the models are feasible.

1.1 The problem of the research

Determined by three dimensions, first is determining the optimal method of achieving MRP balance as a system whose characteristics require acomplex model. The second dimension is the attempt to justify the method of collection and division of MRP production system of materials under real working conditions. The third dimension results from the differences and fluctuations in dividing the production system into two sections: one for materials that are controlled by the assembly and one for materials that are scheduled. This allows for better planning of material needs. The interrelationship of these dimensions constitutes a challenge to improvingthe performance of the MRP production system.

1.2 Research Significance

It’s derives by dealings with operations management techniques. This is because itsignificantly impacts scheduling production operations byproviding a conceptual framework and simulation model for researchers and specialists to keep pace with the knowledge development in Materials Requirement Planning (MRP) and Assembly Line. It will also demonstrate the importance of planning production requirements as a critical system that contributes to exploiting resources, reducing inventory and excluding activities that do not add the product value.

1.3 Research Objectives

Represent by provide specialistswith means and knowledge that support the planning of production requirements to schedule production operations according to a simulation model. This will be a modest contribution to bridging the knowledge gap for material requirements planning.

The objectives of the research can also be identified as follows:

1.3.1 Measuring and evaluatingthe Production Requirements Planning (MRP) system according to a simulation model for scheduling operations and reducing inventory ratios.

1.3.2 Conduct a test of MRP analysis according to a simulation model in the pilot research framework.

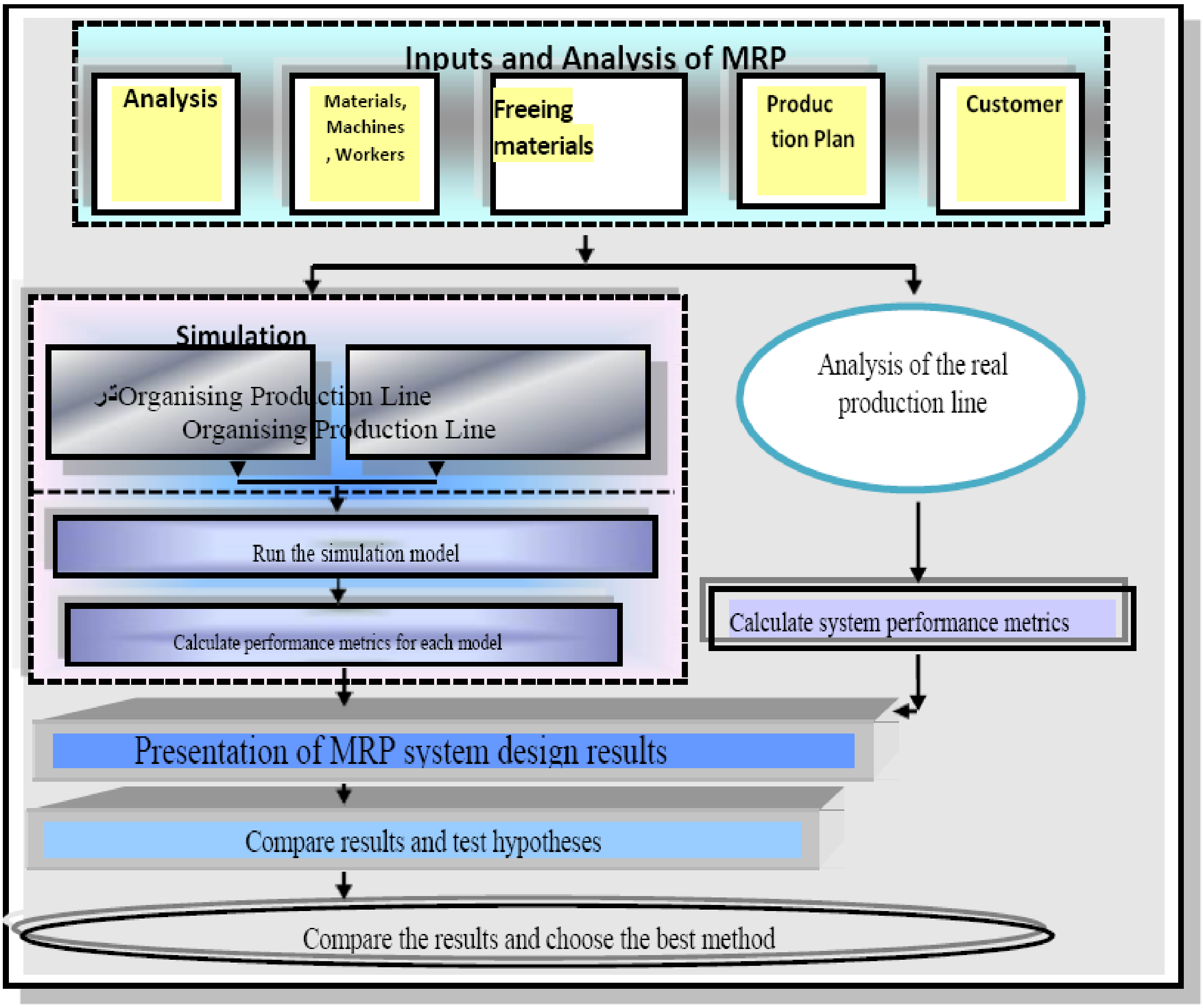
1.4 The hypothesis of the research

Here is one way to construct the research hypothesis:

The simulation model's methodology and various assembly line performance measurements for the study sample's stages provide statistically different results when it comes to measuring performance in relation to MRP requirements.

