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LABOR PRODUCTIVITY ESTIMATION OF ANY MANUFACTURING INDUSTRY USING FUZZY LOGIC IN MATLAB ENVIRONMENT

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ABSTRACT

In every industry/organization Labor Productivity play's a major part in the overall growth and production. Many times, it is observed that industries do not attain their desired goals due to poor labor productivity. Labor Productivity is dependent on many different factors like Delay in Payment, management supervision over workers, proper work planning and scheduling, poor site safety program, lack of financial motivation system, etc. In this study, in order to estimate the Labor Productivity in any industry we have used wide data collection, questionnaire survey and by interviewing industry personals. This work aims to identify the prime factors affecting the Labor Productivity in any industry. The 50 factors of estimating Labor Productivity are chosen from the industrial projects. The survey was done through wide data collection, questionnaire survey and experts views which are then ranked through RII scale. The ranking is done through RII and then it is used for deciding top ranking factors which are responsible for Labor Productivity. After deciding factors for estimating Labor Productivity, fuzzy logic is used in MATLAB environment.

KEYWORDS: Labor Productivity, fuzzy logic, Prediction, decision-making, MATLAB.

1. INTRODUCTION

Due to globalization, all manufacturing industries are now facing competition from all around the globe. Hence to survive in such an environment every industry demands high productivity. But after performing the survey, it came to notice that in developing country like India, which is on the verge of emerging a major economic center most of the industries face a problem of very low productivity levels. Now due to such low productivity level, having a sustainable growth will be very difficult for many industries. Now first let's understand what productivity is then we will discuss the possible solution to improve productivity [1]. “productivity is the term used for the measurable utility of an activity performed for financial gains”. Now for optimizing productivity two type of action can be used. First one is related to the design of a product. For the sake of surviving in the competitive market, every organization has to work on Productivity improvement [37]. In manufacturing industry time of operation of machines in order to complete cycle is very crucial [36]. In this work, various techniques of increasing productivity, the design of products is studied thoroughly and any alteration made that can somehow help in fulfilling our objective is done. On the other hand, the other action deals with the process of developing the product. This action deals with all factors ranging from management related factors available resources, environment friendliness etc. The objective of this work is to underline/rank factors which affects the productivity of manufacturing industries through expert opinion done through survey and then to prepare a model which can help in analyzing productivity of any industries based upon certain factors and to provide details of necessary actions to be done by that manufacturing industry to improve it.

2. LITERATURE REVIEW

Many works have been done in past in search for an algorithm or model which can solve the problem of estimating labor productivity which will further help in optimizing the productivity of manufacturing industries. Some of the latest work has been discussed in this section below:

Every other industry has negative effects of Corporate Label Change over the productivity hence feedback of labor is suggested while making such decisions (Di Fana, Chris K.Y. Lob, Andy C.L. Yeungc, T.C.E. Chengc, 2018). The growth of labor productivity is highly influenced by technical growth along with growth in the capital-labor ratio (Michele Battisti, Massimo Del Gatto, Christopher F. Parmeter, 2017). A more data-oriented model of productivity of previously establishes industries will improve productivity when considered along with work environment and type of work (Dave R. Bonham; Paul M. Goodrum, Ray Littlejohn; Mohammed A. Albertha, 2017). Work reveals that intensity of research and development work and amount of tax government impose will have a curvilinear relationship with Labor productivity thus it required to have an optimal value of two to make best out of labor productivity (Mario Coccia,2017). Optimal productivity is maximum bearable productivity level possible with “good management” and “work field conditions.” (Nirajan Mani, Krishna P. Kisi, Eddy M. Rojas and E. Terence Foster,2017). Kapil Mittal et al. (2017) suggested that for fast evaluation model generation decision-making tool like ANN and Fuzzy for evaluation of labor productivity of any manufacturing facility will be very helpful. Toly Chen, (2016) defined Combine approach of hit and average range criterion used for productivity for evaluation has the limitations that it provides a range of productivity instead of a precise value and can't be applicable when an industry has increased in capability. (Thomas Czumanski and Hermann Lödding, 2016) has linked the decrease in labor productivity with inappropriate compensating measures. The approach should be a combination of data acquisition methods along with a structured evaluation process. The limitation of this technique is that it has a narrow application

area. (Pouya Nojedehi & Farnad Nasirzadeh, 2015) presented an integrated fuzzy System Dynamics (SD) approach for modeling and improving labor productivity. According to him using the proposed integrated fuzzy-SD approach, the project manager may decide on the most appropriate alternative solution to improve the labor productivity. (Erik A. Poirier, Sheryl Staub-French, Daniel Forgues, 2015) from last 4 decades work of labor productivity improvement is done with many models proposed in the process. In a recent study, the effect of Building information modeling has been very significant which may result in an improvement of a very high grade in productivity. (Gholam reza Heravi, and Ehsan Eslamdoost, 2015) proved that statistical approaches like neural network along with Bayesian regulation has benefits in examining the effects of different factors over labor productivity and also will help in modeling using historical data due to self-learning ability.

