

A TRIANGULAR INTUITIONISTIC FUZZY -DEMATEL METHOD TO EVALUATE CRITERIA FOR AFFECTING PRODUCTIVITY IN HP VALVE MANUFACTURING INDUSTRIES

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Abstract:

The high-pressure valves producer tracks down it truly challenging in tracking down the right rules in assembling and creation of the great strain valves. Regardless of whether the makers find the measures, they find it challenging to rank the standards and focus on the rules for the high successful creation of the valves. Here, we have chosen twelve significant rules that influence the efficiency of the assembling of HP valves. Here we have applied Triangular intuitionistic fuzzy DEMATEL (TIF -DEMATEL). These rules are chosen in view of the writing accessible in assembling of the great strain valves

Keywords: HP valves manufacturing; TIF-DEMATEL.

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INTRODUCTION

The high-pressure valves are the main part in any high-pressure evaporator. Indeed, even brief error in the nature of the valve, it could make disastrous mishaps while using the part. Thus, fabricating businesses are looking for the best approach to assembling high tension heater. They are looking for the most splendid and imaginative strategy for high useful rate with top notch in assembling the high-pressure evaporator valves. There are such countless rules that are influencing the assembling and quality during the time spent assembling the great high-pressure evaporator valve. In this exploration of this paper we have chosen twelve models that are the most affecting than the other different standards.

Owing to globalization's extremely low total revenue, buyers' high expectations for quality goods, and the length of lead times, businesses are making every effort to improve. If they have the necessary opportunities, they may try to improve their current advancements in order to supply their materials. Experts understand that choosing the right provider is crucial to reducing their material costs and attempting to increase their advantage in this competitive globe. (Saen 2007). We must analyse the characteristics of the providers, such as their assembling approach and innovation capacity, in order to separate them. (Chen et al., 2007). Dickson (1966) identified quality, conveyance, and execution history as the key metrics.. As per the review (Ho et al., 2010) came to the conclusion that quality, conveyance,

cost/cost, manufacturing ability, administration, the board, and innovation are the important models.. It is difficult to distinguish the overpowering measures in the shop network the board when there are many more standards present. As a result, many analysts are focusing on this area. There are many methods known to predict the methods, such as the Dark hypothesis(Liu and Yang 2003).sing a system-centered, direct, multi-granularity semantic collecting approach to the assessment of supply execution (Chang et al., 2007) , Scientific organization process in Provider choice (Gencer and Gurpinar 2007), dim based dynamic strategy to manage fluffiness in provider determination different models assessment (Chen and Huang 2004). These strategies need voluminous data and won't be quickly propose the main measures which influence different standards. The TIF DEMATEL technique has the ability to reveal the relationship between these variables that affect various aspects of provider determination. This study analyses the causal relationship and strength of provider choice elements, as well as the immediate and abnormal influence among models using the TIFDEMATEL approach. There is not a lot of information needed to complete the TIF DEMATEL process. BMI foundation applied DEMATEL technique in 1972 in the initial time. DEMATEL procedure has been applied in organization control frameworks (Hori and Shimizu 1999) Showcasing system and client execution (Chiu et al.,

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2006) Yet, in actuality, issue, especially in subjective dissect, we can't have the option to examine what is going on by quantitative techniques. Provider chain information depends on the subjective. Consequently Fuzzy information is presented in DEMATEL strategy. Fuzzy was presented by (Zadeh 1965). By utilizing TIF DEMATEL strategy we need to assess the region like green production network the executives rehearses (Lin 2013), sunlight based power improvements (Luthra et al.,2016), electronic businesses (Chang et al., 2011).

The examination of the measures influencing the assembling in the metal manufacture industry utilizing TIF DEMATEL has not been endeavoured in any of the literary works gave as far as we could possibly know.

