EVALUATING THE 'OPTIMALITY GAP' BETWEEN CYCLIC AND NON-CYCLIC PLANNING POLICIES IN SUPPLY CHAINS

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THE AIMS

... OF PROJECT

Extended **c**ollaborative integrated **li**fe cycle supply chain **p**lanning **s**ystem's investigation.

... OF THIS RESEARCH

Development of breakthrough control techniques allowing a smooth switching from one policy to another.

... OF PAPER

Analysis of the thechniques for optimality gap and of influencing factors investigation.

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CYCLIC VS NON–CYCLIC SCHEDULING

CYCLIC SCHEDULING

- fixed order/production intervals
- easy planning and control
- preferred for constant demand
- offers practical benefits
- *higher total cost*

NON-CYCLIC SCHEDULING

- varying order/production intervals
- more flexible
- preferred for dynamic demand
- theoretically more optimal
- *lower total cost*

The gap between cyclic and non-cyclic policies could be analyzed to investigate the utilization of mentioned policies and to choose the right one.

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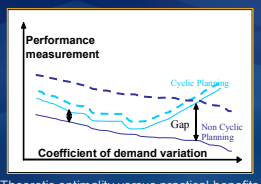
GAP BETWEEN CYCLIC AND NON–CYCLIC SCHEDULING

Optimality gap is defined as a ratio measure to investigate problem's solving approaches and determine how close a solution is to optimum.

The gap between cyclic and non-cyclic policies could be also represented as *additional cost of cyclic schedule (ACCS).*

$$ACCS = \frac{\text{Cyclic Cost} - \text{Non-Cyclic Cost}}{\text{Non-Cyclic Cost}}$$

Formulae of ACCS calculation *(Campbell,1995)*



Theoretic optimality versus practical benefits *(source: Eclips)*

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TECHNIQUES FOR OPTIMALITY GAP INVESTIGATION

To find out optimality of any planning policy or method, different techniques are based on:

- Theoretical Optimality Proof by Costs Comparison,
- Optimality evaluation from the Complexity Perspectives,
- Optimality evaluation by Implementation Guaranty,
- Optimality evaluation *through Simulation Experiments.*

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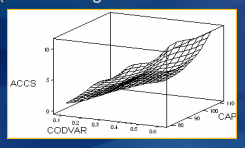
FACTORS AFFECTING OPTIMALITY GAP

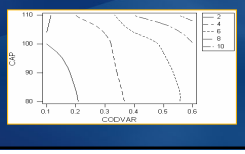
ONE FACTOR'S INFLUENCING:

- coefficient of demand variation (the most significant factor influencing the cost gap);
- capacity utilization;
- setup time;
- time between orders;
- number of items and periods.



TWO-FACTOR INTERACTION

MORE THEN TWO FACTORS COMBINATION



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FACTORS AFFECTING OPTIMALITY GAP

EFFECTS	PARAMETER(S)	DESCRIPTION OF EFFECTS
Main effects	Coefficient of demand variation (CODVAR)	ACCS increases as CODVAR increases because of the reduction of non-cyclic solution costs. *Treatments levels from 1.1 to 1.6.*
	Capacity utilization (CAP)	Higher capacity utilization results in larger ACCS values as flexibility of non-cyclical scheduling is most valuable when capacity is more constrained (*i.e. at treatment levels 100, 110*). The effect is less strong than that of CODVAR for ACCS, and stronger for solution gaps.
	Number of items	Larger number of items decreases the variation of periodic demand and ACCS value, but the effect is less strong than that of. CODVAR or CAP. *Treatments levels from 9 to 30.*
Interaction effects	CODVAR & Capacity utilization	Higher CAP makes stronger CODVAR effect to ACCS, especially to solution gaps. When high levels of both factors combined, it becomes more difficult for non-cyclic & cyclic heuristics to get solutions close to lower bounds.
	Setup time & Capacity utilization	Lower setup times have the effect similar to higher levels of CAP. The effect of lower setup times is greater at the higher CAP level, especially, with regard to solution gap. *Treatment levels randomly generated U[0.15, 0.35].*
	CODVAR & Time between orders (TBO)	The larger order intervals result in lower ACCS when there is less variation in the sum of demand over the order intervals and less variation is associated with lower CODVAR values and/or larger TBO values. As exception occurs at very low levels of TBO. *TBO treatment levels from 1 to 5 periods.*
Combined effects	Ordering cost factor, holding cost factor and CODVAR	The interaction effects of ordering cost and holding cost factors becomes more significant with increase of CODVAR that result in increase ACSS value. *Treatment levels are 0.4, 0.8; 1.6, 2.0 and 0.31, 0.75, correspondingly.*

OPTIMALITY GAP EVALUATION THROUGH SIMULATION

Simulation approach allows:

- model supply chain behaviour under different planning policies in time and by echelon;
- evaluate optimality in condition of demand variability and uncertainty;
- analyse evaluation of the gap in time;
- analyse several gap performance indicators and measures at once;
- compare different planning policies in conditions closely related to the product lifecycle dynamics;
- learn possible effects of supply chain parameters influencing the gap performance.

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CONCLUSIONS

- When the gap value is small enough, the cyclic planning policy will outperform any non-cyclic policy in practice.
- This is why determination of influencing on the ACCS *factors* and analysis of the *optimality gap* is crucial.
- Simulation-based evaluation of the 'optimality gap' can help to define the best scheduling strategy in practice.

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