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A Measuring of a Mass Flow with Geometrically Deformed Orifice Plates

By Kiš R., Malcho & M., Janovcová M.
University of Zilina, Slovakia

Abstract- This work aims to present an impact of an orifice plate's deformation to an accuracy of measured mass flow of an air. Measurements were analyzed at an experimental device, which was a miniature of measuring track for measuring mass flows of natural gas in high-pressure natural gas pipelines. Measurements were repeated at various mass flows and different values of deformations of orifice plates. There was prediction, that changing orifice plate's geometry could cause differences in measured pressure values, which could affect required mass flow value. This paper tries to focus on behavior of the air flowing through the pipeline's measuring track with installed differently deformed orifice plates. It compares values measured by undeformed orifice plate and differently deformed orifice plates.

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A Measuring of a Mass Flow with Geometrically Deformed Orifice Plates

Kiš R., Malcho [α] & M., Janovcová M. [σ]

Abstract- This work aims to present an impact of an orifice plate's deformation to an accuracy of measured mass flow of an air. Measurements were analyzed at an experimental device, which was a miniature of measuring track for measuring mass flows of natural gas in high-pressure natural gas pipelines. Measurements were repeated at various mass flows and different values of deformations of orifice plates. There was prediction, that changing orifice plate's geometry could cause differences in measured pressure values, which could affect required mass flow value. This paper tries to focus on behavior of the air flowing through the pipeline's measuring track with installed differently deformed orifice plates. It compares values measured by undeformed orifice plate and differently deformed orifice plates.

I. Introduction

Worldwide raising requirements for the heat and the energy have huge influence on decreasing amounts of the mineral resources and on increasing tendency of their prices. It is necessary to deal with them responsibly. One of these cases is using natural gas as an energy and heat source. Nowadays there are billions of normalized cubic meters of natural gas transferred and used every day all around the world. The most common flow measurement type, used in high-pressure pipelines, is measuring by pressure differential, which mainly uses orifice plates inserted in the pipelines. This type of measuring is still most common for the flow measurements in the transit gas lines in Slovakia and the other European countries [1].

This paper tries to focus on behavior of the air flowing through the pipeline's measuring track with installed differently deformed orifice plates. It compares values measured by undeformed orifice plate and differently deformed orifice plates.

II. Experimental Device

The experimental device [2] used for measuring pressure differentials is shown in Fig. 1.

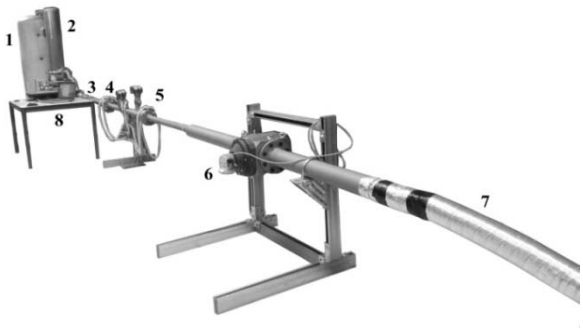

Fig. 1 : The experimental device

The air is transported to the air receiver (1) by the compressor. Then is the air distributed through the distributor (2) into pipeline with the inner diameter 54.5 millimeters (3) by four regulating branches. Each branch has its own throttle and regulating plate with specific hole diameter, which causes different mass flow for each branch. With the combination of opened and closed throttles it is possible to change mass flow rates from 10 to 100%. Number (4) and (5) are measuring tracks, which include plate without any deformation (4) and deformed orifice plate (5). The values of the deformation of the orifice plates were 3; 0,5; 0,7; 1 and 1,3 mm. These deformations were reached in the area around the diameter aperture [3]. Both plates are inserted into the tapings during the measuring. In this case was designed *D and D/2* taping (Fig. 2), where pressures are measured in the distances *D* in the inflow part before the orifice plate and *D/2* in the outflow part behind the orifice plate [4].

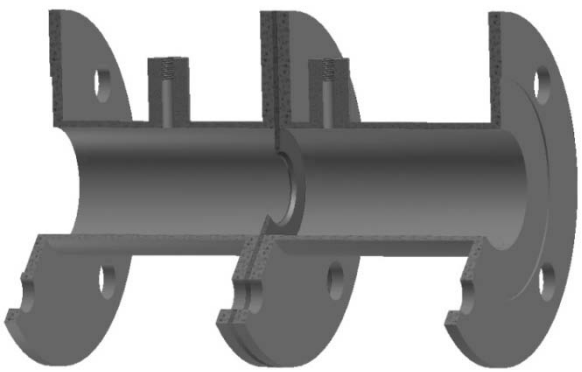

Fig. 2 : *D* and *D/2* tapping with the orifice plate installed in the middle

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After the air flew through the measuring tracks, it reached point where it is measured by a rotary gas meter (6) and then it comes to the outflow pipeline. All measured data are sending into data logger (8) and then to computer to analyzing.

A Flow straightener was used to reduce upstream lengths. In the experimental device was used 19-tube bundle flow straightener. The 19-tube bundle flow straightener consisted of 19 tubes arranged in a cylindrical pattern as it is given in Figure 3. Individual tubes were welded together at the points of contact at both ends of the tube bundle. The straightener was made from copper tubes with diameter 10x1 mm and the bundle was 163.5 mm long.

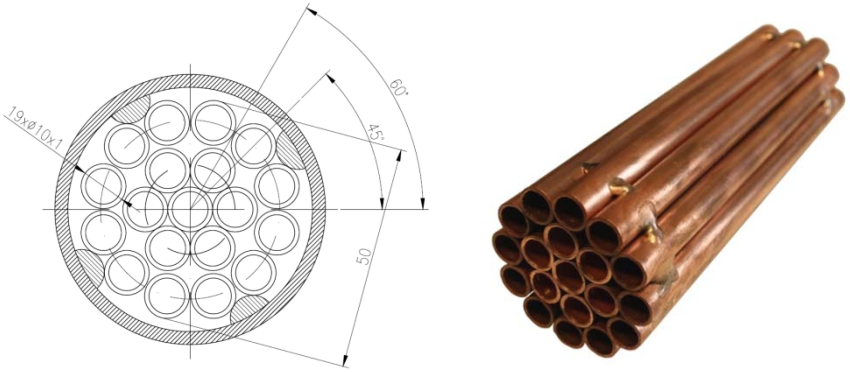

Fig. 3 : 19-tube bundle flow straightener

An exact placing of flow straighteners was given by the European standard ISO 5167. In the figure 4 there is shown placing of two 19-tube bundle flow straighteners in both measuring tracks (C1, C2) in the distance of 12D from the D and D/2 tapping system, where D is diameter of the pipe.

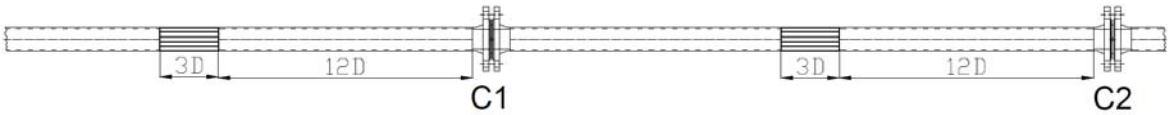

Fig. 4 : Placing of 19-tube bundle flow straightener in the measuring tracks of the experimental device

III. Deformation of Orifice Plates

In the high-pressure natural gas pipelines are shape deformations caused by the action of huge pressure differentials of the natural gas stream. Permanent deformations of orifice plates in these measurements were caused by a deformation press, which was specially constructed for this occasion. The orifice plate is fixed by welded screws in the correct position to reach symmetric deformation. Then is plate fixed by matrix. By rotating of trapezoidal screw thread is steel extension moving upright to a surface of the orifice plate and the deformation on the orifice plate appeared.

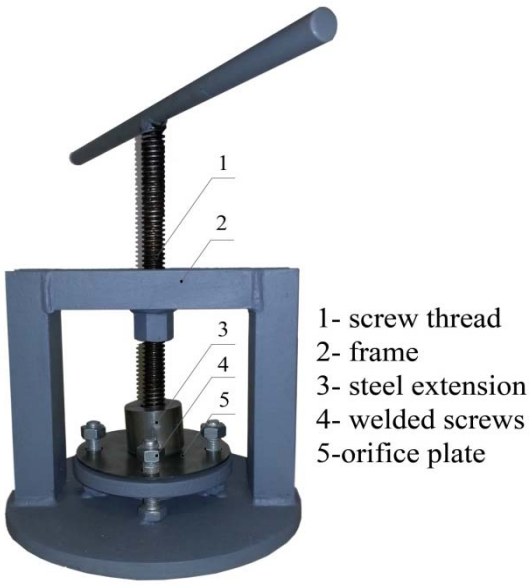

Fig. 5 : Deformation press

For measurement were prepared seven orifice plates with different shape deformations [3]. One of them was undeformed and six others were deformed from 0.2 mm to 1.2 mm [4]. The height of each orifice plate was measured by micrometer in four places

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situated in the aperture of the plate, where the deformation reached its maximum value. Then were values summed up and averaged. This measurement was repeating for each orifice plate in undeformed and then in deformed state. All necessary values of orifice plates before and after deformation are given in table 1.

Table 1 : Values of undeformed and deformed orifice plates

	Undeformed orifice plate					Deformed orifice plate						
n.	d_1	d_2	d_3	d_4	diameter	d_1	d_2	d_3	d_4	diameter	difference	deformation
	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
1.	2.05	2.05	2.05	2.00	2.04	3.25	3.25	3.30	3.25	3.26	1.23	1.20
2.	2.07	2.08	2.07	2.09	2.08	3.08	3.05	3.03	3.05	3.05	0.98	1.00
3.	2.07	2.06	2.05	2.07	2.06	2.74	2.88	3.00	2.83	2.86	0.80	0.80
4.	2.06	2.05	2.05	2.05	2.05	2.70	2.60	2.65	2.75	2.68	0.62	0.60
5.	2.15	2.14	2.17	2.20	2.17	2.65	2.50	2.53	2.58	2.57	0.40	0.40
6.	2.03	2.03	2.03	2.03	2.03	2.23	2.23	2.20	2.18	2.21	0.18	0.20
7.	2.03	2.02	2.02	2.02	2.02	2.03	2.02	2.02	2.02	2.02	0.00	0.00

IV. Measurement

An experimental confirmation of an impact of the deformation was performed by the experimental device with two measuring tracks joined to the pipeline's system in serial way. For measuring 7 orifice plates were used as it was described in previous part. During the measurements was air receiver in constant gauge-pressure in the range from 5.3 to 5.5 bar. A regulation of a flow was given by four regulation branches, where each one had specific diameter of aperture. The measurement of each orifice plate consisted of measurements with five different mass flows. These mass flows were set to values 56, 106, 156, 206 and 256 $kg.h^{-1}$.

To eliminate errors of measuring devices and sensors there was used only one sensor of pressure differential and one sensor of absolute pressure for both measuring tracks. By three-way valves was possible to change measuring from undeformed measuring track to deformed and backward. Each measurement took five minutes after stabilization, then it was changed to measure on deformed orifice plate. To eliminate errors caused in measurement was this part measured once again. Value recording was set to 10 seconds time step. From each measuring part was taken area with 20 recorded values, what means in total 40 values for undeformed orifice plate and 40 for deformed orifice plate. An arithmetic average was calculated from reached values, which eliminated fluctuation values and created medians in final results. In table 1 there are given pressure differences Δp between differential pressures of all deformed orifice plates and undeformed one.

Table 2 : Pressure differences between differential pressures of all deformed orifice plates and undeformed orifice plate

Deformation [mm]	1,2	1	0,8	0,6	0,4	0,2
Orifice plate n.:	1	2	3	4	5	6
Mass flow [kg/h]	Δp					
56 kg/h	3	2	-10	-14	-28	-38
106 kg/h	11	-5	-19	-44	-87	-134
156 kg/h	141	107	52	12	-84	-181
206 kg/h	402	358	267	189	-44	-139
262 kg/h	833	755	741	584	333	31

In a case, where values have positive signs, is differential pressure of deformed orifice plate bigger than in undeformed one. On the other hand, where minus sign appears, the differential pressure of deformed orifice plate is smaller than in undeformed orifice plate.

In the figures 6 and 7 are shown dependences of the mass flow impact to the pressure difference Δp between differential pressures of deformed and undeformed orifice plates. An increment of difference differential pressures Δp has got similar behavior in the deformations with higher values. This specific behavior is given by trend lines, which were set from the measured values at the experimental device. From trend lines were set polynomials of third grade. At the deformation of 0.6 mm started to appear lower influence of the deformation to a final difference of pressure differential and a result is, that a profile of shown line is

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changed. In the two smallest cases is previous phenomenon almost not visible. These two deformations have different phenomenon, what means decrease of pressure differential measured at deformed orifice plate. A reliability equation R^2 is in given dependences in the range from 0.988 to 1.0. This values show us, that trend lines describe very good behavior of measured values.