3. METHODOLOGY:

Fuzzy Logic: The word "fuzzy" usually used for cases in which there is no clear answer or boundary like there is a vague situation. Fuzzy logic resembles the human decision taking methodology and deals with vague and imprecise information, unlike classical set where precise and clear information is used for decision making. Fuzzy unlike Boolean logic where things can be either 0 or 1 i.e. true or false represent value with the degree of truth. This fuzzy logic is applicable to all real-world problems because in none of them the boundary is clear. The value in fuzzy logic comprises of value between 0 & 1 including two [7]. Fuzzy logic was proposed in the USA by Prof L. A. Zadeh, in the early 1960s. FL is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth-truth values between "completely true" and "completely false". Lofti A. Zadeh, who is considered as the father of fuzzy logic introduced fuzzy logic in 1965 in his research paper" Fuzzy Sets" Fuzzy logic is a way to make machines more intelligent, enabling them to reason in a fuzzy manner like humans. Fuzzy models "think" the way humans do and include verbal expressions instead of numbers [8] [9]. This method mimics the way operation of the expert's opinion over any decision making. Let us understand the concept of fuzzy logic by taking a real-life event and comparing it with the crisp set. Let there be a person named Rahul. Now we use a crisp set which is also known as a Boolean set then it can be represented by the following figure:

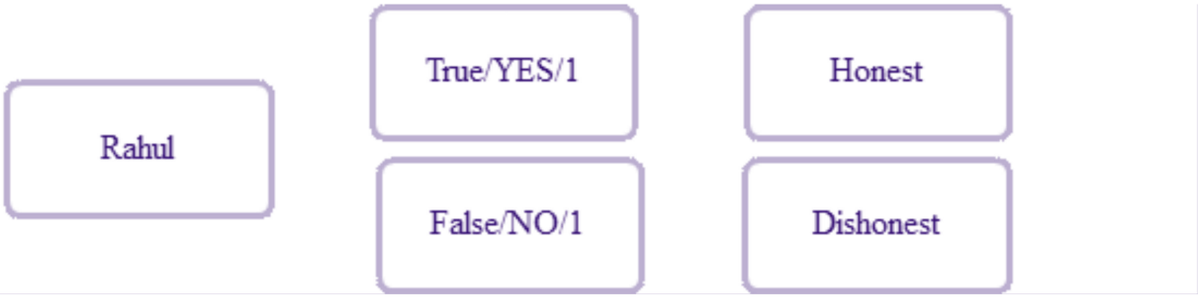

Figure 1: Boolean set logic

Now in this set Rahul can either be honest or dishonest. Now let's represent the same situation using fuzzy logic. Now let's represent the same situation using fuzzy logic. Now from the above figure, we can see that in fuzzy logic we can see that in fuzzy logic we can have many states in between 0 & 1 which indicates different states and somehow can be more relatable with real-life problems.

