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A Bayesian Analysis Approach for Bridging the Gap between Employee Expectations and Employee Satisfaction

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Abstract: Satisfaction of the employees working in an organization is one of the major challenging tasks for any organization. In this research as reported in the title, the Bayesian theorem is applied to find out the combination of possible cases of highly influencing factors that were confirmed using correlation, and the various combinations which will lead to best-case scenarios and worst-case scenarios are found using Bayesian Theorem. The novelty in the article is applying Baye's theorem for the study which was undertaken. Baye's theorem is a mathematical principle based on probability theory where the conditional probability approach is considered to study the likelihood of the outcome of the occurring event based on the previous occurrence.

Key Words: *Ergonomics, Motivation, Employées Expectations, Employées Satisfaction, Bayes Theorem, Employee engagement*

1 Introduction

Various factors which are required for keeping the employee satisfied is one of the most researched topics in the field of organizational behavior. Burnout and commitment mediate the relationship between job demands and resources (i.e. job control and participation in decision-making) on one hand and absence duration and frequency on the other hand respectively Bakker, A. B., and Schaufeli, 2008). An autonomous work environment provides employees with the behavioral latitude to engage in organizational citizenship behavior (Bell, S. J., and Menguc, B., 2002).

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The benefit policies are designed to help employees better balance their work and family (Bruck et al., 2002) and it was observed strong evidence of the causal influences of proposed determinants of satisfaction and commitment (Currivan, 1999). Homogeneously the effect of job demands and job resources on burnout (A Syndrome of exhaustion, cynicism, and lack of professional efficacy), work engagement, and sickness absenteeism was reported by Schaufeli et al., 2009.

Flood et al., 2001 indicated that the most important aspect of the psychological contract related to the role of meeting expectations. It appears that, when employees perceive that their expectations have been met, they feel more obligated to contribute to the good of the organization and conform to organizational values and norms. The influence of employee expectations on the privacy of the email used in the workplace on the amount of email usage was reported by Agarwal and Rodhain, 2002.. The effect of three demographic variables namely environmental conditions, safety related policies and programs and general organizational climate on safety climate was examined by data collected from 2208 employees and the correlation of the various factors with the safety climate was also studied by Dejoy et al.,2004 based on data collected using a 5 point Likert scaled

questionnaire with the following hypotheses constructed (Perceived exposure to hazardous environmental conditions will be negatively related to safety climate, Safety-related policies and programs will be positively related to safety climate, Organisational climate will be positively related to safety climate, Organisational climate will be related to safety climate even after the environmental conditions and safety-related policies and programs have been taken into account, Environmental conditions, safety-related policies and programs and organisational support will be most closely related to safety climate, Safety climate will mediate the relationship between the three categories of work situation factors and perceived safety at work) and multiple regression analysis was used to determine the influence of these factors.

The effect of characteristics like perceived usefulness, perceived ease of use, and usability characteristics on user satisfaction in an Enterprise Resource Planning (ERP) system using data collected using a questionnaire from 24 enterprises using ERP (Calisir and Calisir,2004) as the implementation of ERP require a large number of years to implement and huge investments even for a medium scale industries despite the merits of faster information transactions, reduced inventory, reduced transportation costs, and reduced logistics cost. The questionnaire was divided into 3 major parts namely demographic questions, respondent's satisfaction and interface usability characteristics which were validated using principal component analysis, the output of which was used in multiple regression analysis to find out the mean and standard deviations between data. Bakker, A. B., and Schaufeli, 2008 showed that Positive organizational behaviour has an influence over the organizational outcomes. Based on a questionnaire data from 494 employees, a study was performed to evaluate the nature of expatriate career concept and the impact of international assignment on career advancement and personal development and the effectiveness of corporate expatriate career management systems (Stahl et al.,2002) which revealed that people viewed international assignment to 59 countries as an opportunity for personal development, professional development and career advancement.The questionnaire was divided into five sections comprising demographic questions, expatriate job choice questions, career expectations, satisfaction with corporate expatriation policies and practices and repatriation.