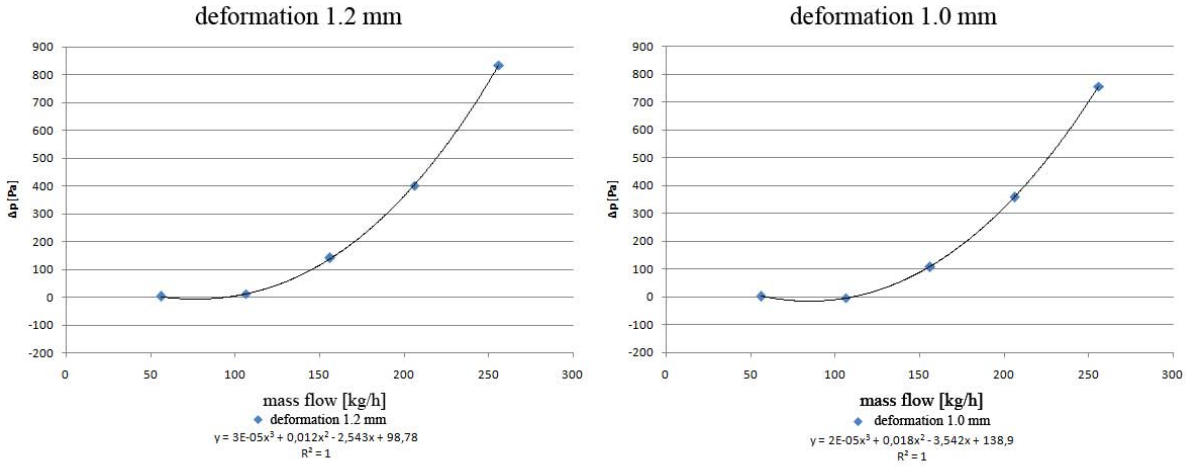

Fig. 6 : Dependence of the mass flow impact to the pressure difference Δp between differential pressures of deformed and undeformed orifice plate for deformation 1.2 mm and 1.0 mm

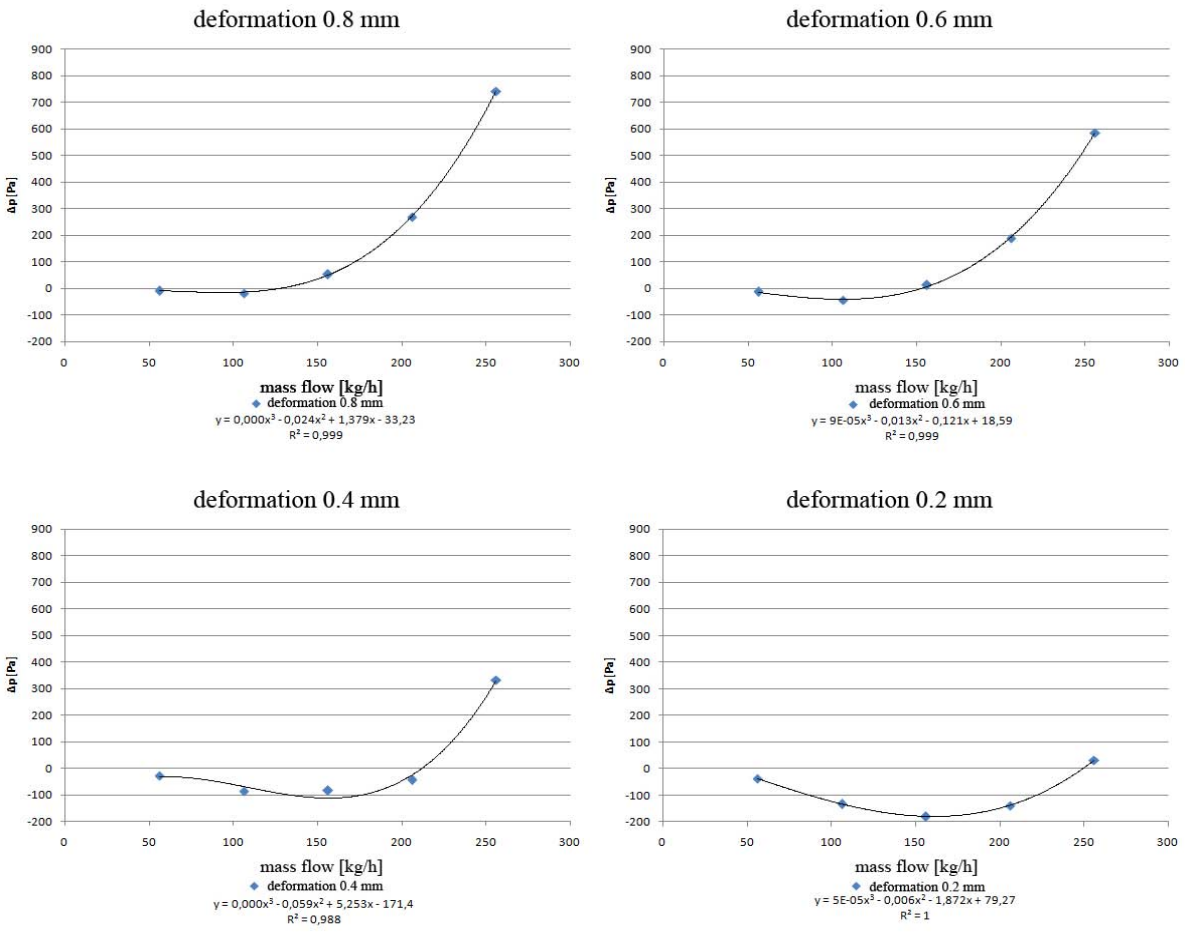

Fig. 7 : Dependence of the mass flow impact to the pressure difference Δp between differential pressures of deformed and undeformed orifice plate for deformation 0.8 mm, 0.6 mm, 0.4 mm and 0.2 mm

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A way of specifying mass flow from measured pressure differential is given in standard ISO 5167:2003 [5, 6], where for various types of pressure tappings are given different conversion equations to calculate required mass flow. In the following table 3 are given percentage differences of mass flows between mass flow measured at deformed and undeformed orifice plate. Differences between measured values were in range from -4.6 % to +3.4 %. This inaccuracy is much bigger than standard inaccuracy of orifice plates, which is in the range 0.6 ÷ 0.8 %.

Table 3 : Percentage difference of mass flows measured at deformed and undeformed orifice plate

Deformation [mm]	1,2	1	0,8	0,6	0,4	0,2
Mass flow [kg/h]	Δq_m [%]					
56	-0.5	-0.5	-1.8	-2.1	-3.6	-4.6
106	0.3	-0.1	-0.4	-1.1	-2.2	-3.3
156	1.5	1.2	0.6	0.1	-1.0	-2.0
206	2.6	2.3	1.8	1.2	-0.2	-0.9
262	3.4	3.1	3.0	2.4	1.4	0.1

V. Conclusion

Measurements showed, that deformation of the orifice plate has huge impact to the mass flow value of the transported air through pipeline system. In smaller mass flows negative percentage difference and in higher mass flows positive percentage difference appeared. In smaller mass flows were percentage differences higher for smaller deformations on the other hand for bigger mass flows were percentage differences higher for bigger deformations of orifice plates. This should be useful knowledge to set up adequate mass flows of natural gas measuring stations to suppress impact of the deformation.

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References Références Referencias

1. Jandačka, J., Malcho, M. *Stanovenie bilančných rozdielov plynovodnej siete v dôsledku neistoty merania množstva zemného plynu*. Bratislava, Slovgas 2006.
2. Kiš, R., Malcho M., Janovcová M. *Behavior of flowing air through a pipeline with installed orifice plate.* Žilina, AEaNMiFMaE 2014.
3. Kiš, R., Janovcová M., Malcho M. *The impact of the orifice plate thickness on the deformation of the orifice plate*. Žilina, TRANSCOM 2013.
4. Kiš, R., Janovcová, M., Malcho, M. *Pressure deformation of the orifice plate for measuring flow*. The application of experimental and numerical methods in fluid mechanics and energy 2012: 136-140.
5. ISO 5167-1:2003, "Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full – Part 1" Slovakia.
6. ISO 5167-2:2003, "Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full – Part 2: Orifice plates." Slovakia.

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Optimization of Supply Chain Network Perspective Environmental Impact based on Fuzzy Mathematical Programming

By Subrata Talapatra & Md. Shakil
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Abstract- Supply chain management (SCM) is concerned with a complex business relations network that contains interrelationships between various entities, such as suppliers, manufacturers, distribution centers and customers. SCM integrates these entities and manages their interrelationships through the use of information technology to meet customer expectation effectively along the entire value chain. Thus, one of the vital issues in supply chain management is the design of the value chain network. In this paper, a multi objective fuzzy mathematical programming model is developed to optimize the supply chain networking under inherent uncertainty of input data. The proposed model is able to optimize the environmental impacts beside the traditional cost minimization objective to make a fair balance between them. The model determines the fuzzy capacities of the facilities and the design of the network con figuration with a minimum total cost. A real case is used to demonstrate the significance and applicability of the developed fuzzy optimization model as well as the usefulness of the proposed solution approach. The developed model is solved by a professional software package (LINDO), and the computational results are discussed.

Keywords: optimization, fuzzy, supply chain network design, environmental impact and model formulation.

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Optimization of Supply Chain Network Perspective Environmental Impact based on Fuzzy Mathematical Programming

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Abstract- Supply chain management (SCM) is concerned with a complex business relations network that contains interrelationships between various entities, such as suppliers, manufacturers, distribution centers and customers. SCM integrates these entities and manages their interrelationships through the use of information technology to meet customer expectation effectively along the entire value chain. Thus, one of the vital issues in supply chain management is the design of the value chain network. In this paper, a multi objective fuzzy mathematical programming model is developed to optimize the supply chain networking under inherent uncertainty of input data. The proposed model is able to optimize the environmental impacts beside the traditional cost minimization objective to make a fair balance between them. The model determines the fuzzy capacities of the facilities and the design of the network con figuration with a minimum total cost. A real case is used to demonstrate the significance and applicability of the developed fuzzy optimization model as well as the usefulness of the proposed solution approach. The developed model is solved by a professional software package (LINDO), and the computational results are discussed.

Keywords: optimization, fuzzy, supply chain network design, environmental impact and model formulation.

I. Introduction

A well-structured supply chain is an important strategic competency that enables firms to be competitive in today's marketplace. Along this important issue, the concern about environmental impact of business activities results in governmental legislations and environmentally conscious consumers. Environmental or green supply chain management can be defined as integrating environmental aspects into supply chain management covering both forward and reverse supply chains from product design to end-of-life management of used products. The ultimate goal is to consider environment in every decision making process across supply chain, especially the strategic level decisions. Supply chain optimization can help define, recommend, and set flexible supply chain strategies based on organization's operations, resources, and other capabilities. Optimization of supply chain network design, as the most important strategic decision in supply chain management, plays an important role in overall environmental and economic performance of the supply chain. In general, supply chain network design includes determining the locations, numbers and capacities of network facilities and the aggregate material flow between them. Since the end-of-life (EOL) products have significant impact on environment, a considerable part of literature is dedicated to EOL product management. This has created a need to develop models for reverse supply chain (logistics) network design. Reverse supply chain network design problem addresses the number of collection, recovery, recycling and disposal centers needed, their location and capacities and material flows between them.

In the last several years, many studies have been proposed and much research has been performed on the design and optimization of supply chain networks. In one study, Pirkul and Jayaram an [1] studied a multi- commodity, multi-plant, capacitated facility location problem and proposed an efficient heuristic solution to the problem. In the capacitated plant and warehouse location model, customers typically demand multiple units of different products that are distributed to customer outlets from open warehouses that receive these products from several manufacturing plants. The objective function of the model minimizes the sum of the fixed cost of establishing and operating the plants and the warehouses plus the variable cost of transporting units of products from the plants to the warehouses and distributing the products from the warehouses to the customer, to satisfy the multiple demands of the customers. Recently Ilgin and Gupta et al. [2] present a comprehensive review on environmentally conscious manufacturing and product recovery; below we have surveyed some relevant papers on environmental supply chain network design. Timpe and Kallrath [3] considered a multi- site, multi-product production network and presented a general mixed integer linear programming model that combines aspects related to production, distribution and marketing and involves production sites (plants) and sales points. Cakra vastia et al. [4] developed an analytical model of the supplier selection process in designing a supply chain network. The constraints on the capacity of each potential supplier are considered in the process. The objective of the supply chain is to minimize the level of customer dissatisfaction, which is evaluated by two performance

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criteria: (i) price and (ii) delivery lead time. The overall model operates at two levels of decision making: the operational level and the chain level. The operational level concerns decisions related to optimizing the manufacturing and logistical activities of each potential supplier, to meet the customer's requirements. At the chain level, all of the bids from potential suppliers are evaluated, and the final configuration of the supply chain is determined. The structure of the chain de pends on the product specfic ations and on the customer's order size. An optimal solution in terms of the models for the two levels can be obtained using a mixed-integer programming technique [4, 5] presented a multi-phase mathematical programming approach for effective supply chain design. Syarif et al. [6] considered the logistic chain network problem formulate d by the 0–1 mixed integer linear programming problem. The design of the problem involves the choice of the facilities (plants and distribution center s) to be opened and the distribution network de sign, with the goal of satisfying the demand with minimum cost. For the solution method, the spanning tree-based genetic algorithm using Prüfer number representation is proposed. Sanayeia et al. [7] proposed an integrated approach of multi-attribute utility theory (MAUT) and linear programming (LP) for rating and choosing the best suppliers and defining the optimum order quantities among selected ones in order to maximize total additive utility. Javadi et al. [8] developed a fuzzy multi- objective linear programming (FMOLP) model for solving the multi- objective no-wait flow shop scheduling problem in a fuzzy environment. The proposed model attempted to simultaneously minimize the weighted mean completion time and the weigh ted mean earliness. A numerical example demonstrated the feasibility of applying the proposed model to no-wait flow shop scheduling problem. The proposed model yielded a compromised solution and the decision maker's overall levels of satisfaction.

