Scheduling Of The Textile Dyeing Process Using Biomimetics

Sheelratan S. Bansode, Rahul B. Hiremath

Abstract*: *In the production of clothing the textile dyeing process is most of the time acts as a bottle neck because it is time consuming and more constrained. The dyeing process also produces water pollutions. This pollution needs to be minimized so that indirectly the production performance can be increased. Thus proper scheduling of the process needs to be carried out. To this end, the dyeing process has been formulated as a bi objective optimization model to reduce tardiness cost and in turn reduce the level of pollutant emission. For this Tabu search clubbed with the Particle Swarm optimization has been used.

Keywords: dyeing process, scheduling, optimization, Tabu, Particle Swarm Optimization.

I. INTRODUCTION

Food clothing and shelter are the three basic human needs. Textile industry plays vital role in meeting one of these along with other aspects. Next to agriculture textile sector is one of the prime aspects of Indian economy and is one of the oldest industries with its share in the nation's GDP is 6% and in exports is 13% [1]. After China India being the second largest producer of textile products, 3rd biggest producer of cotton and the 2nd biggest cotton consumer in the world. Currently the Indian textile industry estimates about US $108 billion and expected to be US $209 billion by the year 2021. It employs around 45 million people directly and 60 million indirectly making it the second largest employer after agriculture [2]. The current growth rate is 9 to 10 percent in th Indian economy. From 2013 to 2016 the export of the local products mainly led by bedding bath and home decor grew at a compound annual growth rate of 10% [4]. The textile industry can be categorized broadly on the following segments namely handloom, handicrafts, powerloom and sericulture forming unorganized sector operating on small scale whereas on the other hand spinning, apparel and garment forming the organized sector using modern manufacturing tools.

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Textile industry has occupied the country with concentration of these in certain areas. Maharashtra, Punjab and Gujarat have a larger share as compared to other states. The present study focuses on textile clusters of Solapur city. Solapur is best known for its textile products, including terry towels, bed linens and cotton blankets (Hindi chaddar). Today there are about 25,000 power looms employing about 100,000 workers. The Solapur textile products also find a considerable place in the countrys export of textile. The textile units in the Solapur are established long back with the minimum traditional equipment setup and have not gone for the improvement since years except for few. These units are far away from the concepts of optimisation and sustainability. The current study tries to focus on the textile wet process i.e. dyeing and bleaching where a large quantity of water is utilised as compared to other processes and releases an equivalent amount of waste water thus causing a harm to the environment as the waste water is directly let out in the open areas with out any preliminary treatment.

A visit to the textile units in the Solapur city was carried out and the various processes involved are studied related to the usage of resources. The study covered both small scale and medium scale units. The textile process involves different processes till the final product comes out. Out of the total processes dyeing is the major process that contributes to emission of the harmful waste water being let out from the units. The daily water requireemnt of an textile unit is around 20,000 litres per day. Water utilisation in textile industry accounts for the 305 % of the running cost o the industry [3]. In the dyeing process large quantity of water around 50 percent of the total water required is consumed for the process to be carried during which wastewater proportionate to the water consumed is allowed to flow out untreated. This results in the contamination of the ground as well as surface water. Moreover Solapur being dry region with uncertain rainfall where scarcity of water is becoming a major problem. Also the surface water sources are getting reduced varying the availability of water from them. The ground water resources are also getting exhausted with the ever increasing amount of water drawn from them every year. Therefore, the cost of water is rising steeply and the textile mills, which need a large quantity of water, should move towards to take measures to conserve the same. It can be said that the textiles aregrowing but in an unsustainable way. To get it on the right track solutions needs to find out that are environment friendly and cost beneficial.

II. WHY BIOMIMETICS

The past writings witness the wonders of nature and the wish of applying the ideas into the present technology. Biomimetics is an important aspect for motivating the advances as long as technical advances are accounted. The problems from the world can easily be taken into account by it. The large potential of it is the main feature for its increasing investigation. The results obtained from biomimetics are sustainable, thus people have an optimistic look towards biomimetics. But the studies carried out till date on application of biomimetics are more concerned to product development. Some of the common laws can be applied to to living, social and likewise organizational systems which can be explored.

