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Research Article

Measuring Employee Performance Key Indicators by Fuzzy Petri Nets

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Abstract: The aim of this study is to device a system based on fuzzy Petri nets for measuring employee performance. Fuzzy Petri net models are very helpful for specifying the expert systems with imprecise description of rules. Much research has been done for measuring human resource based on features like performance indicators generated in their work place. Such features are inherently challenging full to quantify as they are highly subjective and imprecise in nature. Concurrent and reliable systems can be realized or specified using Petri nets. Hence in this study, due to these limitations we focus on establishing the method for constructing fuzzy Petri net for the domain of human performance.

Keywords: Fuzzy rules, high-level fuzzy Petri nets, performance measure

INTRODUCTION

Employee Performance measurement systems helps to measures, evaluate and reward managers and employees. In literature performance measurement is mostly discussed in relation to low, middle and higher management. The group which is missing are the employees. Especially they need measures that are understandable and motivating for achieving their targets. From earlier research performance measurement, when it is well implemented, helps to motivate managers. In this research the focus are the employees and it is found out that performance measurement systems, when implemented, helps to improve the quality of work for employees. It brings more interaction between managers and employees. The company goals and job expectations are clearer to employees. Psychological commitment is increased by using a performance measurement system. Moreover it motivates and takes care of a more dynamical work culture. From the perspective of the employees, it helps to increase the quality of working of the employees.

Performance measuring might be helpful to consider the following:

- To improve the company's productivity
- To make informed personnel decisions regarding promotion, job changes and termination
- To identify what is required to perform a job (goals and responsibilities of the job)
- To assess an employee's performance against these goals

Hence in order to implement such a tool, in this study we try to establish the construction of fuzzy Petri nets for this context.

MATERIALS AND METHODS

Fuzzy Petri nets-a short introduction: Petri Nets (PN) are a graphical and mathematical modeling tool applicable to many systems. There are promising tools for describing and studying information processing systems that are characterized as being concurrent, asynchronous, distributed, parallel, nondeterministic and/or stochastic (Murata, 1989).

A Fuzzy Petri Net model (FPN) (He *et al*., 1999; Shen, 2006) is Petri net having places and transitions, where places are denoted by rings and transitions are denoted by rectangle. Each place represent an antecedent or consequent and may or may not contain a token associated with a truth degree between zero and one that represents the live of trust within the legitimacy of the antecedent or consequent. Each transition representing a rule is associated with a certainty factor value between zero and one. The certainty factor represents the strength of the belief in the rule. The relationships between places and transitions are represented by directed arcs (Edges), arcs exists only between places and transitions and vice versa. The formal definition is given below, Ref (Kouzehgar *et al*., 2011). As with (Liu *et al*., 2008), generally, a FPN structure can be defined as an 8-tuple:

$$FPN = \{P, T, D, I, O, \mu, \alpha, \beta\}$$

where,

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P = $\{p_1, p_2, ..., p_n\}$ is a finite set of places
T = $\{t_1, t_2, ..., t_n\}$ is a finite set of transitions
D = $\{d_1, d_2, \ldots, d_n\}$ is a finite set of propositions:
$P \cap T \cap D = \emptyset$, $| P | = | D |$
I : $P \times T \rightarrow \{0.1\}$ is the input function, a mapping from places to transitions
O : $T \times P \rightarrow \{0.1\}$ is the output function, a mapping from transition to places
μ : $T \rightarrow (0.1)$ is an association function, a mapping from transitions to (0.1) i.e., certainty factor
α : $P \rightarrow (0.1)$ is an association function, a mapping from places to (0.1) i.e., the truth degree
β : $P \rightarrow D$, is an association function, a mapping from places to proportions

Mapping the rule base to FPN: Throughout this mapping technique, all principle is represented as transitions with its relating certainty factor and each antecedent is displayed by an input place and therefore the consequents are incontestable by an output place with scrutiny truth degrees. During this displaying a transition here a suggestion is enabled to be fired if its entire input place have a truth degree resembling or over a predefined limit esteem. After firing the rule, the output place can have a truth degree resembling the input place truth degree multiplied by the transition certainty factor.