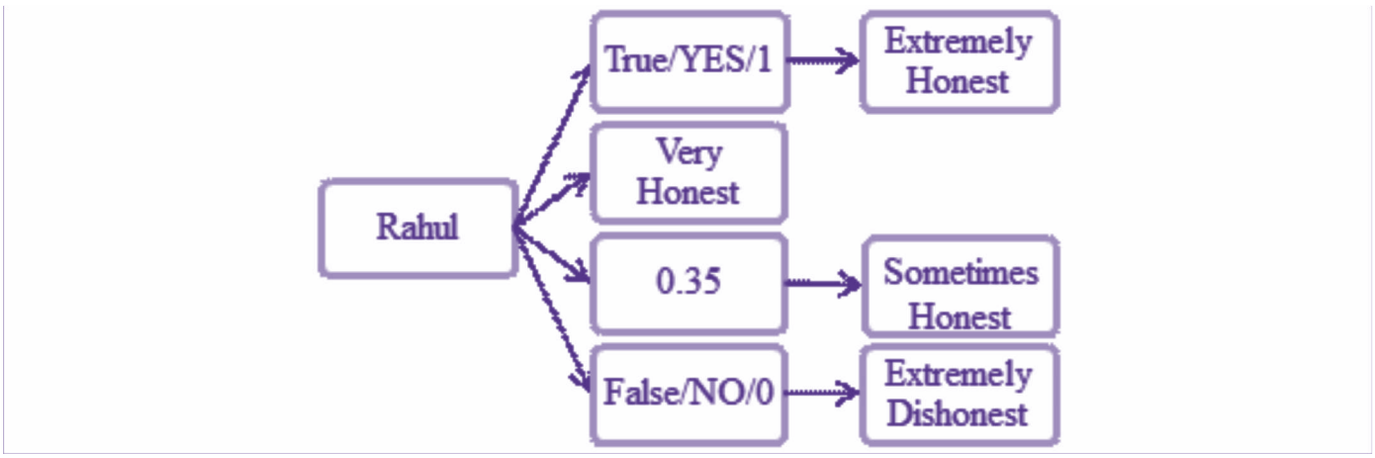

Figure 2: Fuzzy set logic

Following figure 3 depicts the stages involved in designing a fuzzy logic model in the present study. With the start, the input and output data are prepared and processed for designing model. After this stage, the membership function for each parameter is designed for further processing. The range and shape of each membership function are chosen wisely. The stage after this is to construct the if-then rule block. This stage is most important because this rule will directly affect the output of the model. The rules are formed on the basis of expert opinion. The maximum number of rules that can be drawn in any case is "a^n" where n is a number of inputs a is the number of stages of a membership function of each input. In the present case since we have 5 inputs and 3 stages of membership function so a maximum of 243 rules is possible. This stage will be further proceeded with simulating the model. Hence this stage will form the required model using fuzzy logic [10]. This whole process is performed over MATLAB software. MATLAB has a dedicated toolbox for fuzzy logic known as fuzzy interface system. The command used for opening the fuzzy toolbox is "fuzzy". The model is further tested and the result analysis is done to check the accuracy of the model. If results are found unsatisfactory then the process tuning will initiate in which more numbers If-Then rules are added. If the results are satisfactory then the training will stop at that point.

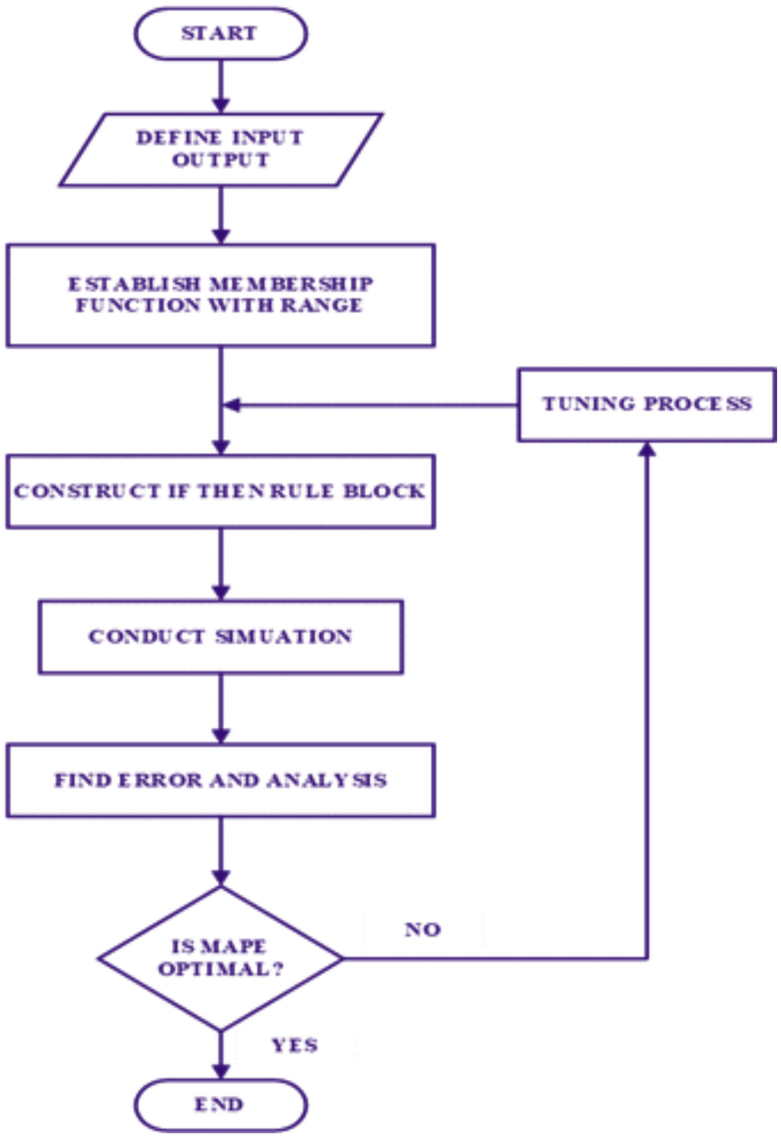

Figure 3: Flow chart for fuzzy logic model

4. RESULTS

After performing RII on the survey data for labor productivity prediction and computations, the parameters which have higher ranking have been chosen here. Out of all factors, the top five parameters with the highest RII value are taken into consideration for further discussion. Selected parameters with their RII values are rank are shown in below table:

Table 1: Top five factors with highest RII value.

