System Dynamics and Artificial Neural Network Integration: A Tool to Valuate the Level of Job Satisfaction in Services

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KEYWORDS	ABSTRACT
	This study presents an integrated intelligent algorithm to valuate the level of job satisfaction(JS) in services. Job Satisfaction plays an important role as a competitive advantage in organizations especially in helth industry. Recruitment and retention of human resources are persistent problems associated with this field. Most of the researchs have focused on job satisfaction factors and few of researches have noticed about its effects on productivity. However, little researchs have focused on the factors and effects of job satisfaction simultanosly by system dynamics approaches.In this paper, firstly, analyses the literature relating to system dynamics and job satisfaction in services specially at a hospital clinic and reports the related factors of employee job satisfaction and its effects on productivity. The conflicts and similarities of the researches are discussed and argued. Then a novel procedure for job satisfaction evaluation using (Artificial Neural Networks)ANNs and system dynamics is presented. The proposed procedure is implemented for a large hospital in Iran. The most influencial factors on job satisfaction are chosen by using ANN and three differents dynamics scenarios are built based on ANN's result. The modelling effort has focused on evaluating the job satisfaction level in terms of key factors which obtain from ANN result such as Pay, Work and Co-Workers at all three scenarios. The study concludes with the analysis of the obtained results. The results show that this model is significantly usfule for job satisfaction evaluation and provide policy makers with an appropriate tool to make more accurate decision on kind of reward. This is because the proposed approach is capable of handling non-linearity, complexity as well as uncertainty that may exist in actual data and situation.

1. Introduction

Job satisfaction (JS) is the most widely-studied topic in organizational psychology. It has a long history in industry [1], where it is determined as a potential cause, correlate, and consequence of both work-related and non-work variables [2]. The traditional model of job satisfaction does focus on all the feelings that an individual has about his/her job. However, what makes a job satisfying or dissatisfying does not depend only upon the nature of the job but on the expectations that individuals have of what their job should provide. The work of Maslow(1954)[3] is seminal and do suggest that human needs form a five-

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level hierarchy ranging from physiological needs, safety, belongingness, love, and esteem to self-actualization. Based on Maslow's theory, job satisfaction has been approached by a number of researchers from the perspective of the need fulfillment [4].

Job satisfaction at a hospital has been of interest to many researchers. Three main approaches have been used in these studies. One approach involves determining the level of satisfaction with very specific facets of the job as such as working conditions, salary, and supervision.

A second approach examines the differences in overall job satisfaction by personal demographic or workplace characteristics (i.e., age, gender, practice setting, and position). Third, researchers examine possible antecedents and consequences of job satisfaction such as role stress, skill utilization, commitment, and intention to leave [5]. Although, several different measures have been developed to assess job satisfaction, there are a few studies noticing system dynamics as a tool in their field. Many factors do influence on job satisfaction but their interactions are of very important to us. Therefore, using the system dynamics model for these topics would be very useful. On the other hand because of large number of factors for investigating job satisfaction field, the use of

system dynamics can help to decrease the complexity of this study.

Using the other techniques to reduce the number of factors can help the researchers to design the accurate casual loop. So in this paper we use the ANN model in order to determine the most important factors. Then by the ANN result, the system dynamic model can be design correctly.

The rest of the paper is organized as follows. Section 1.1 briefly presents the definition of job satisfaction, and section 1.2 is devoted to introduce Artificial Neural Networks and in section 1.3 present the System dynamics. In Section 2, the related factors of job satisfaction are reviewed and a background discussion is presented. The research methodology is illustrated in Section 3. In Section 4, The NN modeling of job satisfaction is presented. According to literature review and ANN result, three scenarios of System dynamics related to job satisfaction field are presented in section 5. Section 6 presents the concluding remarks of this study. It contains the unique features of the study.

1-1. The Definition of Job Satisfaction

One of the most used definitions of job satisfaction is an emotional state resulting from appraising one's job [6]. There are many definitions given by researchers but four of the most important one of them are listed in Tab. 1.

Tab. 1. Definition of job satisfaction

| Definition	researcher	year
A function of satisfaction with the various elements of the job	Herzberg and Mausner	1959
The individual matching of personal needs to the perceived potential of the occupation for satisfying those needs	Kuhlen	1963
All the feelings that an individual has about his job	Gruneberg	1976
The affective orientation that an employee has towards his or her work	Price	2001

1-2. Artificial Neural Networks (ANN)

ANNs mimic the ability of the biological neural systems in a computerized way by resorting to the learning mechanism as the basis of human behavior [7]. ANNs are information-processing systems that generate output values based on specific logic. The ANNs `learns' the governing relationships in the input and output data by modifying the weights between its nodes.

In essence, a trained Neural Network (NN) model can be viewed as a function that maps the input vectors onto the output vectors. ANNs can be applied to problems with non-linear nature or with too complex algorithmic solution to be found. Their ability to perform complex decision-making tasks without prior programming tasks makes ANNs more attractive and powerful than parametric approaches especially for nonlinear problems. ANNs have at least two potential strengths over the more traditional model fitting technique such as parametric methods and multiple regression analysis. First, ANNs can detect and extract nonlinear relationships and the interactions among

inputs and outputs. Second, they are capable of estimating a function without requiring a mathematical description of how the output functionally depends on the inputs and other irritating assumptions of parametric methods. The architecture of a NN model usually consists of three parts: an input layer, hidden layers and an output layer. The information contained in the input layer is mapped into the output layer through the hidden layers.

Each neuron can receive its input only from the lower layer and send its output to the neurons on the higher layer only. Fig. 1 illustrates the network architecture of a NN model consisting of one hidden layer with *S* neurons along with the input and output layers with *R* and one neuron. Here the input vector **p** with *R* input elements is represented by the solid dark vertical bar at the left. Thus, these inputs post multiply *S* row, *R* column matrix **W**. One as a constant value enters the neuron as an input and is multiplied by a vector bias *b* with *S* row and single column. The net input to the transfer function *f* is *n*, the sum of the bias *b* and the product **Wp**. This summation is passed to the transfer

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function *f* to get the neuron's output *a*, which in this case is a *S* length vector [8].
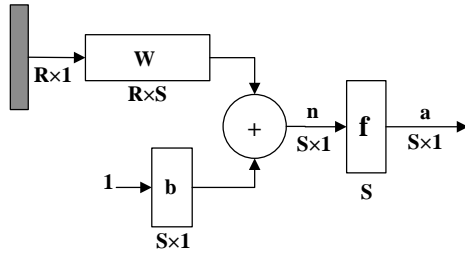
Fig. 1. The typical network architecture of a NN model consisting of one hidden layer

with S neurons along with input and output layers with R and one neuron.

