**PEMODELAN PERSOALAN PENJADWALAN *HYBRID FLOWSHOPBATCH TO BATCH* UNTUK MEMINIMUMKAN *MAKESPAN***

**Tiaradia Ihsan**

Program Pascasarjana, Magister Teknik dan Manajemen Industri, Universitas Pasundan

email: [tiaradia.ihsan@gmail.com](mailto:tiaradia.ihsan@gmail.com)

**ABSTRAK**

Sistem penjadwalan yang tepat merupakan hal terpenting demi kelangsungan dan kelancaran produksi. *Hybrid flowshop* (HFS) merupakan pengembangan dari penjadwalan *flowshop* dengan menambahkan beberapa mesin yang disusun paralel minimal pada satu *stage*. Pada penelitian ini akan mengembangkan model HFS *batch to batch* yang terdiri dari 2 *stage*. *Stage* 1 terdapat 5 mesin paralel identik dengan sistem *job procesor*, sedangkan pada *stage* 2 terdapat 2 mesin paralel identik sistem *batch procesor*.

Fungsi tujuan model penelitian ini yaitu meminimasi *makespan* agar memperoleh urutan proses terbaik*.* Metode yang digunakan adalah metode optimasi, sehingga mendapatkan hasil yang paling optimal (*Global Optimal Solution*). Pengujian model dilakukan dengan menggunakan *software*LINGO 11, pengujian juga dilakukan dengan merubah parameter seperti *demand*, kapasitas dan jumlah *batch* di *stage* 1 untuk melihat kemampuan model terhadap perubahan parameter.

Hasil pengujian berupa waktu komputasi dan *Completion Time*, semakin banyak *job* dan *batch* yang ditugaskan maka waktu komputasi semakin lama. Dikarenakan model merupakan model *NP-Hard* dan *Integer Non-Linier Programing* maka waktu komputasi tidak berbentuk linier. Pengujian dengan merubah *demand* dan kapasitas *batch* di *stage* 1 dapat menyelesaikan berapapun kapasitasnya. Pengujian dengan perubahan *demand* dan jumlah *batch* hanya mampu menyelesaikan maksimum 12*.* Penerapan model pada real sistem PT. X menghasilkan *makespan* sebesar 122 satuan waktu.

**Kata Kunci**:Penjadwalan *HFS, batch to batch, makespan.*

***ABSTRACT***

*The right scheduling system is the most important thing for the continuity and smooth production. Hybrid flowshop (HFS) is a development of flowshop scheduling by adding several machines arranged parallel at least on one stage. In this study, we will develop a batch to batch HFS model consisting of 2 stages. Stage 1 has 5 parallel machines identical to the job processor system, while in stage 2 there are 2 parallel machines identical to the batch processor system.*

*The objective function of this research model is to minimize makespan in order to obtain the best sequence of processes. The method used is the optimization method, so as to get the most optimal results (Global Optimal Solution). Model testing is done using LINGO 11 software, testing is also done by changing parameters such as demand, capacity and batch number in stage 1 to see the model's ability to change parameters.*

*The test results are computational time and Completion Time, the more jobs and batches assigned, the more computational time. Because the model is an NP-Hard and Integer Non-Linear Programing model, computing time is not linear. Testing by changing the demand and capacity of batches in stage 1 can resolve any capacity. Testing with changes in demand and number of batches is only able to complete a maximum of 12. Application of the model to the real system of PT. X produces makespan equal to 122 units of time.*

***Keywords****: HFS scheduling, batch to batch, makespan.*

**DAFTAR PUSTAKA**

Amin-Naseri, M. R., & Beheshti-Nia, M. A. (2009). Hybrid flow shop scheduling with parallel batching. *International Journal of Production Economics*, *117*(1), 185–196.

Baker, K. R., & Trietsch, D. (2009). *Principles of sequencing and scheduling*. Hoboken, N.J: John Wiley.

Baker, K. R. (1974). *Introduction to sequencing and scheduling*. New York: Wiley.

Bedworth, D. D., & Bailey, J. E. (1987). *Integrated production control systems: management, analysis, design* (2[nd] e[d.]). New York: Wiley.

Fogarty, D.W., J.H. Blackstone and T.R Hoffman. 1991. Production & Inventory Management. Cincinnati: South Western Publishing.

Ginting, Rosnani. (2009). Perancangan Produk. Graha Ilmu. Yogyakarta

Gupta, J. N., & Tunc, E. A. (1994). Scheduling a two-stage hybrid flowshop with separable setup and removal times. *European Journal of Operational Research*, *77*(3), 415–428.

Hidayat, N. P. A., Cakravastia, A., Samadhi, T. M. A. A., & Halim, A. H. (2016). A batch scheduling model for *m* heterogeneous batch processor. *International Journal of Production Research*, *54*(4), 1170–1185.

Hidayat, N. P. A., Cakravastia, A., Samadhi, T. M. A. A., & Halim, A. H. (2013). A Batch-Scheduling Problem to Minimize Total Actual Flowtime of Parts Through The Shop. *Asia Pacific Industrial Engineering and Management System.* Cebu, Philippines.

Kaban A., K., Othman, Z., & Rohmah D., Z. (2012). Comparison Of Dispatching Rules In Job-Shop Scheduling Problem Using Simulation:

A Case Study. International Journal of Simulation Modelling, 11, 129-140.

Karthik, S., & Prabaharan, T. (2014). *Hybrid Flowshop Scheduling Using Discrete Harmony Search And Genetic Algorithm.* International Journal of Innovative Research in Science, Engineering and Technology. Volume 3.

Linn, R., & Zhang, W. (1999). Hybrid flow shop scheduling: A survey. *Computers & Industrial Engineering*, *37*(1–2), 57–61.

Morton, Thomas E. 1993. Heuristic Scheduling System : with Applications to Production System and Project Management. John Wiley & Sons, Inc.,

Pinedo, M. L. (2012). *Scheduling*. Boston, MA: Springer US. Retrieved from

Pratiwi, F. R., Rahman, A., & Tantrika, C. F. M. (2014). Penjadwalan Hybrid Flowshop Dengan Integer Linear Programming Untuk Meminimasi Makespan (Studi Kasus: Pt. Dwisutra Setia Agung Surabaya). *Jurnal Rekayasa Dan Manajemen Sistem Industri*, *2*(5), p940–951.

Righi, R. d. (2012). Production Scheduling. Sao Leopoldo: InTech.

Rossi, A., Puppato, A., & Lanzetta, M. (2013). Heuristics for scheduling a two-stage hybrid flow shop with parallel batching machines: application at a hospital sterilisation plant. *International Journal of Production Research*, *51*(8), 2363–2376.

Ruiz, R., & Vázquez-Rodríguez, J. A. (2010). The hybrid flow shop scheduling problem. *European Journal of Operational Research*, *205*(1), 1–18.

Su, L.-H. (2003). A hybrid two-stage flowshop with limited waiting time constraints. *Computers & Industrial Engineering*, *44*(3), 409–424.

Sukoyo, Dkk. 2010. “Model Penjadwalan Batch Multi Item Dengan Dependent Processing Time”. JurnalTeknikIn

Xuan, H., & Tang, L. (2007). Scheduling a hybrid flowshop with batch production at the last stage. *Computers & Operations Research*, *34*(9), 2718–2733.dustri, Vol. 12, No. 2