1.5 Procedural Outline of the Research

Organising Production Line Based on Assembly	Organising Production Line Based on MRP



Source: Prepared by Researcher (Figure 1):The procedural scheme for the variables of the research

2. Theoretical framework of the research

2.1The concept of MRP and Assembly line

Many researchers have contributed to the development of the Concept of (MRP) as it is a technique for timing and determination of requirements of materials according to the requirements of the production process. (Ricki, 2009: 12). Thus, it is a planning system for the components of the product such that the date of its availability is timed to the date of actually needing these components (Preston & Ricki,2009:12). Some see it as a method for inventory management to reduce the level cost to the extent that the manufacturer can manage to meet the requirements of production scheduling (Hubl et al, 2011: 1559). This is because different models for planning material requirements appear in a cascading and overlapping manner. These models differ among themselves in time, volume, materials and machinery used, task times, and precedence relationships. For this reason, we will be contrasting two distinct approaches to machine allocation. In the first approach, the manufacturing system is split down the middle such that materials controlled by the assembly line are on one side and materials slated for MRP are on the other (Hopp & Spearman, 2008:22).The second strategy is applied to groups of common machines for both types of materials.In the workroom organizing strategy, there are two means: mixing assembly line production orders and MRP in front of the machines. Determining which order to take requires additional dispatch work. While orders placed on the assembly line are given an artificial due date, we use a policy of an earlier due date to elaborate on this method. In the first plan, the workshop is divided into two streams: material requirements planning and assembly line. As a result, there is no way for the two sections to be switched. Inventory expenses, order processing times, and service quality are the metrics used to gauge success. The main feature modelled is preparation time when switching among subjects regarding measuringthe assembly line performance and MRP (Ben et al., 2022:2750).

Analytical models or simulation models can as well be applied.Analytical models are a reference to the use of a computer in applying these algorithms and the possibility of performing it mathematically, as it does not require complex mathematical equations when executing it. Yano also sees that models are applied in a stream of literature to optimize the planned time based on the weeks of production systems (Yano, 1987:95). One benefit of them is that they allow one to find optimum solutions under certain conditions. One problem with these models is that they presume too simplistic production processes. However, no perfect answer has been discovered, even though simulation studies do a good job of examining the architecture of more complicated production systems. The simulation approach is used in this study. The model, which was originally proposed by Hubl et al. (2011) and modified for this research, is quantifiable and evaluable. The benefit of this paradigm is that it allows for the design of database schemas, which allows for the incorporation of various manufacturing system structures, such as shared machine policies and fragmented ones.

In this article, we'll take a look at the flow store architecture that the many automotive manufacturing businesses have used as an inspiration. Production planning and control for materials are accomplished via the use of MRP and assembly line (AL) methodologies. With a half-life of 0.5, half of the final products are subject to material needs planning. Items in the second portion of the assembly line are under control and have a variation factor for order amounts of 0.25. manufacturing, transformation, and packaging are the three phases that make up the manufacturing system. Finding an appropriate machine allocation approach in the face of varying item and material counts, average order amounts, and ordering scenarios is the crux of the study.

2.2 Simulation model

To achieve the particular aims of the study, a model is created to stand in for another entity in all the relevant ways. Examining the potential legality, safety, cost, disruption, and speed of the actual system is done via the use of models. Conceptual and theoretical systems may be studied using models. When studying models, which are fundamentally experimental in nature, simulation may be described as a distinct method. Although a physical model or computer method replaces the system of interest in a simulation, the two procedures are conceptually quite similar to doing field testing (Preston & Ricki, 2009:12). (Hubl et al., 2011:1559) laid out the groundwork for a database-based scalable simulation approach. The simulation model is specified here by the particular database; so, new simulation variables may be added to the model at this point. Just like that, the relational database model is built using the pertinent simulation data of a medium-to small-sized firm.It is common practice for the simulation model to first get data from a database.Once the simulation model is launched, the data is used to iteratively build the structure of the production system via the different simulation modules.To the contrary, the information is used to set up the processing, setup, and repair time random number generators and to establish the parameters for production planning. You can tell the difference between master data and transactional data in the database.The foundation of the production system is set by master data, which includes:

2.2.1 Bill of Materials

Bill of Material (BOM): Define the relationship between the source item(s) and the branch
2.2.2 Routes: Define groups of machines and their machines, including capabilities
2.2.3 Specifications for each product's production planning
2.2.4 All skill groups' shift schedules, including vacations
2.2.5 Define the skill sets of workers, including their capabilities

The distributions used to create the data needed to characterise the transactions are defined in the database tables together with the distribution parameters. Time spent processing, setting up, repairing, failing, responding to client requests, leading up to supply, and customer lead times are all broken down. The database also allocates simulation time, often known as model runtime. Anylogic 7.0 is used to program the several modules of the scalable simulation model. Duplicating the required equipment or personnel (resources) in accordance with the master data is the fundamental concept. In order to get the simulation model up and running, a database interface uses the master data to establish the parameters. All all, there are five parts to the simulation model. Consumers, production schedules, material releases, resources (equipment, personnel), and data analysis.

1) Customer: The creation of client orders is the responsibility of the customer module. A customer's order is divided up according to their specified lead time and the number of components needed for a certain final product in each phase.Here we establish the correlation between the order's mention time and the due date. Another option is to generate a real-life client order list and feed it into the simulation. Various demand patterns, such as seasonality, other product mix groups, and customer-required lead times, may be modelled. This device will ship the client the available products as soon as the order due date approaches (Heizer et al, 2017:214).

2) Production Planning: Production orders are generated by the module's production planning using master data. The production planning unit employs the two tiers of hierarchical planning—long-term and medium-term—in accordance with MRP II (Manufacturing Resource Planning). The use of resources is based on short-term planning. The production schedule is computed using forecast data and client orders in the Master Production Schedule (MPS), which is also used for long-range planning. A pair of MPS techniques are put into action. The first strategy maximises output in the final production schedule by comparing each period's predictions with client orders. The second approach takes a long-term view of client needs and wants, then uses the highest value to inform the ultimate production schedule (Ben et al., 2022: 2752).