This paper's main goal is to identify and disentangle the variables that affect product development, supply, and customer loyalty. The elements are then ranked in accordance with the relevant standards and the interdisciplinary relationship between them is applied. The company can then determine which actions are recommended to work on the company actively. There are many standards that have an impact on productivity growth. TIF DEMATEL is the method that we utilised to analyse the metrics. In order to improve fulfilment, this investigation aids the high-pressure valve in understanding the regulations that play a key role in selecting the manufacturing process and delivery strategy. Relevant Literature

Relevant literature is sorted into two sub-sections namely (a) criteria for affecting productivity in manufacturing industries (b) Use of MCDM tools (c) intuitionistic fuzzy number and (d) Literature gap

(a) Criteria for affecting productivity in manufacturing industries
Almstorm and Kinnander (2017) used the efficiency expected evaluation (PPA) technique to evaluate the measures for affecting the efficiency of the Swedish assembly industry. The results demonstrate that among other business measures, manual gathering is the most effective rule. The factors influencing the productivity of the Sri Lankan manufacturing sector were broken down by Dias (1991), and a contextual research was also conducted. The findings demonstrate that capital force and urbanisation have a shady influence on business efficiency. Abri and Mahmoudzadeh (2015) used the information envelopment analysis (DEA) method to assess how data innovation has affected productivity in Iranian manufacturing areas. The findings of the aforementioned study demonstrated that data innovation has an impact on an enterprise's efficiency. Ridley and Ljomah (2015) assessed those components for more information.

(b) Utilization of MCDM apparatuses

By employing the logical pecking order process (AHP) technique, Karmaker and Saha (2016) deconstructed the models for affecting the effectiveness of Bangladesh's article-of-clothes manufacturing industry. The results showed that workplace factors affect representatives' working capacity in the enterprises and efficiency, productivity, and effectiveness. Wu (2012) used the Fuzzy DEMATEL approach to study the components of information execution on the board in the Taiwanese manufacturing sector. The two most important factors that

affect how information is conveyed to the board are cultural risks and executive support.

(c) TRIANGULAR INTUITIONISTIC FUZZY NUMBER
triangular fuzzy number $\tilde{A} (a_1, a_2, a_3)(a_1^*, a_2^*, a_3^*)$ is said to be an triangular intuitionistic fuzzy number if its membership function $\mu_A(x), \nu_A(x) : A \rightarrow [0,1]$, is defined as

$$\mu_A(x) = \begin{cases} 0, & \text{for } x \leq a_1 \\ \frac{x - a_1}{a_2 - a_1}, & \text{for } a_1 \leq x \leq a_2 \\ 1, & \text{for } x = a_2 \\ \frac{a_3 - x}{a_3 - a_2}, & \text{for } a_2 \leq x \leq a_3 \\ 0, & \text{for } x = a_3 \end{cases} \quad \text{and } \nu_A(x) = \begin{cases} 1, & \text{for } x \leq a_1^* \\ \frac{a_2 - x}{a_2 - a_1^*}, & \text{for } a_1^* \leq x \leq a_2 \\ 1, & \text{for } x = a_2 \\ \frac{a_3 - x}{a_3 - a_2^*}, & \text{for } a_2 \leq x \leq a_3 \\ 0, & \text{for } x = a_3 \end{cases}$$

Where $a_1^* \leq a_1 \leq a_2 \leq a_3^* \leq a_3$

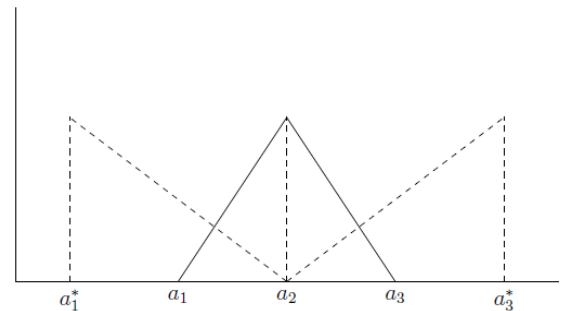


Figure -1 TRIANGULAR INTUITIONISTIC FUZZY NUMBER

Ranking of triangular intuitionistic fuzzy number

The ranking of triangular intuitionistic fuzzy number can be defined as

$$\tilde{A} (a_1, a_2, a_3)(a_1^*, a_2^*, a_3^*) = \frac{(a_1 + 4a_2 + a_3) + (a_1^* + 4a_2^* + a_3^*)}{12} \quad \text{---(1)}$$

(d) Literature gap

The use of MCDM strategies to influence the efficiency of the high strain valve manufacturing business is not yet the subject of any research papers, according to the writing overview. To fill this gap, we investigated the models for affecting productivity in high tension valve manufacturing operations using MCDM techniques, such as the TIF DEMATEL method. The written overview and the contributions from contemporary experts are seen as the models for influencing effectiveness in Table 1.