To overcome the literature gap, this paper proposes a practical, but tractable, multi-objective fuzzy mathematical programming model for optimization of supply chain networking perspective environmental impact problem that is able to (1) consider both economic and environmental objectives in the design of the supply chain network, (2) integrate the design of reverse and forward supply chain networks to avoid the sub-optimality's results from separated design of forward and reverse supply chains, (3) The model allows decision-makers to design the network configuration with the minimum total cost. (4) Handle the epistemic uncertainty in parameters in real cases results from unavailability or incompleteness and imprecise nature of input data. Also, this paper proposes an efficient solution approach that is able to generate both balanced and unbalanced solutions through making a reasonable tradeoff between environmental and economic objectives.

This paper is organized into eight sections. After the introduction, in which some supply chain models are described, the remainder of the paper is structured as follows. In Section 2, problem statement of the proposed supply chain network is introduced. This model is formulated in section 3 and developed an equivalent auxiliary crisp model in section 5. Implementation and evaluation of this proposed model is described in section 6, and section 7 represents the results and discussion. Conclusions are presented in Section 8. As well as finally appendix and references are attached.

II. Problem Statement

The concerned integrated supply chain network in this paper is motivated by a real industrial case. The case is a supply chain network of Coca-Cola drinks in Bangladesh that supplies about 80% of domestic demand. The manufacturer has one production plant with about 600 thousand production capacity per one year. In transportation system of supply chain networking consists of environmental impact like, carbon di oxide (co_2) that is responsible for the environmental disasters. To overcome this problem proposed a multi-echelon supply chain network that includes both forward and reverse networks is illustrated in Fig. 1. Through forward network the new products manufactured by plants (production centers) are distributed among customer zones. In the reverse network, the used products are shipped to recycling centers through collection/disassembly centers. All demands of customers must be satisfied and all of the returned products from customers must be collected. Also, a predefined percent of demand from each customer is assumed as returned products from corresponding customer. Unavailability or incompleteness of data in real world network optimization problems is an important challenge that imposes a high degree of uncertainty in such problem. The problem is concerned with the uncertain parameters are presented by fuzzy numbers described by their possibility distribution. The possibility distributions are estimated based on current insufficient data and the decision makers' knowledge. The main objective of this integrated supply chain under uncertain conditionincludes the material flow quantities between different facilities with respect to two conflicting objective functions: (1) minimization of total cost and (2) minimization of total environmental impact.

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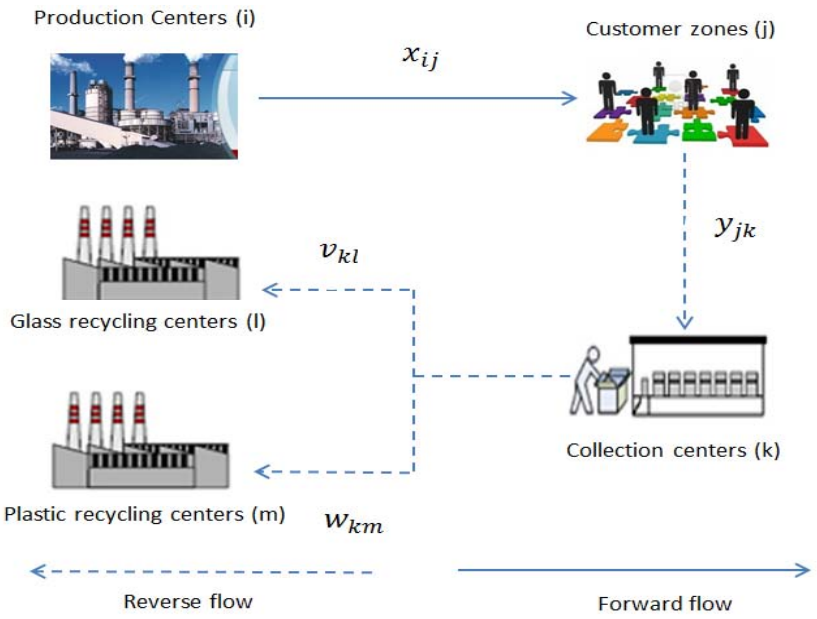

Fig. 1 : Concerned integrated supply chain network

III. Model Formulation

The indices, parameter and variables used to formulate the concerned environmental supply chain network design problem.

a) Indices

i =index of candidate location for production centers, *i= 1, 2, 3, 4…….i*

j=index of fixed location of customer zones, *j=1, 2, 3, 4…….j*

k=index of candidate location for collection centers, *k=1, 2, 3, 4…….k*

l=index of existing glass recycling centers, *l=1, 2, 3, 4…….l*

m=index of existing plastic recycling centers, *m=1, 2, 3, 4…….m*

b) Parameters

d_j = demand of customer zone, *j*

w_j = rate of return percentage from customer zones, *j*

f_i = fixed cost of opening production centers, *i*

g_k = fixed cost of opening collection centers, *k*

c_{ij} = transportation cost per product unit from plant, *i* to customer zones, *j*

a_{jk} = transportation cost of per used product unit from customer zone, *j* to collection center, *k*

b_{kl} = transportation cost of per glass part of used product unit from collection center, *k* to glass recycling center, *l*

h_{km} = transportation cost of per plastic part of used product unit from collection center, *k* to plastic recycling center, *m*

ρ_i = manufacturing cost per unit of product at production center, *i*

ϕ_k = processing cost for per unit of used product at collection center, *k*

β_l = processing cost for per glass part of used product unit at glass recycling center, *l*

α_m = processing cost for per plastic part of used product unit at plastic recycling center, *m*

π_i = maximum capacity of production center, *i*

η_k = maximum capacity of collection center, *k*

δ_l = maximum capacity of glass recycling center, *l*

θ_m = maximum capacity of plastic recycling center, *m*

ei^{pro} = Environmental impact per production of one unit of product

e_{ij}^{tpc} = environmental impact of shipping one unit of product from plant, *i* to customer zone, *j*

e_{jk}^{tcc} = environmental impact of shipping one unit of used product from customer zone, *j* to collection center, *k*

e_{kl}^{tcs} = environmental impact of shipping glass part of used product unit from collection center, *k* to glass recycling center, *l*

e_{km}^{tcp} = environmental impact of shipping plastic part of used product unit from collection center, *k* to plastic recycling center, *m*

ei^{col} = environmental impact per handling one unit of collected used product at collection centers

ei^{src} = environmental impact of recycling the glass part of one unit of used product

ei^{prc} = environmental impact of recycling the plastic part of one unit of used product

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c) Variables

x_{ij} = quantity of product shipped from plant, *i* to customer zone, *j*

y_{jk} = quantity of used product shipped customer zone, *j* to collection center, *k*

v_{kl} = quantity of glass part of used product shipped from collection center, *k* to glass recycling center, *l*

w_{km} = quantity of plastic part of used product shipped from collection center, *k* to plastic recycling center, *m*

$$u_i = \begin{cases} 1, & \text{if a production center opened at location, } i \\ 0, & \text{otherwise} \end{cases}$$

$$q_k = \begin{cases} 1, & \text{if a collection center opened at location, } k \\ 0, & \text{otherwise} \end{cases}$$

d) Objective Function

There are two objective functions are considered:

i. Minimization of total cost
ii. Minimization of total environmental impact

First objective Function: minimization of total cost

$$\text{Min} w_1 = \sum_i f_i u_i + \sum_k g_k q_k + \sum_i \sum_j (\rho_i + c_{ij}) x_{ij} + \sum_j \sum_k (\phi_k + a_{jk}) y_{jk} + \sum_j \sum_k (\phi_k + a_{jk}) y_{jk} + \sum_k \sum_l (\beta_l + b_{kl}) v_{kl} + \sum_k \sum_m (\alpha_m + h_k m) w_{km}$$

Here transportation costs between facilities are calculated by multiplying the transportation cost of one unit shipping per unit of distance.

For the second objective: minimizing the total environmental impact

The purpose of this supply chain network is to fulfill the customer demand by producing and distributing the product at forward network and the safe management of product by reverse network.

The purpose of using ECO-indicator is to estimate the environmental impact of different supply chain network configurations. Following ECO-indicators are considered for this supply chain network design.

- The production *(pro)*
- Transportation from production centers to customer zone *(tpc)*
- Transportation from customer zone to collection centers *(tcc)*
- Handling the used product at collection centers *(col)*
- Transportation from collection to glass recycling centers *(tcs)*
- Glass recycling center *(src)*
- Transportation from collection centers to plastic recycling centers *(tcp)*
- Plastic recycling centers *(src)*

Second objective function: minimization of total environmental impact

$$\text{Min } w_2 = \sum_i \sum_j (ei^{pro} + ei_{ij}^{tpc}) x_{ij} + \sum_j \sum_k (ei^{col} + ei_{jk}^{tcc}) y_{ij} + \sum_k \sum_l (ei^{src} + ei_{kl}^{tcs}) v_{ij} + \sum_k \sum_m (ei^{prc} + ei_{km}^{tcp}) x_{ij}$$

IV. Constraints

Demand and return satisfaction constraints

Here following constraints (3) and (4) ensure the demands of all customers are satisfied and the entire used products are collected from the customer zones.

$$\sum_i x_{ij} \geq d_j \quad (3)$$

$$\sum_k y_{jk} \geq d_j w_j \quad (4)$$

a) Flow Balance Constraints

Here constraints (5) and (6) ensure the flow balance at collection centers. Two EOL options are considered in the proposed model, the collected used product should be sent to glass and plastic recycling centers. Therefore the total number of plastic and glass parts should be equal to recycling centers because they are disassembled from one used product.

$$\sum_j y_{jk} \geq \sum_m w_{km} \quad (5)$$

$$\sum_m w_{km} \geq \sum_l v_{kl} \quad (6)$$

b) Capacity Constraint

$$\sum_j x_{ij} \geq u_i \pi_i \quad (7)$$

$$\sum_j y_{jk} \geq q_k \eta_k \quad (8)$$

$$\sum_l v_{kl} \leq \delta_l \quad (9)$$

$$\sum_m w_{km} \leq \theta_m \quad (10)$$

Here constraints (8) to (10) are capacity constraints on production, collection and glass recycling and plastic recycling centers respectively. Also constraints (7) and (8) prohibit the units of new and used products from being transferred to production and collection centers which are not opened respectively.

Decision variables constraints

The following constraints are related to the binary and non-negatively restrictions on the corresponding decision variables.

$$u_i, q_k \epsilon \{0,1\} \quad (11)$$

$$x_{ij}, y_{jk}, v_{kl}, w_{km} \geq 0 \quad (12)$$

V. Proposed Method

This is a multi-objective probabilistic mixed integer programming model. To solve this model a two phase approach is proposed one is the method of Jimenez to convert the proposed model and the second

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phase proposed a modified version of ε-constraint method to find the final preferred compromise solution.

VI. Equivalent Auxiliary Crisp Model

Jimenez et al. [9] method is selected to develop this equivalent auxiliary crisp model as well as this model is based on mathematical concepts that is expected interval and expected value of fuzzy numbers and also explain a ranking method which can support different kind of membership functions such as triangular, trapezoidal and nonlinear ones in both symmetric and asymmetric functions. This method also computational efficient to solve fuzzy linear problems as it can preserve its linearity and do not increase the number of objective functions and inequality constraints. The detail of this method is given in Appendix.