1-3. System dynamics

System Dynamics was developed by Forrester [9] and it is designed to analyze the dynamic behavior of complex feedback systems. It was used as a preferred analysis methodology due to the fact that it explicitly can present the relationship between the variables in a non-linear, dynamic feedback system [20]. It has been used extensively in the modeling of various systems. It is a methodology based upon the systems' theory. Systems theory has been widely used to study various aspects of an organization such as individual and group behavior [10] but there is few studies that relate system dynamics to job satisfaction. The steps of system dynamics model can be explained as a follow diagram according to Fig. 2:
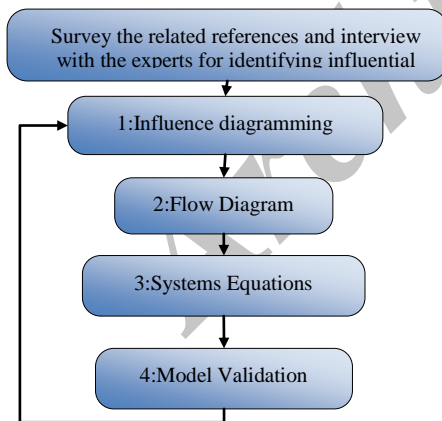
Fig. 2. The procedure for system dynamics

(i)Influence Diagramming. This involves identification of a sequence of pair wise causal hypotheses between variables or components of the system as well as their direction of influence. These variables are connected by arrows and plus or minus signs. A positive relationship (an arrow with a plus sign) occurs when, other things remaining the same, a change in one variable results in a change in another variable in the same direction, whereas a negative relationship occurs when the change is in the opposite

direction. The systematic procedure for constructing an influence diagram has been provided by Wolstenholme and Coyle [11] and Roos and Hall [12].

(ii) Flow Diagram. This consists of symbols borrowed from control engineering to represent levels, rates and flows. The levels are the accumulators or state variables, the rates are the decision points that control the flow into and out of the levels, and information flows represent the decision structure surrounding each rate system regulator.

(iii) Systems Equations. Time difference equations represent the rates and flows described in the flow diagram in mathematical form using simulation languages such as DYNAMO, DYSMAP and STELLA.

(iv) Model Validation. In model validation the model is tested for structure (structure verification, parametric verification, extreme conditions, boundary adequacy and dimensional consistency) [24] .

The advantages of system dynamics approach include [13]:

   (i) It is based on a complementary computer simulation language, such as DYNAMO, which is easy to learn and is also available on microcomputers, and provides an excellent diagnostic tool to the novice programmer.

   (ii) It allows analysts to maintain a one-to-one correspondence between the verbal description of the real world system and the influence diagram representing the cause and effect chain, and between the influence diagram and the set of equations in the computer program which simulate the model.

2. Literature Review
2-1. Related factors of job satisfaction

   In order to identify the literature relating to job satisfaction, nurses and factors, we search through electronic databases (www.elsevier.com).There are a lot of researches in this filed. For example the abstracts or full texts of the papers were based on job satisfaction are more than 1189 published research papers. Each of these papers were examined a lot of related factors of job satisfaction. For example, Spector (1997)[14] summarized the following facets of job satisfaction: appreciation, communication, co-workers, fringe benefits, job conditions, nature of the work itself, the nature of the organization itself, an organization's policies and procedures, pay, personal growth, promotion opportunities, recognition, security and supervision. Because of variety in factors, we summarize these factors in Tab. 2. For example, Brown and Peterson (1993) identify individual level demographic and dispositional variables, role perceptions, supervisory behaviors, and job characteristics as influences on employees' job satisfaction [15].

Tab. 2. Summary of included studies regarding Related factors of job satisfaction at a hospital clinic

Factors	Researchers	Influence	D/ID	Direct influence
Educational level Significantly.]	Lu K-Y, Lin P-L, Wu C-M, Hsieh Y-L, Chang Y-Y (2002), Tzeng H-M (2002), Nathan A. Bowling(2008),Tzeng (2002)]	-	D	
	Rambur B, Palumbo M, McIntosh B, Mongeon J (2003)	+	D	
	Yin J-C, Yang K-P (2002) [	(?)	ID	Turnover
	Fain (1987)[]	(?)	D	
job stress]	Shader K, BroomeM, Broome C, WestM, Nash M (2001), Fletcher C (2001), Davies et al. (2006), Davies et al. (2006), Hood (1997), Staurovsky, 1992; Sarmiento et al., 2004; Davies et al., 2006	-	D	
	Tzeng H-M (2002), Yin J-C, Yang K-P (2002), Yin J-C, Yang K-P (2002), Wu et al. (2000)]	-	ID	Turnover
work schedule]	Shader K, BroomeM, Broome C, WestM, Nash M (2001)	+	D	
	Yin J-C, Yang K-P (2002)	+	ID	Turnover
	Fletcher C (2001)]	(?)		
group cohesion]	Shader K, BroomeM, Broome C, WestM, Nash M (2001)	+	ID	work schedule
	Larrabee J, Janney M, Ostrow C, Withrow M, Hobbs G, Burant C	+	ID	psychological empowerment
Gender(psychological empowerment= Demographic)	(2003) Adams and Bond(2000), Silvia T. Acua.,et al(2009)	+	D	
	Rambur B, Palumbo M, McIntosh B,Mongeon J (2003)	+-		
	Tzeng H-M (2002)	+	D	
	Larrabee J, Janney M, Ostrow C, Withrow M, Hobbs G, Burant C	++(max)	D	
	(2003)	+	D	
	Chen et al. (2005), Fain (1987), Marriner and Craigie (1977)	(?)		
	Moody (1996)	+	ID	Task Conflict, Social Conflict, Cohesion
	Silvia T. Acua.,et al(2009)			
	Brown and Peterson (1993)			
Pay(salary)	Tzeng H-M (2002), Cowin L (2002)	+	D	
	Yin J-C, Yang K-P (2002)	+	ID	Turnover
		+	D	
	Fletcher C (2001)	(?)		
	Holland (1992)	+	D	
	Plawecki and Plawecki (1976)	+(min)	ID	Turnover
	Marriner and Craigie (1977)		ID	Turnover
		+(max)		
	Moody (1996)		D	
		+		
	Cavanagh and Coffin (1992)			
promotion	Hsing-Chu Chen, et al.(2008)			
	Yin J-C, Yang K-P (2002)	+	ID	Turnover
	Holland (1992)	+	ID	Turnover
	Nolan et al. (1995), Lee (1998), Aiken et al. (2001), Price (2002), Tzeng (2002a, b), Wang (2002)			
Superior(Leadership style)	Tzeng H-M (2002)	+	D	
	Yin J-C, Yang K-P (2002)	+	ID	
	Fletcher C (2001)	(?)		
	Larrabee J, Janney M, Ostrow C, Withrow M, Hobbs G, Burant C (2003)	+	ID	psychological empowerment
	Chen et al. (2005)	+	D	
	Kennerly (1989), Shieh et al. (2001)	(?)		
	Lee (1998), Tzeng (2002)	+	D	
fringe benefits, Praise and recognition	Yin J-C, Yang K-P (2002)	+	ID	Turnover
	Chen et al. (2005)	+	D	
	Shieh et al. (2001)	+	D	
	Nolan et al. (1995), Lundh (1999), Aiken et al. (2001), Price (2002), Wang (2002	+	D	
Work environment	Tzeng H-M (2002)	+	D	
	Yin J-C, Yang K-P (2002)	+	ID	Turnover
commitment	Fang Y (2001)	+	ID	Turnover
	Lu et al. (2002)			
professional status(experienced)	Cowin L (2002)	+	D	
	Bailey (1995)	+-		
	Holland (1992)			
Job security	Fletcher C (2001)	+	D	
	Nolan et al. (1995, 1998)	+	D	
hardiness	Larrabee J, Janney M, Ostrow C, Withrow M, Hobbs G, Burant C (2003)	+	ID	psychological empowerment
autonomy]	Marriner and Craigie (1977)			
	Nolan et al. (1995, 1998), Lee (1998), Price (2002), Wang (2002)	+-		
	Silvia T. Acua.,et al(2009)	+	ID	Task Conflict, Social Conflict, Cohesion
	Hsing-Chu Chen, et al.(2008)			
	Nathan A. Bowling(2008)			
ambiguity	Acorn (1991),Fain (1987)	_	D	
	Hsing-Chu Chen, et al.(2008),Nathan A. Bowling(2008)	_		
Conflict	Acorn (1991),Silvia T. Acua.,et al(2009) ,Hsing-Chu Chen, et al.(2008), Nathan A. Bowling(2008)	-	D	
	Fain (1987)	(?)	D	
Interaction(Relationships with patients, co-workers, managers)	Adamson et al. (1995), Nolan et al. (1995), Lee (1998), Tovey and Adams (1999), Adams and Bond (2000), Aiken et al. (2001), Price (2002), Tzeng (2002a, b), Wang (2002) ,Brown and Peterson (1993)	+	D	
Working conditions	Adamson et al. (1995), Nolan et al. (1995), Tovey and Adams (1999), Adams and Bond (2000), Tzeng (2002)	(?)		

