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RANDOM OPTIMIZATION CONTROL OVER SOME RANDOM SAMPLE DYNAMIC PRODUCTION AND ADVERTISING PLANS

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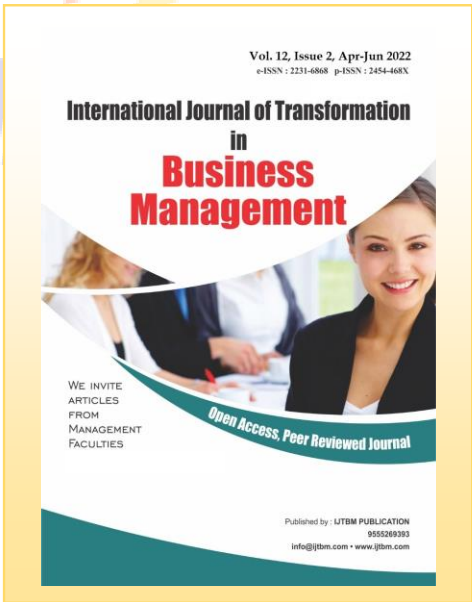


ABSTRACT

Through the study, we will deal with the production control system, improving it with the presence of: Disruption in supply - uncertainty in demand. There are two types of orders, discontinuous ordering and random ordering. In the case of demand disruption we find an increase in the indicators of the dynamic performance of the system (peak order price, production completion, inventory) with the duration of supply disruption, but we find increase and decrease sequentially with the start time of supply disruption.

The direction of change is different

Each peak will be independent of the onset of supply disruption with no disruption to demand.

In random order:

Dynamic performance indicators increase with the duration of the disruption (inventory amplification - variance of inventory relative to demand), since the downward trend increases demand variance.

We propose an algorithm related in dynamic performance indicators of the system where it reduces the objective function by choosing suitable parameters of the system. The optimal parameters are related to:

Under intermittent demand: the time and duration of the interruption of supply

Under random demand: duration of supply interruption

INTRODUCTION :

The success of statistical analysis in general and mainly depends on the extent of the correct questioning and the appropriate and appropriate identification of the problem of the study, as well as the matter in the selection of the study population. The process of collecting data and identifying the studied sample.

Dynamic programming is an approach that makes a complex problem a simple sequence of problems and the main feature of this programming is the multi-stage optimization process. Dynamic programming analyzes types of problems. Thus, it is a set of techniques for improvement. Where it depends on creativity and classification of a specific problem in the form of a dynamic program.

As a result of new global changes and challenges, the world has become fragile and unstable at all levels.

Industry practices are similar in many ways, including:

Shrinking sources of supply

Divided production process

important suppliers

This puts supply chains at risk.

Where it may occur interruption in the flow of materials in supply chains as a result of surrounding factors and conditions, and as a result, it may reach interruption of supplies.

The topic of symptomatic disorder is receiving increasing attention from academics and industry because it causes:

Production resource disruption

Successive delays in customer delivery

Ultimate financial loss

Defined uncertainty in demand: It is the typical accuracy class in supply chains. It arises when demand fluctuation occurs due to internal and external random factors

((In a dynamic environment: supply and demand)) - uncertainties-, the occurrence of which is associated with changes in the dynamic performance of the system.

Uncertainty in (supply or demand) in the production control system may cause fluctuations in both special rates in: production orders and stock levels over time, causing high costs that are difficult to compensate. Which in case of doubt in supply and demand together increases its intensity and negative effects.

Dealing with uncertainty in supply and demand is not a rare occurrence, as we find that companies are constantly exposed to extremely uncertain environmental conditions in modern supply chains.

Accordingly, the issue of uncertainty in supply and demand in particular occupied the great interest of researchers.

Uncertainties in supply and demand have implications for the dynamic performance of production control systems as the previous literature has not been adequately and adequately addressed. Which led to falling into ignorance of the company's management to reduce the negative impact of sources of uncertainty and efficiency of production costs and inventory.

Problem of Study:

Work to improve the production control system free from supply disruption/demand uncertainty.

Order status: intermittent and random order. Where we find that the dynamic performance indicators increase with the duration of the disturbance.

Importance of studying:

The importance of the study lies in finding the effect of random optimal control of production plans, as they affect the supply or demand situations of the company, and the problems and dangers that each of them poses to the company's performance and shareholders' rights.

