Original Article

FIS-Based Prediction And Estimation Of Health Insurance For Workers In The Manufacturing Sector

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Abstract

In the manufacturing industry workers life is very risky and they are getting less salaries. In that situation they need the health insurance for their medical expenditures. Various accept that representatives' wellbeing and financial elements assumes a significant part in their possibility to buy medical coverage. In presents study, a decision model namely Fuzzy Inference System (FIS) tool of MATLAB2014b used for the employees to identify and purchase appropriate insurance policies according to their potential and other various factors which may affect the decision of purchasing a policy. For the same purpose, data of the hundred workers from a manufacturing industry have been considered as input in FIS. The three parameters of workers such as risk of illness, salaries of the workers and age have been considered chance for purchasing health insurance. It is found in this study that 08% workers were probably going to buy health care coverage at 'Low' level and 34% workers show their possibilities at 'high' level. After carefully examination this study advocate that FIS would offer potential legitimizations to set a new approach in distinguishing planned health care coverage buyers and may use for finding the risk factors in other industries.

Keywords — Manufacturing sector, Fuzzy inference system (FIS), Risk factor, Health Insurance policy

1. INTRODUCTION

In Today's world human life comprises of many unexpected and uncertain health issues. Since 2019, we have encountered the vulnerability and sudden demise of life due to COVID-19. It's been three decades since we have seen the sudden growth in the health insurance sector. Now the people are much aware about knowing, analyzing and finally selecting the suitable health insurance policy. The life insurance sector captures 75% of the accounts and share market for 50% insurance companies in India. Until outbreak from COVID-19, the insurance industry experienced double- digit growth, with the life insurance sector growing at11-12% annually. According to PWC, insurance is now considered a necessary risk mitigation tool, not an investment product for the wealthy. The pandemic has also changed the claims pattern: The life insurance claims increased 5-10 times post the 2nd wave.

Health is wealth is no longer an adage. The health insurance becomes an important part of individual's life. Now days, individuals are a lot of mindful around their health care and protect of their wealth. Medical emergencies come unannounced. To get the best medical facilities without a financial burden will need a health insurance. Buying the medical coverage is not at all lengthier an option but has become a compulsion. Health insurance increases accessibility to quality healthcare, the private health care in particular where the cost remains a barrier for many. For people and families those not have a health insurance, hospitalization means spending lot of money out of the pocket to pay the hospital bills. Most of people face the common situation when they do not have adequate cash to deal with a sudden medical emergency. In such a case an insurance plan of health can act as a boon. This paper is about to apply the Fuzzy Model to ensure and motivate the people about how important it is to take medical coverage as they lower the risk of future expenses on the health. As study of many research papers on medical coverage using Fuzzy Logic (FL) has proved to be very helpful in taking appropriate decision at the right time for giving treatment to the patients immediately and it may be monitoring from the treatment in future.

The FL application has been used first time thirty-nine year ago (1982) for purpose of insurance. The data on the FL has been introduced at school of Berkeley, California in his based on fuzzy set paper [1]. Theory of Fuzzy Set (FS) is a procedure for multi-esteemed rationale resulting as of FS to manage endless thinking. FS hypothesis is a compelling device to handle issues of vulnerability. Fuzzy set hypothesis and FL are profoundly appropriate and associated bases

aimed at information-based design in medication for culpabilities, for example, the conclusion therapy of ailment. The FS Theory was first produced for tackling the vague and unclear issues in the field of man-made brainpower/master frameworks, particularly for loose thinking and demonstrating semantic terms. Fuzzy set theory makes many things easier and helped to save time, money, and energy.

FL has been used in various fields in today's time such as in medical science and research. FL based systems are being regularly used in medical diagnostics, radiology for the control of an aesthesia, pressure and the temperature control and other medical uses. The FL is a wide methodology instead of a mathematical logic and is relevant in many branches. [2] the modern procedure of fuzzy sets and FL has fostered and integrated for solving the problem in the field related to management and finance depends on FL control procedure [3].

The main individual who dealt with implemented FL in insurance field and his work was to ascertain the fuzziness in protection field endorsing [4]. Since fuzzy innovations which incorporate the theory of fuzzy set, the numbers of fuzzy, FIS, arithmetic of fuzzy, programming of fuzzy, deterioration of fuzzy and for the protection region the soft-computing has been implementing. Shapiro [5] has been talked about the significant request zones of protection in somewhere around 20 years (1984-2002). It projected liabilities, incorporates order, endorsing, estimating and ratemaking, resource portions and ventures. In general, there are very few works anticipated in the writing near foster model for assessment choosing protection contracts. An assessment model proposed for buying insurance of health and allowance protection utilizing scientific order process and fuzzy rationale [6]. Four elements are measured as the contributions of the anticipated methodology with yearly pay, instructive level, age and hazard inclination. After sometime the modified the model buying five sorts of protections including life, annuity, wellbeing, mishap and venture situated protections. The new modified model consolidated the Delphi method into their projected assessment model given by [7]. A fuzzy standards-based technique to characterize the probabilities of buying medical coverage in view of three different factor of risk which are age, pay and hazard of disease proposed by [8]. Be that as it may, to our superlative evidence, nearby is not any exertion happening fostering for utilizing the selected modeling system FIS explicitly for protection counsellors considering genuinely verifiable dataset analyzed of Kota Star Municipality in Malaysia by [9].

