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A Comprehensive Review on Modern Approach of Capacity Planning to Suit Fast Fashion Model

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ABSTRACT

Currently high fashion clothing market product mix and Variety is high, quantity is small and lead time is very short. There are also many competitors from different corner of the world. Hence, the competition in the market is very complex and strong. In order to take over competitors and get better market share, the companies should have strong planning team. The main intention of this paper is to guide capacity planning for fast fashion garment production. In this study we made a model of capacity planning, as a case study in a company located in Addis Ababa, Ethiopia, which has its own export oriented manufacturing unit working for 3 big brands of Europe and USA, each Brand constantly working with the company in different styles of product of Smaller Quantities per style. Different factors which must be considered in the capacity planning and order assigning process will be shown. Model analysis is prepared to handle the planning process effectively. The study emphasized on modern approach of capacity planning for fast fashion model which supports fast and accurate planning of orders in assigning the right site in the right time with the right resource which is made by benchmarking big fashion brand Benetton's system, the scale and other economical factors are considered.

Keywords : Fast Fashion, Capacity Planning, Delivery Anticipation, Cash Flow, Saturation, Lead Time

I. INTRODUCTION

In global fashion and clothing market in recent years the marketing trend is changed to undetermined and very fast and difficult to forecast long time. Human need is unpredictable and everybody is expecting to be unique with dramatic design with lower cost. Retailers are ordering variety of products with lower volume of each style with short time. The lead time is very short since the need is changed unexpectedly to overcome the problems. Manufacturing units in earlier era were working with high volume and with the high productivity and they had monitoring and correcting time, so they were relatively working relaxed way. But, now they are struggling to finish the orders by operating large amount of overtime and higher additional operators to complete the order in time. Before the order is reaching the manufacturing site the planning should be effectively ready and scheduled in a correct way. Therefore the available capacity in job, available free machines capacities should monitored in each and every time. The fashion and clothing is not complete only with price, value, and products only, but also needs proper time-based- computation across the glove. Producing high quality affordable product is on the one hand and also quality requires in sourcing, processing, manufacturing of goods and addressing the final products to customer in required time is the biggest challenge. Well organized companies/brands like the Benetton, H&M, GAP, G-star Group are able to bit-down such challenges and get success in the business by developing strategic way of handling the supply chain by making compatible planning of consecutive but independent processing companies through technology and unified management mechanism. On high computation of manufacturing companies to produce products in lower price quick responsiveness and understanding customers need. These kind of strategies are essential in the current era of fashion to withstand the demands of the consumers. As otherwise, the industry just need to watch the fashion progress and should proceed towards decline.

II. METHODOLOGY

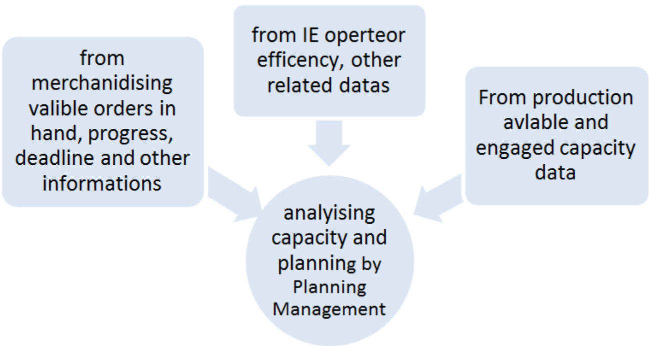

Figure 1. Modern approche of cpacity planning

this article shows how we can apply modern approach of capacity plannig for a companies like situated in Ethiopian , which have few independent sweing production lines, working with five loyal customer which gives orders through out the year with few styles with production volume of 4000-6000 units of products per style. The following details are considered in the company.

- ✓ Preproduction process should be planned effectively before production beigns (cutting capacity, Embroidery/Printing capacity of the company should always be greater than the sewing capacity and managed well).
- ✓ Finishing and other post production process are handled well as per the capacitive production
- ✓ Quality products are produced in the process and rework rate should be lower than 3%.