LITERATURE REVIEW

There is a wealth of literature and studies on the risks of supply chain disruption and operations management. Recent studies have focused on the types of risks, their classification, and their different types.

Supply chain disruption risks are categorized into demand related risks.

Supply disruption occurs when the supplier is unable to meet the company's demand, as demand disruption is associated with a sudden change in it, and risks may be related to costs. According to the study (Shafie and Rice, Jr.), the risks are determined according to the probability of the occurrence of the disorder and the consequences of the risks. The Kleindorfer and Saad study classifies risks in the supply chain as high-probability - low-impact risk and low-probability - high-impact risk.

The occurrence of supply interruption affects the performance of companies.

(Hendricks and Singhal) concluded in their study, that short-term supply disruptions lead to a decrease in shareholders' equity. The average decrease over three years was 40%.

According to (Oke and Gopalakrishnan) supply risks can be absorbed by planning supply and demand, flexibility, identifying supply chain weaknesses, and dealing with the negative impact of supply disruption, he offers various suggestions such as: multiple sources, alternative material sources, and flexible supply.

Comparison with our current study:

Our study is distinguished from the rest of the studies in that we focused on the special dynamic performance in the control system for typical production according to a single source of supply, where supply turbulence and uncertainty in demand.

DYNAMIC PROGRAMMING

The distinguishing characteristics of dynamic programming problems are:

- **stage**

Programming is the arrangement and coordination of improvement problems through successive stages, which are solved sequentially and sequentially. Solving any problem contributes to finding the solution and paves the way for the other problem greatly

The phases are different time periods in terms of the planning horizon of the problem. It is possible to define a problem specific to the level of inventory for a single commodity according to a dynamic program.

The decision variable expresses the target amount in each month; Whereas, the goal is to obtain a reduction in the total costs of both ordering and inventory; The basic constraint is based on fulfilling the demand. In the event that the monthly demand is possible, this requires following an ideal policy for the demand in the later period, where the problem is divided into stages, each of which is considered a decision on the demand.

There are cases where time phases do not carry traces. :

It is often difficult to recognize problems that can be modeled as dynamic programs with phases that do not carry a time effect.

The stages of an optimization problem are related to the cases that are considered to be process cases. It expresses the information needed to prepare a comprehensive assessment of the consequences of the current decision on future actions.

In the inventory problem, we find that each stage contains one variable that expresses the state:

The level of stock available for the item

The minimum delay problem has a variable that expresses:

The intersection where the demand is at the same point

System states specification is the most important parameter in designing an expressive model for dynamic programming. Since there are no fixed rules.

The bulk of this process is art and creativity that often requires creativity. The operator must have intelligence and masterfully approach the considered problem.

The specific characteristics of job selection are:

a) Jobs must express enough information to be able to make decisions without worrying about how to arrive at the status quo in practice

b) It must contain a small number of state variables, because dynamic programming requires a large computational effort, which is considered a high cost. If more than two variables are set, the case variables are included in the model and its formulation.

This feature greatly limits the applicability of dynamic programming in practice.

- **Sequential improvement**

Dynamic programming is the process of making sequential improvement, based on solving the overall problem by solving progressive problems.

First: The stages are addressed sequentially, one at a time, and the problems of each stage are gradually solved, and so on, to reach the optimum level. The reverse induction also deals with the first stage and analyzes it as the last stage of the problem.

Problems are addressed and resolved by going back to the stage to reach all stages.

The process of reversing the recursive procedure is based on forward induction, and what must be solved is considered an initial stage of the problem, and the solution to the problems is reached by solving the interim problems in a sequential form, all the way to all stages. Whereas during the settings of a given problem, only one of these extrapolations is applied (reverse induction is used in the majority of uncertainty problems).

Recursive optimization basis (optimization principle): The optimal policy enjoys "whatever the case and decision, the remaining decisions must be expressive of the optimal policy for the situation resulting from the current decision".

Form preparation

In this section, we first briefly describe the model chosen for our APIOBPCS study and then simulate the model in the case of a system containing: perturbation of supply and uncertainty of demand.

Description of APIOBPCS:

In order to reach the normal production process, the manufacturer relies on one type of material, which is supplied by an external supplier. Determines the shape of the causal loop according to the method of systems dynamics.