Strategies for production planning and control are accomplished via the use of MRP, assembly line, and rearrangement techniques. Individual materials' master data makes use of their own unique set of planning factors and procedures. Safety stock, anticipated leadtime, and batch size policy are the parameters of MRP. The criteria for goods on the assembly line include the amount of boxes and the size of a single assembly box. The two material parameters that are regulated by the reorder policy are the reorder point and the reorder quantity. Variations in MPS, production planning tactics, and lot size rules may be analysed using this module.

3) Material Release: In order to manufacture the product in the exact amount specified in the manufacturing order, this unit must extract the relevant ingredients from inventory. Where necessary resources are available, they will be distributed. This specific manufacturing order will have to wait till the ingredients are available if any of them are out of stock (Heizer et al, 2017:221).

4) Resources: Personnel decisions and material flow management are under the purview of the unit's resources. The same holds true for the human and mechanical resources that are at their command. The master data defines a qualification matrix that is used for worker recruitment. Therefore, the device that is allocated to the device group may be identified by the master data. Equipment and human resources may both benefit from the various shift schedules specified in the master data. Machine resources include distributed processing, setup, mean repair, and time lost between failures. A number of documents outlining the regulations of the hierarchical planning approach's short-term level are at your disposal. Only manufacturing stages with low-level code have inventories. Routing is reviewed after each manufacturing phase, and materials are either dispatched to the next step or put into stock.

5) Analysis: Essential performance indicators are computed by the unit analysis. Metrics used to compile the account include service level, average delay, average delay for production orders, average raw material inventory, average work in progress, average FGI, average appointed time, average utilisation of machine combinations (and machines), and average productivity (Hubl et al, 2011 :1559).

1.3 Description of the problem

A materials list, market factors, and the workshop's structure all stand in for the issue in the production system flow. Furthermore, routing information is used in light of the disparities in processing demands across the three separate simulation experiments that were carried out in accordance with the company's overall production system structure including many layers of vehicle suppliers. The project's prior applied study in the industrial sector informed the development of an operations structure that was in accordance with the market structure, materials list, and planning techniques. Nevertheless, the findings are qualified by a simplified version of these systems. However, we discover that the majority of organisations' material process activities do not adhere to scientific methods. To alter the quantity of workstations and personnel, it instead depends on people's own initiatives. In order to populate the database based on the simulation model, the same study employs actual firm data. You may get this information in the Manufacturing Execution System (MES) or in any of the widely used Enterprise Resource Planning (ERP) systems.

1.3.1 Shop flow paradigm

In Figure 2, we can see a flow workshop with six machines, denoted as M1–M6, that are technically divided into three groups. Manufacturing, processing, and packing are the three categories of machinery. For every set of machines, there exist two systems. Because there is only one system in each machine group, it is feasible to use either system to produce any product that has the same technical need.

1.3.2 Market Variables

Here we look at three distinct Slack variables. The quantity of goods and average order amount vary among these factors. S1, the first variable, examines a manufacturing system with four components: a high lot size, two raw materials, and four production materials.With a lower order quantity (four-item variation - low - lot size), the same structure is defined by the second variable (S2). At this point, the intervals between preparations are crucial. The third variable, S3, represents a tenfold increase in product amount (40 finished goods, 40 raw materials, and 20 manufacturing materials).To keep the production system consumption at the same level as in S1 and S2 (forty items variation), we divide the monthly demand by the same factor. Sections 1, 2, and 3 looked at the question of whether the forty-four item variables were equally affected by various machine allocation procedures.Using the New database specification alone to simulate all of these variables—without having to adjust the

NM efficiency or the simulation model—is a structural advantage of the model (Hubl et al., 2011:1562).

This is what Table (1) shows when we look at the demands of the three dummy variables. There are 3,500 monthly components ordered by customers for product 10 in S1, and 4,500 parts ordered for product 11 in S2. The simulation model exhibits a logarithmic distribution for the order amount (oa), with a coefficient of variation of (0.5) for materials that are part of the planned MRP and (0.25) for items that are part of the regulated assembly line. The lognormal distribution of customer required lead time (crl-time) has a mean of 10 and a standard deviation of 1.4. The reduction of the order amount's mean and standard deviation to one-tenth is the main difference between (S1 and S2). The variance coefficients for the customer's lead time and order quantities are same in (S3), but the monthly orders are just a tenth of what they are in (S1). Also, while utilising, the average client order quantity drops by 50%, which is still below the acceptable service level. One possible explanation for this impact is that the proliferation of new items has led to longer setup times.

Table 1: Case of First, Second and Third Dummy Variable Demands

Thing No.			μ order quantity			σ quantity to be ordered			c. a. per month			μ crl-time	σ crl-time
S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1/S2/S3	S1/S2/S3
10	10	1010-10100	100	10	50	50	5	25	3000	3000	300	10	1.4

Source: Prepared by the researcher based on the requirements of the simulation model of the application case for the first, second and third dummy variable.

Table 2: Demand status for the first, second, and third dummy variable

σ crl-time[day]	μ crl-time[dey]	Per mounth			σ order amount [piece]			μ order quantity [piece]			Thing number		
S1/S2/S3	S1/S2/S3	S3	S2	S1	S3	S2	S1	S3	S2	S1	S3	S2	S1
1.4	10	300	3000	3000	25	5	50	50	10	100	-1010 10010	10	10
1.4	10	450	4500	4500	37.5	7.5	75	75	15	150	-1011 10011	11	11
1.4	10	300	3000	3000	12.5	2.5	25	50	10	100	-1012 10012	12	12
1.4	10	450	4500	4500	18.5	3.75	37.5	75	15	150	-1013 10013	13	13