The mathimatical and Statistical analysis can be solved in the following way:-

Let Xij is the number of unit of products j assigined to sweing line i, with j= 1,2,3...J and i= 1,2,3, ...I(number of lines are 4, so I=4)

Then

$\sum_{i=1}^{I} \sum_{j=1}^{J} ɼ_{ij} \alpha_{ij} \frac{x_{ij}}{p_j}$ (h)

Where

$\boldsymbol{p_j}$, is the process rate for product *j* (unit/h);

$ɼ_{ij}$, is a large positive number that can force the production of those particular items *j* expressly requiring the high technology machinery possessed by assigned company for the particular sewing line *i*, which can be present in the network in a limited portion due to the high investments needed;

$\boldsymbol{\alpha_{ij}}$, is a Boolean parameter equal to 1 only if machines in sewing line *i* have proper tools to process product *j* (e.g. the guides needed to special type of machine);

Subject to:

1. Make-to-order constraint:

$\sum_{j=1}^{J} x_{ij} \alpha_{ij} \leq s_j$ *(unit) j= 1,2,3...J*

Where, s_j is the present ordered quantity of particular style j.

2. Materials resource availability constraint:

$\sum_{j=1}^{J} \sum_{n=1}^{N_j} f_{jnkh} \sum_{i=1}^{I} \gamma_{jn} . x_{ij} \leq \alpha_{ij}$ (Kg or m) $\forall (k, h)$

where $\boldsymbol{f_{jnkh}}$ is the amount of fabric *k*, *h*-coloured, needed to make a type *n* (*n*=1, ... , N_j) coloured unit of product *j*, γ_{jn} is the portion of product *j* units of colour type *n* and d_{kh} is the stock level of yarn *k*, colour *h*;

3. Capacity loading constraint:

$\sum_{j=1}^{j} [\frac{x_{ij}}{p_j} + t_{ij} y_{ij}]\ \beta_i\ (h)$ i= 1, 0..., I

Where, t_{ij} is the set-up time for product *j* to be made in the firm sewing line *i* and y_{ij} is a Boolean variable that is equal to 1 only if product *j* is assigned to sewing line *i*;

- ✓ The Boolean variable y_{ij} must be null if x_{ij} is null, i.e. if product *j* is not assigned to sewing line *i*:

$$x_{ij} \leq y_{ij}\ \forall (i, j) ;$$

- ✓ The Boolean variable y_{ij} must be equal to 1 if x_{ij} is not null, i.e. if product *j* is assigned to sewing line *i*:

$$x_{ij} \leq y_{ij}\ \forall (i, j) ;$$

Where, *M* is a large positive number;

4. Realistic size of assignment constraint:

$\frac{x_{ij}}{p_j} \leq a_i . \beta_i y_{ij}\ \forall (i, j) ;$

Where, a_i is the minimum portion of the capacity β_i to be loaded, established for each sewing line *i*.

- ✓ Sign restriction:

  $x_{ij} \geq y_{ij}$
- ✓ Integer restriction:

  y_{ij} Integer

Sources: A. De Toni, A. Meneghetti / Int. J. Production Economics (2000)

The solution time grows exponentially with the size of the problem (I . J real variables I . J integer variables; for actual system data I=4, J=16, I . J= 64) towards unacceptably large values.

This led us to develop heuristics, in order to obtain a more flexible and faster method for building production plans and running simulations. It was inspired by the finite loading approach (T.E. Volman, etal., 1992) to create a vertical logical procedure, which assigns the best available product to each production line, and a horizontal logic one, which instead tries to associate each product with the best production line for making it. Both the heuristics are proceed by creating for each production line or for each article a set of possible assignment alternatives and by shortening this set on the basis of several criteria applied in sequence, such as ensured capacity occupation, set-up time and required machine characteristics, until a single cardinality is reached. Flow diagrams of the vertical and horizontal logic procedures are clearly shown in flowing Figures. The vertical heuristic was found to be better than the horizontal one, with an average error relative to the optimal solution given by the mixed integer programming model equal to 4.4% and 10% respectively.