Last three columns of Tab. 2 can help researchers in identifying possible future studies or their similarities and dissimilarities to others research works. By this table we can find a sequence of pair-wise causal hypotheses between factors of the system. The abbreviations used are described beneath table 2.

2-2. Effects of Job Satisfaction
According to current literature review some of the researches have focused on the effects of job satisfaction on othe utcoms of organisations. In this section, we summarized the effects of job satisfaction to find the relationship between the effects and the factors of job satisfaction.

The result of this section presented by Tab. 3 can help researches to understand the system dynamics models

presented in the next section. For instance Boles' research shows that supportive aspects of the work environment has a positive influence on the job satisfaction and it has a negative influence on the turnover [16].

On the other hand, work stress, conceptualized as work-role conflict, work-role overload, and work-role ambiguity, is related to the job satisfaction negatively and to intend of leave organization positively. According to prior researches a number of outcomes of job satisfaction have been investigated including turnover intentions, absenteeism, and motivation (for example Tett & Meyer, 1993)[17]. Tab. 3 shows the summarized of these results which it's obvious that we can recognize the relation between job satisfaction and turnover.

Tab. 3.Summary of included studies regarding effects of job satisfaction at a hospital clinic

Effects	Researchers	influence
professional commitment[	Lu K-Y, Lin P-L, Wu C-M, Hsieh Y-L, Chang Y-Y (2002)	+
	Lu K-Y, Lin P-L, Wu C-M, Hsieh Y-L, Chang Y-Y (2002)	
	Rambur B, Palumbo M, McIntosh B, Mongeon J (2003)	-
	Shader K, BroomeM, Broome C, WestM, Nash M (2001)	-
	Tzeng H-M (2002)	-
	Yin J-C, Yang K-P (2002)	-(max)
	Larrabee J, Janney M, Ostrow C, Withrow M, Hobbs G, Burant C (2003)	-(max)
	Holland (1992)	-
Turnover	Christian (1986)	-
Intention to leave	Staurovsky (1992)	-
Burnout	Cavanagh and Coffin (1992)	-
	Gauci Borda and Norman (1997a)	-
	Lu et al. (2002)	-
	Tzeng (2002a)	-
	Yin and Yang (2002)	-
	Hsing-Chu Chen, et al.(2008)	-
	Nathan A. Bowling(2008)	-
	(Boles & Babin, 1996)	-
	Hellman (1997)	-
Recruitment and retention	Marriner and Craigie (1977)	-
	Lenz and Waltz (1983)	
	Wakefield-Fisher (1987)	+
	Fain, 1987	+
Productivity	(Bailey, 1995; Acorn, 1991).	+
	Bailey's (1995)	+
	Huey-Ming Tzeng et al(2002)	+
	Matrunola (1996)	
Absenteeism	Siu (2002)	+-
	Nathan A. Bowling(2008)	-
	Tett & Meyer, 1993	

In summary, the research findings are inconsistent regarding the relationship between job satisfaction turnover, intention to leave, burnout, and productivity.

2-3. System Dynamics and Job Satisfaction
The number of studies related to the job satisfaction and System dynamic is few. Gupta et al. (1990)[18], Mutuc.(1994)[19] and Holmström (2004) have conducted researches on job satisfaction using system dynamics concepts. These models are about the applications of system dynamics and information system employee [20,21], employee participation and job satisfaction in health care industry [22-23]. The

first is about a process model for studying the impacts of role variables on turnover intentions of information systems personnel. This model demonstrates the usefulness of the system dynamics approach as a prototype methodology to deal with dynamic aspects of the organizational behaviors. The model provides an analysis of both the steady state behavior and the transient behavior of the turnover intentions' model. This methodology studies dynamic consequence of relationships among antecedents of job satisfaction and organizational commitment, and management policy variables. The second present an initial investigation of interacting factors in participation, and its construct,

motivation. The model were developed using recognized relationships in social science literature, and the third is about job satisfaction at a maternity department and application of system dynamics to explore staff retention. Some of these researches are complicated due to many factors. Based on past research, there are many methods such as FA, PCA, and ANN for reducing the number of factors. Considering the main purpose of this paper, the ANN method are used to determine the most effective factors and the results of the ANN is used for modeling system dynamics.