In feedback loops, factors interact based on production and inventory decisions made by the plant.

(Ti) Error in AINV ("EINV")

(Tw) A work-in-progress error ("EWIP").

According to the APIOBPCS model:

The error corresponds to EINV: the difference between DINV and AINV

EWIP: The difference between DWIP and WIP

COMRATE expresses the completion rates of production.

The time limit is imposed by (Tp). Tr indicates estimated lead time in the pipeline, then the required DWIP is in progress: AVCON - average product consumption rate.

Symbols used in the study:

ACON: actual consumption/demand rate

AVCON: Average rate of consumption/demand

ORATE: Asking price

COMRATE: Production completion rate

AINV: Actual Stock Level

DINV: Required stock level

EINV: Stock Level Error

work in progress

DWIP: Work in progress

EWIP: work in progress error

Ta: average consumption / ordering time

Ti: It's time to adjust inventory

Tw: It's time to adjust the work in progress

Tp: production delay time

Tr: Estimated lead time of pipeline

Ts: When the power outage started

Td: period of interruption of supply

t: a period of time

Δt: simulation step size

μACON: Average Order Value

σ2 ACON: Differing Request

σ2 ORATE: CHANGE ORATE

σ2 AINV: Inventory Level Change

μEINV2: Predict the EINV box

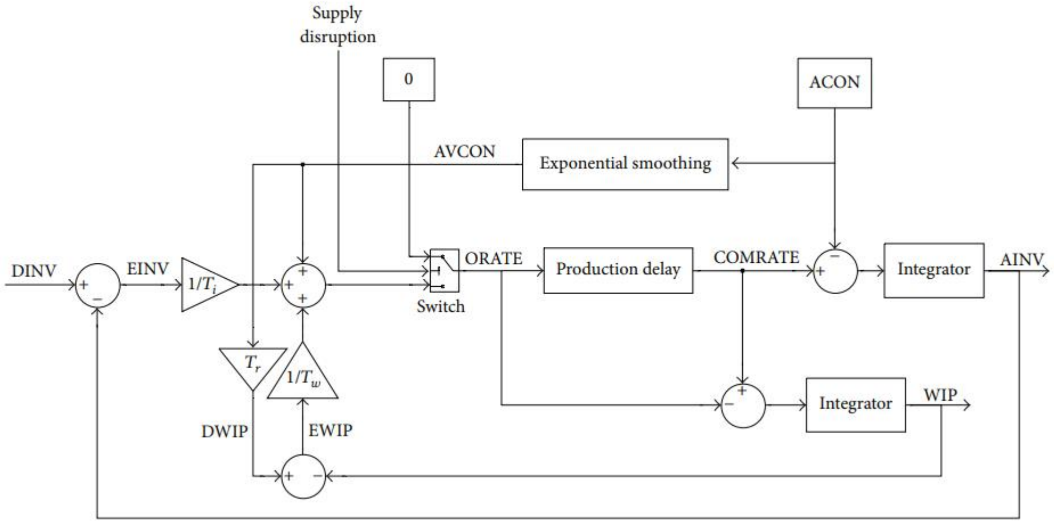


Diagram of APIOBPCS according to the uncertainty of both supply and demand

SIMULATION MODEL:

Work is underway to improve the simulation model using Matlab/Simulink.

"Simulink": a software package for doing vectorial dynamics modeling which has been widely applied in simulating the dynamics of systems for APIOBPCS in Simulink under "supply and demand" uncertainty.

According to the previously developed simulation model.

The difference equations are directly applicable to the model.

- Where the simulation model consists of the variables: modifier + condition.

- Delay production score only

- 1 exponential smoothing

- block integration

Math function groups

- The variable rate includes: "ACON - AVCON - ORATE - COMRATE".

Status variable includes variables related to inventory (AINV, DINV, EINV) and work in progress (WIP, DWIP, EWIP).

All system variables are initially set to zero

The dynamic performance of APIOBPCS is investigated in the uncertainty of both supply and demand. Supply uncertainty is taken as supply disruption. When the supply is interrupted, the flow of materials to APIOBPCS is interrupted.