1.3.3 Materials List

The Low-Level Code (LLC) is the bill of materials for the four-item versions, as shown in Figure (2). The LLC is the most basic level of the BOM, and it is used in one particular way (Hopp & Spearman, 2008:28). At the zero level, LLC, all things are considered completed goods. These goods are then classified into two categories, PG1 and PG2: Product Group.To illustrate, two case studies were developed. The first figure.Starting with a single product (20) with a single limited liability division, item (11) is also constructed with a limited liability section. The basic ingredients that make up Section (31) are one hundred and two hundred. Assembly line (AL) controls parts 12, 13, 21, and 31. This material (100 and 110) is bought as a spare.The bought-in components are not going to be considered since we are assuming they are always accessible.Here is the list of materials, as shown in Figure (2):

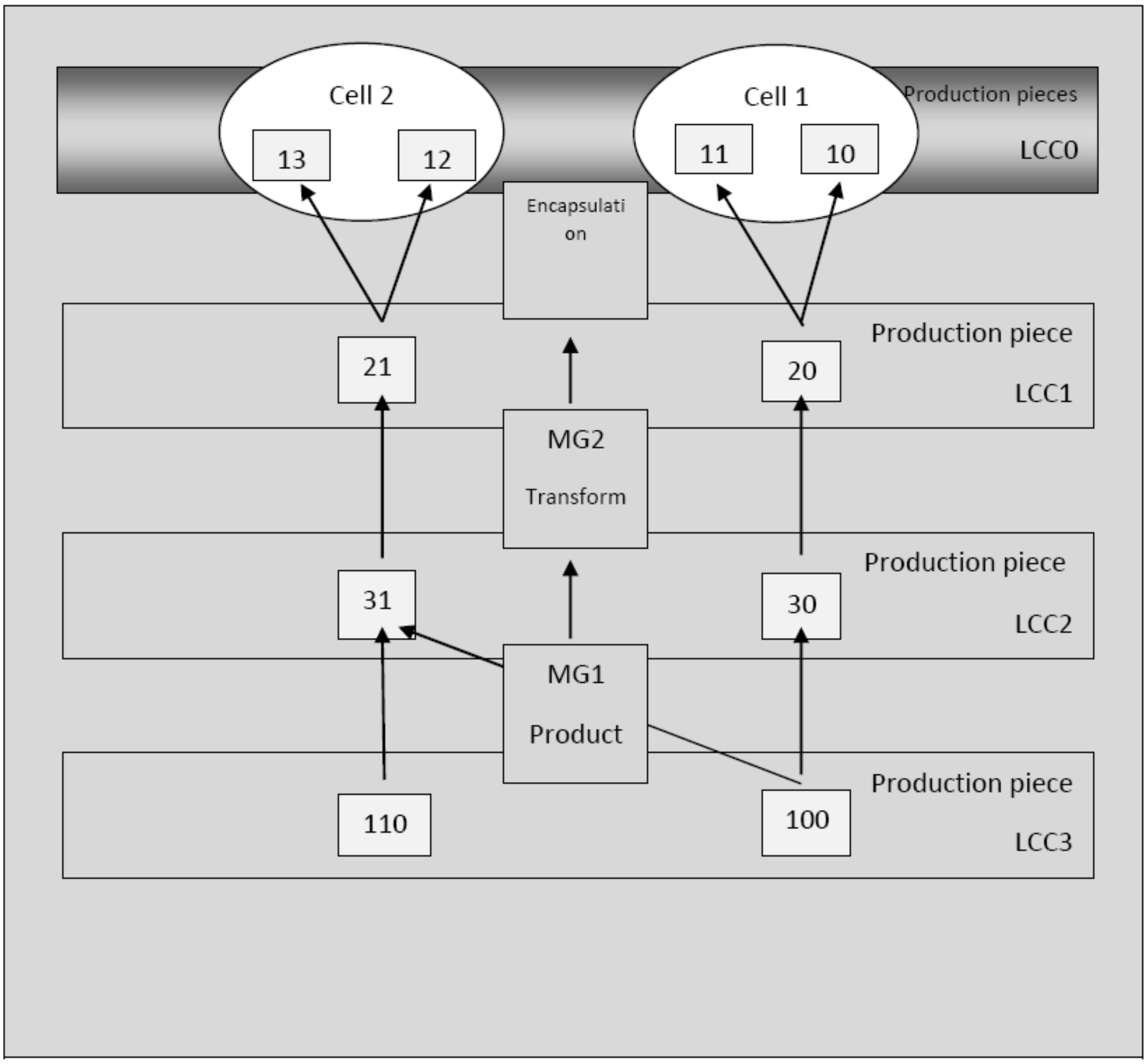


Figure (2) List of material requirements and processing structure

Source: Prepared by the researcher according to simulation requirements

1.3.4 Routing and Machine Allocation Policies

There are two distinct approaches to workshop layout, and each has its own set of rules for allocating machines. The first strategy for allocating machines is shown in Figure 3a. There is a distinct division in a production system for materials that are controlled assembly line materials and those that are MRP-planned. Production orders are combined in the assembly line with MRP done in front of the machines according to Machine Allocation Policy (2) (Fig. 3b). Our standard operating procedure for sorting orders is based on the Earliest Due Date (EDD) dispatch criterion. Various rules for machine allocation are shown in Figure (3).