To cash the benefits of these laws, the study of nature's principles for their application to organizations is necessary. Phil Richardson in his thesis named this as "Business Biomimetics" [4] and proposed it as the emerging field within biomimetics that demonstrates a strategic use of biomimetics in the business environment. It can be used to develop and optimize processes, for business management, scheduling etc. The concepts behind the use of biomimetics for management practices/techniques are the social animals/species like ants, honeybees, bats, birds, fish etc and their behavior in particular situations. The optimisation example can be the work carried out by Rui Zhang [8] where study used the Particle Swarm Optimisation (PSO) and framed the scheduling of textile dyeing process problem as a optimization model,with the objective of reduction in the set up cost and pollutant emission. The particle swarm optimization (PSO) algorithm was inspired by the flocking behavior of birds and was originally proposed for single-objective continuous optimization problems.

In textiles, dyeing process seems to be the most resource consuming and the main emission generator. Thus optimization or scheduling of this process can lead to conservation of the resources like the water, electricity and thus helping to reduce the emissions due to this process. In this similar way the particle swarm optimization can be used to minimize the emissions, electricity, water used in the dyeig process in the Solapur textile units. Along with the PSO, Tabu search can be used for improving a promising solutions by focusing on the pollution objective.

III. DYEİNG PROCESS OPTİMİSATİON

A visit to the textile industries in Solaur city was carried out to study the textile manufacturing process. There various process being carried out to get the final prodcut. But as far as dyeing process is concerned the amount of water used and the comparable amount of waste water generated is of major concern. Solapur comes under the dry zone where there is seasonal rainfall with medium amount of rainfall and the other days are totally dry. There is scarcity of water for domestic as well as othe purpose in Solapur and also the ground water level is going down. Taking this condition into account the dyeing process needs to be improved/scheduled so that the water can be used more effectively and efficiently. To carry out this Particle Swarm Optimisation techniques i carried out along with the Tabu seacrh to get the desired result.

There are on an average 2 machines in the textile units for dyeing process of the same capacity. Processing time of the job depends on the colour and varies from 4.5 to 8 hours and 5 to 8 batches of the jobs. . The jobs are divided into families depending upon the shade as light, medium and dark. When two batches of jobs from different families are processed consecutively on a machine, a setup operation is required in order to clean the dyeing vat. This incurs both setup time and setup cost. During which the cleaning takes 10-15 mins and the mounting of jobs 10-15 mins for this 2 workers are involved. The total jobs considered are 8.

By applying the PSO the ojbs can be scheduled as follows shown by the Gantt chart

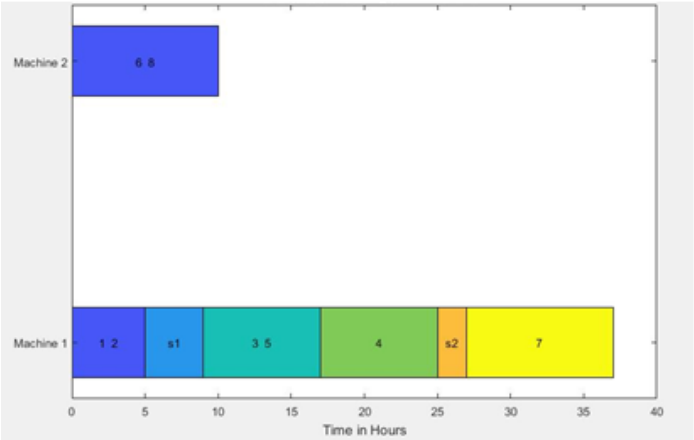

Figure 1: Scheduling of the jobs using PSO

The above results can be more precise by clubbing the Tabu search with the PSO to have the best local solution. The chart for the combination of the Tabu and the PSO is as follows.

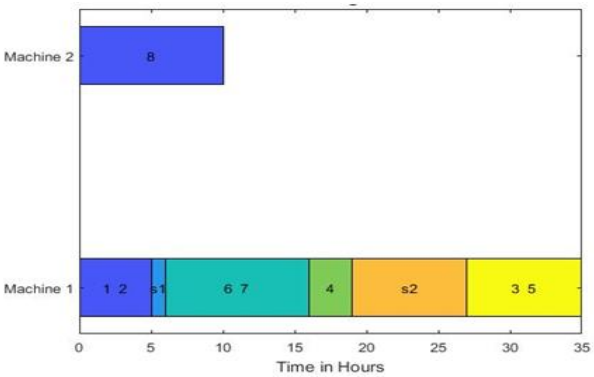

Figure 2: Scheduling of the jobs using PSO

From the above diagram it is clear that the setup time is reduced ad the scheduling has been done in more precise manner thus further reducing the emission of the pollution in terms of waste water.