A questionnaire based study on the effects of fluctuations of job resources namely autonomy, coaching and team climate on personal resources which included self-esteem, self-efficacy, optimism, work engagement and financial resources based on data collected from 42 employees working in three different branches in a fast food company by evaluating four hypothesis which are the day level personal resources mediate the relationship between day level job resources and day level work engagement, day level job resources has a positive effect on day level financial resources, previous day job resources has a positive effect on next days personal resources and effects of next days financial returns (Xanthopoulou et al.,2009) through mediation.. Similarly a study was made on how the two major management operation philosophies namely quality management and just-in-time influence the relationship between Green Supply Chain Management practices and the performances (economic and environmental) by using moderated regression analysis and hypothesis (Enterprises having higher levels of adoption of Green supply chain management practices have better positive economic performance improvements, Enterprise having higher levels of Green supply chain management practices having negative economic performance improvements, The positive relationship between Green supply chain management practice and environmental performance is stronger in enterprises having higher levels of quality management practices adoption than in enterprises having lower levels of quality management practices adoption, (Zhu and Sarkis, 2004)

A survey on how employee employer relationship and supervisory support are important in creating trust was developed by Zhang et al., 2008 from a sample of 545 middle level managers and the regression equation was developed with the trust as the dependent variable and the independent control variables include age, education, gender, firm age and firm's ownership along with the reliability, mean, standard deviation being performed using regression equation and validity of the questionnaire is done by using Factor analysis method. Similarly the effects of motivational potential of job resources has an indirect impact on employee proactivity through work engagement was done (Baker and

Schaufeli,2008) using the independent samples from two places, spain with a sample of 386 employees and netherlands with a sample of 338 employees) by constructing three hypothesis (Job resources are associated with high levels of work engagement, Work engagement is positively associated with proactive behaviour, thus playing a full mediating role between job resources and proactive behaviour, The proposed full mediation model will be invariant across both national samples) by distributing questionnaires and solved by using three job instruments namely job control, Feedback and task variety with the entire problem being solved using Structural Equation Modelling(SEM).

Tudor et al.,2014 focused on the innovative development needs of russian manufacturing industries based on a survey by obtaining data from a questionnaire. It also brings out the light on the relationship between education and technological innovation practices implemented in small and medium manufacturing companies. Innovative strategy on firm performance on manufacturing industries in turkey by using regression by using the data obtained from questionnaires was also reported in literature (Karabulut,2015).

Bhanot et al.,2015 presented the opinions of various researchers around the globe and industry professionals on the important enablers and barriers and analyze them using statistical techniques to highlight the differences in opinions for strategic implementation of Sustainable manufacturing. Finally it distinguishes the opinions of various researchers and industry professionals. Yusof et al., 2012 comducted a study on the employability skills of engineering students in Malaysia based on data obtained from questionnaire, which was validated using Cronbach's Alpha test.

A Bayesian network to find the uncertainties and risk involved in a New Product Development(NPD) process along with a probability generation approach to generate the conditional probability required for creating the Bayesian network is done by comparing two different product concepts considering four major risks namely research and development risk, supply risk, production risk and product reliability in the study by Chin et al.,2009. The clinical expectations of veterinarians regarding the control of the diseases mastitis, lameness and Johne's disease were captured by a technique called probabilistic elicitation and has given a Bayesian framework for evaluating the diversity and strength of veterinarians clinical beliefs (Higgins et al., 2013). As Bayesian approach uses expected values rather than probabilistic values, Bayesian theorem is used to build a sophisticated reliability model in order to deduce the information regrading the lifetime of a system by the estimation of mean time to failure(MTTF) of a component (Goldstein and Bedford ,2007). Similarly Bayesian theorem is also used in medical purposes for the treatment of portal hypertension by transjugular intrahepatic portosystemic shunt(TIPS) by using data collected from a group of 107 patients and a model with 77 variables for predicting the survival rate, within the first 6 months after the TIPS is conducted, is evolved (Blanco et al. (2005).