Analysis of production planning variables

To study about production planning period length, material availability and colour assortment can modify the time-related performance of the system and consequently, from a time-based competition point of view, enhance its ability to satisfy customers' needs, simulation experiments were carried out (A. Meneghetti, 1998).

To build a simulation model that is more adherent to reality, it uses the actual data collected and opinions and suggestions ordered by based on Benetton personnel. It was, in fact, possible to assume a top-down approach to establish the main links between each phase along the supply chain and then detail each component, avoiding possible distortions of interactions at the upper levels. After being saw in one of the 4 sewing line, when the right quantity of items is reached, they are loaded into trucks and then moved on to the next phase in the operative chain. The transport times through the network are set according to the average values recorded in the actual system. The assignment of each job to the proper sewing line in the tailoring, accessorising and finishing stages is performed by choosing the least loaded factory. To maintain productivity aligned with the observed values, breakdowns have been introduced into every shop. As regards materials, in the actual system material purchase orders are set mainly on the basis of forecasts and spaced out along the campaign to meet requirements. Thus are to enhance the capacity of assigning products to the factories. Concerning the link between colour mix of jobs and client orders, analysed the two situations where this relation is maintained or partially removed. It allowed the heuristic to generate colour-incomplete production orders when needed to saturate factories, providing the simulation model with an area where jobs could wait until rejoining the lacking coloured units before leaving the system.

Since in the textile-apparel industry production is fulfilled by successive campaigns, performances have to be evaluated in relation to the whole collection; consequently, global measures are required. For each collection, the analysed network presents a single date promised to all its clients, before which it commits itself to carry out all the orders received. Delivery punctuality is particularly important for network customers, who are retailers, since it affects their ability to fill their shelves with new products on time with high fashion changes and therefore capture fickler and fickler consumers. As an appropriate measure to evaluate system time performances appreciable by clients with regard to a whole collection the proposed the Weighted Average Delivery Anticipation (DA), which have defined as follows:

$$DA = \frac{\sum_{i=1}^{N} Q_i A_i}{\sum_{i=1}^{N} Q_i}$$

Where, Q_i is the number of units of the i^{th} job, with N the total number of jobs processed by the system and A_i s the anticipation of the i^{th} job, defined as the elapsed period (days) between the promised delivery date and the moment each job exits the system and products can be sent to clients.

DA provides an estimate of the system capacity to take an action in product realisation, i.e. in order to react quickly to sales orders/Purchase orders that accumulate during the productive campaign. If DA were improved, the productive campaign could start then after, when the demand is better pre known, for assuring clients the same punctuality. In this way, the material purchasing process would be more easily managed and consequently stocks out is reduced. Conversely, the promised date could be brought nearer to the beginning of production, without affecting the capacity of the system to deliver on time. Such an action would be convenient if the system wanted to accelerate the frequency of lunching new products into the market by introducing more collections in fast succession during the same season, as happens in the quick fashion collection phenomena. The capability of sequencing productive work lines without overlapping them, improved DA would lead to more linear processes and easier coordination between network units.

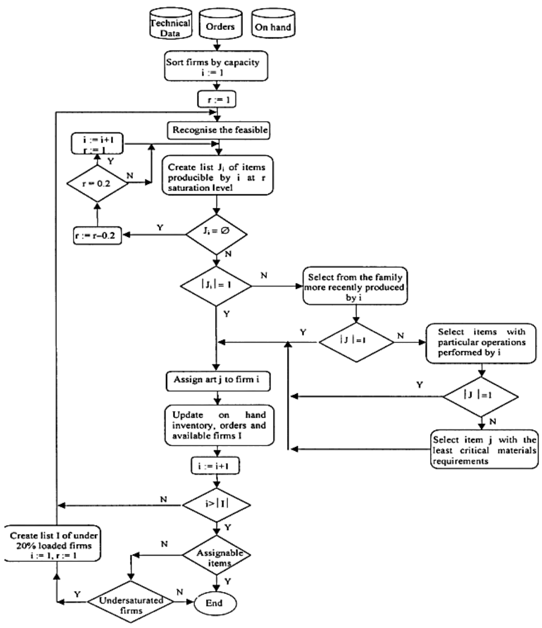

Figure 2. Flow diagram of the vertical logic heuristic Source : *A. De Toni, A. Meneghetti / Int. J. Production Economics 65 (2000)*