Equivalent auxiliary crisp model can be formulated as follows:

$$\min w_1 = \sum_i \left(\frac{f_i^{pes} + 2f_i^{mos} + f_i^{opt}}{4}\right) u_i + \sum_k \left(\frac{g_k^{pes} + 2g_k^{mos} + g_k^{opt}}{4}\right) q_k + \sum_i \sum_j \left(\frac{\rho_i^{pes} + 2\rho_i^{mos} + \rho_i^{opt} + c_{ij}^{pes} + 2c_{ij}^{mos} + c_{ij}^{opt}}{4}\right) x_{ij} +$$

$$\sum_j \sum_k \left(\frac{\phi_k^{pes} + 2\phi_k^{mos} + \phi_k^{opt} + c_{jk}^{pes} + 2c_{jk}^{mos} + c_{jk}^{opt}}{4}\right) y_{jk} + \sum_k \sum_l \left(\frac{\beta_l^{pes} + 2\beta_l^{mos} + \beta_l^{opt} + b_{kl}^{pes} + 2b_{kl}^{mos} + b_{kl}^{opt}}{4}\right) v_{kl} +$$

$$\sum_k \sum_m \left(\frac{\alpha_m^{pes} + 2\alpha_m^{mos} + \alpha_m^{opt} + h_{km}^{pes} + 2h_{km}^{mos} + h_{km}^{opt}}{4}\right) w_{km}$$

$$\min w_2 = \sum_i \sum_j \left(ei^{pro} + ei_{ij}^{tpc}\right) x_{ij} + \sum_j \sum_k \left(ei^{col} + ei_{jk}^{tcc}\right) y_{ij} + \sum_k \sum_l \left(ei^{src} + ei_{kl}^{tcs}\right) v_{kl} + \sum_k \sum_m \left(ei^{prc} + ei_{km}^{tcp}\right) w_{km}$$

Subject to,

$$\sum_i x_{ij} \geq \alpha \left(\frac{d_j^{mos} + d_j^{opt}}{2}\right) + (1-\alpha)\left(\frac{d_j^{pes} + d_j^{mos}}{2}\right)$$

$$\sum_k y_{jk} \leq \left[\alpha\left(\frac{d_j^{mos} + d_j^{opt}}{2}\right) + (1-\alpha)\left(\frac{d_j^{pes} + d_j^{mos}}{2}\right)\right]\left[\alpha\left(\frac{w_j^{mos} + w_j^{opt}}{2}\right) + (1-\alpha)\left(\frac{w_j^{pes} + w_j^{mos}}{2}\right)\right]$$

$$\sum_j q_{jk} = \sum_m w_{km}$$

$$\sum_m w_{km} = \sum_l v_{kl}$$

$$\sum_j x_{ij} \leq u_i \left[\alpha\left(\frac{\pi_i^{pes} + \pi_i^{mos}}{2}\right) + (1-\alpha)\left(\frac{\pi_i^{mos} + \pi_i^{opt}}{2}\right)\right]$$

$$\sum_j y_{jk} \leq q_k \left[\alpha\left(\frac{\eta_k^{pes} + \eta_k^{mos}}{2}\right) + (1-\alpha)\left(\frac{\eta_k^{mos} + \eta_k^{opt}}{2}\right)\right]$$

$$\sum_k v_{kl} \leq \left[\alpha\left(\frac{\delta_l^{pes} + \delta_l^{mos}}{2}\right) + (1-\alpha)\left(\frac{\delta_l^{mos} + \delta_l^{opt}}{2}\right)\right]$$

$$\sum_k w_{km} \leq \left[\alpha\left(\frac{\theta_m^{pes} + \theta_m^{mos}}{2}\right) + (1-\alpha)\left(\frac{\theta_m^{mos} + \theta_m^{opt}}{2}\right)\right]$$

$$u_i, q_k \in \{0,1\}$$

$$x_{ij}, y_{jk}, v_{kl}, w_{km} \geq 0$$

VII. Implementation and Evaluation

The validity of the developed model as well as the usefulness of the proposed solution method is investigated via the data withdrawn from the case study. The manufacturer firm has nine customer zones. The firm is responsible to collect the used product from domestic customers therefore the return rate from the foreign customer is considered equal to zero. To estimate the possibility of distribution parameters first objective data is gathered and the firm managers determined three prominent values (most likely, most pessimistic and most optimistic) of triangular fuzzy numbers according to available data. The fuzzy data for demand and rate of return each customer is represented in table: 1 for the over three years. The firm managers considered eight candidate locations to open new production centers. At reverse network, candidate locations are considered as the collections centers as well as the corresponding capacity are represented in table: 2 and 3.

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Table 1 : Demand (d_j) and rate of return (w_j)

Customer zone (j)	Demand, d_j(Thousand)			Rate of Return (w_j)		
	pes	mos	opt	pes	mos	opt
Khulna	234	254	292	0.65	0.75	0.85
Rajshahi	295	330	390	0.65	0.75	0.85
Chitagong	112	124	138	0.65	0.75	0.85
Dhaka	98	110	127	0.55	0.65	0.75
Narayongonj	84	93	110	0.70	0.80	0.90
Rangpur	100	118	131	0.65	0.75	0.85
Savar	198	211	228	0.65	0.75	0.85
Barisal	215	240	270	0.70	0.80	0.90
India	320	344	360	0	0	0

Table 2 : Data for fixed cost (f_i) and capacity (π_i) for production centers

Location(i)	Fixed Cost, f_i(Thousand)			Capacity, π_i(Thousand)		
	pes	mos	opt	pes	mos	opt
Khulna	13300	14500	15300	190	200	210
Rajshahi	13500	14700	15400	190	200	210
Narayongonj	13600	14800	15500	200	210	220
Chitagong	13500	14700	15400	165	180	195
Dhaka	13000	14000	15000	190	200	210
Rangpur	13600	14700	15400	190	200	210
Barisal	13400	14200	15200	165	180	195
Joshor	0	0	0	170	190	210

Table 3 : Fixed cost (g_k) and capacity (η_k) for collection centers

Location, i	Fixed cost, g_k(Thousand)			Capacity, η_k(Thousand)		
	pes	mos	opt	pes	mos	opt
Khulna	1700	1740	1780	240	245	250
Rajshahi	1750	1790	1830	240	245	250
Chitagong	1700	1740	1780	250	255	260
Dhaka	1680	1720	1740	220	225	230
Narayongonj	1780	1830	1880	230	235	240
Rangpur	1760	1810	1860	220	205	210
Savar	1740	1780	1820	200	205	210
Barisal	1720	1750	1780	210	215	220
Joshor	1730	1770	1810	225	230	235

VIII. Results and Discussion

Firm supplies products from different production centers to customer's zone as well as shipped using transportation by trucks. Products manufactured in production centers are directly dispatched to customer zone, and the manufacturer has to pay transportation costs. The firm assigns trucks with respect to the capacities of truck options and transports the products from the production center to the customer zone.

Table 4. presents the transportation cost form production center to customer zone; here trucks are used to transport the products.

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Table 4 : Data for Transportation cost of production center, *i* to customer zone, *j*

Customer Zone, j \ Production Center, i		1	2	3	4	5	6	7	8
1	pes	900	1000	900	1000	1100	1100	1000	1000
	mos	1000	1200	1200	1200	1300	1250	1400	1250
	opt	800	1100	800	1100	1200	1000	1200	1200
2	pes	1100	1100	1000	1100	1000	1200	1000	1200
	mos	1200	1350	1100	1250	1400	1250	1300	1400
	opt	1150	1200	1200	1300	1200	1300	1200	1100
3	pes	1200	1200	1100	1100	1200	1400	1000	1500
	mos	1400	1400	1150	1300	1450	1100	1350	1600
	opt	1100	1100	1200	1200	1000	1200	1200	1400
4	pes	1400	1200	1000	1100	1200	1200	1300	1300
	mos	1500	1500	1200	1350	1500	1150	1400	1500
	opt	1300	1300	900	1200	1400	1000	1200	1200
5	pes	1200	1200	1000	1200	1300	1000	1000	1100
	mos	1350	1550	1300	1400	1500	1200	1500	1700
	opt	1100	1100	1200	1100	1400	1100	1300	1200
6	pes	1200	1400	1300	1200	1400	1200	1200	1300
	mos	1500	1600	1350	1450	1600	1250	1550	1750
	opt	1100	1350	1200	1100	1300	1300	1200	1200
7	pes	1400	1200	1500	1200	1400	1200	1100	1400
	mos	1600	1700	1400	1500	1250	1300	1600	1600
	opt	1300	1300	1300	1100	1500	1000	1200	1300
8	pes	1500	1400	1400	1300	1000	1000	1000	1200
	mos	1700	1750	1450	1600	1300	1350	1650	1550
	opt	1600	1500	1200	1400	1200	1200	1100	1300
9	pes	1500	1300	1000	1000	1200	1000	1200	1000
	mos	1650	1400	1500	1250	1350	1400	1400	1600
	opt	1400	1200	900	1200	1100	1200	1000	1200

Table 5. Presents the manufacturing cost of products in production center by triangular fuzzy method.

Table 5 : Manufacturing cost (ρ_i) at production center

Production centers, i	pes	mos	opt
1	10000	10500	11000
2	10500	12000	12500
3	11000	11500	10000
4	10000	12000	11000
5	11500	12500	13000
6	12000	11000	14000
7	11000	10000	15000
8	10500	11500	12000

Table 6. Represents the transportation cost of product from customer zone to collection center by using trucks.

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Table 6 : Transportation cost from customer zone, j to collection center, k

Customer Zone, j \ Collection Center, k		1	2	3	4	5	6	7	8	9
1	pes	650	800	900	650	700	650	600	700	800
	mos	800	900	1000	700	600	700	800	900	1000
	opt	700	700	800	600	800	600	700	600	900
2	pes	500	700	700	600	600	700	700	800	650
	mos	750	800	600	650	750	800	850	900	700
	opt	600	750	800	700	700	750	800	700	600
3	pes	700	700	600	700	600	700	600	750	750
	mos	800	600	700	900	1000	800	700	800	900
	opt	850	750	500	750	900	900	650	700	800
4	pes	900	1000	400	800	800	800	800	700	700
	mos	1000	1200	800	900	700	600	1000	800	900
	opt	800	900	500	850	850	900	900	600	800
5	pes	700	800	600	900	900	800	700	850	1000
	mos	800	900	700	650	600	700	800	900	950
	opt	600	750	750	950	800	900	900	950	800
6	pes	800	800	850	700	900	700	800	700	550
	mos	850	950	750	900	700	600	550	500	600
	opt	700	900	800	800	800	950	900	600	700
7	pes	750	800	900	700	900	700	800	700	550
	mos	800	900	950	900	700	600	550	500	600
	opt	700	700	800	800	800	950	900	600	700
8	pes	800	900	700	1000	750	1000	500	600	600
	mos	900	950	800	850	800	700	600	650	550
	opt	700	800	750	900	700	900	700	700	700
9	pes	600	700	1100	700	750	700	500	850	650
	mos	900	800	1000	800	800	800	600	900	700
	opt	500	600	900	600	650	600	550	800	600

Table 7. Represents the processing cost of per unit of used product at collection center in reverse supply chain networking.

Table 7 : Processing cost per unit of used product, ϕ_k

Collection center, k	pes	mos	opt
1	1000	1200	1100
2	800	700	1000
3	900	800	1200
4	1100	1000	900
5	800	700	1000
6	1100	800	1000
7	1000	900	1200
8	1100	800	1000
9	1000	900	1200

Table 8. Represents the transportation cost of product from collection center to glass recycling center by using trucks in reverse supply chain networking.

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Table 8 : Transportation cost (b_{kl}) from collection center, k to glass recycling center, l

Glass recycling center, l / collection center, k		1	2	3	4
1	pes	500	300	900	400
	mos	600	400	500	300
	opt	400	200	600	500
2	pes	600	400	600	400
	mos	700	750	650	600
	opt	650	500	700	300
3	pes	450	600	700	500
	mos	500	550	600	700
	opt	550	700	750	600
4	pes	700	800	600	500
	mos	650	700	800	700
	opt	600	900	700	600
5	pes	500	800	700	700
	mos	600	500	450	300
	opt	400	700	600	800
6	pes	400	400	500	700
	mos	450	550	650	750
	opt	300	500	550	600
7	pes	500	600	900	500
	mos	800	750	700	850
	opt	600	700	800	300
8	pes	700	650	500	200
	mos	900	600	300	400
	opt	800	700	600	300
9	pes	400	700	500	400
	mos	300	450	400	500
	opt	500	800	600	600

Table 9. Represents the production cost of per unit of used product at glass recycling center in reverse supply chain networking.

Table 9 : Production cost (β_l)

Glass recycling center, l	pes	mos	opt
1	500	600	900
2	800	900	700
3	700	450	400
4	600	650	500

Table 10. Represents the transportation cost of product from collection center to plastic recycling center by using trucks in reverse supply chain networking.

