Role of Deterministic Model in Dynamic Environment State of the Art Review

K. Arunprasath[1*], K. Manojprabhakar[2], R. Udhayakuamar[2], K. Rahulbalaji[2]

Assistant Professor[1], Department of Mechanical Engineering, Kalasalingam Academy of Research and Education, Krisknankoil.
UG Scholar, Department of Mechanical Engineering, Kalasalingam Academy of Research and Education, Krisknankoil.
Corresponding Author E-mail Address-arunprasath@klu.ac.in

Abstract—The development of industrial production with newer technology and innovation leads most of the industries with better product quality. The quality of the product helps the manufacturer to meet their market competitor. The rapid changes in the product demand, product life cycle, always a big problem for the manufacturer to sustain in the market. After the introduction of industry 4.0 and later industry 5.0 are move towards the introduction of novel techniques in flexible manufacturing system to keep a place in the market. Sustainability is also an important factor, but customer stratification is the one which increases the number users of their products. Cellular manufacturing system (CMS) is one of the techniques in which, the focuses of flexibility and flow shop of the manufacturing techniques may optimize. In the addition, CMS has the ability to control the cost, labor, machine, time and design of layout. In this review article discusses about dynamic environment's role in the deterministic model which is specifically influenced by design of the layout, efficiency of CMS, reduction of cost and time, problems on cell formation and material flow, design and optimization of CMS. Deterministic model is one were focusing of desired output from the given input. This type of model in CMS provides better results and techniques to improve the level of production from one point to another level of improvement.

Keywords—Flexible manufacturing system, Cellular manufacturing systems, Deterministic model, Dynamic environment

1. INTRODUCTION

Cellular manufacturing, popularly known as group technology it's one of the best tools to improve production efficiency in industry which is applied on any industry it's useful to make a wide variety of mutual products. The basic concept of cellular manufacturing is very simple, Identify the mutual or related part and process to design and manufacturing the products the parts are scheduled production according to the common characteristics [1]. The cellular concept first appears in 1960's and flourished in the 1970's, the U-shaped design called as a cell. The each cell is produced a part family, then the parts identify and send to the required similar machines. The parts normally transforming form a raw material to finished part within a single U shape machine manual assembly , metal fabricating has been found the cellular manufacturing next we discuss about benefits of cellular manufacturing, reduction in material handling cost, reduced tooling , reduced set up time, Reduced expedition, part makes, improved human relations, improved operator expertise these are the benefits of cellular manufacturing, but increased capital investment, lower machine utilization major disadvantage of cellular manufacturing [2]. Then application of cellular manufacturing, it's used multiple product industries because cellular manufacturing for flexibility of production manufacturing system. The goal of cellular manufacturing is increasing the productivity and decrease the waste. Some algorithm will be used in cellular manufacturing and measure of performance for the grouping efficiency, Inter-Intra cell flow work flow distance [3]. Identification and elimination are major method is to reduce and enhance flow of work. The production are reduced, as much as waste are reduced.

2. DESIGN OF LAYOUT AND ITS IMPLEMENTATION

Unbalanced production line and unreasonable process after the implementation of multi objective optimization.The production capacity increased by 58.3% and dissimilarly the balance rate of production line increased by 25.2% and also increased in annual production increased by 29.8%[4].An inventory decision on

DCMS in group layout with (increase in quality & decreased execution time) they found that . Table 1 represents the design of layout and its implementation. The implementation of multi floor liner cellular manufacturing layout by using this type of cellular manufacturing saves 57.6% of area in addition to 23.7% of space similarly in the 29.2% of handling distance as compare with single floor-linear cellular manufacturing layout[5].