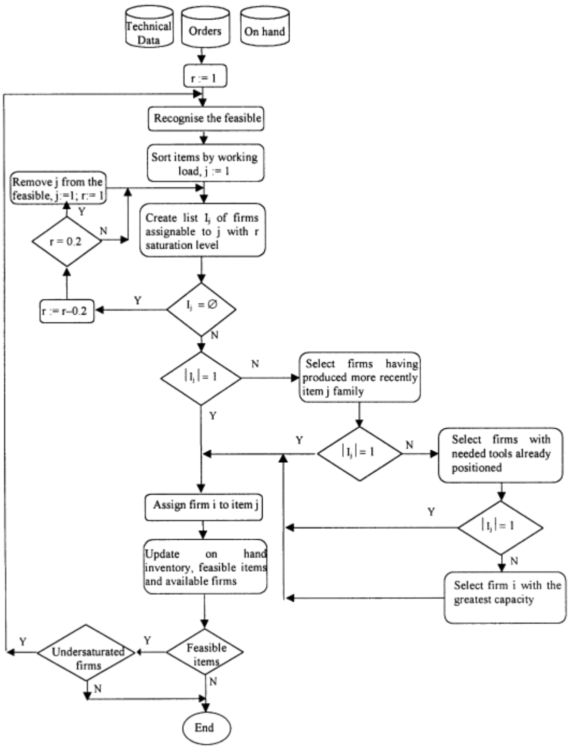

Figure 3. Flow diagram of the horizontal logic heuristic ; (Source : A. De Toni, A. Meneghetti / Int. J. Production Economics 65 (2000

III. RESULT AND DISCUSSION

Simulation Results

Only the length of the production planning period strongly affects time performance achieved by the system and measured by the delivery anticipation. Therefore, only the action of shortening the production planning period can significantly influence the external time-based performance of the network and must be considered by management. So the availability of materials and colour link were no longer investigated, but analysis was directed at the selection of changing the production planning period.

The planning period affects the internal time performance, recognisable only by the system itself and not by its clients, along two directions. As its length is decreased, the average lead time is reduced, because of a shorter job processing time; this is due to a smaller job size, which derives, in fact, from the attempt to fill the knitwear factories to capacity during a shorter planning period. The contraction of lead times is not proportional to the related reduction in the planning period, because as job size is decreased a higher number of jobs is generated during a campaign, leading to increased set-up and queue times, which counteract advantages arising from shorter processing times. The reduction in the planning period also enhances the ability to assign jobs to the firms especially in the early periods of the productive campaign, when the constraints related to availability of materials and customers' orders strongly condition the planning process. The reaction to customers' orders is better with a shorter planning period but the number of set-ups is increased and consequently the set-up time, the effect becoming more evident as the campaign advances and the constraints become less intense. Observing the interpolation curves, it can be seen how a compression of the planning period modifies their asymmetry, moving their median towards the beginning of the campaign. Thus, a first week planning period leads to a higher level of saturation in the first production periods, but to a longer duration of the campaign due to increasing set-ups. These effects can be summarised by the weighted average anticipation of saturation (SA), that have defined as follow:

$$SA = \frac{\sum_{i=1}^{N} O_i A_i}{\sum_{i=1}^{N} O_i}$$

Where, O_i is the actual knitting hours assigned in the i^{th} planning period, N the total number of planning periods and A_i the anticipation of the i^{th} period, defined as the period (days) elapsed between the promised delivery date and the moment jobs of each period enter the system.