II.PROBLEM DESCRIPTION

TABLE 1. CRITERIA FOR AFFECTING PRODUCTIVITY

Notations	Criteria	Notations	Criteria
C1	Product quality	C7	Lead time
C2	Product price	C8	Reaction demand change in time

C3	Technology ability	C9	Stable production capability
C4	Service	C10	Financial Situation
C5	Delivery Performance	C11	Customer Satisfaction
C6	Stable delivery goods	C12	E – Commerce

III.METHODOLOGY TIF DEMATEL

In DEMATEL technique, they involved causal figures for straightforward the co operations between models of efficiency in HP valve fabricating ventures. Be that as it may, the DEMATEL isn't most likely to deal with information unclearness and human expectation. To stay away from this, TIF DEMATEL is recommended in this paper. The Fuzzy rationale dealt with the information fluffiness which changes information into fresh qualities. DEMATEL and Triangular intuitionistic Fuzzy rationale are joined to frame a TIF DEMATEL to examine the measures for efficiency in HP valve fabricating enterprises. Numerous analysts involved TIF-DEMATEL for tackling the issues (Bhalaji et al., 2019; Govindan et al., 2015; Lin et al., 2018). The strategies of the TIF DEMATEL are talked about beneath:

Step 1: Searching for master perspectives and recognizable proof of rules

A group of specialists is shaped and their thoughts pertinent to these themes are obtained. The models for efficiency are distinguished by inputs from modern specialists and furthermore possible writings.

Step 2: Plan the Fuzzy assessment lattice

After the models recognizable proof, it is vital for structure a pairwise correlation framework. By utilizing the Fuzzy semantic scale with five different qualities (0=no effect, 1=very low effect, 2=low effect, 3=high effect, 4=very high effect), the chiefs are surveying the collaboration between various standards. For the improvement of assessment framework, the chiefs are mentioned to given rating subject to the Fuzzy semantic scale.

TABLE 2: TRIANGULAR INTUITIONISTIC FUZZY LINGUISTIC VARIABLE

Linguistic variable	Level of influence	Triangular fuzzy numbers (TFN)	Ranking of Triangular fuzzy numbers (TFN)
No impact	0	(0.25,0.00,0.25) (0.00,0.00,0.50)	0.083
low	1	(0.25,0.25,0.50)	0.292

impact		(0.00,0.25,0.75)	
Normal impact	2	(0.25,0.25,0.75) (0.00,0.25,1.00)	0.333
High impact	3	(0.50,0.50,0.75) (0.00,0.50,1.00)	0.521
Very high impact	4	(0.50,0.75,0.75) (0.25,0.75,1.00)	0.729

Step 3: Transform triangular fuzzy numbers into the initial direct-relation matrix (F)

By utilizing Defuzzification strategy changed the fluffy numbers into applicable fresh regards. F is gained in light of the division of the technique, to defuzzify the fuzzy assessment network by utilizing Eq (2) and displayed in Table 3.

$$X_k = \begin{pmatrix} z_{11}^n & z_{12}^n & \dots & z_{1i}^n \\ z_{21}^n & z_{22}^n & \dots & z_{2i}^n \\ \vdots & \vdots & \ddots & \vdots \\ z_{i1}^n & z_{i2}^n & \dots & z_{ii}^n \end{pmatrix} \quad (2)$$

Step 4: The review processes the transforms triangular fuzzy numbers by the ranking method strategy. The surveys are defuzzified as a fresh worth which gets the Z_{ij} .

The strategic recipe processes the underlying direct-connection lattice, consequently getting the underlying direct-connection network F.