Table. 1 Design of Layout and Its Implementation

S.no	Reference (author name /year)	Objectives	Applied methodology	Movements		Cellular Environment
				Intra Cellular	Inter Cellular	
1	HongfeiGuoa,b, MinshiChena,b,*, Khalgui Mohameda, Ting Qua,b, Siming Wangc, Jianke Lid Accepted 14 July 2020	To address the coupling problems, such as unreasonable production line layout and unbalanced process	Unintelligent equipment testing	Yes	Yes	Flexible (Both)
2	Hananekhamlichi 1, kenza oufaska3, tarikzouadi 2, And rachid dkiouak1 August 4, 2020,	To develop the Group Layout Design and Lot sizing Problem in a Dynamic Cellular Manufacturing System (DCMS)	Methodology Algorithm	Yes	Yes	Dynamic
3	Yanlin Zhao1,2 , Jiansha Lu1 and Wenchao Yi Accepted: 19 April 2020	To Put forward the new layout methodology of the multi-floor linear cellular manufacturing layout	Algorithm	No	No	Dynamic
4	FahimehKhaksar-Haghani, et. al [16],2004	The Dynamic environment implies the changing product mix.	Fuzzy Programming	Yes	No	Dynamic
5	Reza Kia, et. al [20],2006	The model is to minimize the total cost incurred by the intercell and intra-cell movements.	Simulated Annealing (SA)	Yes	No	Static

3. Process Efficiency of CMS

In this the group technology is developed by an integrated approach of parts and machine families . In this integrate approach used to solve cell formation , process planning and production planning simultaneously .

Two methods are used to solve , they are exact (optimal) and heuristic. The methods used to solve an integer programming problem is to find the process plan . It's minimal of inter part flow and Interflow cost. Problem Process planning, production planning and family formation . Simultaneously remedies Mathematical Formulation of problem and heuristic method[6]. This is to identify the types of manufacturing system Used and what kind of process can be implemented to solve the issues. It's the improve product efficiency and product capacity. The waste can eliminate by the way of using lean manufacturing tool and it's technique is to improve our product efficiency. Various process includes to reduce the waste in the current manufacturing process [7-9].Table 2 represents the process efficiencies of Cellular Manufacturing Systems (CMS).

Table.2Process Efficiency of CMS

S.no	**Reference (author name /year)**	**Objectives**	**Applied methodology**	**Movements**		**Cellular Environment**
				Intra Cellular	**Inter Cellular**	
1.	Behnam Malakootiy, Nima R. Malakootiz and ZiyongYangy Accepted: October 14, 2003.	To develop an integrated method for solving process planning, production planning	Exact (optimal) and heuristic.	No	Yes	Static
2.	Cameron Hutchinson Accepted: 2019	To identify what manufacturing systems and processes can be implemented to help improve product efficiency and capacity	Neutral Network	No	No	Dynamic
3.	Anan Mungwattana Accepted :September 1, 2000	To improve the efficiency and productivity of their production activities.	Methodology Algorithm	Yes	Yes	Dynamic
4.	SaeedDehnavi-Arani, Ahmad Sadegheih	Time Management and productive improvement	Algorithm	No	Yes	Dynamic

5.	Jocelyn Drolet, Georges Abdulnour, Martin Rheault Accepted: 02 July 1996	Focuses on exposing their fundamental roots and their advantages and inconveniences	Exact flexibility	No	No	Dynamic

4. Reduction of Cost and Time

At the present time the world need more perfection, quality, fulfillment ,variety of cost ,delivery the above factors are much needed for the consumer. Industry must use some strategy to make their process more flexible and efficient to reduce the waste and non value added activities lean manufacturing is used in many industries some lean tolls such as VSM,SME (single minute exchange) over all equipment (OEE),CM and TPM are the best suitable tool with low cost and maximum profitability[10-12].The Expected total moving time of material movement is to minimize the production lines to locate the area study parts and machine and to allocate the uncertainty of the product. Table 3 shows the reduction of cost and time, The "Finite Horizons" is a dynamic program was by found the result of sensitivity analysis of numerical example the fluctuation of the demand of layout optimization gives highefficiency and more flexible [13].