S. NO.	Factors	RII Value	Rank
1	Management Supervision over Workers	0.78	1
2	Proper Work Planning and Scheduling	0.728	2
3	Poor site safety Program	0.7	3
4	Lack of Financial Motivation System	0.692	4
5	Delay in Payment	0.688	5

The fuzzy system may provide result using if…then rule and range of each input and output parameters with membership function and may easily understand by the following algorithm. For the labor productivity estimation fuzzy model is developed using the Mamdani method in five inputs parameters and one output parameters. Five inputs and one output membership functions were defined for all linguistic variables. All of them were represented by a combination of trapezoidal and triangular forms of fuzzy numbers. According to RII in labor productivity estimation, a factor which is ranked first in Management Supervision over Workers with RII value 0.78. The second-ranked factor affecting labor productivity is Proper Work Planning and Scheduling with RII value 0.728. The third-ranked factor affecting labor productivity is Poor site safety Program with RII value 0.7. The fourth-ranked factor affecting labor productivity is Lack of Financial Motivation System with RII value 0.692. The fifth-ranked factor affecting labor productivity is Delay in Payment with RII value of 0.688.

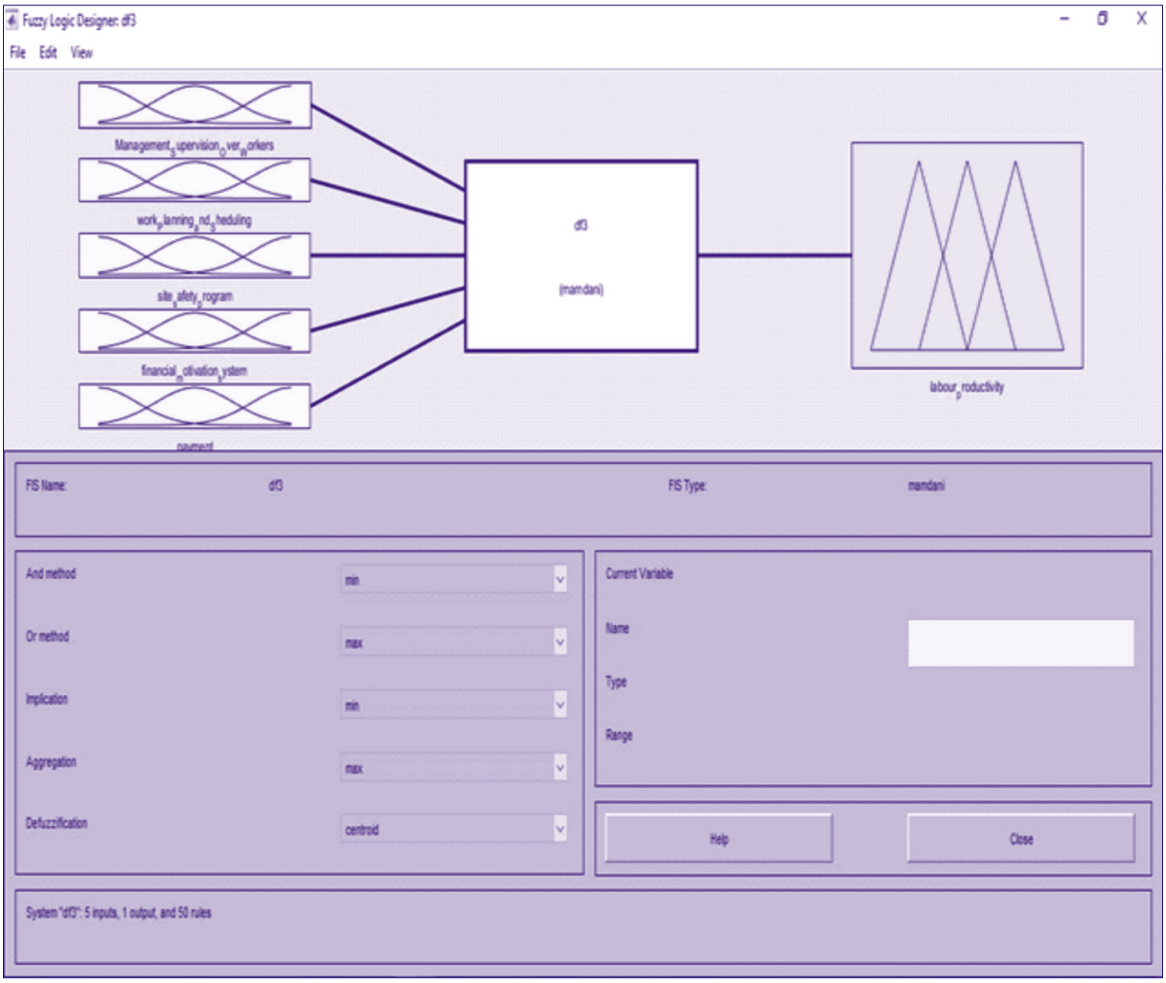

Figure 4: FIS editor

A fuzzy logic model was developed to predict labor productivity. For this model, a madman interface engine with triangular membership functions was used. Fuzzy subsets were used in inputs subsets namely very low (L), medium (M) and high (H).

Figure 5 Membership function editor for Management Supervision over Workers.