Ts and Td Indicate the start time and indicate the start time and duration of interruptions, respectively. Once a supply interruption occurs, the manufacturer's production order before the interruption ends becomes invalid; In other words, ORATEt = 0 for $Ts \leq t <+ Td$. Such a change is recorded in the ORATE status in the presence of a supply interruption.

During a supply interruption, the COMRATE value may not always be zero because it is possible to complete the order submitted before the interruption. To learn about the different types of demand uncertainty, we are interested in two patterns of demand uncertainty.

The first pattern: represents a disruption in demand with a change in demand (demand changes from zero to one). Where the disrupted demand is at the beginning of the time horizon at (t = 0).

The second pattern: random arrangement according to a normal distribution; We respectively allow μACON and σ2 ACON to refer to: "the average value and variance of the customer's order".

ORDER CHANGE CONDITION: STEP, PEAK: ORATE, COMRATE, AINV (indicating the maximum value over the entire simulation time); being the dynamic key indicators considered; The peak value is widely used in evaluating dynamic performance in production if the system undergoes a custom input step. In the case of random demand, we choose stock and stock volatility amplification as the main investigated dynamic indicators.

Variance amplification in ORATE corresponds to customer demand. The mathematical definition is as follows:

Bullwhip = σ2 ORATE / σ2 ACON

σ2 ORATE represents the variance of ORATE. Stock volatility amplification includes stock variance amplification (VA) and stock error amplification (EA), and

VA*I* = σ2 AINV / σ2 ACON

EA*I* = μEINV2 / σ2 ACON

σ2 AINV represents the AINV variance and μEINV2 represents the EINV square prediction. Both VA*I* and EA*I* reflect the amplification of stock volatility with respect to the demand variance, the main difference being that EA*I* is related to restoring stock towards the desired level throughout the study, and the simulation model will be examined. In addition, the simulation model can be indirectly validated and validated as it is similar to the APIOBPCS model studied in the literature but we incorporate multiple sources of uncertainty.

Dynamic Analysis

In this section we adopt the system parameters Ta = 16, = 8, and Tp = Tr = 8 according to APIOBPCS where dynamic analyzes are performed for both uncertainty in demand - supply disruption, respectively.

Demand Disturbance:

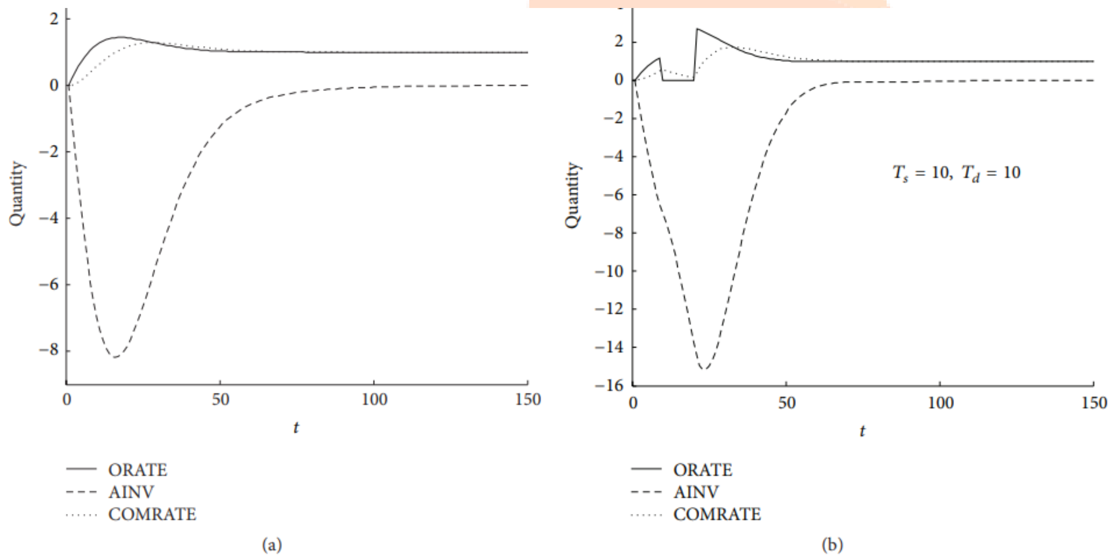
At the beginning of this section we will examine the effects of Td on ORATE, COMRATE and AINV peaks with demand disorder and compare them with those subject to no demand disturbance. The simulation time horizon is from 0 to 150 (t [0, 150]).