3. The Research Methodology

In this section, we present the main structures of the proposed model according to Fig. 3. In the proposed evaluation model, the major factors of the model were identified with the help of ANN model (see Fig. 3). An ANN model was implemented and trained using collected data by Surveying Questionnaire in order to determine the most important related factors of job satisfaction. The details of ANN procedure have been shown in Fig. 3-b and it is explained briefly in section 3.1. By the result of ANN, we can achieve necessary input of system dynamics.
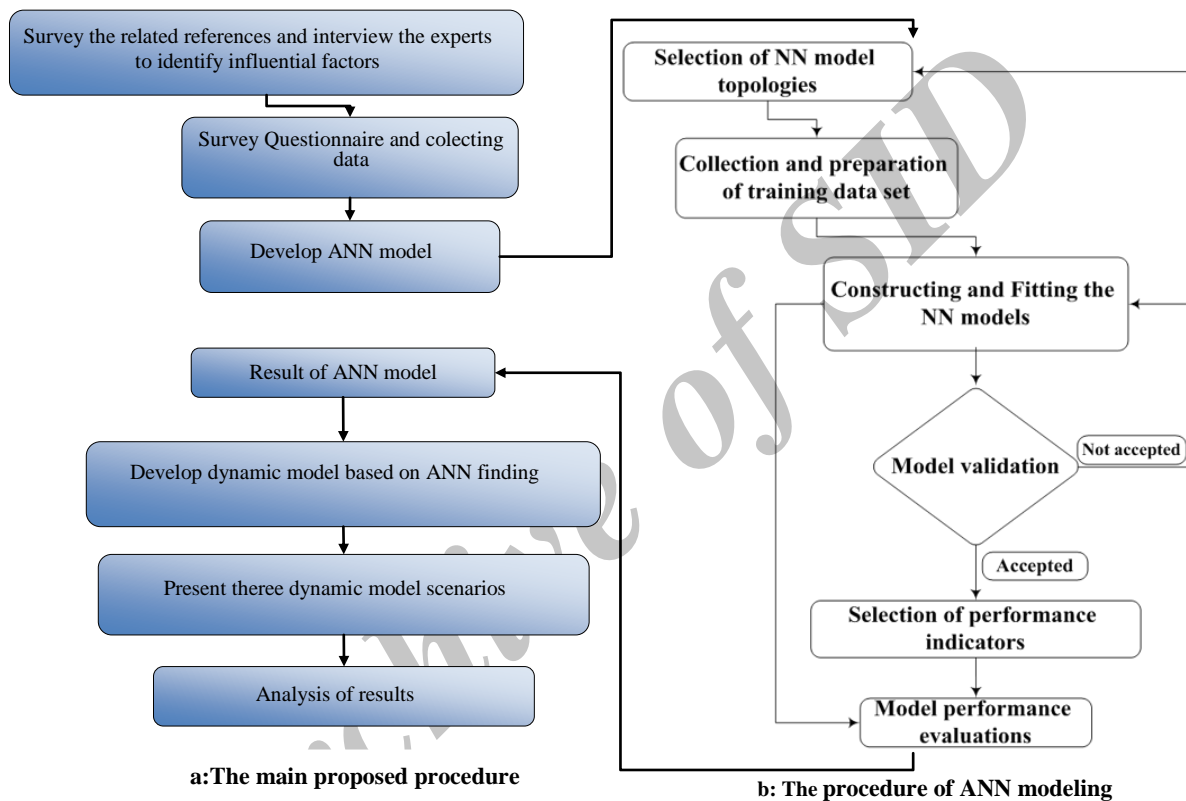

a:The main proposed procedure

b: The procedure of ANN modeling

Fig. 3 Procedure for job satisfaction evaluation by ANN and system dynamics

Developing the dynamic model based upon the ANN finding is the next stage of the proposed model. One of the most important things which the top management needs to select the best strategy for encourage of staff. Three scenarios is developed for analyses the influence of different strategy about the kind of reward. Financial reward, nonfinancial reward and both of them are the three elements of every scenarios of dynamic model which are explained in section 5.

3-1. The Procedure of NN Modelling
Selecting the most effective job satisfaction factor using artificial neural network is performed in two steps as described below(see Fig. 3-b): The first step is constructing various NN models of job satisfaction

level as an output which vary in their inputs (the effective factors) then in the second step, is the selection of the best effective factors which are related to the most fitted model based on the performance indicators.

Phase1. Selecting the neural network model topologies: There are 31 different NN topologies, which are being employed in researches at present time. The most common networks are: Multilayer Perceptrons (MLP) also called Multilayer Feed forward Networks, Adaptive Resonance Theory Models (ART), Recurrent Associative Networks (RAN), and Self-Organizing Maps (SOM) [23].
In this phase, models topology and their training algorithms considering the nature of modeling problem

are chosen. The other important thing addresses the definition of input variables (e.g., effective factors) and output variables (e.g., Job satisfaction level) for assigning them to the network of each model as inputs and outputs, respectively. Also, the way of presenting data to the network have to be determined. One way to do this is to present all available process variables as network inputs, and then let the network modify itself during training so that the connection of any insignificant variables becomes weak. Another approach is to be more selective and introduce as inputs only those variables that are surely affecting on the process outputs. The first approach is called the ''global network'' while the second is termed the ''focused network'' [24].

Phase2. Collection and preparation of training data set: In the Data collection stage, it is necessary to ensure the sufficiency and integrity of the data used to train and test the network, whereas the network performance can be directly influenced by the presented data. It is not simply possible to say how many data sets are required, because this depends on the nature of the process modeling problem and the cost of providing data. The prepared data set is categorized randomly into two sets: Training data set and test data set. Generally, the training data should cover the all of the data variation range, unless there is a good reason to resort to stratification or data blocking. In order to enhance the model fitness, several tasks for preparing data may be performed such as: (1) data integrity check, (2) extreme data removal, (3) data scaling, and (4) data coding.

Phase3. Constructing and fitting the NN models: Construction of NN model architecture includes determining few features:

- The number of layers;
- The number of neurons in each layer;
- Each layer's transfer function;
- How the layers are connected to each other.

So the performance of a NN model depends on the fitness of the network features. There are various training algorithms to fit NN models. The most popular algorithm in optimization and estimation applications is the standard back propagation (BP) [25]. This algorithm is a widely used iterative optimization technique that locates the minimum of a function expressed as

$$E = \frac{1}{2}\sum_{m}\left(y_{dm} - y_{m}\right)^2 \tag{1}$$

Where y_{dm} is the target output value of the output layer, and y_m is the value of the output layer. Based on BP algorithm, during the training process, the deviation

between the network output and the desired output at each presentation is computed as an error. This error, in quadratic form, was then fed back (back propagated) to the network and used for modifying the weights by a gradient descent method.