Table.3Reduction of cost and time

S.no	**Reference (author name /year)**	**Objectives**	**Applied methodology**	**Movements**		**Cellular Environment**
				Intra Cellular	Inter Cellular	
1.	SohamRavishekhar Deshpande 02, February-2020	To reduce the waste and nonvalue added activities, lean manufacturing techniques in Industries	Genetic algorithm(GA)	Yes	No	Static
2.	KanchalaSudtachat Accepted : June 02,2020	Reduce the Material Cost and Maximize the Machining time	Dynamic programming, un certainty	No	Yes	Dynamic
3.	Sunderesh S. Heragu Accepted: 12 February 1994	Reducing the Production cost and Increase the machineability	Algorithm, Grouping	Yes	Yes	Flexible (Both)

4.	A NouriHoushyar,Z. Leman, N. Ismail, H. Pakzad Moghadam, H. Iranmanesh,Accepted: 06/11/2014	Reducing the work in process, Decreasing the set up time and throughput time	Genetic Algorithm	Yes	Yes	Dynamic
5.	F. CHOOBINEHT Accepted: 07 May 2007	Reduction in New machining cost and Process	Group technology	No	No	Flexible (Both)

5. Problems on Cell Formation and Material Flow

Dr. N. Singh says a short review on a cell formation in (CMS).It's very much useful and limitations of information were identified . according to their customers requirements the cell of CMS were change in alternative ways in different types of arrangements [14].Customer requirements and expectations are more higher than manufacture demand machine modification is a tool to reduce the cost of buying a new machine and inter-cell movement .very much effective in fewer cost and high degree of response [15, 16].The robust cell formation and design CBCMS under the uncertainty. The robust cell formation is more in effective over a long period of time MPCFP (Multi period of cell formation problem), CMS (Central Backup cell manufacturing system) It's design a overall outcome of robust optimization in this multi period of cell formation problem[17, 18].The author says how cluster of products design depends on basic product line and ideal layout optimization calculate on this of the intensity of material flow in the layout production cell is based on a Schmitt modified triangular method and Schwevolteger circular process the end of the journal they suggested cell to a real U-Cell. Table 4 represents the problems on cell formation an material flow

Table.4Represents the problems on cell formation an material flow

S.no	**Reference (author name /year)**	**Objectives**	**Applied methodology**	**Movements**		**Cellular Environment**
				Intra Cellular	**Inter Cellular**	
1.	Ronald G. Askin1, Hassan M. Selim2 and Asoo J.Vakharia3,Accepted October1996	To introduce andillustrate an interactive cell formation method that can be used to design `Flexible' cells	Flexible cellular manufacturing	No	Yes	Dynamic
2.	N. Singh Accepted 1993	To review the literature on cell formation aspects of design of cellular manufacturing systems.	algorithm	No	Yes	Dynamic

3.	Reza Babazadeh, HamedRafiei and MasoudRabbani Accepted: 2013	Cell formation, Group layout, Group scheduling, Resource allocation	Genetic algorithm	No	Yes	Dynamic
4.	Salah Mehdi Elaskari Accepted : 2014	Dynamic cell transformation problem	Robust Optimization Extension for the MPCFP	No	Yes	Dynamic
5.	Zupam, h.; Herakovic, N.Zerovnik, J.&Berlec,T. Accepted: 2017	To identify analyses and optimize an internal material flow.	Lean production method	No	Yes	Static

6. Design and Optimization of CMS In Simulation Software

The objective of this inquire is to consider labor adaptability in cellular fabricating framework in the intra-cell .this work proposes a classification conspire composed by a set of experimental and incorporate s the concept of work load adjusting, sharing and the nearness of bottleneck operation etc.Biological mathematical model is proposed to design four -dimensional (i.e. portion ,machine administrator and approach)[19,20] .This model mainly proposes to minimize add up to cost counting instruments preparing taken and to expertise a maximizing expertise level of administration (MOVDO),multi-objective vibration damping operation [21-23].The dynamic cellular facility format issues DCFLP could be well known hard NP hard issues. The material flow contributes 10-30% of the entire takes a toll simulated score-based two -phases heuristic approach to solve the numerous item in different time to be fabricated within the fabricated format to all machine clusters .an input to moment stage to play down inter/intra fabric taking care of improvement cost over the complete arranging period [24,25].By using the new integrated mixed integer programming to rectify the DCMS both unreliable machines and process planning simultaneously in this robust optimization. Table 5 shows the design and optimization of CMS using simulation software. Figure 1 illustrates the research gap analysis on chosen problems.