Established an extraordinary a Fuzzy Expert Systems as a tool for construction intelligent decision-making systems to investigate is the significance for medical diagnosis [10]. Sreekantha and Kulkarni (2013) [11] present a report on different insurance assessment techniques. A FL-controller of PI to make the change easy in output scaling factor designs by [12]. Application for FL in protection area which incorporates characterization, anticipated responsibilities, guaranteeing, fuzzy future, pricing, cash flows, and investments presented by [13]. Mayilvaganan and Rajeswari (2014) [14] used FL controller scheme as a tool for finding a health risk analysis which is associated to Level of Blood Pressure, Pulse rate and Kidney function. The mathematical modeling has used by different authors for medical and some other purpose [15-26].

Hemba and Islam (2017) [27] used fuzzy logic to design fuzzy controller for the representation of uncertainty. The investigated domain for designing and developing real world problem in the fuzzy logic which includes the taxonomy by [28]. Arbitrary impact model to recognize and control the interest for medical coverage and Takaful in Malaysia [29]. Vijaya and Arthi (2019) [30] investigated a fuzzy logic bases system for performance and assessment of students in education sector by using fuzzy reasoning approach and gave comparative study amid fuzzy and traditional average. A model by exploitation of fuzzy numbers and FL controlled variety bazaar worth and considered measurement rates as fuzzy numbers [31].

A FL system for patient nursing by sensors and shows reasonable accuracy to recover the efficiency of the system for patient care has proposed by [32]. A pocket friendly device worked on fuzzy inference rule for treatment of the treatment of hypertension and diabetes [33]. A fuzzy logic treatment of infected persons with COVID-19 and developed the fuzzy relation between deaths and the worsening condition of patients applied [34]. Health monitoring methods which involve costly sensors and identify fault signatures produced in induction motor by exploitation mechanical recent sign analysis developed [35]. Dairo and Szűcs (2020) [36] developed fuzzy system for mobile service provider's customer which base on an emerging market. A fuzzy logic system to test report records to process Blood pressure levels, Diabetes, Lipid distribution, Liver function tests that will be used as input to the system proposed [37]. Fuzzy inference rules to provide a quantitative security index to the cloud service providers developed [38]. Vanani and Sohrabi (2020) [39] advocate the chance of implanting the past valuable experiences into a brought together framework that can diminish the significant weight of execution disappointment. A hybrid approach and analyses the properties of strategy improvements on community medical coverage on families established [40]. Identified and investigate the low back pain of the workers those are working by using fix chairs in the garment factory in Bangladesh and recommend to provide them ergonomically designed chairs for working [41]. The FIS applied in medical area to diagnosis prostate cancer and child anemia [42, 43]. The FL regulator arrangement used in many different fields [44, 45].

The treatment of any dieses is very expensive for a meddle or low-income family and it's a very burden of the workers those are working in the industries such as manufacturing, garments, chemicals etc. For better treatment its necessary to buy the health insurance according to their salaries. In this paper, we will discuss and understand the concept of fuzzy logic as a verdict model for purchasing the health insurance by the manufacturing industry workers form Gurugram region.

2. METHODOLOGY:

Fuzzy Logic-Inference System

Zadeh (1965) [1] developed FIS which remains indispensable component of a FL and fuzzy set hypothesis. The FIS is an interaction to decipher fresh qualities as information factor and applying a few arrangements of fuzzy principles and elasticity the outcome allocates comparing values as the result factor. This is a strategy to plan a contribution to a result utilizing FL which depends on the planning system. The rules of fuzzy are characterized to decide the standard result from the specified instruction input information. The rules of fuzzy mirror the human expert information, address as etymological factors, while participation work address expert understanding of those factors.

FIS is otherwise called rule-based frameworks of fuzzy, FES), Fuzzy cooperative recollections or Fuzzy rationale regulators when utilized as regulators [9]. Design or interaction of a FL framework is described in present section.

In the engineering of the FL framework, every part assumes a significant part. The design comprises of the different four parts which are given underneath:

1. Rule Base: it is a part utilized for putting away the arrangement of rules and the If-Then environments specified by the experts are utilized for governing the dynamic frameworks.
2. Fuzzification: It is a component or part for changing the framework inputs, i.e., it changes over the crisp values into number of fuzzy. Crisp numbers are individual's inputs which are estimated from sensors and afterward Fuzzification agreed them into the resistor frameworks for additional handling.
3. Inference Engine: This part is a primary part in any FL framework, on the grounds that all the data is handled in the Inference system. It permits clients to track down the matching degree between the present fuzzy information and the guidelines. After the corresponding degree, this framework figures out which regulation is to be supplementary through the specified info arena. Whenever wholly regulation is terminated, formerly they are joined for fostering the rheostat activities.