Step 5: Acquire normal Value

The review acquires the typical worth of starting direct connection lattices F from the aggregate sum of all underlying direct-connection network isolated by the quantity of respondents.

$$X = \frac{\sum_{k=1}^n x_k}{n} \quad (3)$$

where n is the number of teams formed.

$$X = \begin{pmatrix} z_{11} & z_{12} & \dots & z_{1i} \\ z_{21} & z_{22} & \dots & z_{2i} \\ \vdots & \vdots & \ddots & \vdots \\ z_{i1} & z_{i2} & \dots & z_{ii} \end{pmatrix}$$

Step 6: Set up the total- relation matrix M.

Since each element in N is between zero and one,

$\lim_{n \rightarrow \infty} Z^n = [0]$ (zero matrix),

$$\sum_{i=1}^{\infty} N_i = N + N + N^2 + \dots = N(I + N + N^2 + \dots) = N(I - N)^{-1} \quad (4)$$

Let $T = N(I - N)^{-1}$

The total-relation matrix M is acquired from the generalized direct relation matrix. The total-relation matrix is shown as Table 4.

Step 7: Obtain the sum of rows and columns.

The sums of rows and the sum of columns are separately denoted as D and R within the total relation matrix M and shown in Table 5.

Step 8: Set up the causal diagram.

The causal diagram was built by horizontal axis (D+R) which is the degree of central role. The vertical axis (D - R) which is the degree of relation and appeared in Fig 2.

I. CASE STUDY

Due to a few factors, the case industry has experienced production problems over the past ten years. These requirements are causing the job to be delayed. It has an impact on both industrial production and turnover. With a yearly revenue of 50 crores of Indian rupees, the case industry leads the high pressure valve manufacturing sector in southern India. The industry employs over 300 direct workers and 100 indirect workers. To successfully carry out operations, it is crucial to examine the productivity-related factors. The findings of this study will assist managers in understanding the numerous industry criteria and implementing productivity to lessen its severity.

III. RESULTS AND DISCUSSION

Using a decision-making process and assessment laboratory, the production criteria for boiler HP valves are examined (TIF DEMATEL). There are numerous decision-making approaches for the examination of criteria; however, because to the interconnectedness of the components, we chose the TIF DEMATEL methodology. The criteria are analysed using the TIF DEMATEL technique based on how closely connected components are and how one criterion affects others. Here, we've chosen 12 factors that have an impact on the production and delivery of high-pressure boiler valves. These standards were chosen based on the material that was accessible on high-pressure boiler valve production and delivery. Generally speaking, firms in the HP boiler business deal with difficult problems from the manufacturing, social, and consumer issues perspectives. This essay focuses on examining these 12 criteria in terms of the impact they have on both the production and delivery of HP boiler valves as well as the impact of each criteria on the others. The graph between the prominence vector and the relative vector can be used to obtain the results of each criterion's influence on the other criteria by combining the results of the prominence vector and the relative vector. As shown in Fig. 1, this causal diagram has been divided into two groups: the cause group criterion and the effect group criteria. The cause group criteria are represented by the positive values of the results, while the effect group criteria are represented by the negative values of the results. The positive numbers show that, in comparison to the other criteria, the criterion has a high influencing nature. When compared to other criteria, these positive numbers have a higher driving potential. The numbers that are negative show that the criteria are greatly influenced by other factors. These requirements have a lot of drive. From the causal diagram, it is observed that delivery performance (C5), customer satisfaction (C11), product price (C2), reaction demand change in time (C8), service (C4) and technology ability (C3) are falling under the cause group criteria. Similarly, stable production capability (C9), financial situation (C10), product quality (C1), stable delivery goods (C6), E- commerce (C12) and lead time (C7) are falling under the effect group criteria.

The cause group criteria are the driving factors because of the higher prominence vector and the effect group criteria are the driven factors. Here the cause group criteria influence the effect group criteria. from the casual diagram, it is observed that the delivery performance (C5),