To examine the effects of disruption and lack of demand, we look at two different cases (with/or without) disruption in supply. In uninterrupted supply, AINV initially declines to a peak and then stabilizes again. Also, the value of ORATE and COMRATE rise to a peak and then stabilize. This direction of change is related to the feedback mechanism of the system in the event of a demand malfunction. When the order jumps from 0 to 1 initially (t = 0), AINV starts declining because the value of ACON is greater than COMRATE.

To improve AINV to an advanced level, the system requests an increase in ORATE

Late version of ORATE, COMRATE is incremented. As COMRATE increases, AINV can increase when COMRATE becomes larger than ACON.

AINV decreases and increases progressively. We note the decrease for the ORATE values and the ORATE increase for AINV; Thus, we find that each of them increases and decreases sequentially.



Two cases (without/with) supply interruption due to demand disruption

In the case of the supply discontinuity ($Ts = 10$; $Td = 10$), we find the gradual regression of ORATE at the beginning of the discontinuity and then the jump from zero to the top at the end. First COMRATE decreases and then rises to a peak (lead production is distributed, because production is not zero during outages). After the supply is interrupted for similar reasons, ORATE and COMRATE decrease and then return to stability.

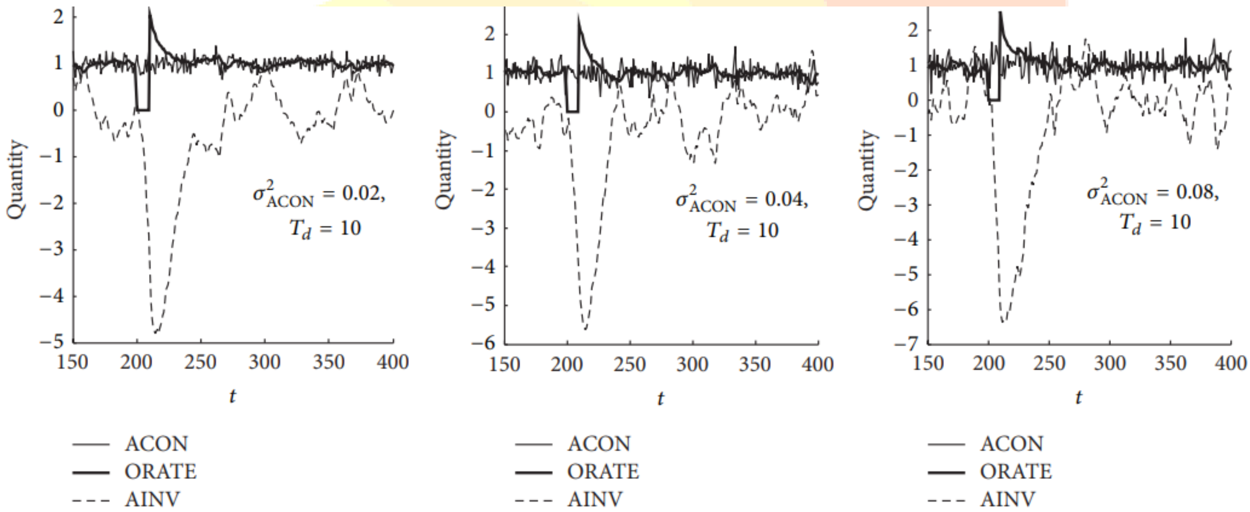
Like the unbroken state, AINV first declines to a peak value and then returns to stability. Comparison result: that the peaks of: (ORATE, COMRATE, AINV) all increased compared to the unbroken case; We find that the peaks of ORATE, COMRATE and AINV are 2.680, 1.726 and 15.15 in this case while they are 1.330, 1.230 and 8.385 in the previous case.

To further demonstrate the impact of a supply interruption, we allow the initiation and duration of the interruption. Each type of peak has an increasing trend, with increasing Ts; Each type of peak has an increasing slope and a decreasing slope as Ts increases for Td. Changing trends of peak values can be observed further by allowing one to change constantly while the other remains constant.