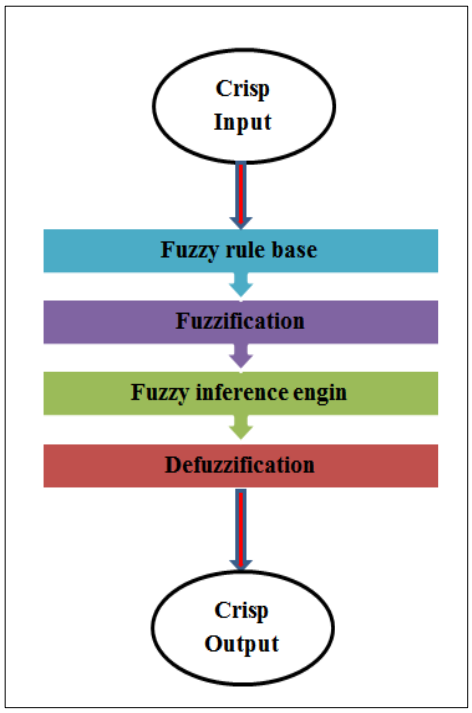

Fig1: Block diagram of Process of Fuzzy Inference System

4. Defuzzification: Defuzzification is the inverse process of Fuzzification. It is used to convert the fuzzy sets obtained by inference engine into a crisp value. There are a few Defuzzification techniques accessible and the most ideal Mamdani strategy utilized in this paper.

The means in Fuzzy deduction framework are utilized to test a contextual analysis of workers in buying medical coverage. The means explicitly altered to the target of this paper are made sense of in section III.

3. RESULT AND DISCUSSION

The FIS is developed to test the data of one hundred workers form manufacturing industry near Gurugram. We take the three input variables such as age of the worker, risk of illness and salary that may impact the chance of insurance purchasing. Mamdani Fuzzy inference method used by Temple (2006) [45] and Boadh et al. (2022) [21] in this system which take contribution factor and integrated the fuzzy set directions on those ideals and gives crisp output factor. There are some important steps which accomplished employees in buying the medical coverage plan.

Step 1: variables: Input and output

In Mamdani strategy of FIS, the variables of probability of buying health care coverage are salary, chance of illness and, result of the technique is chance of buying medical coverage.
As displayed in Fig. 2, input factors relate to chance of buying medical coverage as a result variable displayed in Fig. 3. The output variable shows the possibility of purchasing health insurance is represented as chance of purchasing to manufacturing industry workers which is depending on the capability due to salaries, neediness, and condition of the individual worker. The function of membership is age of the workers and their salaries have chosen based on the previous study done over Malaysia [9]. Iqbal et al. (2021) [41] also used the criteria of the age for finding the low back pain of garment industries workers in Bangladesh.

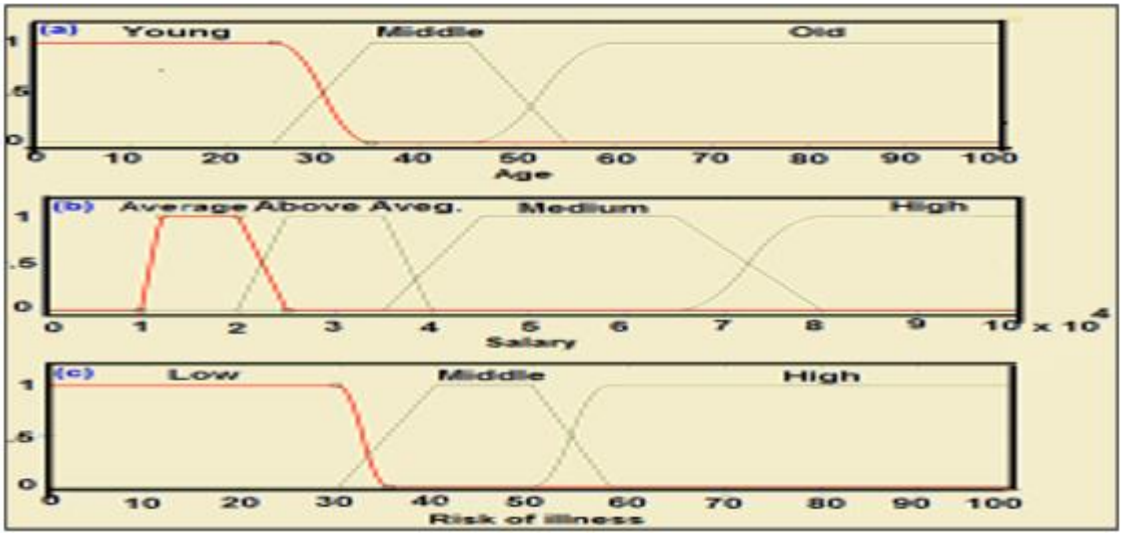

Fig 2: Input parameters of the system (a) Age, (b) Salary, (c) Risk of illness

Step 2: System Variable: fuzzy sets

To obtain the membership function linguistic variables need to be fuzzily. The system identifies the input and the output factor for defines esteemed memberships. Membership linguistic variables for salary are average, above average, medium, and high. Membership linguistic variables for Age, are young, middle, and old have been considered. The risk of illness of the industry workers are consider low, middle, and high as Abdullah and Rahman (2012) [9] used for garment workers over Bangladesh.