Table 10 : Transportation (h_{km}) from collection center, k to plastic recycling center, m

Plastic recycling center, m / Collection Center, k		1	2	3	4
1	pes	300	400	400	400
	mos	400	300	450	500
	opt	500	500	500	300

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2	pes	400	700	700	500
	mos	500	600	650	550
	opt	300	650	800	400
3	pes	350	700	900	500
	mos	700	650	700	600
	opt	500	800	800	400
4	pes	600	700	650	700
	mos	550	600	700	800
	opt	700	750	600	900
5	pes	600	500	500	600
	mos	400	300	450	550
	opt	550	600	550	700
6	pes	600	400	650	700
	mos	700	600	700	650
	opt	650	500	600	600
7	pes	750	450	700	500
	mos	700	650	500	450
	opt	800	700	650	400
8	pes	500	700	700	500
	mos	300	400	500	600
	opt	400	800	650	550
9	pes	500	700	600	600
	mos	700	800	750	650
	opt	600	650	700	700

Table 11. Represents the processing cost of per unit of used product at plastic recycling center in reverse supply chain networking.

Table 11 : Processing cost of plastic part (α_m)

m	pes	mos	opt
1	500	600	700
2	600	650	550
3	500	400	450
4	500	650	700

Table 12. Represents the environmental impact of shipping product from production center to customer zone, here environmental impact means the amount of carbon di oxide (CO_2) obtained from the trucks during transportation.

Table 12 : Environmental impact (e_{ij}^{tpc}) of shipping product from production center, *i* to customer zone, *j*

i \ *j*	1	2	3	4	5	6	7	8
1	30	32	34	30	32	36	38	40
2	42	35	36	38	39	40	42	45
3	46	47	48	39	40	46	47	48
4	50	52	42	46	47	48	49	50
5	52	53	54	55	46	48	50	52
6	54	32	34	36	38	40	42	45
7	46	48	50	52	54	46	48	50
8	42	46	40	38	35	45	46	48
9	44	48	38	36	32	40	48	46

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Environmental impact per production of one unit of product, ei^{pro} =42

$$\sum_i \sum_j (ei^{pro} + e_{ij}^{tpc}) = 6155$$

Table 13. Represents the environmental impact of shipping one unit of product from customer zone to collection center, here environmental impact means the amount of carbon di oxide (CO_2) obtained from the trucks during transportation.

Table 13 : Environmental impact of shipping one unit of product from customer zone, *j* to collection center, *k*

k \ J	1	2	3	4	5	6	7	8	9
1	24	26	28	30	39	32	36	38	40
2	26	28	30	32	34	36	38	40	38
3	32	36	38	44	32	24	28	30	32
4	34	34	40	42	34	32	30	28	34
5	30	28	32	36	34	35	28	30	32
6	36	32	38	40	36	26	32	48	38
7	38	34	36	38	38	32	36	46	36
8	36	36	34	36	36	44	38	44	32
9	40	38	32	36	40	42	40	42	34

Environmental impact of handling one unit of collected used product at collection center, ei^{col} =32

$$\sum_j \sum_k (ei^{col} + e_{ij}^{tcc}) = 5416$$

Table 14. Represents the environmental impact of shipping glass part from collection center to glass recycling center, here environmental impact means the amount of carbon di oxide (CO_2) obtained from the trucks during transportation.

Table 14 : Environmental impact of shipping glass part from collection center, *k* to glass recycling center, *l*

k \ l	1	2	3	4
1	50	48	50	52
2	52	46	54	54
3	48	44	56	55
4	46	42	58	42
5	44	44	42	44
6	50	46	44	46
7	52	48	46	48
8	54	50	48	50
9	50	52	50	52

Environmental impact of recycling one unit of glass part, ei^{src} =40

$$\sum_k \sum_l (ei^{src} + e_{kl}^{tcs}) = 3197$$

Table 15. Represents the environmental impact of shipping plastic part from collection center to plastic recycling center, here environmental impact means the amount of carbon di oxide (CO_2) obtained from the trucks during transportation.

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Table 15 : Environmental impact of shipping plastic part from collection center, *k* to plastic recycling center, *m*

m / *k*	1	2	3	4
1	16	18	20	22
2	24	18	22	24
3	26	20	18	16
4	28	18	22	18
5	30	28	18	18
6	32	26	20	20
7	34	24	16	22
8	32	22	20	24
9	18	20	18	18

Environmental impact of recycling one unit of plastic product, ei^{prc} =20

$$\sum_{k}\sum_{m}(ei^{prc} + e_{km}^{tcp}) = 1510$$

Table 16. Represents the maximum capacity of glass and plastic recycling center in reverse supply chain networking.

Table 16 : Maximum capacity of glass (θ_m) and plastic (δ_l) recycling center

l, m	θ_m			δ_l		
	pes	mos	opt	pes	mos	opt
1	100	150	200	180	150	200
2	200	150	180	180	200	250
3	190	200	250	220	180	250
4	230	250	180	240	250	180

Simplifications of the constraints are obtained by developing a program using Code blocks programming software:

$$\text{minw}_1 = 10175u_i + 15925q_k + 918900x_{ij} + 138675y_{jk} + 43925v_{kl} + 41375w_{km}$$

$$\text{minw}_2 = 6155x_{ij} + 5416y_{jk} + 3197v_{kl} + 1510w_{km}$$

Constraints,

$x_{ij} \geq 15012$

$y_{jk} \geq 10730.61$

$x_{ij} \leq 13860$ or $x_{ij} \leq 0$

$y_{jk} \leq 18639$ or $y_{jk} \leq 0$

$v_{kl} \leq 7281$

$w_{km} \leq 6736.5$

Optimize this problem using LINDO 12 for this purpose use some symbol to put this equation in LINDO 12 more easily represent in table 17.

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Table 17 : Symbol transformation

Symbol	Modified Symbol
u_i	*X*
q_k	*Y*
x_{ij}	*Z*
y_{jk}	*W*
v_{kl}	*M*
w_{km}	*N*

Optimal solution for minimizing total cost (w_1):

Global optimal solution found.
Objective value: 0.1394333E+11
Infeasibilities: 0.000000
Total solver iterations: 0

Model Class: LP

Total variables: 6
Nonlinear variables: 0
Integer variables: 0

Total constraints: 5
Nonlinear constraints: 0

Total nonzeros: 10
Nonlinear nonzeros: 0

Variable	Value	Reduced Cost
X	0.000000	10175.00
Y	0.000000	15925.00
Z	15012.00	0.000000
W	10730.61	0.000000
M	0.000000	43925.00
N	0.000000	41375.00

Row	Slack or Surplus	Dual Price
1	0.1394333E+11	-1.000000
2	0.000000	-918900.0
3	0.000000	-13867.00
4	7281.000	0.000000
5	6736.500	0.000000

The above solution represent the minimization of total cost is 0.1394333E+11; here no iteration is required to get the optimal solution. The optimal solution is obtained for the proposed supply chain networking contains of variables of production centers *(X)* is 10175.00 that shows that if a new production center is opened than cost will increase otherwise reduced amount is 10175.00. The variables *(Y)* represent the collection center that is obtained 15925.00, that presents if a collection center is opened than cost will increase amount of 15925.00 otherwise reduced. Variables *(Z)* show the quantity of product shipped from production centers *(i)* to customer zone *(j)* that is obtained 15012.00 units for the minimization of cost. Variables *(W)* shows the quantity of product shipped from customer zone *(j)* to collection center *(k)* that is obtained 10730.61 for the minimization of total cost. For the reverse flow variables *(m) & (n)* presents the quantity of used product shipped from collection center *(k)* to glass recycling center *(l)* & quantity of plastic part of used product shipped from collection center *(k)* to plastic recycling center *(m)* those are 43925.00 and

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41375.00 reduced cost. Inequality constraint to transform it to equality slack and surplus values for the row 1,2,4,5 are 0.1394333E+11, 7281.000, 6736.500 and row 2 & 3 presents the transportation cost of production center *(i)* to customer zone *(j)*& customer zone *(j)* to collection center *(k).*

Optimal solution for minimizing environmental impact (w_2):

Global optimal solution found.	
Objective value:	0.9239886E+08
Infeasibilities:	0.000000
Total solver iterations:	0
Model Class:	LP
Total variables:	5
Nonlinear variables:	0
Integer variables:	0
Total constraints:	5
Nonlinear constraints:	0
Total nonzeros:	8
Nonlinear nonzeros:	0

Variable	Value	Reduced Cost
Z	15012.00	0.000000
Y	0.000000	5416.000
M	0.000000	3197.000
N	0.000000	1510.000
W	10730.61	0.000000

Row	Slack or Surplus	Dual Price
1	0.9239886E+08	-1.000000
2	0.000000	-6155.000
3	0.000000	0.000000
4	7281.000	0.000000
5	6736.500	0.000000

The above solution represent the minimization of total environmental impact here environmental impact minimization means the reduction of carbon di oxide *(CO_2)* during the transportation of product from production center *(i)* to customer zone *(j)* and customer zone *(j)* to location centers *(k)* finally location centers *(l)* to glass or plastic recycle center *(l or m)* through trucks. Here for the proposed supply chain networking problem only carbon di oxide *(CO_2)* is considered as an environmental impact others are neglected. The 2nd objective function shows the minimization of environmental impact that is 0.9239886E+08 as well as no iteration is required to get the optimal solution. Variables (Z) show the quantity of product shipped from production centers *(i)* to customer zone *(j)* that is obtained 15012.00 units for the minimization of environmental impact. The variables *(Y)* represent the collection center that is obtained reduced 5416.000. A variable *(M)* is the quantity of glass part shipped from collection center *(k)* to glass recycling center *(l)* than the reduced amount of 3197.000. A variable *(N)* is the quantity of plastic part shipped from collection center *(k)* to plastic recycling center *(m)* than the reduced amount of 1510.000. A variable *(W)* is the quantity of used product shipped from customer zone *(j)* to collection center *(k)* amount of 10730.61.Inequality constraint to transform it to equality slack and surplus values for the row 1,4,5 are 0.9239886E+08, 7281.000, 6736.500 and dual prices are showing in row 1 & 2.

IX. Conclusion

Effective supply chain network design and optimization of the network are tasks that provide a competitive advantage to firms and organizations in today's highly intractable global business environment. In this study, design and optimization supply chain networking based on multi-objective fuzzy mathematical programming model, this consists of minimizing the total cost and environmental impact and determining the optimal physical shipment of product from production center to customer zone in forward flow and collection center to recycling center in reverse flow. The proposed

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fuzzy model includes the design of the network configuration with a minimum total cost and environmental impact under the fuzzy capacity constraints with triangular and trapezoidal member ship functions. The total cost involves the following: the transportation costs between production center and customer zone; customer zone to collection center and collection center to recycling center. To solve the proposed optimization model, an interactive fuzzy solution approach is developed based on the e-constraint method and the possibility programming approach proposed by Jimenezet al. [9].The proposed hybrid solution approach is able to generate both balanced and unbalanced solutions and making a reasonable tradeoff between environmental and economic objectives. The effectiveness of the developed fuzzy optimization model as well as the usefulness of the proposed solution approach is investigated through a real industrial case. Finally, a sensitivity analysis developed to show the correlation between the objective function value and the constraints using LINDO 12 optimization software.

Appendix

The Jimenez et al. [9] method is based on the definition of the ''expected interval'' and the ''expected value'' of a fuzzy number. Assume thatČ is a triangular fuzzy number. The following equation can be defined as the membership function of Č.

$$\mu_{\check{C}}(x)=\begin{cases} f_c(x)=\frac{x-c^{pes}}{c^{mos}-c^{pes}} \; if\; c^{pes} \le x \le c^{mos} \\ g_c(x)=\frac{c^{opt}-x}{c^{opt}-c^{mos}} \; if\; c^{mos} \le x \le c^{opt} \end{cases}$$

$$\mu_{\check{C}}(x)=\begin{cases} 1; if\; x=c^{mos} \\ 0;\; if\; x \le c^{pes}\; or\; x \ge c^{opt} \end{cases}$$

Here $c^{mos}, c^{pes}\; and\; c^{opt}$ are the three prominent points (the most likely, the most pessimistic and the most optimistic values), respectively. Eqs. (13) And (14) define the expected interval (EI) and the expected value (EV) of triangular fuzzy number Č.

$$EI(\check{C}) = [E_1^c, E_2^c] = \left[\int_0^1 f_c^{-1}(x)dx, \int_0^1 g_c^{-1}(x)dx\right] = \left[\frac{1}{2}(c^{pes}+c^{mos}), \frac{1}{2}(c^{mos}+c^{opt})\right] \quad (13)$$

$$EV(\check{C}) = \frac{E_1^c+E_2^c}{2} = \frac{c^{pes}+2c^{mos}+c^{opt}}{4} \quad (14)$$

According to the ranking method of Jimenez [10], for any pair of fuzzy numbers 'a and b', the degree in which a is bigger than b can be defined as follows.

$$\mu_m(a,b)=\begin{cases} 0; if\; E_2^a - E_1^b \le 0 \\ \frac{E_2^a-E_1^b}{E_2^a-E_1^b-(E_1^a-E_2^b)}; if\; 0 \epsilon [E_1^a-E_2^b, E_2^a-E_1^b] \\ 1; if\; E_1^a - E_2^b > 0 \end{cases} \quad (15)$$

When $\mu_m(a,b) \ge \alpha$ it will be said that a is bigger than, or equal to, b at least in degree of α and it will be represented as $a \ge_\alpha b$. Now, consider the following fuzzy mathematical programming model in which all parameters are defined as triangular or trapezoidal fuzzy numbers.

$$\begin{aligned} &Min\; z = \check{C}x \\ &ST, \\ &a_i x \ge b_i\;,\; i=0,1,2.....l; \\ &x \ge 0 \end{aligned} \quad (16)$$

Based on Jimenez et al. [9], a decision vector $x \epsilon R^n$ is feasible in degree of α if $min_{i=1,2.....l}\{\mu_m(a_i x, b_i)\} = \alpha$ According to (16), equation $a_i x \ge b_i$ is equivalent to the following equation.

$$\frac{E_2^{a_i x}-E_1^{b_i}}{E_2^{a_i x}-E_1^{a_i x}+E_2^{b_i}-E_1^{b_i}} \ge \alpha \; if i=1,2,3.....l; \quad (17)$$

Eq. (17) can be rewritten as follows.

$$\left[(1-\alpha)E_2^{a_i}+\alpha E_1^{a_i}\right]x \ge x E_2^{b_i}+(1-\alpha)E_1^{b_i}\;,\; i=1,2,3.....l; \quad (18)$$

Also, Jimenez et al. [9] showed that a feasible solution like x^0 is an acceptable optimal solution of the model (18) if and only if for all feasible decision vectors say x such that $a_i x \ge b_i$;$i=1,2,3.....l$; and $x \ge 0$; the following equation holds.

$$c^t x \ge {}_{1/2}c^t x^0 \quad (19)$$

Therefore, with the objective of minimizing, x^0 is a better choice at least in degree 1/2 as opposed to the other feasible vectors. The above equation can be rewritten as follows.