is having the highest influencing factor when compared to rest of the criteria. Here delivery performance (C5) is the one driving the rest of the criteria. The delivery performance (C5) is a crucial component of supply chain management because it demonstrates how successfully the company can deliver items on time, with the use of anticipated resources, and without incurring additional costs to the company. It is also recognized to represent a company's capacity to meet customers' needs.. So from this, the influencing criteria can be sorted as $C5 > C11 > C2 > C8 > C4 > C3 > C9 > C10 > C1 > C6 > C12 > C7$. After C5 the next important driver to be prioritize is the C11 (customer satisfaction). The client anticipates excellent service. They pay you money in order for them to receive a product that is both on time and undamaged. Whenever an issue does arise, they expect your business to be transparent enough to explain why it happened and what you're going to do to make it right. These criterions are influenced by the delivery performance (C5), and the rest of the criteria are influenced by customer satisfaction (C11). From the causal diagram, it is observed that the least influence criteria is given to lead time (C7), because building all elements of a finished product onsite may take longer than completing some items offsite in terms of production. Transportation issues can cause parts to be delivered late, halting or slowing production and lowering output and return on investment. Using locally sourced parts and labour can help to reduce lead time. So, for any HP valve manufacturing organization to be successful in the market and have high growth of the product, these are important criteria to be considered. These all criteria are inter-related to each other by the TIF DEMATEL analysis and ranked upon the influence they possess on other criteria.

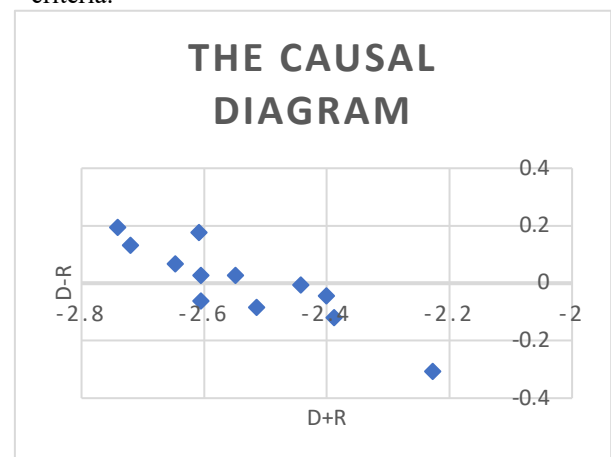


FIG 1: CAUSAL DIAGRAM

II. CONCLUSION

From this study, it is observed that the effects of the effects of the aforementioned criteria have played an important role in the manufacture of high-quality high-pressure valves, where companies are looking for new methods and innovative techniques to improve themselves, compete in the industry, and manufacture high-quality high-pressure valves. Similarly, when a company seeks customer satisfaction, certain criteria should be considered, such as customer feedback, which assists the company in developing a product to satisfy customers in the metal fabrication industry.

To the best of our knowledge, no literature has attempted to analyse the criteria affecting manufacturing in the metal fabrication industry using

TIF DEMATEL. This study was primarily concerned with the factors that could influence agile manufacturing in the metal fabrication industry. This analysis aids in determining which criteria should be considered in agile manufacturing. Available literature only results in finding the criteria on agile manufacturing, but there was no study on ranking and prioritizing the criteria in the metal fabrication industry. TIF DEMATEL methodology is used to identify the influence of criteria on agile manufacturing in the metal fabrication industry to overcome this. As discussed in the results section, when analysed using the TIF DEMATEL methodology, both manufacturing and social criteria have the same influence on agile manufacturing. However, when all twelve criteria in the TIF DEMATEL analysis are considered, it is discovered that customer satisfaction and concurrent engineering are the most influential criteria in the metal fabrication industry's agile manufacturing process. When it comes to the least influencing criteria in the metal fabrication industry, mounting product requirements and competing priorities are the least influencing criteria when compared to the other criteria of agile manufacturing. So, in order for any metal fabrication industry to be successful, they must consider these criteria priorities when selecting agile manufacturing. This research assists the metal fabrication industry in prioritising criteria that may assist the product in having a high growth rate in the market..

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This study also has some limitations in that it only addresses the ten criteria that we chose from the literature. However, in the real world, there may be additional criteria that influence agile manufacturing. These criteria are only applicable to the metal fabrication industry and are not applicable to any other industry. Furthermore, this research opens up possibilities for future research in the metal fabrication industry, such as supply chain management, customer service, product quality control, machine durability, and so on. Finally, this research assists the metal fabrication industry in the selection of the criteria and the criteria that most affect agile manufacturing, as well as the prioritisation of the criteria so that they can be applied in the metal fabrication industry.