Step 3: Implementing Fuzzy Rules

To describe the system methodology the succeeding phase is defining the IF- THEN Rule. For chance of purchasing the health insurance for manufacturing industry workers, the fuzzy rules are defined in this step. Abdullah and Rahman (2012) [9] have generated 28 fuzzy rules, but in this study total 50 fuzzy rules implemented. It observed that if the fuzzy knowledge base rules are more than high accuracy in results obtained by FIS [42].

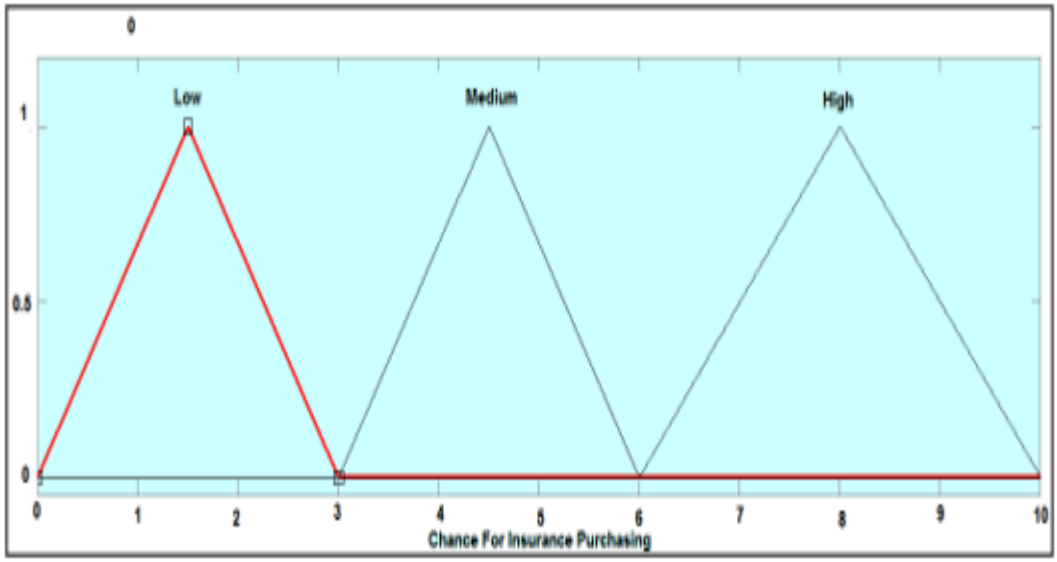

Fig 3: Chance for insurance purchasing as Output factor

The data from industry workers are injected into the system in this step. This data converted into fuzzy rules on the basis of expert knowledge (Fig. 4). The rules describe on the basis of linguistic variable are considered in this study as shown in below surveys:

Rule 1: IF age is 51 years old AND salary is 52,000 AND the risk of illness is Medium (40) THEN the chance of buying the medical coverage is 6.5 High.

Rule 2: IF age is 18 years old AND salary is 10,000 AND the risk of illness is Low (15) THEN the chance of buying the medical coverage is 5 Medium.

Rule 3: IF age is 36 years old AND salary is 32,000 AND the risk of illness is High (52) THEN the of buying the medical coverage is 5 Medium.

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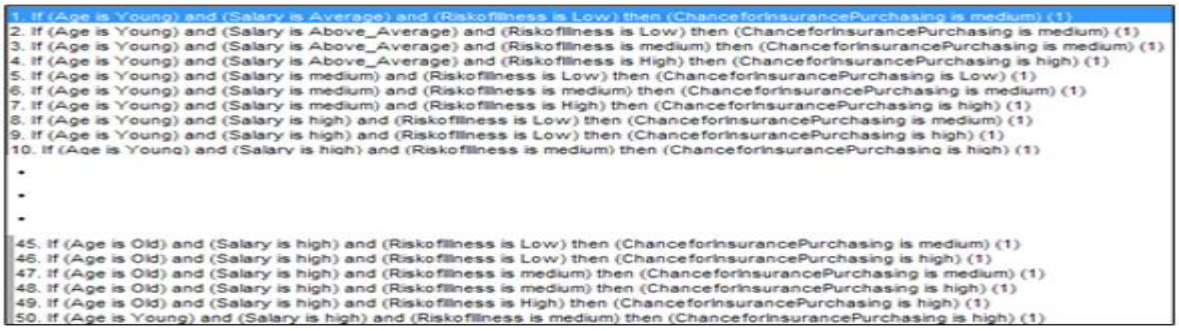