Table.5design and optimization of CMS in simulation software

S. no	**Reference (author name /year)**	**Objectives**	**Applied methodology**	**Movements**		**Cellular Environment**
				Intra Cellular	Inter Cellular	
1.	Viviana I. Cesani´a, Harold J. Steudel Accepted: 1 April 2003	To study labor assignment flexibility in cellular	Cellular Manufacturing	Yes	No	Static
2.	N. Aghajani-Delavara, E. Mehdizadehb, R. TavakkoliMoghaddam c, H. Halehd	To design a Fourdimensional cellular manufacturing system (CMS) in a dynamic	Heuristic Algorithm	No	Yes	Dynamic

		environment				
3.	Ravi Kumar and SuryaPrakash Singh Accepted 6 December 2016	To solve theproblem Acquires in DCFLP	Heuristic Algorithm	Yes	Yes	Dynamic
4.	M. Sakhaiia, R. Tavakkoli-Moghaddamb.c,M.Bagherid, B. Vatanie Article accepted: 14 May2015	Robust optimization and machine reliability	Robust optimization, algorithm	No	Yes	Dynamic
5.	Salah Mehdi Elaskari Accepted: July 2014	Facility Layout Design, Factors in Facility Layout Design, Addressing the Re-Layout	Genetic Methodology	Yes	Yes	Dynamic

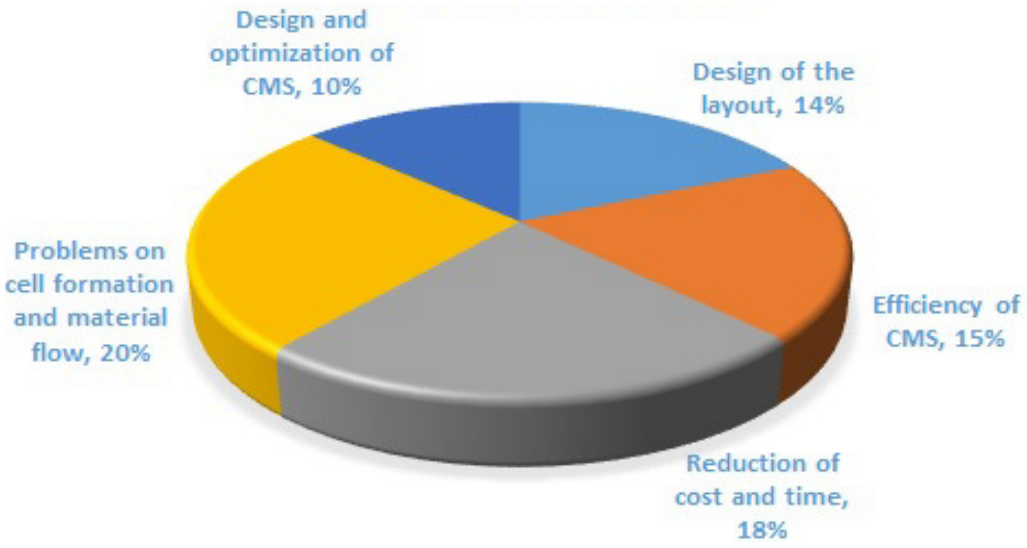

Fig.1. Research gap analysis

7.Conclusion

The Modeling of cellular manufacturing system based on industrial need in one of the big challenge in now a days . In this review paper the major concepts discussed about Design of layout and it's implementation, Efficiency of CMS in process , Reduction of cost and time , problem on cell formation and material flow, design and optimization of CMS using simulation The conclusion of this review work is listed below which represents the gap of the research work in chosen areas

7.1.Design of layout and its implementation:

In area of Design of layout and its implementation in cellular manufacturing system the formation layout , Reconfiguration cell and its implementation set to be an issue , but the utilization of multi criteria of decision making an effective results

7.2.Efficiency of CMS in process:

Process efficiency is one of key area which responsible for group technology related approaches.The mathematical Formulation meta heuristic technique in process total product efficiency and proper utilization of machine .