A general Bayesian approach for non linear stochastic dynamic models using three stochastic variants of chaotic dynamic systems is evolved by optimising a free energy bound using the results from variational calculus (Daunizeau et al., 2009). A model for estimating the traffic flows in congested areas was derived using origin-destination travel demand and stochastic user equilibrium principle whereas the probability density function is derived using Bayesian theorem and the mean and variances of the traffic flows were estimated using Metropolis-Hastings algorithm (Wei, and Asakura,2013). Similarly a self diagnosis system was created using Bayesian formulas by integration of artificial intelligence, probabilistic diagnostic methods and diagnostic database in order to recognise disease on the basis of symptoms (Suchanek et al., 2014).

A Bayesian approach was developed for predicting the nesting preference of piping plover (a shore bird that nests on barrier islands that responds to changes in physical environment) based on uncertain and complex datas like sea level rise, response of barrier island inhabitants to sea level rise and response of piping plover to sea level rise based on data collected for 3 years (1999, 2002 and 2008) (Gieder et al. (2014). Similarly, using Bayesian approach, a model has been proposed for making decisions regarding a nuclear reactor for various unanticipated events based on data collected during the shutdown of the reactor due to de-energisation of the control rod magnet and the flapper valve opening (Chatzidakis and Starasv2013). Bayesian theorem was also used for the evaluation of particle size by converting the Laplace transform to first

kind integral equation of convolution type by using photon correlation spectroscopy (Iqbal,2000). Bayesian approach is also used for the design, analysis and interpretation of clinical mega trials rather than the conventional statistical approach (Diamond and Kaul,004). A non informative prior is used for comparing Bayes estimates of symmetric loss functions and asymmetric loss functions with each other as well as with the maximum likelihood estimates and it was found that Baye estimates performs consistently well for small values of time (Elkahlout,2006)). Bayesian approach is also used in creating a collaborative intelligent tutoring system by combining the concepts of computer supported collaborative learning and intelligent tutoring systems (Suebnukarn and Haddawy,2006). The individual student critical reasoning , the group critical reasoning along with the basic domain knowledge in areas os head injury, strokes and heart attack is used for creating this model. In handling huge amounts of data, knowledge discovery in large databases(KDD) is the most commonly used technique. In KDD technique Bayesian networks plays a vital role for problems related to probabilistic knowledge and such Bayesian networks are created and used as a knowledge discovery tool for nurse researchers (Lee and Abbott,2003). A probabilistic coding scheme for lay person oriented clinical genetics was also created using a Bayesian network coding scheme (Green,2005). By gathering information and knowledge from the above literature, this paper has planned to identify the requirements of the workers in an organisation, identify factors which are highly correlated to the satisfaction of the employees, bring out the various possible cases which may happen on changing these factors and identify the best and worst combination of factors and changes made in these factors to get satisfying results .

2 Problem description and Methodology

In this article, we have found out major factors required by the employees and the importance of these factors based on a questionnaire provided to them. The questionnaire consisted of 70 questions based on 5 point Likert scale. The questionnaire was validated using Cronbach's alpha reliability test. The correlation between various factors is also found. Thus the importance of various factors were found and inferences were drawn. All these activities were performed using SPSS 16.0 software. Finally based on the importance of various factors, both converted using a suitable method , Baye's theorem is applied to find out the various possibilities which may occur under when various set of actions are taken by the employer . Both the best case and worst case scenarios which may occur were determined with the help of Bayesian Theorem and inferences were drawn based on these probability values. All these data were collected from an industry named Shenbaga Soap Works, Thiruvarur, which manufactures detergent soaps. The questionnaire was distributed among the 50 employees and data was collected.

The objectives of this research are as follows:

1. To Design a questionnaire on 5 point Likert scale to find out the various requirements of the employees.
2. To Validate the questionnaire using Cronbach's alpha reliability test.
3. To Find the correlation between the various factors and employee satisfaction.
4. To Apply Bayesian theorem to find out the possible combination of scenario.
5. To identify the scenarios which brings out the best as well as the worst possible outcomes.