Fig 4: Fuzzy rules developer

Employee	Age (year)	Salary	Risk of illness	Chance of Insurance Purchasing	Employee	Age (year)	Salary	Risk of illness	Chance of Insurance Purchasing
1	18	10,000	15	5	**51**	50	41,000	27	4.26
2	25	25,000	35	5	**52**	52	25,000	20	4.96
3	40	50,000	20	1.5	**53**	53	44,000	42	6.5
4	51	52,000	40	6.5	**54**	54	31,000	49	4.74
5	36	32,000	52	5	**55**	55	65,000	55	6.5
6	24	20,000	55	4.68	**56**	57	65,000	29	6.5
7	44	18,000	26	1.5	**57**	57	29,000	29	5
8	31	30,000	24	4.5	**58**	60	35,000	19	3
9	56	40,000	52	6.5	**59**	60	35,000	39	4.5
10	15	12,000	42	4.5	**60**	60	35,000	49	4.5
11	28	26,000	22	4.5	**61**	61	65,000	18	6.5
12	45	33,000	28	4.5	**62**	61	65,000	28	6.5
13	39	28,000	30	4.5	**63**	63	42,000	32	6.5
14	53	35,400	56	5.7	**64**	65	72,000	28	5.14
15	20	22,000	38	4.5	**65**	65	72,000	18	5.14
16	37	45,000	28	1.5	**66**	65	72,000	32	5.14
17	51	52,000	20	4.81	**67**	65	72,000	44	6.5
18	60	65,000	45	6.5	**68**	70	48,000	27	6.5
19	42	56,000	40	6.5	**69**	17	25,000	10	4.5
20	20	35,000	15	4.5	**70**	29	32,000	25	4.5
21	37	26,000	56	5	**71**	18	25,500	25	4.5
22	50	36,000	56	5	**72**	27	35,500	55	5.96
23	60	66,000	54	6.5	**73**	37	35,500	55	5
24	48	25,000	17	4.07	**74**	67	45,400	53	6.5
25	20	36,000	56	7.11	**75**	18	24,500	49	4.5
26	38	80,000	16	5	**76**	17	15,500	15	4.5
27	22	26,000	56	7.13	**77**	27	23,500	15	3.65
28	62	70,000	17	5.7	**78**	47	45,400	43	6.5
29	48	66,000	27	2.91	**79**	18	25,500	19	4.5
30	45	26,000	47	5	**80**	47	35,500	55	5
31	62	70,000	57	6.5	**81**	27	23,500	20	3.65
32	17	25,000	40	4.5	**82**	67	35,400	13	3.25
33	19	12,000	25	4.5	**83**	31	55,400	36	6.5
34	22	13,000	20	4.5	**84**	42	65,400	36	6.5
35	19	12,000	50	4.5	**85**	47	55,400	31	3.08
36	19	12,000	10	4.5	**86**	27	23,500	55	5.96
37	25	23,000	23	4.5	**87**	18	25,500	55	6.84
38	23	27,000	18	4.5	**88**	57	35,500	55	6.5

39	27	33,000	40	4.83	**89**	67	35,400	53	6
40	31	14,000	40	4.5	**90**	42	55,400	36	6.5
41	33	15,000	33	2.97	**91**	51	47,000	41	6.5
42	35	25,000	27	4.5	**92**	21	27,000	21	4.5
43	37	40,000	18	1.5	**93**	27	35,400	12	4.28
44	39	31,000	37	5	**94**	65	35,400	33	3.45
45	40	50,000	41	6.5	**95**	67	35,400	43	4.83
46	41	57,000	50	6.5	**96**	47	45,400	23	2.22
47	43	32,000	37	5	**97**	47	45,400	33	4.96
48	44	37,000	34	5	**98**	27	23,500	42	4.84
49	47	40,000	41	6.5	**99**	47	35,400	43	5
50	49	33,000	47	5	**100**	27	35,400	32	4.85

Table 1: Chance for buying the medical coverage in different conditions

Rule 4: IF age is 44years old AND salary is 18,000 AND the risk of illness is Low (26) THEN the chance of buying the medical coverage is 1.5 Low

All the created fuzzy rules has shown in the Fig. 4 and implemented to the all 100 workers of the manufacturing industry. For obtains crusty value of production need toward Defuzzifire of the fuzzy output.

Step 4: Defuzzification

The last important step is Defuzzification to convert the all-linguistic input factors into crisp output which is meaningful to determine the chance of purchasing health insurance. If the employee age is 51 years and his salary is 52,000 and his risk of illness is 40 then the Defuzzification result shows the output 6.5 (Fig. 5). Thus, based on output, the chance for buying medical coverage is 6.5 (Medium), based on Abdullah and Rahman (2012) [9]. If the salary of the employee, age and hazard of sickness are 22000, 20 and 38 considered as input then the chance for purchasing health insurance is only 4.5 shown in Fig. 6.