IV. CONCLUSION

Form the above study it can be concluded that textile sector in Solapur city needs to be improved in terms of the resource consumption specifically water and the resource intensive processes needs to be properly channelized so that will

indirectly lead to the improvement in the productivity of the firm. Also to achieve this Biomimetics in terms of PSO and Tabu search proved to be effective and it has been seen that the proposed PSO and Tabu algorithm can out perform a traditional multi-objective optimizer.

REFERENCES

1. http://www.ibef.org/industry/indian-textiles-and-apparel-industry-analysispresentation, Textiles and Apparel, India Brand Equity Foundation (IBEF)–June 2017
2. http://midcindia.org (Last Accessed on 31.03.2014)
3. https://www.researchgate.net/publication/319824064_Recycling_of_Wastewater_in_Textile_Wet_Processing [accessed Jul 20 2018].
4. Phil Richardson, Fitness for the future: applying biomimetics to business strategy, A thesis submitted for the degree of Doctor of Philosophy, University of Bath, Department of Mechanical Engineering March 2010.
5. Markus Schatten* and Miroslav Žugaj, Biomimetics in Modern Organizations – Laws or Metaphors?, Interdisciplinary Description of Complex Systems 9(1), 39-55, 2011
6. Gouri Beriha, Occupational Health and Safety Issues in Social Marketing, thesis submitted for the degree of Doctor of Philosophy, Indian Institute of Technology, Rourkela March 2012
7. Weiss, S.M. and Kulikowski, C.A. (1991). Computer systems that learn. San Mateo, Morgan Kaufmann Publishers, Inc. CA.
8. Rui Zhang, Pei-Chann Chang, Shiji Song, Cheng Wu, Local search enhanced multi-objective PSO algorithm for scheduling textile production processes with environmental considerations, Applied Soft Computing Journal 2017, http://dx.doi.org/10.1016/j.asoc.2017.08.013
9. Rahul B. Hiremath, Ruth Kattumuri, Bimlesh Kumar, Vishwas N. Khatri, Sharmila S. Patil, An integrated networking approach for a sustainable textile sector in Solapur, India, Urbani izziv, volume 23, no. 2, 2012
10. Rahul B Hiremath, Ruth Kattumuri, Bimlesh Kumar And Gurudevi R Hiremath, Health and safety aspects of textile workers from Solapur (India) textile industries, Indian Journal of Community Health / VOL 26 / ISSUE NO 04 / OCT – DEC 2014
11. Milwich M.,Speck T,Speck O,Stegmaier T, Planck H. (2006), Biomimetics and Technical Textiles: Solving Engineering Problems with the Help of Nature's Wisdom American Journal of Botany 93(10): 1455–1465.
12. Singh A. V., Rahman A, Sudhir Kumar N. G. V., Aditi A. S, Galluzzi M, Bovio S, Barozzi S., Montani E, Parazzoli D, (2012) Bio-inspired approaches to design smart fabrics, Materials and Design 36, 829–839
13. Srinivasan A. V., Haritos G. K.,Hedberg F. L., (2009) Biomimetics: Advancing Man-Made Materials Through Guidance From Nature, Appl. Mech. Rev. 44(11), 463-482
14. M. Karimi-Nasab, M. Modarres, S. Seyedhoseini, A self-adaptive PSO for joint lot sizing and job shop scheduling with compressible process times, Applied Soft Computing 27 (2015) 137{147.
15. Tsai, K.H. (2000). Relationships among organization commitment, job satisfaction and turnover intention: A meta-analysis. Journal of Chinese Management Review 3(4), 33-49.
16. Mingers, J.: Observing organizations: An evaluation of Luhmann's organization theory. In Bakken, T. and Hernes, T., eds.; Autopoietic Organization Theory Drawing on Niklas Luhmann's Social Systems Perspective. Abstract, Liber, Copenhagen Business School Press, Oslo, pp.103-122, 2003,

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