The training process carries on while one of three user-specified conditions is met at least. These conditions consist of (1) exceeding the maximum number of epochs, (2) meeting the performance goal, and (3) decreasing of the gradient descent rate to the less than the allowable limit.

Phase 4. Model validation: In this phase, all of fitted models are validated. The validation data set is used to ensure that there is no overfitting in the final result. In order to validate the models, a data set is selected randomly from training data. When a significant overfitting has occurred, the error of validation data starts to increase and the training process is stopped.

Phase 5. Selection of performance indicators: To find out the most reliable model, several performance indicators can be used. The performance of the NN models based on their reliability is evaluated by a regression analysis between the predicted values by the NN models and the actual values. The indicators used with aim of performance evaluation for both training and test data sets are the root mean square error (RMSE) and correlation coefficient [26]. The root mean square error is calculated by:

$$RMSE = \sqrt{\frac{1}{m}\sum_{i=1}^{m}(y_i - \hat{y}_i)^2} \tag{2}$$

Where $\hat{y}_i$ is the predicted value by NN model, y_i is actual value and m is the number of points in the data set. The absolute fraction of variance, a statistical criterion that can be applied to multiple regression analysis, is calculated by:

$$R^2 = 1 - \left(\frac{\sum_{i=1}^{m}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{m}(y_i - \bar{y})^2}\right) \tag{3}$$

The absolute fraction of variance ranges between zero and one. Ideally, R2 should be close to one, whereas a poor fit results in a value near zero.

Phase 6. Model performance evaluation: By termination of process training and validation, the networks are ready for prediction. So, the input vectors from the separate test data are introduced to the trained network and the responses of the network, i.e., the predicted output, are compared with the actual ones using the performance indicators. The most reliable

model for the job satisfaction level is chosen in respect to the evaluation and training results. Hence, the factors related to the chosen model are the best effective factors.

4. The NN Modeling of Job Satisfaction

According to result of literature, there are a lot of effective factors which cause complexity of collecting data as an input of ANN model. For avoiding this problem we use the Job Descriptive Index (JDI) for measuring job satisfaction level. The JDI is a measure of job satisfaction that presents adjectives thought to relate to satisfaction with one of five aspects of jobs: Pay (PA-9 items), Work (WO-18 items), Opportunities for Promotion (OP-9 items), Supervision (SU-18 items),and Co-Workers (CW-18 items). Examiners respond to the adjective by endorsing either ''Yes,'' ''No,'' or ''?''[27], scored 3, 0, and 1, respectively in addition to, the JDI is the most commonly used measure of job satisfaction in the world. Data were obtained from the JDI at large hospital in Iran).(JDI). In this study, a group of eligible members of nurses have completed the JDI.

The group consists of 250 nurses including staff nurses who worked on patient unit. Full-time and regular part-time employees on all shifts were included and managers are excluded. The 200 registered staff nurses at work in the hospital were reached by an online JDI which designed under excel program. The response rate, however, was %84 with a total number of 250

nurses completing useable questionnaires. Therefore, the collected data consisted of 212 data vectors. As, each vector consisted of five data elements related to the values of the effective factor (EF) of job satisfaction and one data element relevant to their corresponding job satisfaction level (JSL). The 212 data vectors were randomly split into 180 training data vectors and 30 test data vectors.

Seven models for the mentioned JSL with different inputs were proposed (Further information is presented in Tab. 4). The topologies of seven NN models was MLP trained by BP algorithm based on Levenberg-Marquart rule [28]. In order to choose the optimal configuration for each network, a number of different network configurations, consisting of one to three hidden layers and different number of neurons in hidden layers with various transfer functions were considered.

The training process was run under the MATLAB environment.A minimum of the user-specification error function i.e., RMSE of 1e-001 was reached while the number of epochs is less than 1000 and grad rate is more than 1e-010. The optimal configuration of each training network was selected based on the degree of model fitness which is demonstrated by the value of error function. As Fig. 4 indicates when the number of neurons in first and second hidden layers were equal six and nine respectively, it was the most of the training RMSE of network for model 5.
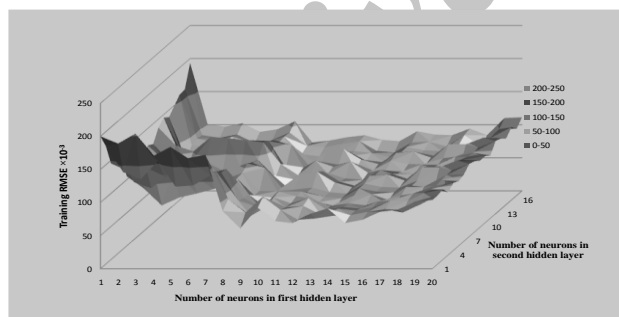
Fig. 4. Effect of number of neurons in first and second hidden layers on training RMSE for model 5

Tab. 4. The features of the configurations for networks of seven proposed models

Models	Selected EFs	MLP structure	Transfer function
Model 1	PA	1-4-6-1	Tansig-logsig- purline
Model 2	WO	1-4-1	logsig- purline
Model 3	CW	1-4-1	logsig- purline
Model 4	OP, SU	2-4-1	logsig- purline
Model 5	PA, WO	2-6-9-1	purline-tansig- purline
Model 6	SU,CO	2-8-8-1	purline-logsig- purline
Model 7	PA, WO, CO	3-8-9-1	purline-logsig- purline

(Pay =PA, Work=WO, Opportunities for Promotion=OP, Supervision =SU, and Co-Workers=CW)

Tab. 4 shows the features of the configuration for

networks of seven NN models and the result of training

process relevant to models are demonstrated in Tab. 5. So, in order to find the most reliable model, all 30 test data vectors were used for model evaluations. The test data vectors were customized and presented to each

model. The results of the model evaluation using performance indicators for seven models are provided in Tab. 5.

Tab. 5. The results of model evaluation using performance indicators for seven models

Models	RMSE		R2	Priority
	Training	Testing		
Model 1	0.0721	0.0812	0.2942	4
Model 2	0.0789	0.0824	0.3068	3
Model 3	0.0812	0.0852	0.2713	5
Model 4	0.0897	0.0910	0.2512	7
Model 5	0.0423	0.0513	0.3825	1
Model 6	0.0845	0.0897	0.2632	6
Model 7	0.0493	0.0527	0.3427	2

With regard to the results of Tab. 5, "PA, WO", "PA, WO, CO", "WO", "PA", are four most effective factors. Because the relevant model (i.e., the model *5)* is the most reliable one considering its minimum value for RMSE (both training and testing) and also its maximum value for R^2. The results of proposed ANN model can help us in designing system dynamics models. The results of the ANN model shows that three main factors which influence on job satisfaction are PA, WO, and CW. Therefore, we can use these main factors in modeling our system dynamics.