MANAGERIAL IMPLICATION According to the causal diagram's findings, the HP Valve manufacturing unit's two most important influencing factors are delivery performance and customer satisfaction. These results can be used to improve the manufacturing of HP valves and increase customer satisfaction. This outcome is useful in determining the essential requirements for producing HP valves. The findings are helpful in classifying and ordering the factors that affect the production of HP valves. As a result, the manufacturing unit is better able to choose the correct standards to support efficient operation, and the organization is better able to adapt to compete in the market with the rest of the organization.

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IV. ANNEXURE

TABLE 3: INITIAL INFLUENCE MATRIX

	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C 10	C 11	C 12
C 1	0.0	0.6	0.5	0.4	0.5	0.4	0.2	0.4	0.4	0.4	0.3	0.3
C 2	0.3	0.5	0.1	0.7	0.8	0.7	0.6	0.4	0.4	0.7	0.0	0.3
C 3	0.4	0.8	0.0	0.5	0.4	0.3	0.3	0.4	0.3	0.4	0.4	0.4
C 4	0.2	0.7	0.8	0.2	0.6	0.2	0.6	0.2	0.2	0.8	0.1	0.5
C 5	0.7	0.4	0.3	0.7	0.8	0.1	0.6	0.1	0.3	0.0	0.7	0.9
C 6	0.4	0.5	0.4	0.5	0.0	0.4	0.3	0.3	0.3	0.3	0.5	0.3
C 7	0.2	0.2	0.7	0.2	0.8	0.7	0.0	0.8	0.8	0.3	0.2	0.0
C 8	0.7	0.1	0.4	0.1	0.3	0.4	0.2	0.0	0.0	0.3	0.1	0.2
C 9	0.3	0.5	0.4	0.4	0.4	0.0	0.3	0.4	0.4	0.3	0.5	0.3
C 10	0.8	0.2	0.7	0.7	0.2	0.8	0.5	0.7	0.2	0.8	0.2	0.5
C 11	0.0	0.1	0.4	0.4	0.7	0.3	0.4	0.4	0.7	0.0	0.1	0.9
C 12	0.3	0.8	0.2	0.8	0.8	0.7	0.2	0.8	0.7	0.8	0.7	0.4
C 13	0.0	0.1	0.0	0.0	0.4	0.7	0.3	0.4	0.0	0.0	0.4	0.9

8	4	4	4	4	5	3	2	0	4	3	5	4
2	7	2	2	6	8	7	8	8	7	3	6	0
7	4	7	7	8	0	6	3	3	4	3	8	6
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	4	3	4	3	4	3	2	5	0	4	4	3
C	2	8	2	8	7	3	7	2	8	2	7	0
9	7	0	7	0	4	3	6	1	3	7	4	2
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C	4	4	4	3	4	3	2	4	3	0	5	3
1	7	2	2	8	7	8	5	2	3	8	2	0
0	4	7	7	0	4	0	0	7	3	3	1	2
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C	4	5	3	3	5	3	2	4	3	3	0	3
1	2	2	8	2	6	2	6	2	8	8	8	5
1	7	1	0	3	8	3	6	7	0	0	3	9
	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C	3	5	3	3	5	3	2	4	3	3	5	0
1	8	2	8	8	2	8	5	7	8	8	2	8
2	0	1	0	0	1	0	0	4	0	0	1	3

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TABLE 4: TOTAL RELATION MATRIX