Fuzzy Petri nets (Fpns): (Mintzberg, 1989; Meseguer, 1992; Shiu *et al*., 1996; He *et al*., 1999; Duric *et al*., 2002; Dorsey and Coovert, 2003; Schermerhorn *et al*., 2003; McNally, 2005; Kubota and Nishida, 2006; Zhang *et al*., 2006; Okuda *et al*., 2007; Zhuomin, 2007; Lokman *et al*., 2008; Li and Mingzhe, 2009; Ding *et al*., 2009) are utilized for learning illustration what is more thinking within the section of imprecise information and learning bases. Fpns like AND-OR neurons (Murata, 1989; Liu *et al*., 2008; Kouzehgar *et al*., 2011) and with like Petri nets (Tousset, 1988) are projected by Pedrycz.

Regularly, a collection of transitions emulated by a collection of places constitutes a layer. An l-layered like Petri net on these lines holds l-layers of moves emulated by places and an additional embody layer comprising of places simply. The places within the last layer are known as closing place. Such a system has 2 types of benefits. To start out with, it will speak to inaccurate learning like normal Fpns. Second, the system may well be ready with a collection of input-output examples (as in an exceedingly food forward neural net).

Celebrity fashions limited is one of India's consummate garments exporters with the capability to manufacture the largest number of trousers in the industry. The company has their own national premier men's wear brand, Indian terrain. The company has two subsidiaries namely Indian terrain fashions Ltd and Celebrity clothing Ltd. Our survey is based on the Poonamallee branch (Chennai) of celebrity fashions ltd. It has 1,000 employees working on it. Celebrity fashions continuously upgrade its facilities to set new benchmarks in the garment manufacturing industry by always keeping to its quality and time commitments.

We conducted the survey very successfully and collected the data as we planned; we partitioned the data into 22 parts obtained from the answers. We also categorize the data according to the nature of the answers as input and internal properties. This is described in the following sub section.

The input properties:
Work engagement:

- At my work I feel energetic.
- My job inspires me.
- I am enthusiastic about my job.
- At my job I feel strong and vigorous.

Service environment of my organization:

- My organization does a good job keeping customers informed of changes that affect them.
- I understand management vision of my organization.
- Managers in my organization are very committed to improving the quality of work.

Job satisfaction:

- All in all am satisfied with my job.
- In general I like working at my organization.
- In general I do not like my job.

Personal attachment to my organization:

- I am proud to tell others I work at my organization.
- I feel strong sense of belonging to my organization.
- Working at my organization means a great deal to me personally.
- I really feel that problems faced by my organization are also my problems.

Reward from my job and organization:

- When I do my work gives me a feeling of my accomplishment.
- When I perform my job well it contributes to my personal growth and development.
- When I do my work well receive a higher salary or pay rise.
- When I do my work well receive a higher bonus or rewards.

Relationship with my superior:

- My working relationship with my superior is effective.
- My superior considers my suggestion for change.
- My superior and I are well suited to each other.
- My superior recognizes my potential.

The internal properties: The inside properties of the framework are made on the groundwork of some arrangement of the info properties:

- The input properties Q1 to Q4 form an internal property called "Work engagement".

- The input properties Q5 to Q7 form an internal property called "Service environment of my organization".
- The input properties Q8 to Q10 form an internal property called "Job satisfaction".
- The input properties Q11 to Q14 form an internal property called "Personal attachment to my organization".
- The input properties Q15 to Q18 form an internal property called "Reward from my job and organizations".
- The input properties Q19 to Q22 form an internal property called "Relationship with my superior.

As it where we have a fuzzy deduction in two levels.