3 Results and Discussion

The events which we consider are generally without reference to other events. But the most common case is when certain event is to be considered in relation with various other events. This condition is called Conditional Probability. The problem of conditional probability can be solved using Bayesian Theorem.

Table 1 Correlation for Satisfaction

S.No.	Factors	Correlation
1	Ergonomics	.894**
2	Allowances	.894**
3	Group cohesiveness	.422**
4	Automation	.436**
5	Recognition Factor	.879**
6	Work life balance	.786**
7	Challenging Environment	.331*
8	Job Security	.901**
9	Working with similar age group	.464**
10	Providing Responsibility	.218
11	Participation in Decision Making	.188
12	Sensitivity to change	.901**
13	Pay for over time	.819**
14	Job Satisfaction	1

Table 2 Regression Analysis

Factor	Coefficients	Significance
Ergonomics	2.002	.178
Allowances	-.113	.691
Group Cohesiveness	.206	.397
Automation	-.074	.374
Recognition Factor	-.207	.016
Work Life Balance	.350	.014
Challenging Environment	.157	.086
Job Security	-.003	.952

Working with similar Age Group	.030	.912
Providing responsibility	.198	.005
Participation in Decision making	-.064	.265
Sensitivity to change	-.011	.869
Pay for Overtime	.435	.046
Job Satisfaction	-.059	.614
R	.947	
R Squared	.897	

Let A1, A2, ….,An be mutually exclusive events with respective probabilities of p1, p2,….pn. Let B be an event such that P(B) is not equal to zero. Then P(A1/B) is given by

$$P(A1/B) = \frac{P(A1)\,P(B/A1)}{P(A1)\,P(B/A1) + P(A2)\,P(B/A2)} \quad \text{…. (4.1)}$$

Table 3. Conversion of factors into Bayesian model

Factors/Values	Average	Rounded Off	Scale Value 1	Scale Value 2	Probability 1	Probability 2
Allowances	16.6	17	2	1	0.66	0.34
Recognition	16.74	17	5	2	0.71	0.29
Job Security	16.82	17	7	3	0.7	0.3
Similar Age Group	15.88	16	8	5	0.62	0.38
Sensitivity to change	16.62	17	2	0	1	0

Table 4 Various Combinations of factors

Combinations	A1	A2	A3	A4	A5
11111	0.18	0.19	0.18	0.16	0.27
11112	0.25	0.26	0.26	0.23	0
11121	0.19	0.05	0.2	0.11	0.29
11122	0.27	0.29	0.28	0.16	0

11211	0.2	0.22	0.09	0.19	0.3
11212	0.29	0.31	0.13	0.27	0
11221	0.22	0.23	0.09	0.12	0.33
11222	0.22	0.35	0.15	0.19	0
12111	0.2	0.09	0.21	0.19	0.31
12112	0.29	0.13	0.31	0.27	0
12121	0.22	0.09	0.23	0.13	0.33
12122	0.33	0.14	0.35	0.19	0
12211	0.23	0.1	0.1	0.22	0.35
12212	0.35	0.16	0.16	0.33	0
12221	0.25	0.11	0.12	0.14	0.38
12222	0.08	0.03	0.04	0.05	0
21111	0.1	0.21	0.2	0.18	0.29
21112	0.14	0.29	0.29	0.26	0
21121	0.1	0.23	0.22	0.12	0.32
21122	0.15	0.33	0.32	0.18	0
21211	0.12	0.24	0.1	0.21	0.03
21212	0.17	0.36	0.15	0.32	0
21221	0.12	0.26	0.11	0.14	0.37
21222	0.19	0.41	0.17	0.22	0
22111	0.12	0.09	0.24	0.21	0.34
22112	0.17	0.15	0.26	0.32	0
22121	0.13	0.11	0.26	0.14	0.37
22122	0.19	0.17	0.41	0.22	0
22211	0.13	0.11	0.12	0.24	0.39
22212	0.22	0.19	0.19	0.39	0
22221	0.15	0.13	0.13	0.16	0.433
22222	0.26	0.22	0.23	0.29	0

where

position of digits in order - Allowances, Recognition factor, Job Security, Working with Similar age group and Sensitivity to change

1 = 0-10% increase in the specified factor

2 = 10-30% increase in the specified factor

A1, A2, A3, A4, A5 - Bayesian value of corresponding factors 1,2,3,4 and 5.