The increase in the average anticipation of saturation could provide the firm of the system with a greater chance of loading their available capacity by ordering it to other subjects not belonging to the network, during the period of structural decline of the campaign. If the asymmetry of the saturation curve were modified, so that only two consecutive periods of high and low saturation levels were recognised, each production unit could rely, in fact, on an uninterrupted time interval with sufficient resources to be dedicated to other significant commitments. On the other hand, if the network were used to launch fashion collections, i.e. mini collections added to the usual winter and summer ones to improve the frequency of introducing new products to the market, then a greater anticipation of saturation could allow the campaigns to be sequenced instead of overlapped, reducing the complexity of the production system.

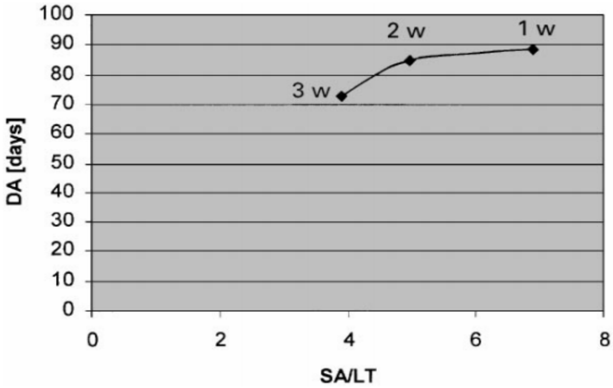

Figure 4. Relation between the internal time performance measured by the ratio SA/LT and the external one measured by the average delivery anticipation DA

The ratio SA/LT summarises in a single indicator the effects of the planning period length on the internal time performance measures LT and SA. As can be seen from the previous figure, the increase in the ratio SA/LT is associated with an increase in the value of the external performance measure DA. This is reasonable, if it is consider that the delivery anticipation depends on the planner's ability to lead the system to saturation as soon as possible, so that products are introduced into the system and processed early. With the same anticipation of saturation, however, products exit from the system as fast as their lead time is shortened. *(A. De Toni, A. Meneghetti / Int. J. Production Economics 65 (2000))*

Time performance of the network and cash flow

A system that provides a quick response to customers' needs can not only attract more clients and encourage brand loyalty by increasing its market share, but also win a price premium for the speed and punctuality of its deliveries. A client that is very sensitive to time performance, in fact, might be inclined to pay a price that is a non-decreasing function of the delivery anticipation with which products are provided. On the other hand, the same client could reasonably decline paying the full price if products are not delivered on time (see Fig. 11). The following behaviour of the unit price *p* can be considered:

$$\bar{p}(1+m_1), \quad a \geqslant a_{\max},$$

$$p = \bar{p} + m_1 \frac{\bar{p}}{a_{\max}} a, \quad 0 \leqslant a < a_{\max},$$

$$\bar{p} + m_2 \frac{\bar{p}}{|a_{\min}|} a, \quad a < 0,$$

Where, a is the delivery anticipation of the unit; $a_{\max}$ the greatest value of anticipation recognisable by clients for a price premium; $a_{\min}$ the (negative) anticipation for which products have still a market value; $\dot{P}$ the full price set for products delivered on the promised date; m_1 the relative increase in the full price $\dot{P}$ for an anticipation equal to $a_{\max}$; m_2 the relative decrease in the full price $\dot{P}$ for an anticipation equal to $a_{\min}$.

Cash inflows gained by applying the above price relation to products managed with a planning period of 3, 2 and 1 week are shown in Fig. 12, setting $\dot{P}$ =35000 Italian Lire (18 Euro), $a_{\max}$ = 72 days, $a_{\min}$ = 120 days, m_1 = 0.2, m_2 = 0.5. Shortening the planning period length leads to increased cash inflows, but a growth in cash out- flows has also to be considered. These results from more numerous set-ups and transports inside the network due to the greater number of jobs generated; Figures shown their behaviour based on data from the Benetton system.