Level one is supposed to deduce the internal properties, level two is supposed to deduce the employee's performance based on the internal and input properties.

Level 1:

If Q1 to Q4 is ….. then "Work engagement" is …...
If Q5, to Q7 is ……then "Service environment of my organization" is …..
If Q8 to Q10 is ……then "Job satisfaction" is …..
If Q11 to Q14 is ……then "Personal attachment to my organization" is …….
If Q15 to Q 18 is ……then "Reward from my job and organization" is …..
If Q19, to Q22 is ……then "Relationship with my superior" is ……

Level 2: Each of the unfilled spaces is loaded with a linguistic value: Strongly disagree (vl), disagree (l), Neutral (m), Agree (h), Strongly agree (vh). An example principle base for the above careful investigation could be displayed as an Employee Performance Measuring (EPM) as the accompanying structure indicated in Fig. 1:

EPM = (Emp, IPS, InPS, OPS, RS)
EPM.IPS = {"Q1, Q2, Q3, Q4, Q5, Q6, Q7 to Q22"}
EPM. InPS = {Internal properties}
EPM.OPS = {Emp Per}
EPM.RS = {R1, R2 .....R10}

R1 = Q1 (vh) ^ Q2 (h) ^Q3 (m) ^Q4 (vh), "Work engagement (vh)"
R2 = Q5 (m) ^ Q6 (h) ^Q7 (vh), "Service environment of my organization (h)"

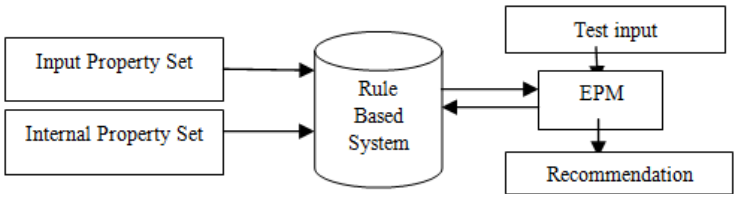

Fig. 1: The decision model

Table 1: Sample of dataset

	Employees									
Questions	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
Q1	M	H	H	H	H	VH	H	H	VH	M
Q2	H	M	M	H	H	M	VH	L	M	VH
Q3	VH	M	M	M	H	VH	H	L	VH	H
Q4	M	VH	M	M	L	VH	M	M	M	M
Q5	H	M	H	M	VH	M	H	M	M	H
Q6	VH	H	H	H	H	H	VH	VH	H	VH
Q7	VL	L	L	VL	VL	M	M	H	L	M
Q8	H	L	M	H	H	H	H	H	H	H
Q9	VH	L	M	M	H	VH	H	H	M	VH
Q10	VL	M	VL	M	L	VH	VL	L	VL	L
Q11	H	VL	H	M	M	M	H	H	H	M
Q12	H	L	H	H	M	H	VH	L	H	M
Q13	VH	L	L	M	H	VH	VH	L	M	H
Q14	H	H	H	M	H	VL	H	M	H	VH
Q15	H	M	M	L	M	M	H	M	M	M
Q16	VH	L	M	M	M	H	VH	L	M	H
Q17	M	L	L	L	VL	VL	VH	H	L	M
Q18	L	L	L	M	VL	VL	VH	H	L	M
Q19	L	M	M	M	M	M	H	L	H	VH
Q20	H	L	H	L	H	M	M	M	M	H
Q21	M	M	L	M	H	H	VH	L	M	H
Q22	L	M	L	L	H	M	M	L	H	VH