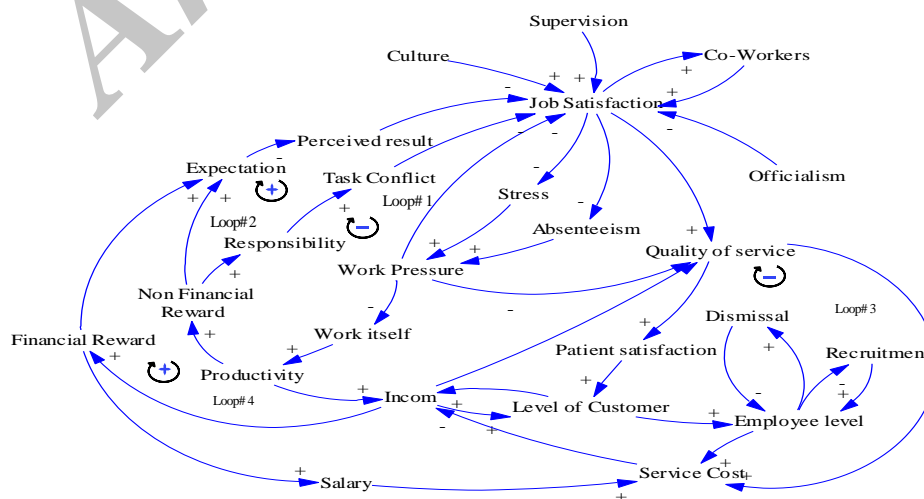## 5. The Proposed System Dynamics Model and its Interface

Causal loop (influence) diagrams exhibit the structure of a system in the system dynamics methodology. Causal loop diagrams play four important roles in SD. First, during model development, they can show the sketches of causal hypotheses, secondly, they can simplify the representation of a model, thirdly we can have different scenarios, and fourthly the major feedback mechanisms are captured by a causal loop diagram. These mechanisms are either positive feedback (reinforcing) or negative (balancing) loops. In a positive feedback loop an initial disturbance leads to further change, suggesting the presence of an unstable equilibrium. A

negative feedback loop exhibits a goal-seeking behavior [29].

In this section we present job satisfaction Causal loop diagrams according to the various studied models based on the previous researches and the ANN result in three different scenarios. This model contains two important kinds of rewards which top management may use for increasing staff motivation. In the next sections we will analyze all these scenarios.

5-1. Scenario 1 – Finantial & Non Finantial Reward

In Fig. 5 we proposed casual loop according to previous finding for job satisfaction. The arrows represent the relations among variables. The direction of the influence lines displays the direction of the effect. Signs ''+'' or ''_'' at the upper end of the influence lines exhibit the sign of the effect. When the sign is ''+'', the variables change in the same direction; otherwise they change in the opposite one. In this influence diagram (Fig. 5), several distinct loops can be observed, which control the job satisfaction. We can use this diagram for determining the rate of job satisfaction and also we can determine the kind of reward (financial and non financial rewards) in order to achieve the best rate of job satisfaction in healthcare organization. In addition we can make different scenarios for determining the best situation.

Fig. 5. Proposed influence diagram for healthcares' staff job satisfaction
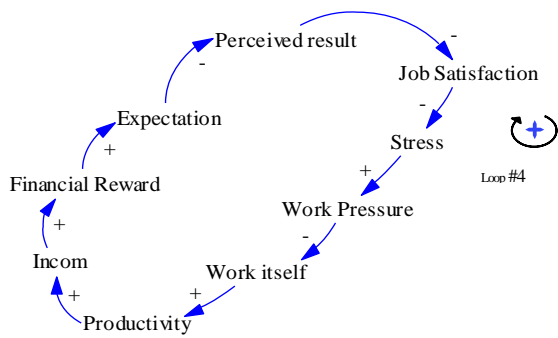
Four main loops of this model are shown as loop#1, loop#2, loop#3, and loop#4. Two of them contain financial reward and two others have nonfinancial reward (Fig. 5).

The first loop (Fig. 6) shows that the job satisfaction has a negative influence on the job stress and vice versa, in the other word when job satisfaction increases, the job stress will decrease and when job stress increase the job satisfaction will decrease. Job stress has a positive influence on the work pressure which has a counteractive effect on the work itself (Workload; scheduling; challenging work; routinization; task requirements) and productivity. Therefore, when work pressure is high the work itself will be low and when the work itself is good the productivity will be high. The productivity has a positive influence on non-financial reward. When productivity increases so does the non-financial reward. The non-financial reward influences the expectation in the same direction (+). Therefore, as the non-financial reward increases the staff expectation will also increase. As staff expectation increases the influence on the perceived result is negative. Finally the perceived result has a counteractive (negative) effect on the job satisfaction. The above loop is positive as it involves a reinforcing influence. The overall influence of the loop can also be checked by multiplying the individual influences (-)(+)(-)(+)(+)(+)(-)(-) = (+). Due to the fact that this is a positive type loop it will always try to increase the job satisfaction. Other factors which have positive influence on the job satisfaction, as shown in Fig. 5, are Culture, supervision co-workers and officialism.

Fig. 6. Causal loop diagram of nonfinancial reward (loop1)

Loop #2 (Fig. 7) is defined by the sequence of the variables Job satisfaction – Stress– Work pressure – Work itself – Productivity – Non-financial reward – Responsibility – and Task conflict. To explain the negative feedback mechanism, we follow the route around Loop #2. From Job satisfaction to non-financial reward is the same as loop#1 which is explained in the previous section. An increase in non-financial reward will increase Responsibility. This causes Task Conflict to increase. Finally, the increase in Task Conflict causes decrease in job satisfaction. By multiplying individual influences the overall influence of the loop determined as a negative loop.

Fig. 7. Causal loop diagram of nonfinancial reward (loop#2)

The third and fourth loops represent the financial reward and job satisfactions. Loop#3 contains job satisfaction, quality of service, service cost, salary, financial reward, expectation, and perceived result. As Fig. 8 suggests, the overall influence of the loop can be determined by multiplying the individual influences (+)(+)(-)(+)(+)(-)(-) = (-). Due to the fact that this is a negative type loop it will try to reduce the level of job satisfaction.