Table 5 Combinations having critical effect on employee satisfaction

Combinations	A1	A2	A3	A4	A5
11111	0.18	0.19	0.18	0.16	0.27
11112	0.25	0.26	0.26	0.23	0
11121	0.19	0.05	0.2	0.11	0.29
11122	0.27	0.29	0.28	0.16	0
11211	0.2	0.22	0.09	0.19	0.3
11212	0.29	**0.31**	0.13	0.27	0
11221	0.22	0.23	0.09	0.12	0.33
11222	0.22	**0.35**	0.15	0.19	0
12111	0.2	0.09	0.21	0.19	0.31
12112	0.29	0.13	**0.31**	0.27	0
12121	0.22	0.09	0.23	0.13	**0.33**
12122	**0.33**	0.14	**0.35**	0.19	0
12211	0.23	0.1	0.1	0.22	**0.35**
12212	**0.35**	0.16	0.16	**0.33**	0
12221	0.25	0.11	0.12	0.14	**0.38**
12222	0.08	0.03	0.04	0.05	0
21111	0.1	0.21	0.2	0.18	0.29
21112	0.14	0.29	0.29	0.26	0
21121	0.1	0.23	0.22	0.12	**0.32**

21122	0.15	**0.33**	**0.32**	0.18	0
21211	0.12	0.24	0.1	0.21	0.03
21212	0.17	0.36	0.15	0.32	0
21221	0.12	0.26	0.11	0.14	**0.37**
21222	0.19	**0.41**	0.17	0.22	0
22111	0.12	0.09	0.24	0.21	**0.34**
22112	0.17	0.15	0.26	**0.32**	0
22121	0.13	0.11	0.26	0.14	**0.37**
22122	0.19	0.17	0.41	0.22	0
22211	0.13	0.11	0.12	0.24	**0.39**
22212	0.22	0.19	0.19	0.39	0
22221	0.15	0.13	0.13	0.16	**0.433**
22222	0.26	0.22	0.23	0.29	0

Table 4.7 Combinations having weakest effect on employee satisfaction

Combinations	A1	A2	A3	A4	A5
11111	0.18	0.19	0.18	0.16	0.27
11112	0.25	0.26	0.26	0.23	**0**
11121	0.19	0.05	0.2	0.11	0.29
11122	0.27	0.29	0.28	0.16	**0**
11211	0.2	0.22	**0.09**	0.19	0.3
11212	0.29	0.31	0.13	0.27	**0**
11221	0.22	0.23	0.09	0.12	0.33
11222	0.22	0.35	0.15	0.19	**0**
12111	0.2	0.09	0.21	0.19	0.31

12112	0.29	0.13	0.31	0.27	**0**
12121	0.22	**0.09**	**0.23**	0.13	0.33
12122	0.33	0.14	0.35	0.19	**0**
12211	0.23	0.1	0.1	0.22	0.35
12212	0.35	0.16	0.16	0.33	**0**
12221	0.25	0.11	0.12	0.14	0.38
12222	**0.08**	**0.03**	**0.04**	**0.05**	**0**
21111	0.1	0.21	0.2	0.18	0.29
21112	0.14	0.29	0.29	0.26	**0**
21121	0.1	0.23	0.22	0.12	0.32
21122	0.15	0.33	0.32	0.18	**0**
21211	0.12	0.24	0.1	0.21	0.03
21212	0.17	0.36	0.15	0.32	**0**
21221	0.12	0.26	0.11	0.14	0.37
21222	0.19	0.41	0.17	0.22	**0**
22111	0.12	**0.09**	0.24	0.21	0.34
22112	0.17	0.15	0.26	0.32	**0**
22121	0.13	0.11	0.26	0.14	0.37
22122	0.19	0.17	0.41	0.22	**0**
22211	0.13	0.11	0.12	0.24	0.39
22212	0.22	0.19	0.19	0.39	**0**
22221	0.15	0.13	0.13	0.16	0.433
22222	0.26	0.22	0.23	0.29	**0**