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$$\frac{E_2^{c^t}x+E_1^{c^t}x}{2} \geq \frac{E_2^{c^t}x^0+E_1^{c^t}x^0}{2} \quad (20)$$

Finally, by the aid of the definition of expected interval and expected value of a fuzzy number, the equivalent crisp α-parametric model of the model (16) can be written as follows.

$$\begin{aligned} &min\ EI\ (\check{C})x \\ &ST, \\ &\left[(1-\alpha)E_2^{a_i}+\alpha E_1^{a_i}\right]x \geq \alpha E_2^{b_i}+(1-\alpha)E_1^{b_i}\ ,\ i=1, 2, 3\ldots\ldots I; \quad (21) \\ &X \geq 0 \end{aligned}$$

References Références Referencias

1. H. Pirkul, V. Jayaraman, A multi-commodity, multi-plant, capacitated facility location problem: formulation and efficient heuristic solution, Computers & Operations Research 25 (10) (1998) 869–878.
2. M.A. Ilgin, M. Surendra, S.M. Gupta, Environmentally conscious manufacturing and product recovery (ECMPRO): a review of the state of the art, J. Environ. Manage. 91 (2010) 563–591.
3. C.H. Timpe, J. Kallrath, Optimal planning in large multi-site production networks, European Journal of Operational Research 126 (2) (2000) 422–435.
4. A. Cakravastia, I.S. Toha, N. Nakamura, A two-stage model for the design of supply chain networks, International Journal of Production Economics 80 (3) (2002) 231–248.
5. S. Talluri, R.C. Baker, A multi-phase mathematical programming approach for effective supply chain design, European Journal of Operational Research 141 (3) (2002) 544–558.
6. A. Syarif, Y.S. Yun, M.A. Gen, Study on multi-stage logistic chain network: a spanning tree-based genetic algorithm approach, Computers & Industrial Engineering 43 (2002) 299–314.
7. A. Sanayeia, S.F. Mousavib, M.R. Abdic, A. Mohagharb, An integrated group decision-making process for supplier selection and order allocation using multi-attribute utility theory and linear programming, Journal of the Franklin Institute 345 (2008) 731–747.
8. B. Javadi, M. Saidi-Mehrabad, A. Haji, I. Mahdavi, F. Jolai, N. Mahdavi-Amiri, No-wait flow shop scheduling using fuzzy multi-objective linear programming, Journal of the Franklin Institute 345 (2008) 452–467.
9. M. Jimenez, M. Arenas, A. Bilbao, M.V. Rodriguez, Linear programming with fuzzy parameters: An interactive method resolution, Eur. J. Oper. Res. 177 (2007) 1599–1609.
10. M. Jimenez, Ranking fuzzy numbers through the comparison of its expected intervals, Int. J. Uncertain. Fuzziness Knowledge. Based Syst. 4 (4) (1996) 379–388.
11. L. Meade, J. Sarkis, A. Presley, The theory and practice of reverse logistics, Int. J. Logistics Syst. Manage. 3 (2007) 56–84.
12. S.K. Srivastara, Green supply-chain management: a state-of-the-art literature review, Int. J. Manage. Rev. 9 (1) (2007) 53–80.
13. M.T. Melo, S. Nickel, F. Saldanha-da-Gama, Facility location and supply chain management – A review, Eur. J. Oper. Res. 196 (2009) 401–412.
14. A.I. Barros, R. Dekker, V. Scholten, A two-level network for recycling sand: A case study, Eur. J. Oper. Res. 110 (1998) 199–214.
15. V. Jayaraman, V.D.R. Guige Jr, R. Srivastava, A closed-loop logistics model for manufacturing, J. Oper. Res. Soc. 50 (1999) 497–508.
16. F. Du, G.W. Evans, A bi-objective reverse logistics network analysis for post-sale service, Comput. Oper. Res. 35 (2008) 2617–2634.
17. H.R. Krikke, A. Van Harten, P.C. Schuur, Reverse logistic network re-design for copiers, OR Spektrum 21 (1999) 381–409.
18. J.E. Lee, M. Gen, K.G. Rhee, Network model and optimization of reverse logistics by hybrid genetic algorithm, Comput. Ind. Eng. 56 (2009) 51–964.
19. N. Aras, D. Aksen, Locating collection centers for distance- and incentive-dependent returns, Int. J. Prod. Econ. 111 (2008) 316–333.
20. M.S. Pishvaee, R.Z. Farahani, W. Dullaert, A memetic algorithm for bi-objective integrated forward/reverse logistics network design, Comput. Oper. Res.37 (2010) 1100–1112.
21. H.J. Ko, G.W. Evans, A genetic-based heuristic for the dynamic integrated forward/reverse logistics network for 3PLs, Comput. Oper. Res. 34 (2007) 346–366.
22. M.S. Pishvaee, F. Jolai, J. Razmi, A stochastic optimization model for integrated forward/reverse logistics network design, J. Manufact. Syst. 28 (2009) 107–114.
23. M. El-Sayed, N. Afia, A. El-Kharbotly, A stochastic model for forward_reverse logistics network design under risk, Comput. Ind. Eng. 58 (2010) 423–431.
24. M.S. Pishvaee, S.A. Torabi, A possibilistic programming approach for closed_loop supply

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chain network design under uncertainty, Fuzzy Sets Syst. 161 (2010) 2668–2683.
25. H.F. Wang, H.W. Hsu, Resolution of an uncertain closed-loop logistics model: an application to fuzzy linear programs with risk analysis. J. Environ.Manage. (in press).
26. Mir Saman Pishvaee, Jafar Razmi, Environmental supply chain network design using multi-objective fuzzy mathematical programming. Applied Mathematical Modelling 36 (2012) 3433–3446.
27. S.A. Torabi, E. Hassini, An interactive possibilistic programming approach for multiple objective supply chain master planning, Fuzzy Sets Syst. 159 (2008) 193–214.
28. C.L. Hwang, A. Masud, Multiple Objective Decision Making. Methods and Applications: A State of the Art Survey, Lecture Notes in Economics and Mathematical Systems 164, Springer-Verlag, Berlin (1979).
29. G. Mavrotas, Effective implementation of the e-constraint method in multi-objective mathematical programming problems, Appl. Math. Comput. 213 (2009) 455–465.
30. C.H. Timpe, J. Kallrath, Optimal planning in large multi-site production networks, European Journal of Operational Research 126 (2) (2000) 422–435.
31. K.-M. Tsai, S.-Y. You, Y.-H. Lin, C.-H. Tsai, A fuzzy goal programming approach with priority for channel allocation problem in steel industry, Expert Systems with Applications 34 (2008) 1870–1876.
32. J. Xu, Q. Liu, R. Wang, A class of multi-objective supply chain networks optimal model under random fuzzy environment and its application to the industry of Chinese liquor, Information Sciences 178 (2008) 2022–2043.
33. H. Yan, Z. Yu, T.C.E. Cheng, A strategic model for supply chain design with logical constraints: formulation and solution, Computers & Operations Research 30 (14) (2003) 2135–2155.
34. M. Kumar, P. Vrat, R. Shankar, A fuzzy programming approach for vendor selection problem in a supply chain, International Journal of Production Economics 101 (2) (2006) 273–285.

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Time-Dependent Learning Effect and Deterioration on Single Machine's Scheduling

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Abstract- Learning effect and deterioration do not always occur separately. If both of them are founded simultaneously, the actual processing time of the jobs will both increase and decrease at the same time. The actual processing time is defined by a function of the starting time and position of jobs in the sequence. In this paper, the effect of learning and deterioration is applied to single machine's scheduling problem in a paper-mill. Learning effect as a result of regular performance-evaluation reduce the effect of deterioration up to 206, 5509 hours. This paper-mill operates jobs by their interest. This paper show that Earlier Due Date (EDD) rule construct a better sequence under maximum lateness problem then either Shortest Processing Time (SPT) rule or Most Urgent Job rule do. Maximum lateness of the jobs under EDD rule is 13,6% less then sequence that is recently used in that paper-mill.

Keywords: single machine, deterioration, learning effect, maximum lateness.

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Time-Dependent Learning Effect and Deterioration on Single Machine's Scheduling

Dian Ayu Nurul Ihsani [α], Sunarsih [σ] & Robertus Heri [ρ]

Abstract- Learning effect and deterioration do not always occur separately. If both of them are founded simultaneously, the actual processing time of the jobs will both increase and decrease at the same time. The actual processing time is defined by a function of the starting time and position of jobs in the sequence. In this paper, the effect of learning and deterioration is applied to single machine's scheduling problem in a paper-mill. Learning effect as a result of regular performance-evaluation reduce the effect of deterioration up to 206, 5509 hours. This paper-mill operates jobs by their interest. This paper show that Earlier Due Date (EDD) rule construct a better sequence under maximum lateness problem then either Shortest Processing Time (SPT) rule or Most Urgent Job rule do. Maximum lateness of the jobs under EDD rule is 13,6% less then sequence that is recently used in that paper-mill.

Keywords: single machine, deterioration, learning effect, maximum lateness.

I. Introduction

On-time product is needed by an industry manufacture to make a grade. Plan a good schedule is one of competitive strategy to solve that. It orders to accommodate all of the jobs in some machines and get an optimum result. Relatively to delays of production, this paper proposes maximum lateness problem on a single machine's scheduling. Maximum lateness problem is optimum when the sequence of jobs is giving smallest value of maximum lateness.

In single machine environment, scheduling is putting in order to make a sequence of jobs because the processing times are assumed to be fixed. The processing time of jobs is considered have a constant value. However, in many real situations, the company most certainly gets some factors that is make the actual processing time being longer because of deterioration or shorter because of learning.

The effect of learning and deterioration in the scheduling problem has often been learned for this recent years. Kou and Yang [5] introduce the impact of time-dependent learning effect in the single machine's scheduling that is optimum when it solved by Shortest Processing Time (SPT) rule. Koulamas and Kyparisis [4] showed that O(n log n) (n is the number of jobs) SPT rule is optimum for make span and minimizing total completion time in single machine environment if the learning effect is function of the sum of processing times that was done. Browne and Yechiali [1] are analyzed the effect of deterioration for optimum scheduling order to make a minimum makespan. Cheng, et al. [2] used O(n log n) algorithm to solve job-dependent deterioration problem in single machine under the case of due date, earliness, and tardiness.

Both of learning effect and deterioration are not always separately occur. In many real situation, both of them right usually simultaneously found. Sun [9] introduced deterioration and learning effect that is occurring in single machine at the same time. He showed that makespan, total completion time, sum of quadratic job completion time, total weighted completion time, and maximum lateness problems have an optimum solution. Yang and Kuo [12] introduced two kind of learning effect that were occurring in a deteriorated single machine. They were job-dependent learning effect and job-independent learning effect. Low and Lin [6] show that time-dependent learning effect in deteriorated single machine and flowshop environment has an optimum solution for makespan, total completion time, and weighted completion time problems.