As the external time improvement gained by modifying the production planning period can increase both cash inflows and outflows, its entity must be established so that advantages can be maximised. Curves describing the behaviour of in- flows and outflows as a function of external time performance have to be plotted, so that the network could choose the service level which best realises a compromise between customer satisfaction and profit.

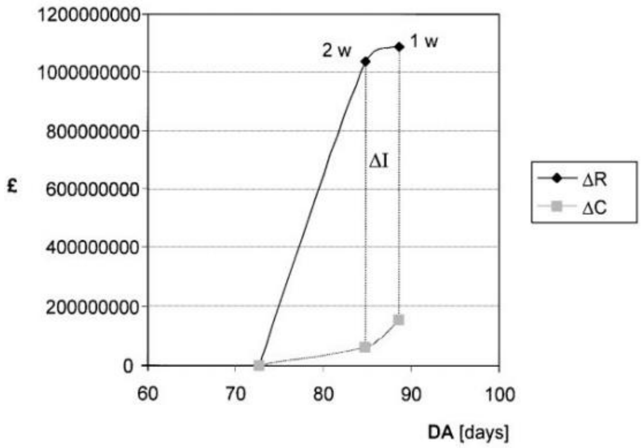

Figure 5. Relative increase in returns (ΔR) and costs (ΔC) when moving from a 3 to a 2 and 1 week planning period.

For the analysed network, the relative increase in returns ΔR and costs ΔC by moving from an initial 3 week period to 2 and 1 week is shown in Fig. 5, where the advantages of reducing the planning period length are evident. Fig. 6 represents the increase in income ΔI associated with a 2 and 1 week reduction and the associated improvement in delivery anticipation ΔDA. The ratio ΔI/ΔDA describes the increase in income (relative to the initial condition) which can be gained for each unit improvement in the external time performance appreciable by clients; it is graphically represented by the tangent of angles α and β identifying the possible reduction in the production planning period. Thus, for the analysed network and the given data, the ratio is more favourable for a movement from a 3 to a 2 week planning period rather than a more drastic change. (*Sources: A. De Toni, A. Meneghetti / Int. J. Production Economics (2000))*

IV. Summary

Simulations have shown how even from a systemic as well as from a single firm point of view, achieving a favourable internal time performance as a means of gaining an external time performance, recognisable by customers.

The production planning process was found to be an important area of improvement for a network in a time-based logic; shortening the production planning period, in fact, significantly affects the weighted average delivery anticipation. It leads, however, to increase set-up and transportation costs due to the greater number of jobs generated during a campaign.

The path of the network towards time-based competition consequently appears traditional; where an improved customer service level, measured by DA, is accompanied by higher costs (see Fig. 17): the network is moved from point *A* to point *B* along its costs-service curve.

A new capability for managing the costs-performance trade-off could be reached by shifting the competition towards more advanced frontiers than its competitors' curves. In this way the network would be moved from point *A* to point *C* through an innovative path, where the advantage of better delivery anticipation is gained without increasing costs.

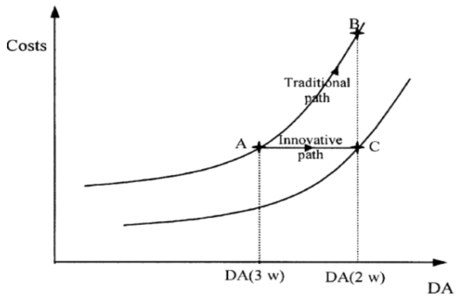

Figure 6. Traditional and innovative path of the network towards time-based competition

To obtain such a result, the planning period compression must be matched with system process reengineering: actions which are able to modify the technological means and managerial techniques of each firm in the network have to be undertaken so that the whole system becomes intrinsically faster as the time-based competition philosophy suggests. For example, if a reduction in set-up time were gained at each step in the chain, a greater number of jobs during a single campaign would not lead to higher costs. The behaviour described in Figs. 6 could be changed in favour of a more drastic contraction of the planning period length, so that the customer's sensitiveness to external time performance could be fully exploited. Thus, while the production planning process is shown to be an important area for improvement in a time-based logic, its results can be amplified by involving the other processes performed in the network.