Each type of peak increases strictly with Td if it is relatively small (Ts = 0, 2, 8, 16) but remains constant first and then increases with Td if Ts is relatively large (for example, Ts = 100). This result relates to the comparison of COMRATE and ACON (rate of consumption) when the system undergoes a step entry in demand. If Ts is relatively small, then COMRATE is smaller than ACON, and therefore, AINV is still decreasing at perturbation onset.

Given this case, as the duration of the perturbation increases, the AINV peak will increase, which subsequently causes the ORATE and COMRATE peaks to increase as well. If it is large enough, the system recovers to the steady state after entering the required step.

Therefore, AINV will not drop to the lowest value before perturbation occurs unless the duration of inactivation is sufficiently large. Therefore, the AINV peaks consistently to the minimum AINV value before cut-off for a relatively small Td and increases with Td if it is large enough.



Under random order the change states

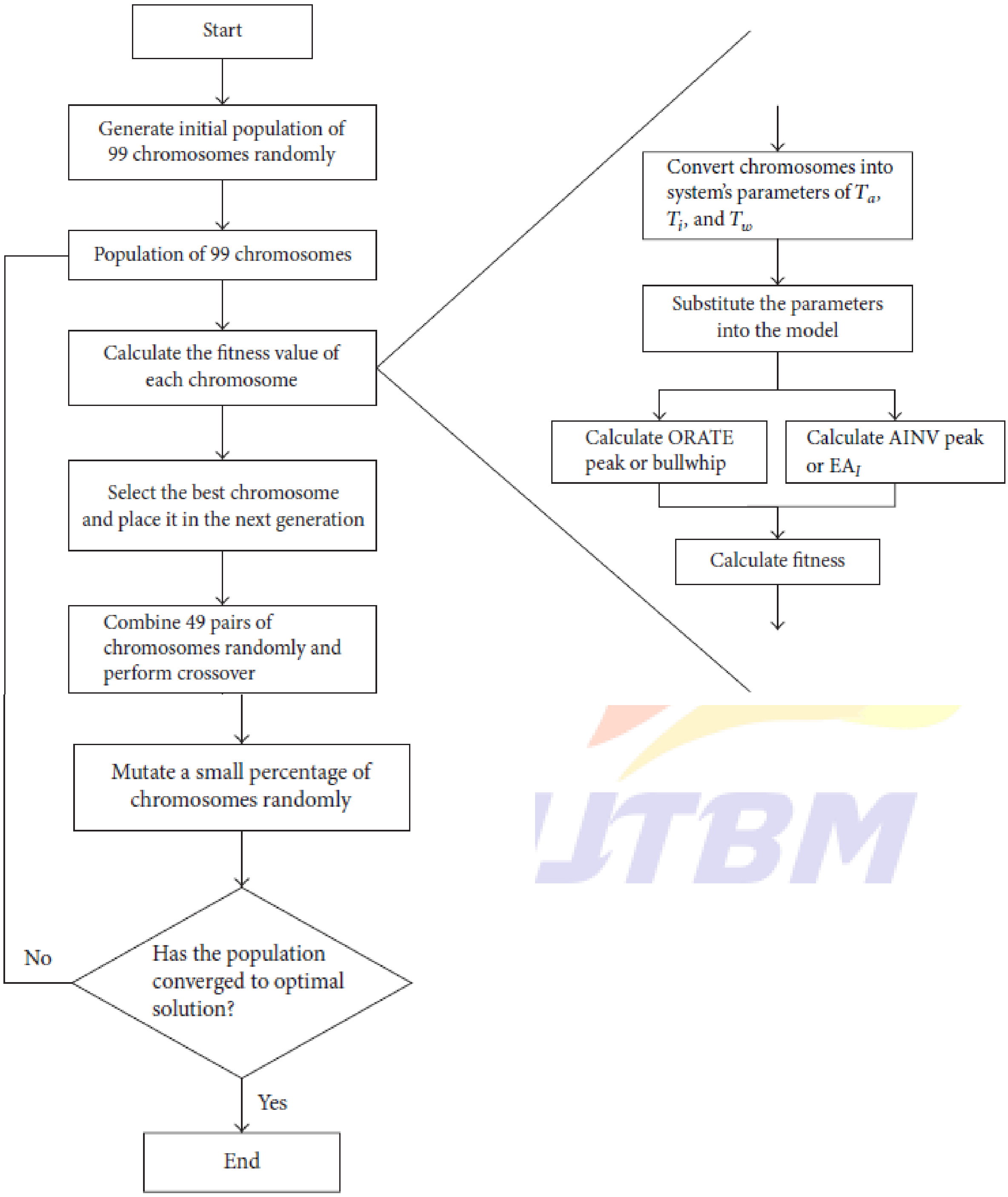
of ORATE and AINV in different values of σ2 ACON