Model that is considering in this paper is applied in a paper-mill that is use single machine to produce papers. Deterioration occurs when the machine either producing less quantity (tonase) of reel then usual or different gramatur (/) value. It gives occasion to increase the actual processing time. To solve this problem, the employers have to upgrade their capability of making paper-pulp and repair the splitting reel. Their effort to reduce the impact of delay is example of learning effect in this paper-mill. They usually sequences jobs by their weight. This sequence brings some jobs getting late. Because of that, the maximum lateness problem able to applied in this paper-mill.

II. Consideration Method

Consideration method that is used in this paper is literature-study from journals, books, and any other references. Validation of the theory in the real situation gets by applied model to existing data observation in a paper-mill. We consider three rules of scheduling to compared, that are: Earlier Due Date, Shortest Processing Time, and Most Urgent Job-sequence.

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III. Result and Consideration

a) Actual Processing Time Model

Single machine is simplest case of scheduling because the operation is only occurring in one machine. Still single machine scheduling most often practically occur [3]. Single machine is able to be a special case of any other machine environment. Problem solving in this case is usually able to be heuristic-base of more other complex environment [8].

Learning effect is one of the impacts of effort the company to upgrade their performance. This acquisition often comes from regular either employers or overall company evaluation. An employee will find the way to do his job efficiently along his number of repeating [5]. In other world, he will do better and better along his experiences. The actual processing time of jobs is enable to calculate if the scheduled processing time unknown. This is called time-dependent learning effect in literature.

Deterioration is a condition when machine's performance piecemeal goes down. Machine is in a highest performance at the beginning. Its reducing of performance is come in sight at its longer time to completing next jobs [1]. If deterioration occur in the machine, allover of job's processing times increase under this condition. Every job get same deterioration rate because they operate in one single machine [2].

If both of learning and deterioration are occurring simultaneously, actual processing time of jobs is defined as a related function of starting time to its position in the sequence. Low and Lin [6] introduce actual processing time model for scheduling problem with time-dependent learning effect and deterioration.

There are n jobs to operate in a single machine. The machine is able for one job one time and no idle time allowed up to the last job leave the machine. Actual processing time of job that is start at time t and scheduled in position r is defined by:

$$P_{jr}(t) = P_j\left(1 - \frac{\sum_{l=1}^{r-1} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^a b^{r-1} + st$$

$$= P_j\left(\frac{\sum_{l=r}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^a b^{r-1} + st \qquad (3.1)$$

Where, $r = 1, \ldots, n$ with

a : learning index $(a \geq 1)$,
b : learning index $(0 < b < 1)$,
s : deterioration rate $(s \geq 0)$,
t : starting time (hour),
r : position of job in sequence,
$P_{jr}(t)$: actual processing time of job J_j that is t started at time and scheduled in position- in sequence (hours),
P_j : processing time of job (hours),
$P_{[l]}$: processing time of job that is scheduled in position- in sequence (hours).

In the model above seems that the actual processing time can not calculated if processing time of the previous job unknown. Not like position-dependent learning effect, in this model r shown the number of previous jobs. Increasing number of finished job will reduce the value of $\left(\frac{\sum_{l=r}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^a$. So that the processing time less steeper. In other word, the efficiency increase by number of previous job proportionally [4].

Deteriorating jobs have constant-dependence to their position [7]. Equation (3.1) satisfies the principal of learning effect by actual process capacity because dependences to position yet time at all [6].

In this model, show the relation of deterioration and job's starting time. It classically describes times increasing of starting time proportionally by its deteriorating rate.

b) Completion Time

Given schedule $\pi = [J_1, J_2, \ldots, J_n]$ with $P_{[j]}$ as normal processing time of J_j, then processing time of the first job $(j = 1, r = 1)$ in beginning position $(t = 0)$ and initial value $C_{[0]} = 0$ is

$$C_{[1]} = 0 + P_{[1]}\left(\frac{\sum_{l=1}^{n} P_{[1]}}{\sum_{l=1}^{n} P_1}\right)^a b^0 + s.0 = P_{[1]}$$

The second job $(j = 2, r = 2)$ is start after the first job finish. So that it has second value $t = C_1$ and so on. Substitute t to equation (3.1):

$$C_{[2]} = C_{[1]} + P_{[2]}\left(\frac{\sum_{l=2}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^a b^{2-1} + s.C_{[1]}$$

$$= P_{[1]} + P_{[2]}\left(\frac{\sum_{l=2}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^a b + s.P_{[1]}$$

$$= P_{[1]}(1+s) + P_{[2]}\left(\frac{\sum_{l=2}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^a b$$

Generally, completion time of job-k $(j = k)$ is

$$C_{[k]} = P_{[1]}(1+s)^{k-1} + P_{[2]}(1+$$

$$s)^{k-2}\left(\frac{\sum_{l=2}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^a b + P_{[3]}(1+$$

$$s)^{k-3}\left(\frac{\sum_{l=3}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^a b^2 + \cdots +$$

$$P_{[k]}\left(\frac{\sum_{l=k}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^a b^{k-1}$$

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$$= P_{[1]}(1+s)^{k-1} + \sum_{i=2}^{k} P_{[i]}\,(1+ s)^{i-2}\left(\frac{\sum_{l=i}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b^{i-1}$$

Where as, for $j = k+1$:

$$C_{[k+1]} = P_{[1]}(1+s)^{k-1} + P_{[2]}(1+ s)^{k-2}\left(\frac{\sum_{l=2}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b + P_{[3]}(1+ s)^{k-3}\left(\frac{\sum_{l=3}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b^2 + \cdots + P_{[k]}\left(\frac{\sum_{l=k}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b^{k-1} + P_{[k+1]}(1+s)^{-1}\left(\frac{\sum_{l=k+1}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b^{k}$$

$$= P_{[1]}(1+s)^{k-1} + \sum_{i=2}^{k} P_{[i]}\,(1+ s)^{i-2}\left(\frac{\sum_{l=i}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b^{i-1} + P_{[k+1]}(1+s)^{-1}\left(\frac{\sum_{l=k+1}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b^{k}$$

$$= P_{[1]}(1+s)^{k-1} + \sum_{i=2}^{k+1} P_{[i]}\,(1+ s)^{i-2}\left(\frac{\sum_{l=i}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b^{i-1}$$

Because of the equation for $j = k+1$ right, by mathematical induction, this equation is valid for every $k \in N$. Completion time of all job $(j = n)$ can wrote as

$$C_{[n]} = P_{[1]}(1+s)^{n-1} + \sum_{i=2}^{n} P_{[i]}\,(1+ s)^{i-2}\left(\frac{\sum_{l=i}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b^{i-1} \quad (3.2)$$

$$1\left|P_j\left(\frac{\sum_{l=r}^{n} P_{[l]}}{\sum_{l=1}^{n} P_l}\right)^{a} b^{r-1} + st\right| L_{max} \quad (3.3)$$

Problem

Optimum solution for lateness problem in single machine environment is building on this Theorem 3.1 and corollary 3.1 below.

c) Theorem 3.1

For $1|P_j(\alpha(t)+\beta r^a)|L_{max}$ problem, if the jobs have agreeable weight $(P_i \le P_j)$ implies that $d_i \le d$, , for each J_i and J_j, optimum schedule is got by sequencing jobs in non-decreasing order d_j (EDD rule) [10].

d) Proof

Let S_1 as schedule of two contiguous jobs J_i and J_j without EDD rule. In other word $d_i > d_j$ implies $P_i \ge P_j$ then $S_1 = \{\pi_1, J_i, J_j, \pi_2\}$. Another schedule is got by exchange the sequence of job-i with job-j . π_1 and π_2 are a partial sequence that is may empty. This exchange makes a new schedule $S_2 = \{\pi_1, J_j, J_i, \pi_2\}$.

Assumed there are $r-1$ jobs in π_1 where completion time of this last job is B. J_i and J_j are job-r and job-$(r+1)$ in S_1. Similarly, J_j and J_j are job-r and job-$(r+1)$ in S_2.

Completion time of S_1 under condition $P_{jr}(t) = P_j(\alpha(t)+\beta r^a)$ is:

$$C_i(S_1) = B + P_i(\alpha B + \beta r^a)$$

$$C_j(S_1) = B + \beta P_i r^a + P_i \alpha B + P_j \alpha B + P_i(\alpha B + \beta r^a) + \beta P_j (r+1)^a$$

Completion time of S_2:

$$C_j(S_2) = B + P_j(\alpha B + \beta r^a)$$

$$C_i(S_2) = B + \beta P_j r^a + P_j \alpha B + P_i \alpha B + P_j(\alpha B + \beta r^a) + \beta P_i (r+1)^a$$

So, the lateness:

$$L_i(S_1) = B + P_i(\alpha B + \beta r^a) - d_i$$

$$L_j(S_1) = B + \beta P_i r^a + P_i \alpha B + P_j \alpha B + P_i(\alpha B + \beta r^a) + \beta P_j (r+1)^a - d_j$$

$$L_j(S_2) = B + P_j(\alpha B + \beta r^a) - d_j$$

$$L_i(S_2) = B + \beta P_j r^a + P_j \alpha B + P_i \alpha B + P_j(\alpha B + \beta r^a) + \beta P_i (r+1)^a - d_i$$

Let $L(S_1)$ is lateness of job-$(r+2)$ in S_1 and $L(S_2)$ is lateness of job-$(r+2)$ in S_2, can be seen that $L(S_1) = L(S_2)$. Let $L_i(S_1)$ and $L_k(S_1)$ are lateness of J_i and J_k in S_2. Then $L_i(S_2)$ and $L_k(S_2)$ lateness of J_i and J_k in S_2 . Maximum lateness of S_1 is

$$L_{max}(S_1) = \max\{L(S_1), L_i(S_1), L_k(S_1)\}$$

Then maximum lateness of S_2 is

$$L_{max}(S_2) = \max\{L(S_2), L_i(S_2), L_k(S_2)\}$$

Because of P_j always positive, then $L_j(S_1) > L_j(S_2)$ Meanwhile, because $d_i > d_j$ and $P_i \ge P_j$, , then $L_j(S_1) > L_i(S_2)$. Therefore,

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$$L_k(S_1) > max\{L_i(S_2), L_k(S_2)\}$$

$$max\{L(S_1), L_i(S_1), L_k(S_1)\} > max\{L(S_1), L_i(S_2), L_k(S_2)\}$$

$$\text{with } L(S_1) = L(S_2)$$

$$max\{L(S_1), L_i(S_1), L_k(S_1)\} > max\{L(S_2), L_i(S_2), L_k(S_2)\}$$

$$L_{max}(S_1) > L_{max}(S_2)$$

$L_{max}(S_1) > L_{max}(S_2)$ shows that S_1 is not optimum schedule because there is another schedule make smaller maximum lateness. It proofs that sequencing jobs by non-decreasing order of d_j reduce maximum lateness (EDD rule).

e) Corollary 3.1

For $1 \quad j \quad \frac{\sum_{l=r} P_{[l]}}{\sum_{l=1}^{n} P_l} \quad b^{r-1} + st \quad max$ problem, if the jobs have agreeable weight $(P_i \leq P_j)$ implies that $d_i \leq d_j$, for each J_i and J_j optimum schedule is got by sequencing jobs in non-decreasing order d_j (EDD rule).

f) Case Simulation in Manufacturing

A paper-mill that is has deterioration rate expect S = 0,004 to produce 74 tons paper daily (about 2.250 tons for a month). But then, on May 2014 they only produce 2.188 tons along that month. From the existing data of processing time of 159 jobs in May 2014, gotten index of learning effect $a = 1{,}4$ and $b = 0{,}99$.

Normal processing time by the data is 700.16 hours. Though learning is qualitative, the impact of this effort can expect by the production data. Effect of learning in this paper-mill by existing data on May 2014 is shown in Table 3.1.

Table 3.1 : Comparison of Completion Times (hours)

Normal	$s = 0.004$	$s = 0.004,$ $a = 1.4, b = 0.99$
700.16	926.4909	719.94

Although jobs still delay 19.76 hours, but effect of learning in this paper-mill reduces the impact of deterioration up to 206.5509 hours. This paper-mill usually sequence jobs by its weight. They make a mark of each job and operate job with highest mark first. This sequence is similar with Donald Waters's [11] scheduling rule, Most Urgent Job First (MUJ).

Furthermore, to determine optimum sequence under the maximum lateness problem, there are three rules of scheduling will be compared. There are EDD, SPT, and Most Urgent Job that is recently used in this paper-mill. The output of this comparison is written in Table 3.2.

Table 3.2 : Comparison of EDD's, SPT's, and MUJ's Output

	MUJ	SPT	EDD
Late-product (unit)	65	59	59
L_{max} (jam)	1859,2	1735,678	1606,856

Table 3.2 show that EDD rule gives smaller value of maximum lateness. If it was compare to MUJ that is recently used in this paper-mill, EDD less the value of maximum lateness up to 13.6%.

IV. Conclusion

Actual processing time model for single machine with time-dependent learning effect and deterioration is applicable to Earliest Due Date (EDD) rule. In the case simulation in a paper-mill, sequence under EDD rule give smallest maximum lateness then either Shortest Processing Time or Most Urgent Job First does. The maximum lateness of EDD rule less 13.6% then Most Urgent Job First rule that is recently used in this paper-mill.