7.3. Reduction of cost and time:

Using of finite planning horizons is purely responsible the development of flexibility of demand and getting more flexibility in the process

7.4. Problem on cell formation and material flow:

Cell formation and material flow clutter of product design gives an Idea for Robust optimization multi period cell formation problem

7.5. Design and optimization of CMS using simulation:

Utilization of simulation model for flexible manufacturing system is latest technology to solve cell arrangement , cell formation , arrangement parts and machine in the chosen planning horizon

Overall information from this study provides a valuable information and suggestion to implement the effective cell manufacturing system for a production industry.

REFERENCE

[1] Guo, Hongfei, et al. "A digital twin-based flexible cellular manufacturing for optimization of air conditioner line." Journal of Manufacturing Systems (2020).

[2] Khamlichi, Hanane, et al. "A Hybrid GRASP Algorithm for an Integrated Production Planning and a Group Layout Design in a Dynamic Cellular Manufacturing System." IEEE Access 8 (2020): 162809-162818.

[3]Zhao, Yanlin, Jiansha Lu, and Wenchao Yi. "A new cellular manufacturing layout: Multi-floor linear cellular manufacturing layout." International Journal of Advanced Robotic Systems 17.3 (2020): 1729881420925300.

[4]Khaksar-Haghani, Fahimeh, et al. "A genetic algorithm for solving a multi-floor layout design model of a cellular manufacturing system with alternative process routings and flexible configuration." The International Journal of Advanced Manufacturing Technology 66.5 (2013): 845-865.

[5] Kia, Reza, et al. "A multi-objective model for designing a group layout of a dynamic cellular nufacturing system." Journal of Industrial Engineering International 9.1 (2013): 1-14.

[6] Malakooti, Behnam, Nima R. Malakooti, and Ziyong Yang. "Integrated group technology, cell formation, process planning, and production planning with application to the emergency room." International journal of production research 42.9 (2004): 1769-1786.

[7] Hutchinson, Cameron. "Implementing cellular manufacturing to improve product efficiency."

[8] Mungwattana, Anan. Design of cellular manufacturing systems for dynamic and uncertain production requirements with presence of routing flexibility. Diss. Virginia Tech, 2000.

[9] Dehnavi-Arani, Saeed, and Ahmad Sadegheih. "A Fuzzy Goal Programming for Dynamic Cell Formation and Production Planning Problem Together with Pricing and Advertising Decisions." International Journal of Industrial Engineering 31.1 (2020): 13-34.

[10] Drolet, Jocelyn, Georges Abdulnour, and Martin Rheault. "The cellular manufacturing evolution." Computers & industrial engineering 31.1-2 (1996): 139-142.

[11] Deshpande, SohamRavishekhar. "An Overview on Lean Application Methods for Produvtivity Improvement."

[12] Sudtachat, Kanchala. "Dynamic Programming Model for Cellular Manufacturing Layout under Demand Uncertainty."2020 9th International Conference on Industrial Technology and Management (ICITM).IEEE, 2020.

[13]Heragu, Sunderesh S. "Group technology and cellular manufacturing." IEEE Transactions on Systems, Man, and Cybernetics 24.2 (1994): 203-215.

[14] Houshyar, A. Nouri, et al. "Literature review on dynamic cellular manufacturing system." IOP conference series: materials science and engineering. Vol. 58.No. 1.IOP Publishing, 2014.