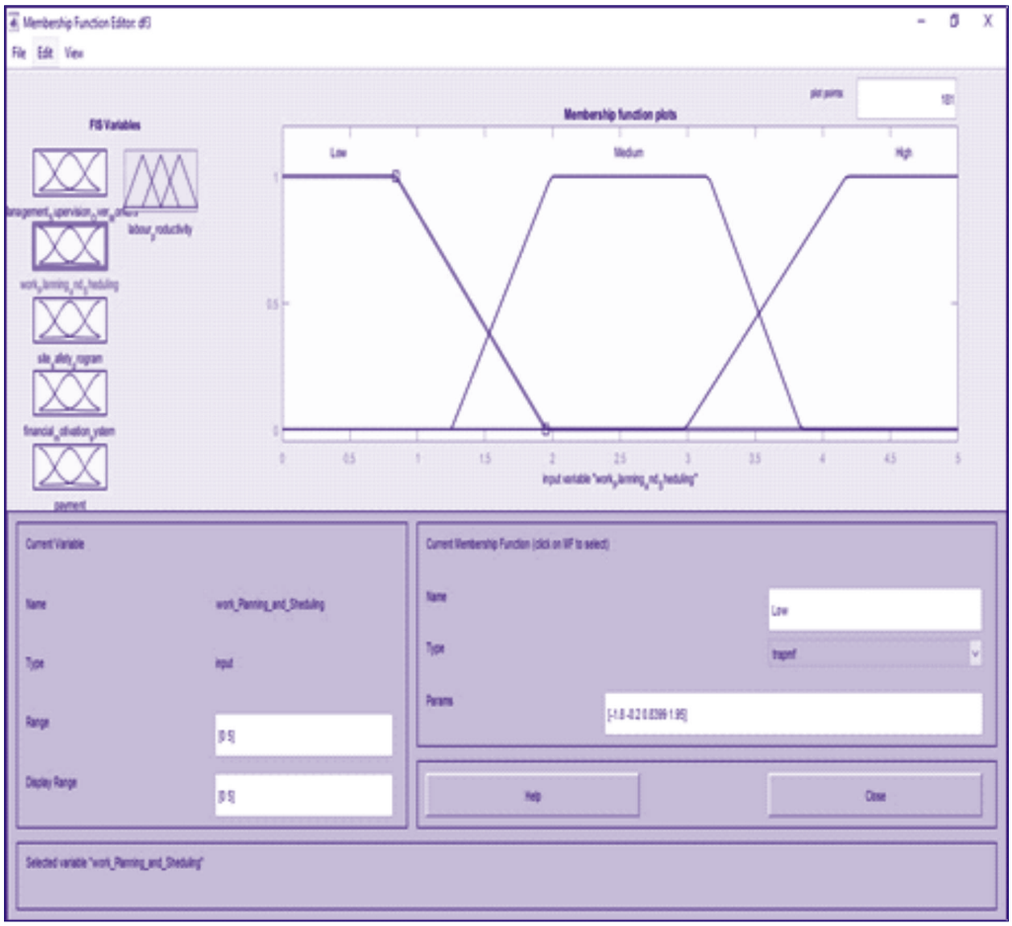

Figure 6 Membership function editor for Proper Work Planning and Scheduling

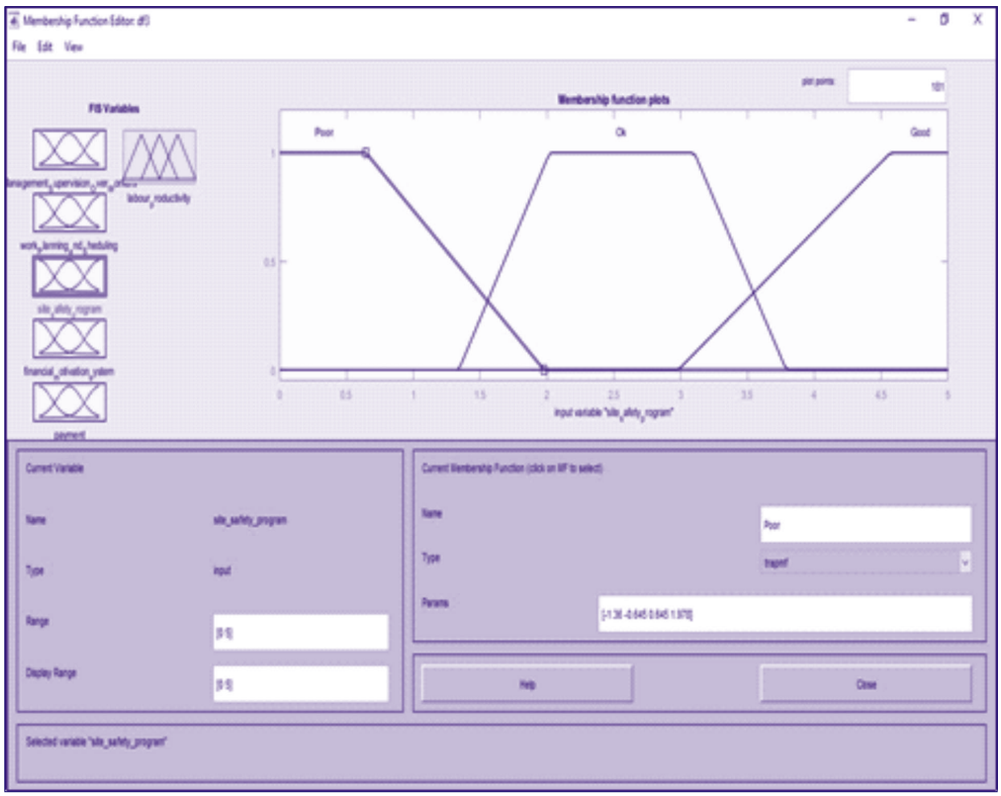

Figure 7 Membership function editor for Poor site safety Program