R3 = Q8 (h) ^Q9 (m) ^Q10 (l), "Job satisfaction (h)"
R4 = Q11 (m) ^Q12 (m) ^Q13 (l) ^Q14 (h), Personal attachment to my organization (m)"
R5 = Q15 (m) ^Q16 (m) ^Q17 (h) ^Q18 (h), "Reward from my job and organization (h)"
R6 = Q19 (m) ^Q20 (h) to Q21 (h) ^Q22 (vh), "Relationship with my superior (vh)"
R7 = Q1 (h) ^Q2 (m) ^Q3 (h) ^Q4 (m), "Work engagement (h)"
R8 = Q8 (vh) ^Q9 (h) ^Q10 (vl), "Job satisfaction (vh)"
R9 = Work eng (vh) ^Ser envir (m) job sat (vh) ^Per att (h) ^Rew (h) ^Rel with sup (vh), "Employee performance (vh)"
R10 = Work eng (h) ^Ser envir (h) Job sat (h) ^Per att (m) ^Rew (m) ^Rel with sup (m), "Employee performance (h)" (Table 1)

In the above structure, Employee Performance Measuring (EPM) is presented inside a 5-tuple comprising of the Input Property Set (IPS), Internal Property Set (InPS); Output Property Set (OPS) and Rule Set (RS). Q1 to Q22 represent Question 1 to 22 as input properties. Work engagement, Service environment of my organization, Job satisfaction and Personal attachment to my organization, Reward from my job and organization and Relationship with my superior as internal properties. Terms vl, l, m, h and vh represent the linguistic value: very low, low, medium, high, very high, respectively. In the guideline, the second component demonstrates the antecedent, the third component indicates the consequent and the last number demonstrates the certainty factor committed to the rule. For instance Rule 1 is as follows:

EPM.R1 = Q1 (vh) ^Q2 (h) ^Q3 (m) ^Q4 (vh), Work engagement (vh)

If Q1 is very high and Q2 is high and Q3 is medium and Q4 is very high, then the work engagement is very high.

The corresponding Petri net model is illustrated in Fig. 2. In the Petri net model, according to the proportions dedicated to each place, transitions 1 to 10 respectively represent rules 1 to 10 in the introduced rule base above and firing each transition means the corresponding rule is fulfilled.

RESULTS AND DISCUSSION

In order to fulfill the rule base verification phase, we must first map the rule base to Petri net as shown in Fig. 2. Then as with the algorithm mentioned in (He *et al*., 1999; Yang *et al*., 2003) a special reach ability graph is generated on the basis of the concept of ω-nets.