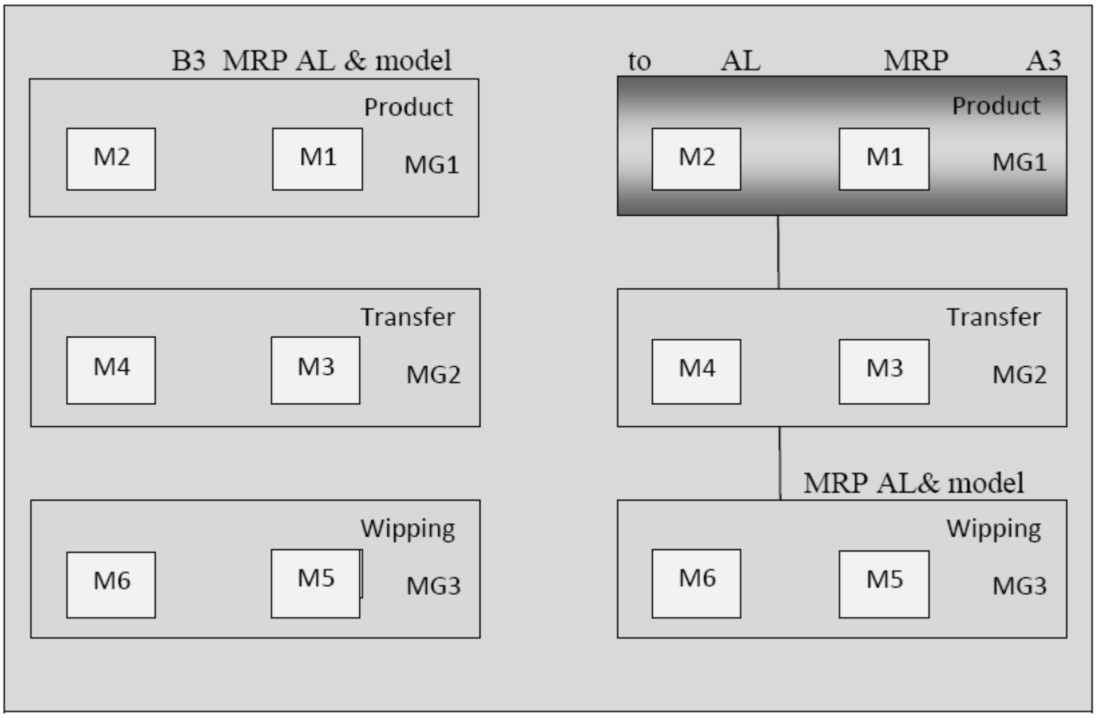


Figure 3: Different policies for machine allocation

Source: prepared by the researcher according to the machine allocation policies

For typical processing and configuration times, the simulation module uses logarithmic shared value. Every object and substance in every version is presumed to have the same value. The average and standard deviation values for the durations of preparation and treatment are shown in Table 3. The routing information details the order in which a component is processed by several

Table (3) Orientation information

μ Processing [Min]	σ Processing [Min	μ Set [Min]	σ Set [Min]
4.78	2.44	6	0.15

Source: prepared by the researcher according to the results of the simulation model

Following a consecutive processing of identical material requests does not need any preparation, according to the simulation model. The 40-item variation uses the same bill-of-materials (BOM), routing, and layout structure, but they flip the order of the items ten times (1010, 2010, …, 100010; 1011, 2011, …, 10011) and their unique items ten times (1020, 2020, …, 100020), among other things..

1.3.5 Assembly Line Logic (AL) and MRP

Two models that are extensively used in the industry for production planning and control are assembly line (AL) and material requirements planning (MRP). Using the customer's orders or expectations for the bill of materials, MRP mainly calculates material needs with an eye towards payment. By taking demand circumstances and planned periods into account, the batch sizing policy and the beginning and ending dates of the planned periods are used to calculate the size of the production order (Hopp & Spearman, 2008:30). Accordingly, MTO and MTS manufacturing systems are both compatible with MRP. Bill of materials, physical inventory, scheduled receipts (for orders already in the production system), and total requirements for finished products from the master production schedule (MPS) are the input data for MRPrun. The MPS provides additional information on hierarchical production planning, including how to calculate it according to scientific standards. Additional information is also available on request.A rigorous mathematical strategy is followed by the MRP technique. The four processes that are computed for each material are netting, batch sizing, compensation, and BOM release.Production orders generated by the MRP computation must include at least the following details: material number, batch size, order start period, and order end period. Safe stock, scheduled lead time, and lot size policy are the core MRP factors that are modelled in this study.

The assembly line is a pure production control technology that runs production orders by automatically drawing materials from boxes on the assembly line; it is the pull (on demand) alternative to material requirements planning (MRP). According to Hopp and Spearman (2008), a fresh order for the specific material is given whenever a bin is emptied in the assembly technique. As a result, manufacturing is continuously driven by demand, whether it comes from components (completed goods) or their raw materials. There will be no further processing of the customer's order details using this pure (MTS) approach. Our study's fundamental factors for the assembly line system are the quantity of assembly orders and the dimensions of the assembly boxes (MRP's batch size equivalent) for each regulated material on the line.

1.3.6 Parameters of the planning approach

To achieve a service level of 95% utilising a production system of 85%, the three dummy variables—two techniques of planning (MRP), the assembly line, and associated ordering settings—were parameterised in the early investigations. The various parameters of the planning approaches are shown in Tables (4) and (4). The Fixed Order Period (FOP) is the relevant MRP for determining batch size and batching task count (Hopp & Spearman, 2008:35).

Table 4 Parameters of the planning method determined four variables.

Material	Planning Type	Safety Stock	Planned Lead Time Periods	FOP Periods	#Assembly	Size of assembly line
10	MRP	200	5	1	-	-
11	MRP	300	5	1	-	-
12	Assembly line	-	-	-	3	100
13	Assembly line	-	-	-	3	150
20	MRP	200	5	1	-	-
21	Assembly Line	-	-	-	4	150
30	MRP	300	5	1	-	-
31	Assembly line	-	-	-	4	15

Source: Prepared by the researcher according to simulation requirements

Table 5 Parameterization variable of the planning method consisting of forty items.