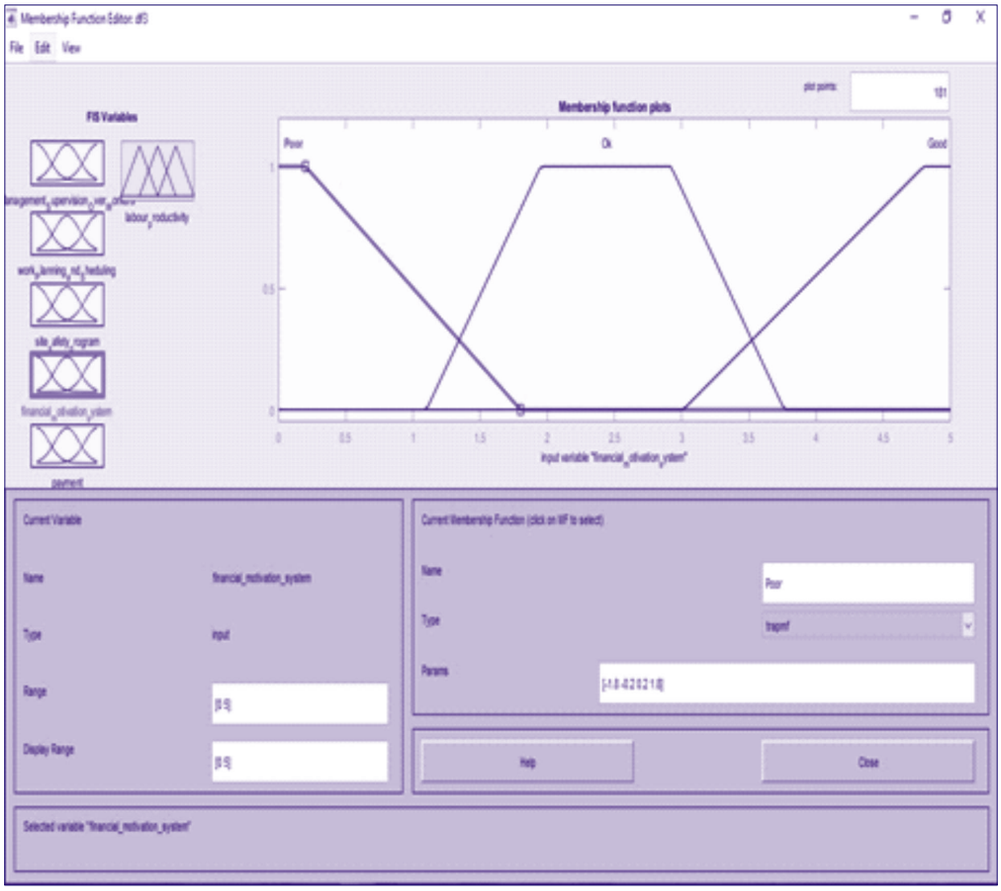

Figure 8: Membership function editor for Lack of Financial Motivation System

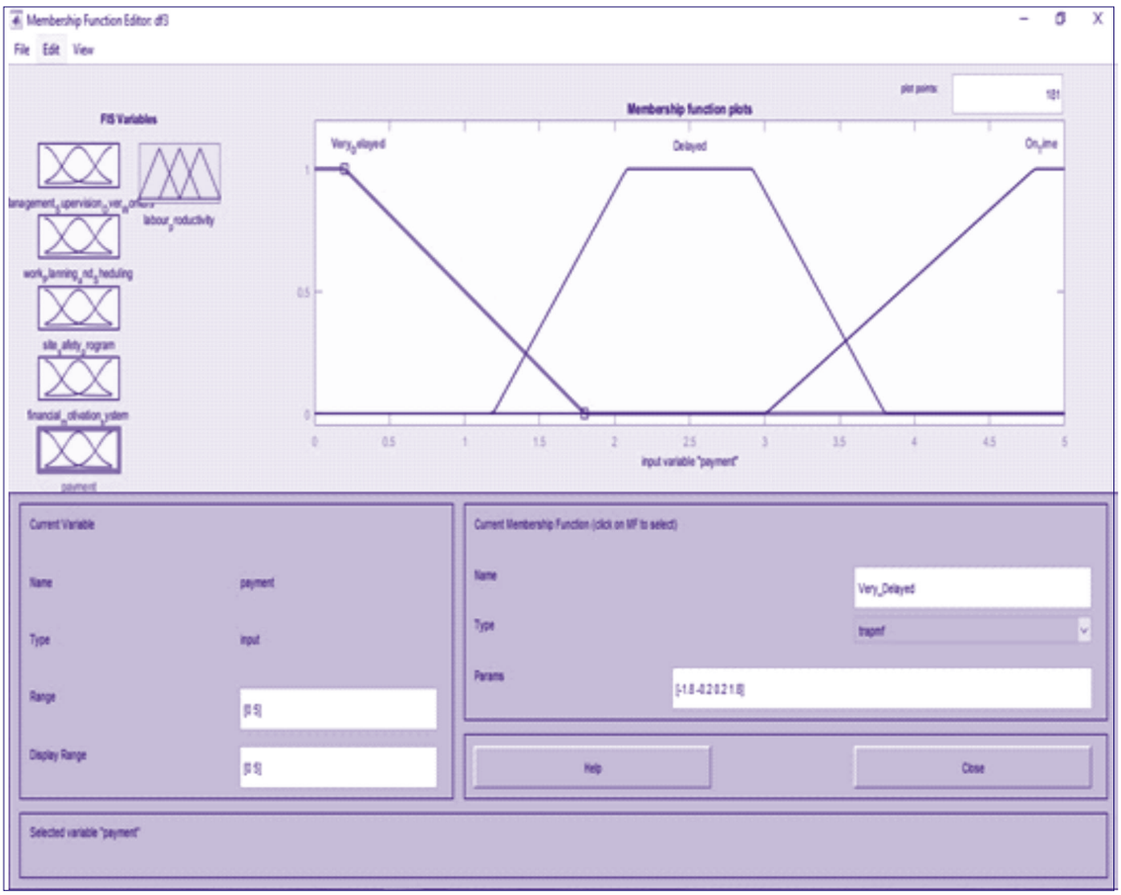

Figure 9: Membership function editor for Delay in Payment

Figure 10: Membership function editor for Labor Productivity

Fuzzy model is developed for the Labor Productivity and many different rules are made shown in rule viewer as shows in fig 11.