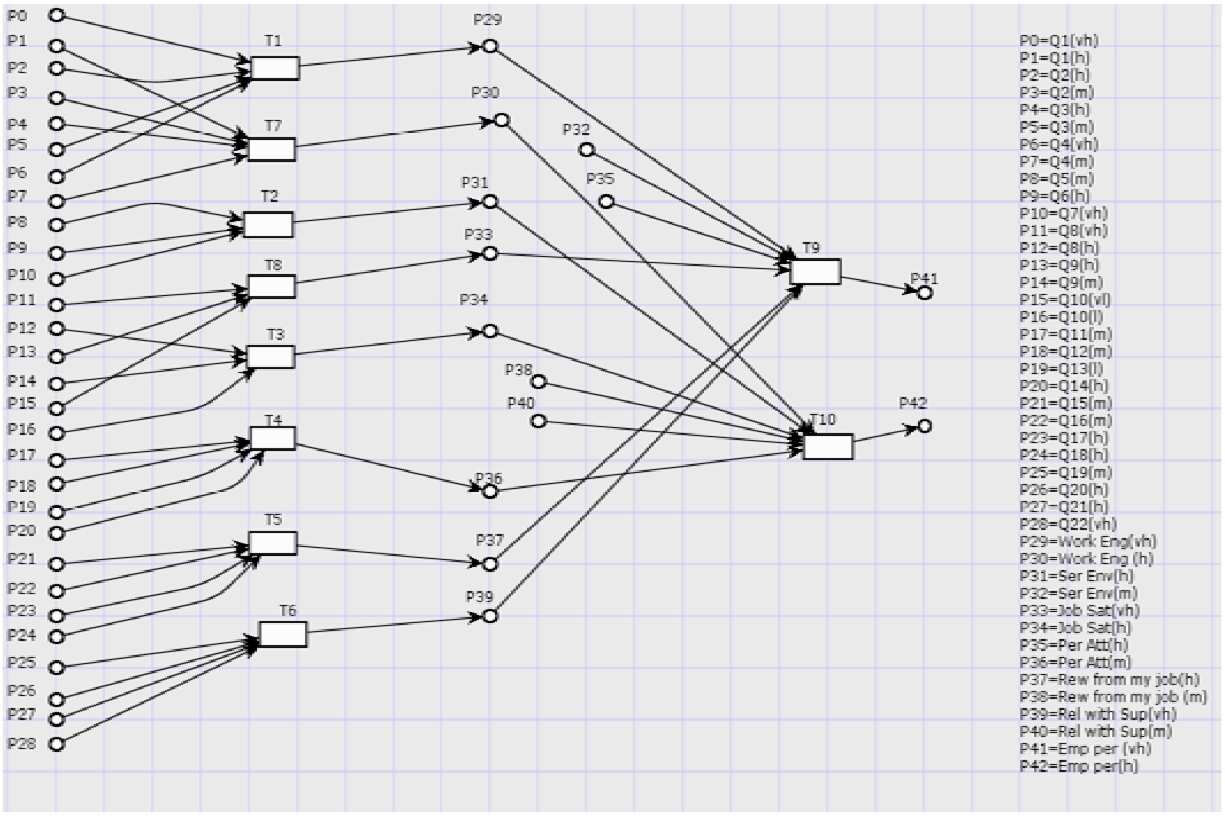

Fig. 2: CPN tool snapshot for EPM

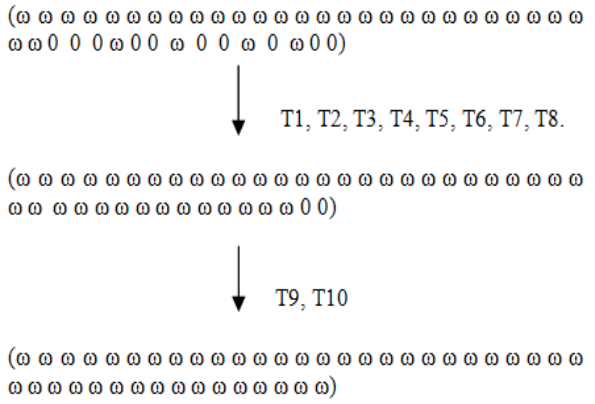

Fig. 3: The reach-ability diagram

In this reach-ability graph, first, a zero vector is defined as the root node as long as the range of places. Then at any current marking, among the transitions yet not considered, the enabled transitions are determined. At every step by firing the set of enabled transitions, a new node is added to the graph in which the corresponding elements of the node-the places which are filled after firing the transitions-are set to ω which is assumed as an enormous price. During this manner at every step there's a marking. If firing of the transitions at a step ends in an exceedingly repetitive marking, the graph can have a loop.

The corresponding reach-ability graph for the above Petri web model is portrayed in Fig. 3. The places P0 to P28, 32, 35, 38 and 40, respectively are regarded as TRUE antecedents and are initially filled (set to ω) for this reason. That's why in the initial node there are thirty three ω's. During this marking transitions T1, T2, T3, T4, T5, T6, T7 and T8 are enabled, respectively. Once firing these transitions, within the second step, places P29, P30, P31, P33, P34, P36, P37 and P39, respectively are filled and also the corresponding values in the node vector are set to ω. On the final step by firing T9 and T10 (the enabled transitions), the places P41 and P42 will be stuffed up.

CONCLUSION

The system based on fuzzy Petri nets has been constructed and verified for an instance involving a corporate context, celebrity fashions limited. This can be extended with other key performance indicators.

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