Material	Planning Type	Safety Stock	Planned Lead Time Periods	FOP Periods	#Assembly	Size of assembly line
10	MRP	50	5	1	-	-
11	MRP	75	5	1	-	-
12	Assembly line	-	-	-	3	50
13	Assembly line	-	-	-	3	75
20	MRP	50	5	1	-	-
21	Assembly line	-	-	-	3	75

Source: Prepared by the researcher according to simulation requirements

2. Results

2.1 Experimental Design in the model

The studies should employ a mixed method approach to experimental design that combines a contextual, user-friendly approach with an exploratory, experimental, more technology-based approach (Preece et al., 2002:72; Gulliksen et al., 2002; 2006:568). This will confirm the model's validity.As a result, the former method is mostly used to direct the process of designing experiments by outlining needs and design implications for certain populations. The latter serves a similar purpose, namely to investigate untapped demographics and test the limits of emerging technology in order to spark ideas for other design projects. In order to come up with a solution for the experimental design that worked for the three dummy variables that were evaluated, the two methods were interdependent and used interchangeably throughout the iterative process.Changing the (lambda) yield factor to assess the range of usage from 50% to 98% in twenty repetitions causes customer demand to vary every month. Four components, four materials, and two raw materials made up the manufacturing system we examined in S1 (four components - high-lot size version). With a lower order quantity (four-line variable - low - lots -), the same structure is examined in S2. S3 has a tenfold increase in product amount (40 items, 40 materials, and 20 raw ingredients). Similarly, the first item version is used to split the monthly demand.

Total expenses broken down by inventory, delay, service level, and workshop utilisation constitute the performance metrics. Each material (MRP and AL) has its own set of service standards and fees associated with delays. The average value of the overall costs to rectify fees at the conclusion of the simulation run, including default charges for all unfulfilled client orders, is used to assess each iteration. The inventory-to-delay-costs-per-item ratio is 1:20.0. Each run is iterated 100 times throughout the trials, and the total number of days analysed is one year, or 360.

2.2 The four variables in the model

The two machine allocation rules of S1 (the high-volume four-element variation) are shown in Figure 4, together with the service level curves (Figure 4a) and total costs (Figure 4b).

Both curves are displayed relative to the workshop's utilization-determining production factor, lambda. Figure 3a's secondary axis illustrates the service level difference between the two machine allocation schemes. The machine allocation split policy's service level curve is somewhat better than a non-segmented policy's, and this variation has a very low setup time to processing time ratio (<1% of workshop utilisation). This variation differs significantly from the original in terms of total costs at greater productivity levels.Compared to the non-fragmented policy's targeting costs, the delay costs are larger, especially for the segmented machine allocation strategy.

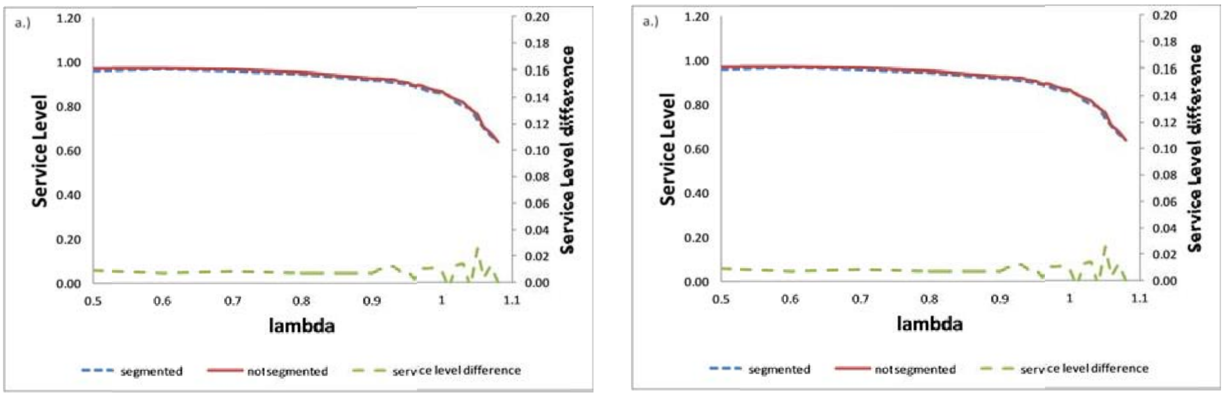


Figure (4) Comparison of Two Machine Allocation Policies in Terms of Service Level and Overall Costs for the Four Elements Variable—High Lot Size S1

The four-element variation with a smaller lot size (S2) (more setups owing to a lower average order amount) and high productivity is clearly seen in Figure 5a and Figure 5b, respectively, when looking at the service level curves and total costs.In terms of service level performance, the machine allocation split strategy is light years ahead of its divided counterpart.This is because the machine allocation split strategy requires less work during setup.The machine allocation split strategy provides a lower total cost for greater productivity levels, according to the service level curve (Figure 5b). When it comes to reduced productivity, keep in mind that machine group policy is more effective.