	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C 10	C 11	C 12
C 1	- 0. 3 5 6	- 0. 0 6 0	- 0. 0 5 2	- 0. 0 9 3	- 0. 0 9 3	- 0. 0 7 7	- 0. 0 8 6	- 0. 0 0 6	- 0. 0 0 0	- 0. 0 6 0	- 0. 0 7 2	- 0. 0 7 6
C 2	- 0. 1 1 4	- 0. 3 9 7	- 0. 0 5 6	- 0. 0 6 7	- 0. 0 2 4	- 0. 0 9 5	- 0. 0 3 7	- 0. 0 9 3	- 0. 0 0 2	- 0. 0 6 4	- 0. 0 2 7	- 0. 0 1 7
C 3	- 0. 0 8 8	- 0. 1 0 9	- 0. 3 4 9	- 0. 0 7 8	- 0. 0 7 6	- 0. 0 1 3	- 0. 0 8 1	- 0. 0 7 1	- 0. 0 2 5	- 0. 0 9 1	- 0. 0 2 9	- 0. 0 7 9
C 4	- 0. 0 5 1	- 0. 1 0 2	- 0. 1 4 1	- 0. 3 3 8	- 0. 1 1 0	- 0. 1 2 1	- 0. 0 4 3	- 0. 0 6 0	- 0. 0 5 6	- 0. 0 7 8	- 0. 0 9 3	- 0. 0 6 7
C 5	- 0. 0 8 2	- 0. 0 8 1	- 0. 0 6 8	- 0. 0 3 1	- 0. 4 0 1	- 0. 0 4 1	- 0. 0 5 4	- 0. 1 3 4	- 0. 0 9 1	- 0. 0 0 6	- 0. 0 7 9	- 0. 0 0 5
C 6	- 0. 1 1 7	- 0. 0 9 5	- 0. 0 8 0	- 0. 0 7 0	- 0. 1 5 2	- 0. 3 3 3	- 0. 0 3 3	- 0. 0 9 3	- 0. 0 7 5	- 0. 0 8 9	- 0. 0 8 2	- 0. 0 0 0
C 7	- 0. 1 1 1	- 0. 0 8 0	- 0. 1 1 8	- 0. 0 0 9	- 0. 1 1 9	- 0. 0 6 5	- 0. 2 3 5	- 0. 0 8 8	- 0. 0 9 1	- 0. 0 8 1	- 0. 0 9 4	- 0. 0 7 8
C 8	- 0. 8 7	- 0. 1 1 3	- 0. 0 9 9	- 0. 0 9 0	- 0. 0 7 2	- 0. 0 0 0	- 0. 0 8 2	- 0. 0 7 7	- 0. 0 4 5	- 0. 0 1 4	- 0. 0 5 5	- 0. 0 5 7
C 9	- 0. 0 6 2	- 0. 1 4 3	- 0. 0 7 7	- 0. 0 9 7	- 0. 0 9 4	- 0. 0 0 4	- 0. 0 7 0	- 0. 0 4 8	- 0. 0 0 5	- 0. 0 4 3	- 0. 0 7 9	- 0. 0 0 2
C 10	- 0. 3 7	- 0. 1 1 0	- 0. 0 7 2	- 0. 0 9 4	- 0. 0 9 5	- 0. 0 7 5	- 0. 0 8 2	- 0. 0 0 0	- 0. 0 0 4	- 0. 0 0 6	- 0. 0 9 9	- 0. 0 5 8
C 11	- 0. 0 6 1	- 0. 0 6 1	- 0. 0 9 2	- 0. 0 1 8	- 0. 0 4 6	- 0. 0 0 3	- 0. 0 6 9	- 0. 0 0 0	- 0. 0 7 7	- 0. 0 6 5	- 0. 0 6 0	- 0. 0 6 1
C 12	- 0. 1 0 3	- 0. 0 7 5	- 0. 0 1 2	- 0. 0 0 3	- 0. 0 8 4	- 0. 0 9 0	- 0. 0 8 6	- 0. 0 8 7	- 0. 0 8 8	- 0. 0 7 8	- 0. 0 6 3	- 0. 0 8 5

TABLE 5: CALCULATION OF (D+R) & (D-R) DATA SETS OF CRITERIA IN PRODUCTIVITY

	D	R	D+R	D-R
c1	-1.333	-1.272	-2.605	-0.062
c2	-1.294	-1.426	-2.721	0.132
c3	-1.289	-1.316	-2.606	0.027
c4	-1.261	-1.289	-2.549	0.028
c5	-1.273	-1.468	-2.741	0.194
c6	-1.299	-1.215	-2.515	-0.084
c7	-1.268	-0.960	-2.227	-0.308
c8	-1.290	-1.357	-2.648	0.067
c9	-1.224	-1.218	-2.442	-0.007
c10	-1.223	-1.178	-2.401	-0.045
c11	-1.216	-1.392	-2.608	0.176
c12	-1.254	-1.135	-2.388	-0.119