Step 4: Defuzzification

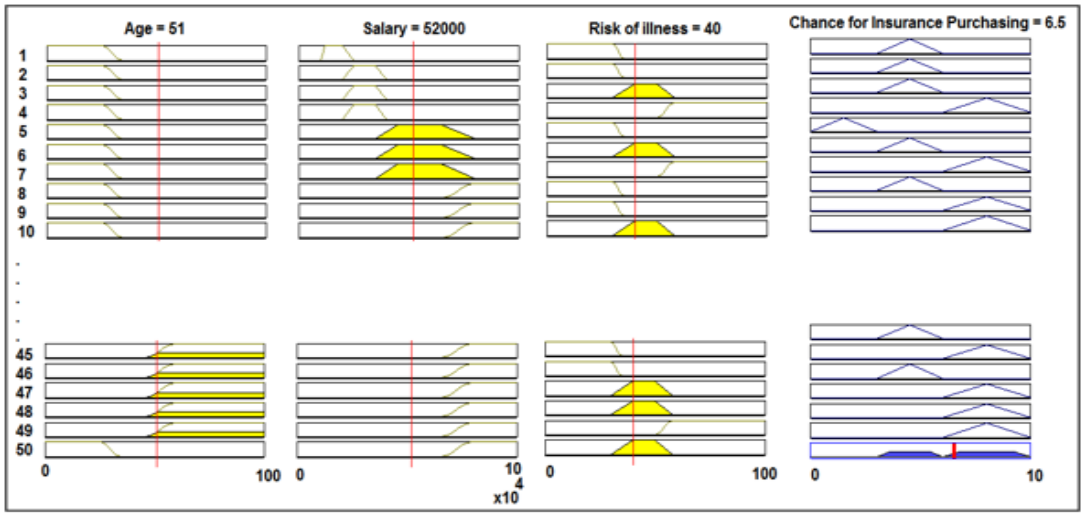

Fig 5: FIS rule viewer when age is 51

The last important step is Defuzzification to convert the all-linguistic input factors into crisp output which is meaningful to determine the chance of purchasing health insurance. If the employee age is 51 years and his salary is 52,000 and his risk of illness is 40 then the Defuzzification result shows the output 6.5 (Fig. 5). Thus, based on output, the chance for buying medical coverage is 6.5 (Medium), based on Abdullah and Rahman (2012) [9]. If the salary of the employee, age and hazard of sickness are 22000, 20 and 38 considered as input then the chance for purchasing health insurance is only 4.5 shown in Fig. 6.

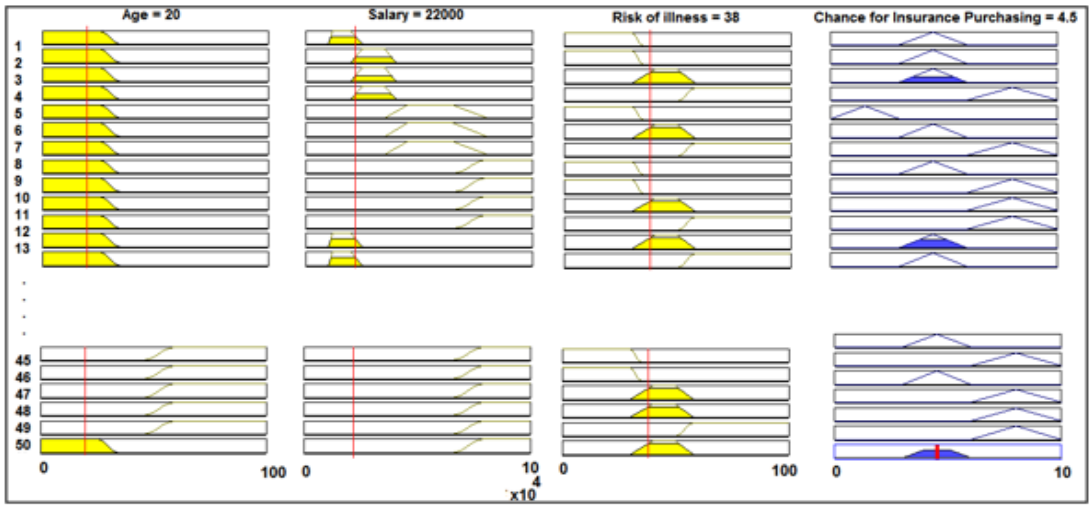

Fig 6: FIS rule viewer when age is 20

If the employee is 62 years old and his salary is 70,000 and his risk of illness is 57 then the chance for buying medical coverage is only 6.5 (Fig. 7). This decision model is very much helpful to identify the worker chance for buying medical coverage based on three etymological parameters for individual worker. Based on this method result of the rest of the worker were find out the high, medium and low for chance for buying the medical coverage. Age, salary, risk of illness and chance for buying medical coverage has shown in Table 1.