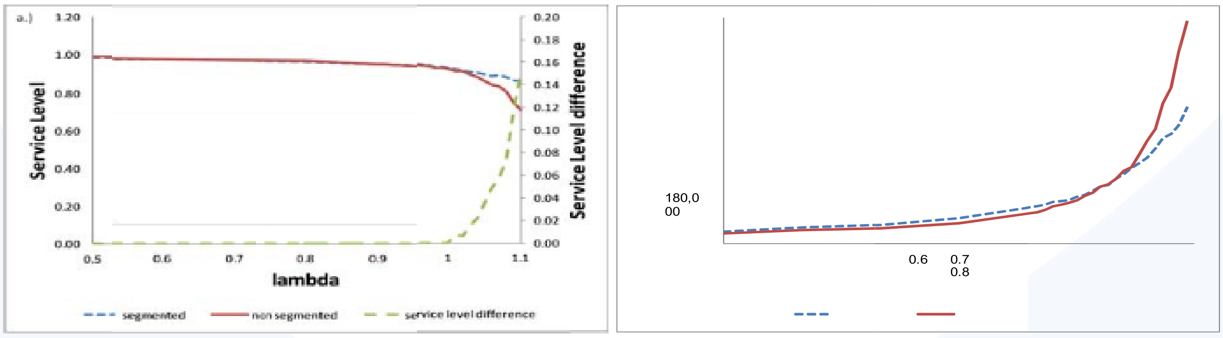
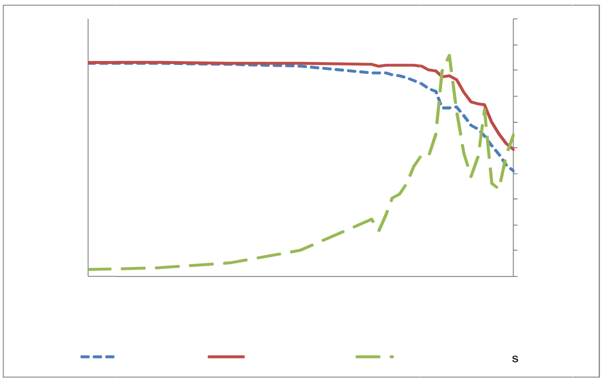
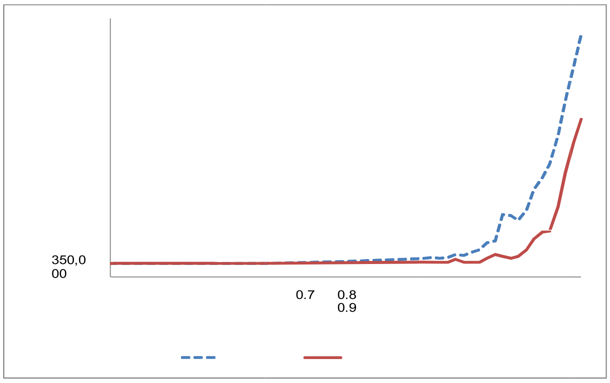


Figure (5): S2, a four-element variation with a small lot size, and its service level and overall cost. In contrast, Figure 6a shows the service level curve and Figure 6b shows the total expenses curve for the two machine allocation rules used for the forty-item S3 version.





Figures 6a and 6b illustrate the minor differences between the two machine allocation strategies with low productivity (lambda). In terms of service level and total costs, a non-segmented machine allocation strategy outperforms a segmented approach beginning at lambda 0.9, which is about the same as 80% workshop utilisation. Take the lambda value of 1.1 as an example; compared to the segmented machine allocation strategy, the unsegmented approach provides 14% better service. The improved performance is a result of the unsegmented state's more flexible routing, which compensates for the segmented machine allocation policy's advantage in shorter setup times. Because there are so few tools for reducing settings, the fragmentation policy mostly limits routing and offers nothing to improve speed, especially when dealing with a large number of textures and objects.

2.3 MRP System and Assembly Line (AL) and Performance (P)

The assembly line-controlled materials have performed better at the service level for all three variables when comparing the service level curves (S1a, S2a, and S3a) with the delay (S1b, S2b, and S3b) for the three variables of MRP materials and the assembly line (Figure 7).According to this study, the issue of delivering two separate kinds of orders arises when assembly materials and MRP are handled on the same resources.The rule of thumb is that the orders with the earliest due dates are given priority while sorting the machines. The original sample's intended start period for the code of the following low-level (lower Limited Liability Company) is the scheduled due date for the production order for material requirements planning (MRP) supplies. Because the manufacturing order is established at the same time as the expected delivery date for materials controlled by the assembly line, these items are often prioritised. For the manufacturing system under consideration, the MTS policy outperforms the MTO policy due to the improved performance of the assembly line under the split machine allocation strategy, which accounts for the demand fluctuations. Applying an unpartitioned device allocation strategy impacts MRP materials due to grouping priority. Prioritising materials for the assembly line results in a substantial decrease in the service level for items that are slated for MRP, as shown in (S2), while the overall performance of a segmented approach is superior. The unpredictable nature of the simulation results at high productivity causes the delay figures to display non-consistent behaviour. The findings are also examined with other cost and planning parameters in structure S1. The major conclusions on costs and service level are kept the same, but the individual figures in this sensitivity analysis are noticeably different.