C++ CODING FOR BAYESIAN THEOREM

```
#include<iostream.h>
#include<conio.h>
void main()
{
        int f,r,i,j,a,b,c,d,e,in[10];
        float ai[10], ba[2][5], ab[10], sum;
        clrscr();
        cout<<"Enter the number of factors \n";
        cin>>f;
        cout<<"Enter the number of ranges considered \n";
        cin>>r;
        cout<<"Enter the value of factors \n";
        for(i=0;i<f;i++)
        {
                cout<<"Enter the value of "<<i+1<<"th factor";
                cin>>ai[i];
        }
        cout<<"Enter the range values in the order of first range values and then second range values";
        for(i=0;i<f;i++)
        {
                for(j=0;j<r;j++)
                {
                        cout<<i+1<<"th factor"<<j+1<<"th range \n";
                        cin>>ba[i][j];
                }
        }
for(a=0;a<r;a++)
{
        for(b=0;b<r;b++)
        {
                for(c=0;c<r;c++)
                {
                        for(d=0;d<r;d++)
                        {
                                for(e=0;e<r;e++)
```

```
                                        {
                                                in[0]=a;
                                                in[1]=b;
                                                in[2]=c;
                                                in[3]=d;
                                                in[4]=e;
                                                sum=0;
                                                for(i=0;i<f;i++)
                                                        sum+=ai[i]*ba[in[i]][i];
                                                cout<<a+1<<b+1<<c+1<<d+1<<e+1;
                                                for(i=0;i<f;i++)
                                                {
                                                        ab[i]=(a[i]*b[in[i]][i])/sum);
                                                        cout<<ab[i]<<"  ";
                                                }
                                                cout<<"\n";
                                                }
                                get ch();  }
                                }
                        }
                }
        getch();
        }
```

The following inferences can be drawn from the works done above:

1. The factors which the workers of the organisation preferred were Recognition of their work by higher authorities, proper balance between work and personal life, Job security, Working with employees of similar age group and Sensitivity to changes.
2. The factors which were highly correlated with the workers Job satisfaction was found under 95 percent and 99 percent confidence levels to be Ergonomics, Recognition, Allowances, Work life balance, Pay for overtime and Sensitivity to changes.
3. Other factors (Group Cohesiveness, Automation, Interesting Work, Responsibility and Participation in decision making) were scarcely correlated with the employees Job satisfaction.
4. A regression equation was formed using the factors evaluated using regression analysis(Allowances, Recognition factor, Job Security,Work life balance, Working with Similar age group and Sensitivity to change)
5. The factors which the employer may be able to provide were found to be Recognition of work, Job security, Working with people of similar age group and Sensitivity to changes.
6. The probability of employer providing certain percentage increase in factors were also found.
7. Using Bayesian Theorem, the following inferences were made:

- The employees were resistive to changes made in the machines they handled.

- The employee satisfaction remained unchanged for changes made in the machines they handled.
- The combination of increase in allowance, changes in machines the worker handles, increase in recognition, increase in Job security and making people work with the same age group proved to be worthless unless a valid combination is used.
- The highest effect on Job satisfaction was achieved by making people work on the same machine which was obvious from the table above.

4 Conclusion

This article studied the influencing factors with respect to employee expectations and employee satisfaction. Out of these factors, the likelihood of the employer to provide these factors and the extent to which he can implement these factors was also studied. Bayesian theorem is applied to find out the best possible combination of factors which the employer should provide in order to keep the employee satisfied.

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