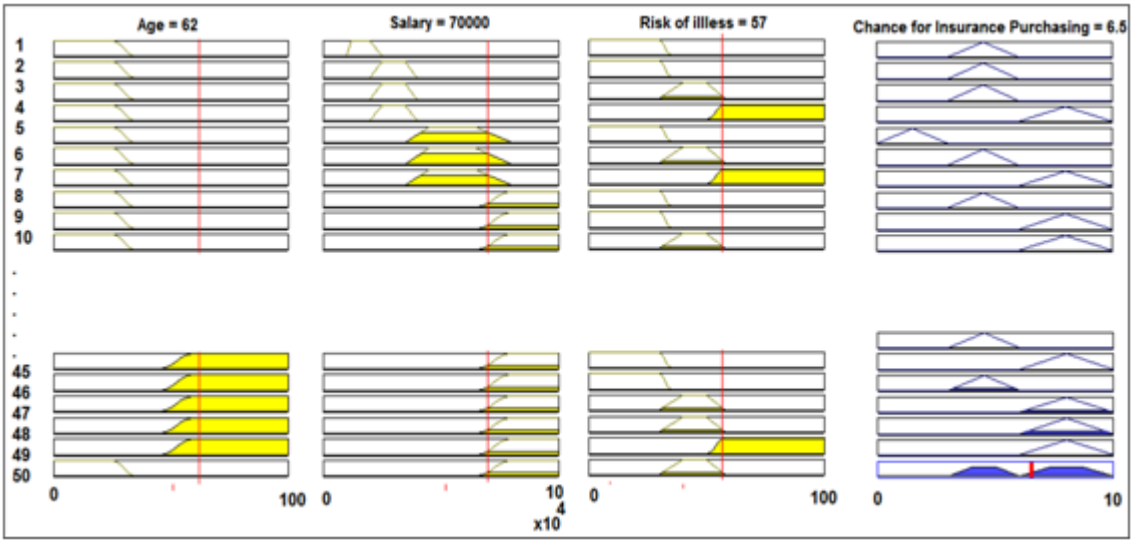

Fig 7: FIS rule viewer when age is 62

The FIS is very much helpful to take the decision to the employees on the basis of three input factor and one output factor. Abdullah and Rahman (2012) [9] have also calculated the percentage of employees with likelihoods of one hundred twenty-eight garment workers.

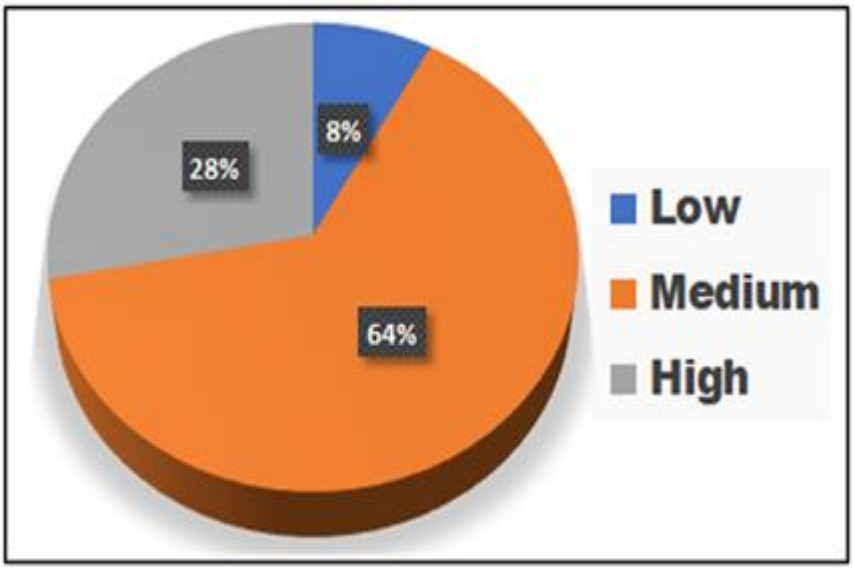

Fig. 8: Number of employees and their chance of purchase

The illustrative ratio examination demonstrations that the possibility of eight workers (8%) to buying medical coverage is HIGH and possibility of sixty-four workers (64%) is medium and the possibility of twenty-eight workers (28%) is low (Fig. 8).

On the basis of input factors, FIS strongly analyzed the possibility of buying medical coverage for workers of manufacturing industry into three output factors low, medium and high.

The chance for buying medical coverage for hundred workers is exposed in Fig. 8. It is clearly seen 64% medium income workers are chance to purchase the health insurance followed by high income after those low-income workers.

The three-dimension representation of the chance for health insurance purchasing with all three input parameters have been revealed in Fig. 9 even Abdullah and Rahman (2012) [9] have not shown the 3D graphically representation in their study. If age and hazard of sickness utilized as input then chance for purchasing of health insurance has shown in Fig. 9a. If age is 60 and hazard of sickness is approximately 50 than chance of the purchasing of the insurance are 7. If the salary of the worker is near about Rs. 60,000 and the age is 40 years, then 6.5 chance for the buying the health insurance (Fig. 9b). If risk of illness is more than 60 and salary of the employees in between Rs. 40,000 to Rs. 80,000 than chance of the health insurance buying is 6 to 8 (Fig. 9c). Similar, 3D analysis of results have done by Boadh et al. (2022a) [22] for diagnosis risk factor of prostate cancer by using FIS. Based on the above results, the FIS is effectively classified to integrate chance for buying medical coverage and identify by this study that it may very tough to determine the function of membership hazard factor to obtaining the health insurance.