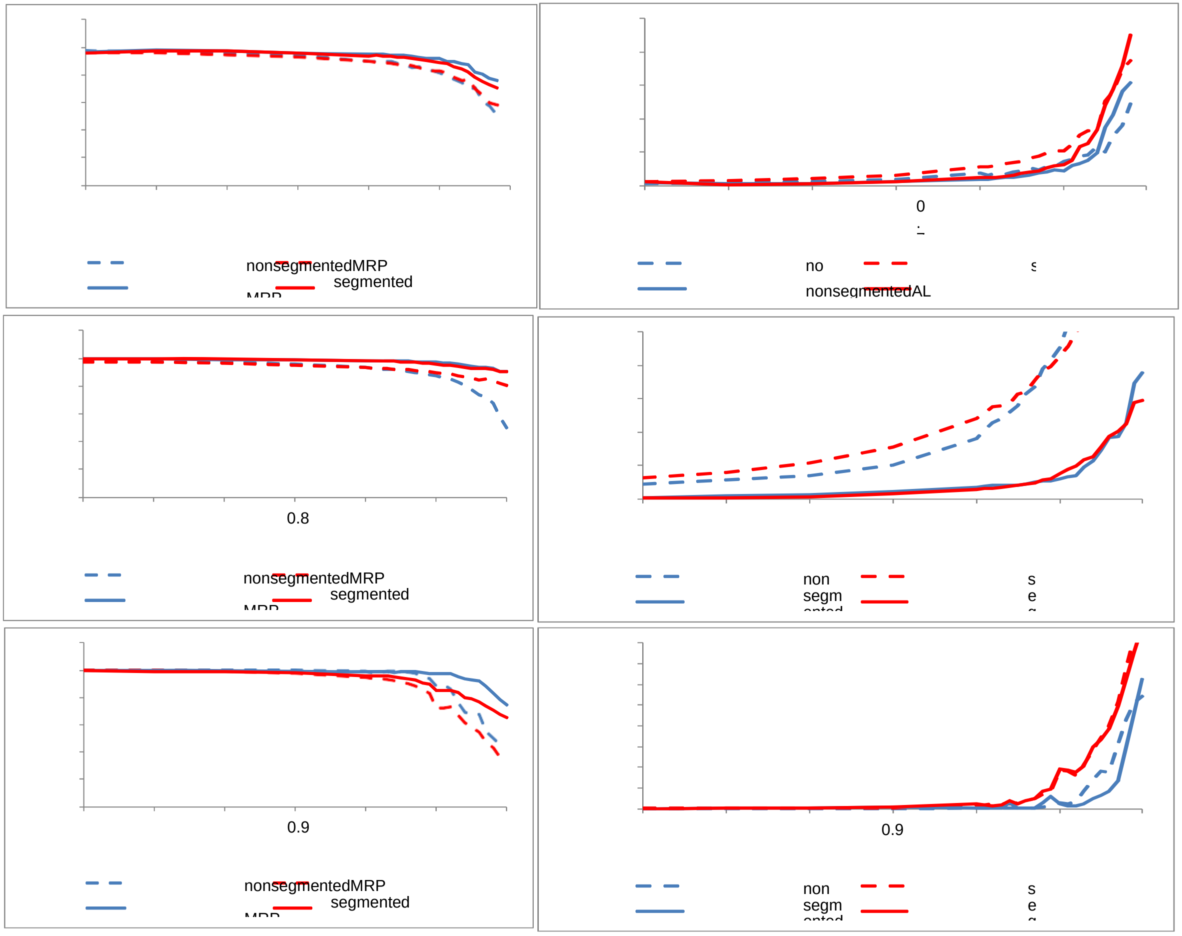


Figure 7 Service level and delay in MRP materials/assembly line for the three dummy variables

3. Conclusion

Simulation research conducted in this research has revealed that a flexible simulation model with a well-suited database to represent scalable production systems achieves the best approach to Production. It is compatible with a production system at low setup times, while low-level performance service is used almost independently of the applicable machine allocation policy. As for high use, the flexibility of the production system is increased due to the lack of fragmentation of the production system and improved performance. The increased flexibility of the production system also leads to improved performance and productivity, especially comparedto the total costs of the two approaches. The undivided production system in such cases results in much lower costs than the split costing as in a variable that significantly impacts preparation time. It is also found that significant cost improvements for the split production system compared to the undivided system for high productivitylead to cost optimization by reducing the total preparation time, which increases the loss of flexibility in this policy. Therefore, in all productivity scenarios, the loss of segmentation flexibility results in greater costs and the gain in preparation time reduces when the same situation is examined with a larger number of items. Moreover, under both the split and undivided production systems, we compared the service level, delay performance, and planned assembly line materials of MRP.

Based on the study, in non-fragmented production systems, the service level for (MRP) components is lower than that of assembly line parts. Because of this, more study is required to find out how to transfer materials to the MRP and assembly line in the event that they share the same equipment. This study only adds light on the factors that were specifically examined. So, to explore the behaviour in a wider variety of production system configurations, more study is required.

REFERENCES

1. Altendorfer, K. and Minner, S. 2011. "Simultaneous optimization of capacity and planned lead time in a two-stage production system with different customer due dates." European Journal of Operational Research 213: 134–146.
2. Axsater, S. 2005. "Planning order releases for an assembly system with random operation times." OR Spectrum 27: 459–470.
3. Jodlbauer, H. and Huber, A. 2008. "Service-level performance of MRP, Kanban, CONWIP and DBR due to parameter stability and environmental robustness." International Journal of Production Research 46: 2179–2195.
4. Hopp, W. J. and Spearman, M. L. 2008. Factory Physics. Boston: Mc Graw Hill / Irwin.
5. Jodlbauer, H. 2007. Produktionsoptimierung: Wertschaffende sowie kundenorientierte Planung und Steu- erung. Wien u.a.: Springer.
6. Smet, R. de and Gelders, L. 1998. "Using simulation to evaluate the introduction of a Kanban subsystem within an MRP-controlled manufacturing environment." International Journal of Production Eco- nomics 56-57: 111–122.
7. Yano, C. A. 1987. "Setting Planned Leadtimes in Serial Production Systems with Tardiness Costs". Man- agement Science 33: 95–106.
8. Hubl, A., Altendorfer, K., Jodlbauer, H., Gansterer, M., and Hartl, R. F. 2011. "Flexible Model for Ana- lyzing Production Systems with Discrete Event Simulation." In Proceedings of the 2011 Winter Simu- lation Conference. December 11 - 14, 2011, Phoenix, Arizona, USA; [including] MASM (Modeling and Analysis for Semiconductor Manufacturing) Conference, IEEE Service Center, Piscataway, NJ, 1559–1570.
9. Preston K. White, Ricki Jr. G. Ingalls(2009) Introduction To Simulation ,Proceedings of the Winter Simulation Conference.978-1-4244-5771-7/09/$26.00. IEEE.
10. Preece J, Rogers Y, and Sharp H (2002). Interaction Design – beyond human computer interact ion. Wileys, 2002.
11. Gulliksen, J., Boivie, I., and Goransson, B. (2006). Usability professionals-current practices and future development. Interact. Comput. 18, 4 (Jul. 2006), 568-600.
12. Heizer, jay & Render, Barry & Munson, Chuck,(2017), (Operation Management-Sustainability and Supply Chain Management). 12th Ed. Pernter –Hall, New jersey.
    Ben-Ammar* A.Dolgui F.Hnaien M.-A.Ould-Louly (2022) Supply planning and inventory control under lead time uncertainty: a literature review and future directions. https://doi.org/10.1016/j.ifacol.2022.10.138.