References Références Referencias

1. Browne, S. Yechiali, U. 1990. Scheduling Deteriorating Jobs on a Single Processor. Operations Research Vol 38 PP 495-498.
2. Cheng, T C E. Kang, L. Ng, C T. 2004. Due-date assignment and single-machine scheduling with deteriorating jobs. Journal of the Operational Research Society Vol 55 PP 198-203.
3. French, S. 1982. Sequencing & Scheduling: An Introduction to the Mathematics of the Job-Shop. England: ELLIS HORWOOD LIMITED.
4. Koulamas, C. Kyparisis, G J. 2007. Single-Machine and Two-Machine Flowshop Scheduling with General Learning Functions. European Journal of Operational Research Vol 178 PP 402-407.
5. Kuo, W H. Yang, D L. 2006. Minimizing the Total Completion Time in a Single-Machine Scheduling Problem with a Time-Dependent Learning Effect. European Journal of Research Vol 174 PP 1184-1190.
6. Low, C. Lin, W Y. 2013. Some Scheduling Problems with Time-Dependent Learning Effect and Deteriorating Jobs. Applied Mathematical Modelling Vol 37 PP 8865-8875.

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7. Mosheiov, G. 1994. Scheduling jobs under simple linear deterioration. Computer & Operations Research Vol 21 PP 653-659.
8. Pinedo, M. 2002. Scheduling Theory, Algorithms, & System. New Jersey: PRENTICE-HALL, Inc.
9. Sun, L. 2009. Single-Machine Scheduling Problems with Deteriorating Jobs and Learning Effects. Computers & Industrial Engineering Vol 57 PP 843-846.
10. Wang, J B. 2007. Single-machine scheduling with the effects of learning & deteriorating. Omega Vol 35 PP 397-402.
11. Waters, D. 2003. Logistics an Introduction to Supply Chain Management. New York: PALGRAVE MACMILLAN.
12. Yang, D L. Kuo, W H. 2010. Some Scheduling Problems with Deteriorating Jobs and Learning Effects. Computers & Industrial Engineering Vol 58 PP 25-28.

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Productivity Improvement by Lean Manufacturing an Automobile Industry with the Help of Method Study

By Jitendra Mandloi & Mr. Abhishek Yadav

Abstract- In assembly line design, the problem of balancing has received most attention from past researchers, and a number of algorithms have been devised for the analysis of single, multi- and mixed-product assembly lines. In many cases, such algorithms seek a solution for the particular situation, which is under consideration and therefore have very little flexibility for generic application to assembly line design. Real life practical design issues include stochastic operation times, parallel workstation requirements, feasibility for workstation combining, and parallel line implementations, all of which are features which are ignored in many analyses.

Keywords: *lean manufacturing, material, time study, method study.*

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Productivity Improvement by Lean Manufacturing an Automobile Industry with the Help of Method Study

Jitendra Mandloi [α] & Mr. Abhishek Yadav [σ]

Abstract- **In assembly line design, the problem of balancing has received most attention from past researchers, and a number of algorithms have been devised for the analysis of single, multi- and mixed-product assembly lines. In many cases, such algorithms seek a solution for the particular situation, which is under consideration and therefore have very little flexibility for generic application to assembly line design. Real life practical design issues include stochastic operation times, parallel workstation requirements, feasibility for workstation combining, and parallel line implementations, all of which are features which are ignored in many analyses.**

Keywords: lean manufacturing, material, time study, method study.

I. Introduction

Lean design is the continuous improvement of facilities, equipments, tooling, and layouts that utilizes the best practices of lean manufacturing to achieve company goals. Company should make lean strategies to support lean design of facilities, equipments, tooling and layouts. Company can continuously improve leanness of a plant, during the future project and changes, by implementing lean program according to the lean strategies. For example whenever there is a change in the layout company should keep in mind the present condition of calculated lean parameters and design new layout accordingly.

Lean manufacturing is "A systematic approach for identifying and eliminating waste through continuous improvement by flowing the product at the pull of customer in pursuit of perfection".

Lean manufacturing concepts are mostly applied in industries where more repetitive human resources are used. In these industries productivity is highly influenced by the efficiency working people with tools or operating equipments. To eliminate waste, it is important to understand exactly what it is and where it exists. The processes add either value or waste to the production of goods.

II. Aim of the Paper

Find out and measure effective lean strategies that support continuous improvement through, developing a system, which is easily manageable (e.g. length of assembly line, operator density, equipment location, visual control etc.) Built in quality and feedback (e.g. repair station, and on, inline inspection stations etc.), efficient operations (e.g. eliminated isolated work station, maximize man and machine utilization, avoid non value added activities, maintaining continuous flow etc.), maximize throughputs, safety and ergonomics point of view e.g. minimize fork truck delivery.

When companies implement several or all of these lean methods, several outcomes consistently result:

- Reduced *inventory* levels (raw material, work-in-progress, finished product) along with associated carrying costs and loss due to damage, spoilage, off-specification, etc;
- Decreased *material* usage (product inputs, including energy, water, metals, chemicals, etc.) by reducing material requirements and creating less material waste during manufacturing;
- Optimized *equipment* (capital equipment utilized for direct production and support purposes) using lower capital and resource-intensive machines to drive down costs;
- Reduced need for factory *facilities* (physical infrastructure primarily in the form of buildings and associated material demands) by driving down the space required for product production;
- Increased production *velocity* (the time required to process a product from initial raw material to delivery to a consumer) by eliminating process steps, movement, wait times, and downtime;
- Enhanced production *flexibility* (the ability to alter or reconfigure products and processes rapidly to adjust to customer needs and changing market circumstances) enabling the implementation of a pull production, just-in-time oriented system which lowers inventory and capital requirements; and
- Reduced *complexity* (complicated products and processes that increase opportunities for variation and error) by reducing the number of parts and material types in products, and by eliminating unnecessary process steps and equipment with unneeded features.

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At the same time, lean implementation consistently fosters changes in organizational culture that exhibit the following characteristics:

- A *continual improvement* culture focused on identifying and *eliminating waste* throughout the production process;
- *Employee involvement* in continual improvement and problem-solving;
- *Operations-based* focus of activity and involvement;
- A *metrics-driven* operational setting that emphasizes rapid performance feedback and leading indicators;
- *Supply chain investment* to improve enterprise-wide performance; and
- *whole systems view and thinking* for optimizing performance.

III. Problem Environment

The objective of this paper is to use a case-based method to demonstrate how lean manufacturing principles when used appropriately, can help the industry eliminate waste, improve productivity and product quality, reduce lead time and obtain better overall financial and operational control.

IV. Method Study

a) Introduction

Method Study is the first of the two main divisions of w01\k study and i~ concerned with the way in which work is done. Method study is essentially used for finding better ways of doing work. It is a technique for cost reduction. The philosophy of method study is that 'there is always a better way of doing a job' and the tools of method study are designed to systematically arrive at this better way of doing a job. Method Study, as defined in chapter 1, is a technique for improving the efficiency of every type of work, ranging from that of complete factories to the simplest manual movements used in mass production.

b) Objectives

The objectives of method study can be:

- The improvement of processes and procedures.
- The improvement of factory, shop and workplace layout.
- The improvement of the design of plant and equipment.
- Economy in human effort and the reduction of unnecessary fatigue.
- Improvements in the use of materials, machines and manpower.
- The development of a better physical working environment.
- Improvement of quality of the products.

The distinction of method study is that it is a step-by-step procedure for improvements of methods of work, starting with the objectives, the selection of the activity to be studied, it proceeds to the collection and recording of the facts. The critical examination of the facts is the crux of the method study. This is followed by development of an improved method and the attainment of assured results· in terms of greater output, cost savings and other benefit. This standard procedure, with flexibility of critical examination makes method study the most penetrating tool of investigation known to the Management.

c) Method Study Procedure

This procedure involves seven basic steps as follows:

SELECT: the work to be studied

RECORD: all the relevant facts about the present method

EXAMINE: the facts critically and in ordered sequences, using the techniques best suited to the purpose.

DEVELOP: the most practical, economic and effective method having due regard to all contingent circumstances.

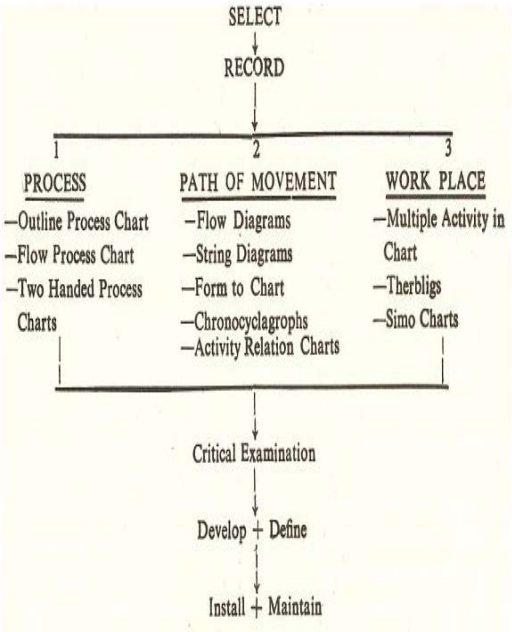
DEFINE: the new method so that it can always be identified

INSTALL: The method as standard practice

MAINTAIN: the method by regular routine checks.

It has been proved that the adoption of such a procedure ensures that no significant point is overlooked and helps in achieving maximum possible results. Each of these basic steps has been dealt in details in-the following chapters.

d) Method Study Procedure



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V. Conclusion

a) Major Finding and Implementation Details

The basic aim of the project is to make effective increase to productivity, which will help in assessment of leanness of the company. Company now has some parameters on the basis of which company can measure its existing lean condition of shop floor and continuously improve its leanness during the future project by improving the calculated productivity parameters.

Now company can plan its future program and new vehicles launch which required changes in facilities, layout etc by keeping in mind calculated productivity parameters; it helps to improve lean conditions of a company, from start of the project because it is better to work as per lean strategies from beginning rather than taking corrective action latter. After the analysis which company has certain base or thumb rule which help in improving manpower utilization and control of defects rate in future. On the basis of lean parameters, which are calculated for the present condition, company can improve its leanness during future project of increasing volume.

References Références Referencias

1. Aquilano Chase, *Production and Operation Management,* Eighth Edition, Tata McGraw Hill Publication, New Delhi, 1999, pp. 424-449.
2. Atkinson P., "Creating and Implementing Lean Strategies" Journal of Management Services, Vol-48, ISSN 0307-6768, Feb 2004, pp.18-33.
3. Berg Anderson., F. Ohlsson., "Lean Manufacturin g at Volvo Truck Production Australia", Thesis Report, Master of Science Program, Lulea University of Technology, Gothenborg , May 2005, pp. 1-95.
4. Chitale A.K, G.S. Narang, *Just- In- Time for World Class Manufacturing,* First Edition, Ajanta Publication, 1991, pp.1-60.
5. Emiliani M.L., "Origins of Lean Management in America" Journal of Management History, Vol.12, No.2, 2000, pp.167-184.
6. Flinchbangh W. J., "I mplementing Lean Manufacturing Through Factory Design", Project Report, Master of Science in Management, Massachusetts Institute of Technology, 1998, pp.1-90.
7. Askin, Goldberg, "Design and Analysis of Lean Production System", First Edition, John Willey & Sons Publication, 2003, pp. 1-300.
8. ILO, *Introduction to work study,* Universal Publishing Corporation, Forth (Rev.) Edition, 2003, pp. 1-143, 243-343.
9. Klipatrick Jerry, "Lean Principals", Utah Manufacturing Extension Partnership, 2003, pp.1 -5 (Source: www.mep.org/textfiles/leanprinciple)
10. Liker K. Jeffrey, *The Toyota Way,* first Edition, Tata McGraw Hill Publication, 2005, pp.1 -200.
11. Liker K. Jeffrey , Thomas Lamb, "Develop and Implement a World Class Manufacturing Model For U.S Commercials & Naval Ship Constructions", Guide University of Michigan, June 2000, pp.1 -48 (www.nsrp.org/projects/deliverables)
12. Memanus Hugh, "Lean Engineering; doing the right thing right", 1st International conference on Innovation and Integration of Aerospace Science, Queens University, Belfast, UK, Aug¶2005, pp.1-5.
13. Murphy Jim, "Lean Error proofing: Data Board for Kaizen", Nummi White Paper, July 1993, , pp.1-17
14. Newman John, Larry Tyler, "Forklift Free Plants", K-Tech white Paper, June 2004, pp.1- 15.
15. Oliver Nick, "Lean Production and Manufacturing Performance Improvement in Japan, the U.K, & U.S", ESRC Centre for Business Research, University of Cambridge Working Paper No.232, June 2002 pp.1-23.

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1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

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27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

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Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

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Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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