V. CONCLUSION

The modern approach of capacity planning is done by analysing the company resources, work force, machinery availability and capability to work with respect to actual available capacity, which can be used for particular order. This new approach towards capacity planning will help to use the machinery and other resources effectively as well as improving productivity of the company. Making exact action plan and performing based on this can provide customer satisfaction and get loyal customer due to meeting lead time of the orders to have great benefit in the fashion market. Lagging from schedule in a situation of fast fashion market will not get the relevant loyal brands to work on, but looses the business financially. The nature of fashion market is currently completely fast seasonal and colour and style variation of the products are abundant. Hence, Ethiopian garment manufacturing should work towards meeting deadlines and using modern approach of capacity planning to give priority to the target market also to achieve cost benefit issues. Overall industry can achieve due respect from the global market apart from achieving the individual organizational benefits.

VI. REFERENCES

[1]. Christoph Pickardt, Mengjie Zhang, and Jurgen Branke (2015), /Automated Design of Production Scheduling Heuristics/: A Review

[2]. Chung KH, Kim YH. Economic analysis of inventory systems: a rejoinder. The Engineering Economist 1989; 35:75-80.

[3]. Cohen, M. A., H. L. Lee. 1988. Strategic analysis of integrated production distribution systems: Models and methods. Oper. Res. 36 212-228.

[4]. De Toni, A. Meneghetti / Int. J. Production Economics/ 65 (2000)p.p 17-32

[5]. D.N. Burt, Managing suppliers up to speed, Harvard Business Review, July}August (1989) 127-135.

[6]. Diponegoro, B.R. Sarker, Computers & Operations Research 33 (2006) 2387-2404

[7]. E. K. Burke, M. Gendreau, M. Hyde, G. Kendall, G. Ochoa, E. Ozcan," and R. Qu, "Hyper-

heuristics: a survey of the state of the art," Journal of the Operational Research Society, vol. 64, no. 12, pp. 1695-1724, 2013.

[8]. E. K. Burke, M. Hyde, G. Kendall, G. Ochoa, E. Ozcan, and J. R." Woodward, "A classification of hyper-heuristic approaches," in Handbook of Metaheuristics, 2nd ed., ser. International Series in Operations Research & Management Science, M. Gendreau and J.-Y. Potvin, Eds. New York, Springer, 2010, vol. 146, pp. 449-468.

[9]. J.B. Quinn, in: The Intelligent Enterprise. A Knowledge and Service Based Paradigm for Industry, The Free Press, New York, 1992.

[10]. R.A. Inman, Time-based competition: Challenges for industrial purchasing, Industrial Management 34 (2) (1992

[11]. R.J. Tersine, E.A. Hummingbird, Lead-time reduction: The search for competitive advantage, International Journal of Operations and Production Management 15 (2) (1995) 8-18.

[12]. Rutth E. Glock and Grace I. Kunz (2005), Apparel Manufacturing, fourth edition. P.P 352-372

[13]. T.E. Volman, W.L. Berry, D.C. Why bark, Manufacturing Planning and Control Systems, Business One Irwin, Homewood, IL, 1992

[14]. U. Dorndorf and E. Pesch, "Evolution based learning in a job shop scheduling environment," Computers & Operations Research, vol. 22, no. 1, pp. 25-40, 1995.

[15]. Wang, G., T. C. E. Cheng. 2000. Parallel machine scheduling with batch delivery costs. Internat. J. Production Econom. 68 177-183.

[16]. Ward, J.K. Liker, J.J. Cristiano, D.K. Sobek, The second Toyota paradox: How delaying decisions can make better cars faster, Sloan Management Review (1995) 43- 61.