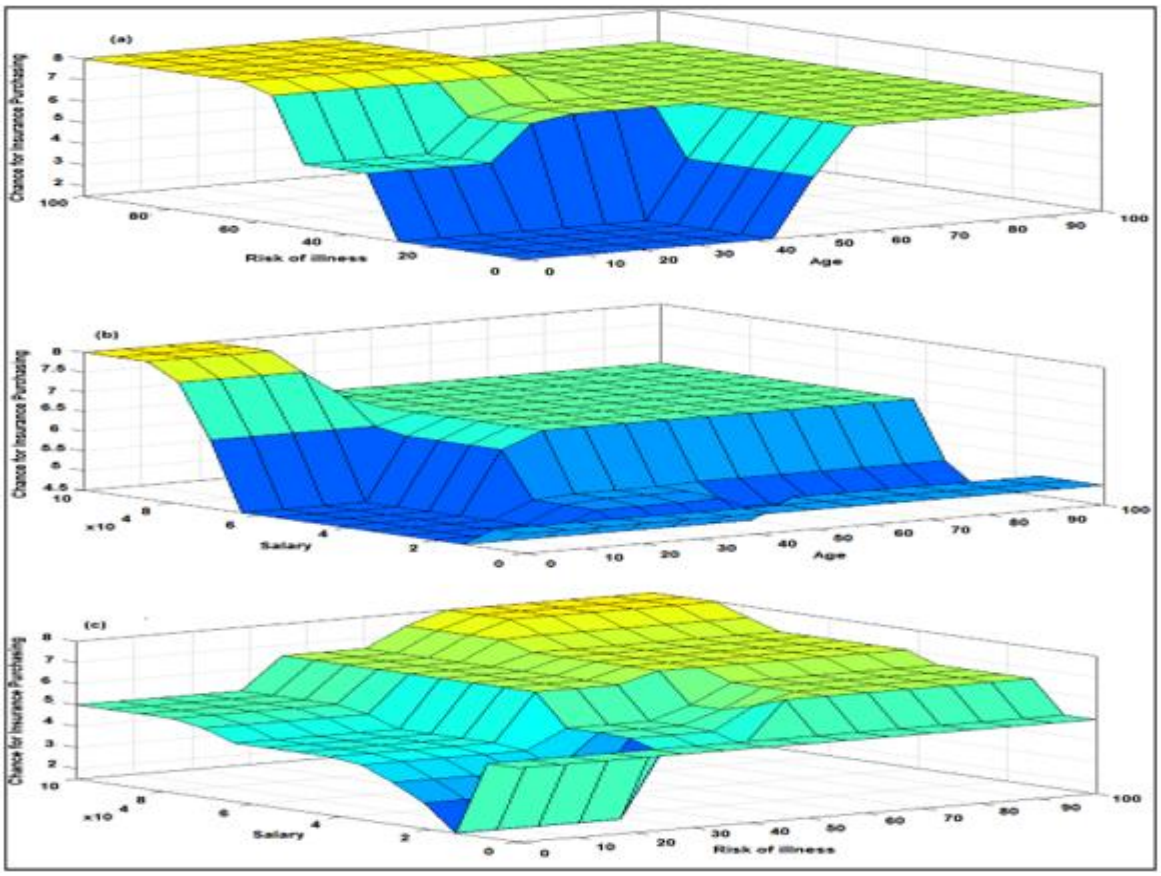

Fig 9: Analysis of Chance for Insurance Purchasing (a) Age vs Risk of illness (b) Age vs Salary (c) Salary vs Risk of illness

4. CONCLUSION

A significant component in deciding the prospects of buying health care coverage is a technique which can consider the multi dynamics. The strategy must to build up a choice to replicate the commitment of apiece described factor. Besides strategy must to be applied, straight investigation and utmost significant is outcomes remain effectively reasonable. In presented study, FL technique for finding the probabilities of buying medical coverage for manufacturing industry workers. The FIS used in this study for predicting the decision to purchase the health insurance. Three hazard features that influence the capability of buying medical coverage were measured with risk of illness, age and monthly income of the workers. The previous study was done on employees in Kota Star municipality over Malaysia but this study done near about the Gurugram, India. This is the first study to predict chance for buying medical coverage by any industry workers over India. The arrangement perceived the possibilities from three etymological terms perceptively changed by structure. The results advocate the adequacy of structure in separable the possibilities for buying medical coverage of industry workers. The FIS system can be utilized as a tool by researchers and scientists for predicting the chance of health insurance as well as this tool can also use by insurance agency during the time spent identifying forthcoming buyers. In future, this methodology may be used for identifying the performances of the workers in different industries such as garments, steel manufacturing, mines etc.

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