Fig. 8. Causal loop diagram of financial reward (loop#3)

As can be seen from diagram in Fig. 9, job satisfaction is dependent upon the Perceived Result. It shows that the Perceived Result has a negative influence on the job satisfaction. The expectation has a negative influence on the perceived result which has affected by financial reward and income. In other words when productivity increases the income and thus the financial reward and expectation will also increase. When expectation and perceived results increase, job satisfaction would be decreased. Although in loop#4 (Fig. 9) there are some negative arrows the overall influence of the loop is positive.

Fig. 9. Causal loop diagram of financial reward (loop#4)

5-2. Scenario 2 –Financial Reward

In scenario 1, there are two distinct loops: financial reward and non-financial reward which is examined simultaneously. In scenarios 2 and 3, we study every kinds of reward separately. In scenario 2, it is assumed that financial reward is that kind of reward which management wants to allocate. In this scenario the effect of financial reward on job satisfaction is studied. In Fig. 10 , when income increases due to increasing productivity, the financial reward will increase. Two main effects of financial rewards are increasing expectation and increasing salary. Each of these effects can influence on the level of job satisfaction indirectly. Service cost increases when salary or quality service increases. The two most important loops in Fig. 10 are shown as lopp#3 and loop#4 which were discussed in some more detail before. The overall influence of the loop#3 is negative and of loop#4 is positive. Therefore, in this model there are balancing and reinforcing loops. According to this model we can analyze all loops and study the effects of any factors especially financial rewards on job satisfaction.

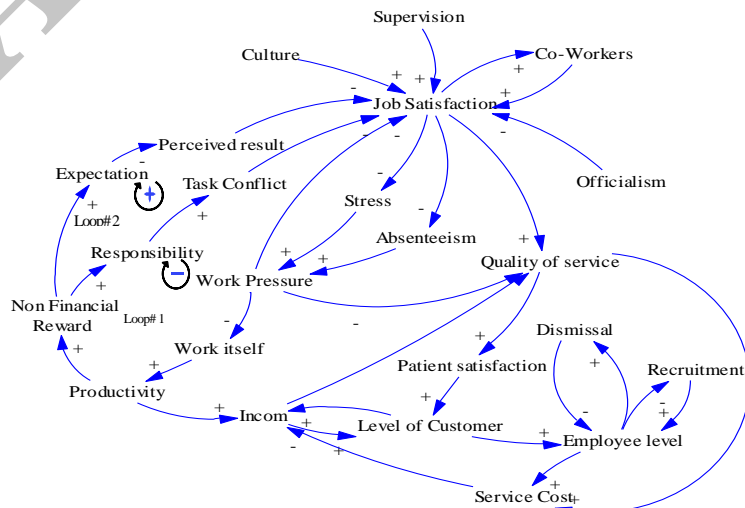**Fig. 10. Influence diagram contain financial reward for scenario 2**

Fig. 11. Influence diagram contain non financial reward for scenario 3

In this scenario the effect of financial reward on job satisfaction is studied. In Fig. 10 , when income increases due to increasing productivity, the financial reward will increase. Two main effects of financial rewards are increasing expectation and increasing salary. Each of these effects can influence on the level of job satisfaction indirectly. Service cost increases when salary or quality service increases. The two most important loops in Fig. 10 are shown as lopp#3 and loop#4 which were discussed in some more detail before. The overall influence of the loop#3 is negative and of loop#4 is positive. Therefore, in this model there are balancing and reinforcing loops. According to this model we can analyze all loops and study the effects of any factors especially financial rewards on job satisfaction.

5-3. Scenario 3 –Non Finantial Reward
Top managements believe that increasing non-financial reward has better impacts on job satisfaction in comparison with financial reward. Scenario3 is designed as Fig. 11 in order to survey the effect of nonfinancial reward on job satisfaction. In this scenario, when productivity increases the nonfinancial reward will increase as well. When non-financial reward increases, two factors (expectation and responsibility) also become high. In loop#1 increasing responsibility cause increasing task conflict and then it cause decreasing of job satisfaction. The overall influence of this loop is negative while the overall influence of loop#2 is positive. The detail of these two loops is shown in Fig. 6 and Fig. 7.

6. Summary and Conclusion
Determining the influenced factor on job satisfaction in service organization especially in health industry is so important for managers. Dissatisfaction at hospital has increased and it causes bad effect on organizations' outputs such as productivity. Job satisfaction has been identified as a key factor in employees' turnover with the empirical literature suggesting that it is related to a number of organizational, professional and personal variables which is summarized in Tab. 2 and Tab. 3..

In this study we can find some important factors which are influenced on job satisfaction (Tab. 2) and important effects of job satisfaction on organizations' outputs (Tab. 3). The second important finding of this paper is, finding of confliction and similarity between factors and effects based on literature review. For example in Table 2 there are some studies which have different results. According to Lus' study, educational level has positive influence on job satisfaction, while according to Ramburs' study (2003), this factor has negative effect on job satisfaction. Result of Matrunolas' study (1996) shows job satisfaction has no significant influence on absenteeism and Sius' study (2002) shows that job satisfaction has negative

influence on absenteeism. These are two important conflicts among JS's studies. Therefore, although several models of job satisfaction have been postulated, these models require further testing especially regarding the relative contribution of different factors and effects by some tools such as system dynamics. The literature suggests that the current models of job satisfaction need to be modified as they omit some important factors or effects of job satisfaction such as role perception. The lack of a comprehensive model of job satisfaction and lack of using system dynamics in job satisfaction is a major shortcoming. Therefore the current worldwide dissatisfaction at hospitals highlights the importance of understanding the impact and interrelationships of the identified variables by system dynamics.

In this study, we presented a system dynamics based on ANN result for mapping and analyzing the job satisfaction evaluation and effect of kind of reward on it. The methodology constructs ANN for selecting best factors base on JDI. The evaluation weights provided by ANN can be applied as the criteria for selecting the important factors. The system dynamics designed based on the ANN result which it can be used to identify effective policies for selecting the kind of reward. The methodology has been implemented for the large hospital in Iran. Three main scenarios are developed to survey effect of different factors (i.e. financial and nonfinancial rewards and both of them) on job satisfaction. The developed model can be further used to simulate various scenarios. The model can further be used in a wide range of healthcare system.

References

[1] Wright, T. A. . "*The Emergence of Job Satisfaction in Organizational Behavior: A historical Overview of the Dawn of Job Attitude Research*" Journal of Management History, 12, 2006, pp. 262–277.

[2] Bowling N.A., Hammond G.D., "*A Meta-Analytic Examination of the Construct validity of the Michigan Organizational Assessment Questionnaire Job Satisfaction Subscale*", Journal of Vocational Behavior, 73 , 2008, pp. 63–77.