[15] Choobineh, F. "A framework for the design of cellular manufacturing systems." The International Journal Of Production Research 26.7 (1988): 1161-1172.

[16] Singh, N. "Design of cellular manufacturing systems: an invited review." European journal of operational research 69.3 (1993): 284-291.

[17] Babazadeh, Reza, HamedRafiei, and MasoudRabbani. "A dynamic sustainable cell formation problem in agile production systems." International Journal of Operational Research 16.4 (2013): 448-464.

[18] Elaskari, Salah. "Multi-commodity Network Flow Based Approach to the Dynamic Cell Formation Problem: An Exploration of Design Robustness." (2014).

[19] Zupan, H., et al. "Layout optimization of a production cell." International Journal of Simulation Modelling 16.4 (2017): 603-616.

[20]Luściński, Sławomir, and VitaliiIvanov."A simulation study of Industry 4.0 factories based on the ontology on flexibility with using FlexSim® software." Management and Production Engineering Review 11 (2020).

[21]Cesaní, Viviana I., and Harold J. Steudel."A study of labor assignment flexibility in cellular manufacturing systems." Computers & industrial engineering 48.3 (2005): 571-591.

[22] Aghajani-Delavar, Naeem, et al. "A multi-objective vibration damping optimization algorithm for solving a cellular manufacturing system with manpower and tool allocation." ScientiaIranica (2020).

[23] Kumar, Ravi, and Surya Prakash Singh. "A similarity score-based two-phase heuristic approach to solve the dynamic cellular facility layout for manufacturing systems." Engineering Optimization 49.11 (2017): 1848-1867.

[24] Sakhaii, M., et al. "A robust optimization approach for an integrated dynamic cellular manufacturing system and production planning with unreliable machines." Applied Mathematical Modelling 40.1 (2016): 169-191.

[25] Elaskari, Salah. "Multi-commodity Network Flow Based Approach to the Dynamic Cell Formation Problem: An Exploration of Design Robustness." (2014).

[26]. Krishnan, B. Radha, M. Ramesh, M. Selvakumar, S. Karthick, A. Sasikumar, D. VarunGeerthi, and N. Senthilkumar. "A Facile Green Approach of Cone-like ZnO NSs Synthesized ViaJatrophagossypifolia Leaves Extract for Photocatalytic and Biological Activity." JOURNAL OF INORGANIC AND ORGANOMETALLIC POLYMERS AND MATERIALS (2020).

[27]. Beemaraj, Radha Krishnan, MathalaiSundaram Chandra Sekar, and VenkatramanVijayan. "Computer vision measurement and optimization of surface roughness using soft computing approaches." Transactions of the Institute of Measurement and Control (2020): 0142331220916056.

[28]. Krishnan, B. Radha, and M. Ramesh. "Optimization of machining process parameters in CNC turning process of IS2062 E250 Steel using coated carbide cutting tool." Materials Today: Proceedings 21 (2020): 346-350.

[29]. Parthiban, A., A. Mohana Krishnan, B. Radha Krishnan, and V. Vijayan. "Experimental Investigation of Mechanical and Wear Properties of AL7075/Al 2 O 3/MICA Hybrid Composite." Journal of Inorganic and Organometallic Polymers and Materials (2020): 1-9.

[30]. Dr. Radha Krishnan B, Ph.D, Dr. Harikishore S, and Dr. V. Vijayan, Wear Behavior of B4C reinforced Al6063 matrix composites electrode fabricated by stir casting method (2020).Transactions of the Canadian Society for Mechanical Engineering DOI: 10.1139/tcsme-2019-0294.

[31]. Karthikeyan, N., B. Radha Krishnan, A. VembathuRajesh, and V. Vijayan. "Experimental analysis of Al-Cu-Si metal matrix composite by powder-metallurgy process." Materials Today: Proceedings (2020).

[32]. Sanjeevi, R., G. Arun Kumar, and B. Radha Krishnan. "Optimization of machining parameters in plane surface grinding process by response surface methodology." Materials Today: Proceedings (2020).