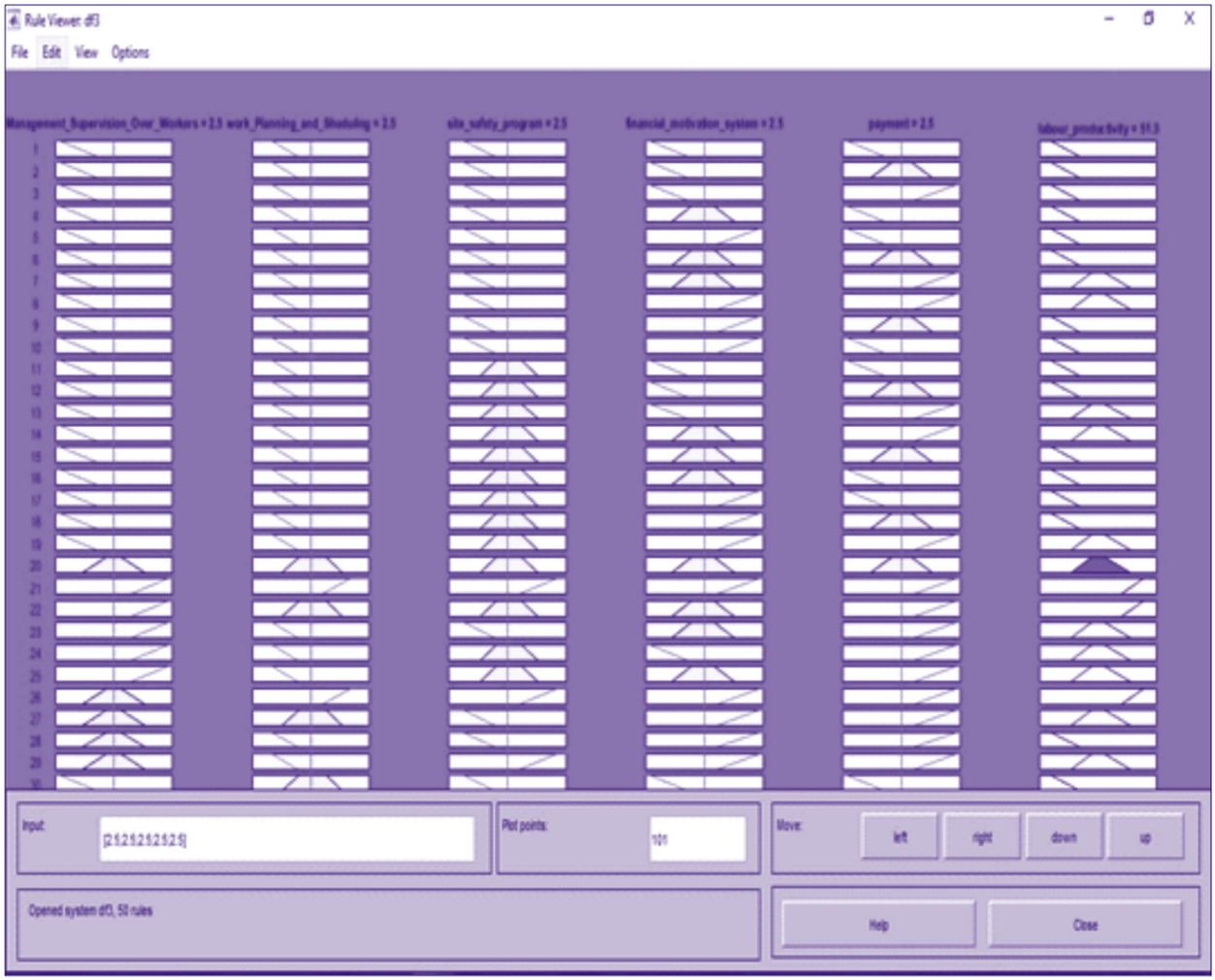

Figure 11: Rule Viewer for Labor Productivity

5. CONCLUSION

On analyzing results, it can be concluded that this study will be very helpful in analyzing productivity by simulating above designed fuzzy model with any manufacturing industry survey data and thus helping them to improve productivity on by improving underlined factors which are primarily responsible for poor productivity. In the present work, the ability of Fuzzy logic in estimating labor productivity is verified. A survey is performed and data is collected and organized. RII is performed on the data and all factors are ranked accordingly. In this work, we have utilized the top 5 factors for predicting labor productivity. After finalizing factors Fuzzy logic has been successfully applied and the result showed variation in labor productivity based on the change in values of various input factors. The work has been performed on a Fuzzy logic toolbox of MATLAB software.

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