Relying on the continuous change of state to change the step in order; Thus, the AINV peak is unaffected and remains of a constant value. Based on the direction of change, we can conclude that both the ORATE and COMRATE peaks have similar change directions as Ts increases.

Now, we compare the effects of supply disruption on peak values when there is demand disruption and when it is not. Without losing generalization, we allow

ACON to be 1 under no power perturbation. It is easy to find that, in the absence of demand perturbation, each type of peak value has a positive correlation with Td but is independent of Ts (the relevant simulations are omitted here for simplicity).

The effects on dynamic performance "with and without" demand interruptions are significantly different. Each type of maximum value increases and decreases in case of disturbance of demand sequentially.



The optimization procedure

According to some distributions, the time and duration of deactivation begins. Where we consider the case without losing the generalization:

where (Ts or Td) each follows the given distribution, if Ts follows a uniform distribution in the value range [0, 16] and expects a value of 8. Td follows a constant value of 8/16/24. Under GA, here the optimal parameters can be obtained , since the optimal parameters of the system have different directions of change; More specifically:

$T*a$ remains unchanged

$T*i$ increases

$T*w$ increases and decreases sequentially.

The condition of giving the two distributions: following a uniform distribution where it corresponds to the expectation of 8 in the value range [0, 16]. The probability that Td is satisfied is one of the values 8, 16, and 24. Then we can derive the optimal parameters.

We find that the specified optimal values for both the system parameters and the target function except for ($T^*{}_w$) are approximately equal to the values of Td = 16 in the first case. Because of the distributions, this result occurs.

Td	T*a	T*i	T*w	F*
8	1	2	10	8.84
16	1	3	256	17.04
24	1	16	5	26.06

Optimal parameters and objective function values for uniformly distributed Ts

T*a	T*i	T*w	F*
1	3	27	17.65

Objective function values - optimal parameters in certain condition and distributions Ts and Td

CONCLUSION

The study dealt with dynamic performance according to APIOBPCS model and system optimization where: supply disruption and demand uncertainty. We found that when demand is disrupted and a step is changed in it, the rate of each of: peak demand, peak full production, and increased peak inventory with the presence of supply disruption if the beginning of the interruption is relatively small leads eventually to an increase in the duration of the interruption.

For any interruption in supply at the same time, the peak rates for all species increase first and then begin to decline gradually until reaching a constant with the increase in the time of the onset of supply disturbance.

The start time of the supply disturbance has a different effect on the performance of the dynamic system with the disturbance of demand and in the case of the non-disturbance of demand because the start time has no effect on the dynamic performance as no disturbance of the demand has arisen. In the case of a random demand subject to a normal distribution, where a high demand variance has a decreasing effect on: Wealth Inflation - The inventory variance for a specified period of supply disruption.

Conversely, with an increase in supply disruption increases: wealth amplification - stock variance in a given variance in demand.

In pursuit of improving dynamic performance, we develop an algorithm, depending on the optimum parameters of the system, namely: (average depreciation time, inventory adjustment time, and private time to modify work in progress). According to the change of the demand step, the given weighted amount of peak demand and peak stock is an objective function of reduction.

It turns out that the average time to optimum consumption does not conflict with the duration of supply interruption, optimal time to adjust inventory has different trends of change with increasing duration of supply interruption, and optimal time to adjust work-in-progress does not decrease or decrease with the duration of supply interruption for a relatively long period; The optimum inventory adjustment time does not decrease, increase or decrease with the time the supply interruption begins in the sequence.

Work has been done to study the improvement of the system according to the possible values of the start of the outage and its duration. In random order, the weighted sum of the pool is determined and inventory errors are amplified as an objective function of underestimation. Where the results showed: the relationship between the optimal choice of parameter and demand variance was not significant, as the relationship between the choice of the optimal parameter and the duration of supply interruption.

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