[33]. Sanjeevi, R., R. Nagaraja, and B. Radha Krishnan. "Vision-based surface roughness accuracy prediction in the CNC milling process (Al6061) using ANN." Materials Science 2214 (2020): 7853.

[34]. Veluchamy, B., N. Karthikeyan, B. Radha Krishnan, and C. MathalaiSundaram. "Surface roughness accuracy prediction in turning of Al7075 by adaptive neuro-fuzzy inference system." Materials Today: Proceedings (2020).

[35]. Giridharan, R., A. VennimalaiRajan, and B. Radha Krishnan. "Performance and emission characteristics of algae oil in diesel engine." Materials Today: Proceedings (2020). (Scopus Indexed)

[36]. Radha Krishnan, B., Vijayan, V., ParameshwaranPillai, T. and Sathish, T., 2019. Influence of surface roughness in turning process—an analysis using artificial neural network. Transactions of the Canadian Society for Mechanical Engineering, 43(4), pp.509-514.

[37]. Krishnan, B. Radha, and M. Ramesh. "Experimental evaluation of Al-Zn-Al2O3 composite on piston analysis by CAE tools." Mechanics and Mechanical Engineering 23, no. 1 (2019): 212-217.

[38]. Krishnan, B. R., V. Vijayan, and G. Senthilkumar. "Performance analysis of surface roughness modelling using soft computing approaches." Applied Mathematics and Information Sci 12, no. 6 (2018): 1209-1217.

[39]. Kumar, N. Saran, N. Kaleeswaran, and B. Radha Krishnan. "Review on optimization parametrs in Abrasive Jet Machining process." International Journal of Recent Trends in Engineering and Research 4, no. 10 (2018): 2455-1457.

[40]. BR Krishnan, M Ajith, RA kumar, P Bala, GG Maurice, "Determination of Surface Roughness in AA6063 Using Response Surface Methodology". International Research Journal of Engineering and Technology 5 (3), 2556-2558

[41]. Radhakrishnan, B., P. Ramakrishnan, S. Sarankumar, S. Tharun Kumar, and P. Sankarlal. "Optimization of CNC machining parameters for surface roughness in turning of aluminium 6063 T6 with response surface methodology." SSSG international journal of mechanical engineering–(ICCRESt 17), Specia issue 23 (2017).

[42]. Krishnan, B. Radha, R. Aravindh, M. Barathkumar, K. Gowtham, and R. Hariharan. "Prediction of Surface Roughness (AISI 4140 Steel) in Cylindrical Grinding Operation by RSM." International Journal for Research and Development in Technology 9, no. 3 (2018): 702-704.

[43]. KRISHNAN, B. RADHA, and K. ARUN PRASATH. "Six Sigma concept and DMAIC implementation." International Journal of Business, Management & Research (IJBMR) 3, no. 2, pp: 111-114.

[44]. Krishnan, B. Radha. "Review Of Surface Roughness Prediction In Machining Process By Using Various Parameters." Int. J. Recent Trends Eng. Res.(IJRTER) 6, no. 1 (2020): 7-12.

[45]. Krishnan, B. Radha, C. MathalaiSundaram, and A. Vembathurajesh. "Review of Surface Roughness Prediction in Cylindrical Grinding process by using RSM and ANN." International Journal of Recent Trends in Engineering and Research 4, no. 12 (2018): 2455-1457.

[46]. Sundar, S., T. Sudarsanan, and Radha Krishnan. "Review of Design and Fabrication of four wheel Steering system." International Journal of Recent Trends in Engineering & Research (IJRTER) 4, no. 10 (2018): 1034-1049.

[47]. Radhakrishnan, B., Sathish, T., Siva Subramanian, T.B., Tamizharasan, N. and VarunKarthik, E., 2017. Optimisation of Surface Roughness in CNC Milling Process Using RSM. SSRG International Journal of Mechanical Engineering-(ICRTECITA-2017)