[3] Bowling, N.A., Hammond G.D., "*A Meta-Analytic Examination of the Construct Validity of the Michigan Organizational Assessment Questionnaire Job Satisfaction Subscale*", Journal of Vocational Behavior, 73 , 2008, pp. 63–77.

[4] Maslow, A., , "*Motivation and Personality.*" Harper and Row, New York,1954.

[5] Lu,H., While, A.E., Barriball, K.L., "*Job Satisfaction Among Nurses: a Literature Review*",International Journal of Nursing Studies 42 , 2005, 211–227.

[6] Gaither, C.A., "*Job Satisfaction and Intention to Leave the Profession: Should we Care?*", Administrative Pharmacy 5 , 91–93, 2009.

[7] Locke, E.A., *"What is Job Satisfaction?"* Organizational Behavior and Human Performance, 4, 1969, pp. 309–336.

[8] Herzberg, F., Mausner, B., The Motivation to Work, second ed. Wiley, NewYork.1959.

[9] Kuhlen, R.G., "*Needs, Perceived Need Satisfaction Opportunities, and Satisfaction with Occupation*". Journal of Applied Psychology XL VII (1), 1963, pp. 56–64.

[10] Gruneberg, M.M. (Ed.), Job Satisfaction-A Reader. Macmillan Press, London. 1976.

[11] Price, J.L., "*Reflections on the Determinants of Voluntary Turnover.*" International Journal of Manpower 22 (7), 2001, pp. 600–624.

[12] Cui, B., Han, R., "*Modeling of Dimensional Errors in Slender Bar Turning Using Artificial Neural Networks*", Proceeding 7th World Congress on Intelligent Control Automation, China, 2008, pp. 6053-6.

[13] Demuth, H., Beale, M., Neural Network Toolbox User's Guide, 4th edition, The Mathworks, Inc, MA, USA, 2000.

[14] Forrester, J.W., *Industrial Dynamics*, M.I.T. Press, Cambridge, MA, 1962.

[15] Holmström, P., Elf , M., *"Staff Retention and Job Satisfaction at a Hospital Clinic - a Case Study"*, The Twenty-Second International Conference of the System Dynamics Society July 25-29, 2004.

[16] Laszlo, E., "*The Relevance of General Systems Theory*", Braziller, New York, 1972.

[17] Wolstenhoime, E.F., Coyle, R.G., "*The Development of system Dynamics as a Methodology for System Description and Qualitative Analysis*", Journal Operation Research Society, 34, 7, 1983, 569-581.

[18] Roos, L.L., Hall, R.I., "*Influence Diagrams and Organizational Power*", Admin. Sci. Q., 25, 1980, pp.57-71.

[19] Forrester, J.W., Senge, P.M., "*Test for Building Confidence in System Dynamics Models*", in A.A. Legasto, J.W. Forrester and J.M. Lyneis (eds.), "System Dynamics", North Holland, New York, 1980.

[20] Gupta, Y.P., Gupta, M.C., *"A Process Model to Study the Impact of Role Variables on Turnover Intentions of Information Systems Personnel"*, Computers in Industry 15, 1990, pp. 211-238.

[21] Chien-Chang, C., *"A Fuzzy MCDM Method for Solving Marine Transshipment Container Port Selection Problems,"* Applied Mathematics and Computation, Vol. 186 (1), 2007, pp. 435-444.

[22] Spector, P.E., "*Job Satisfaction: Application, Assessment, Causes, and Consequences.*" SAGE Publications, London, 1997.

[23] Namasivayam, K., Zhao, X., "*An Investigation of the Moderating Effects of Organizational Commitment on the Relationships Between Work–Family Conflict and Job Satisfaction Among Hospitality Employ*",Tourism Management 28 , 2007, pp.1212–1223.

[24] Coomber, B., Barriball, K.L., "*Impact of Job Satisfaction Components on Intent to Leave and Turnover for Hospital-Based Nurses: A Review of the Research Literature*", International Journal of Nursing Studies 44 , 2007, pp.297–314.

[25] Gui, L., Barriball, K.L., While, A.E., "*Job Satisfaction of Nurse Teachers: A Literature Review. Part II: Effects and Related Factors*", Nurse Education Today 29, 2009 , pp.477–487.

[26] Acua , S.T., Gmez, M., Juristo, N., "*How Do Personality, Team Processes and Task Characteristics Relate to Job Satisfaction and Software Quality?*" Information and Software Technology 51, 2009, pp. 627–639.

[27] Chen, H.C., Chuc, C.I., Wang, Y.H., Lin, L.C., "*Turnover Factors Revisited: A Longitudinal Study of Taiwan-Based Staff Nurses*", International Journal of Nursing Studies 45, 2008, pp.277–285.

[28] Boles, J.S., Babin, B.J., "*On the Front Lines: Stress, Conflict, and the Customer Service Roles.*" Journal of Business Research, 37, 1996, pp. 41–50.

[29] Tett, R.P., Meyer, J.P., "*Job Satisfaction, Organizational Commitment, Turnover Intention, and Turnover: Path Analyses Based on Meta-Analytic Findings.*" Personnel Psychology, 46, 1993, pp.259–293.

[30] Tzenga, H.M., Ketefian, S., Redman, R.W., "*Relationship of Nurses' Assessment of Organizational Culture, Job Satisfaction, and Patient Satisfaction with Nursing Care*", International Journal of Nursing Studies 39 , 2002, pp.79–84.

[31] Mutuc, J.E.S., *"Investigating the Dynamics of Employee Prediction."* International System Dynamics Confrece, 1994.

[32] Eracar, Y.A., Kokar M.M., "*Self-Control of the Time Complexity of a Constraint Satisfaction Problem Solver Program*", Journal of Systems and Software, Volume 85, Issue 12, 2012, pp. 2697-2706.

[33] Aggelidis ,V.P., Chatzoglou P.D., "H*ospital Information Systems: Measuring end User Computing Satisfaction (EUCS)* " Journal of Biomedical Informatics, Volume 45, Issue 3, 2012, pp. 566-579.

[34] Hosseinabadi R., Karampourian A., Beiranvand S., Pournia Y., "*The Effect of Quality Circles on Job*

Satisfaction and Quality of Work-Life of Staff in Emergency Medical Services", International Emergency Nursing, 2012, In Press.

[35]   Krycha, K.A., Wagner, U., "*Applications of Artificial Neural Networks in Management Science: A Survey*", Retailing and Consumer Services, NO.6, 1999, pp.185-203.

[36]   Wilcox, J.A.D., Wright, D.T., "*Towards Pultrusion Process Optimisation using Artificial Neural Networks*", Materials Processing Technology, NO.83, 1998, pp.131-41.

[37]   Nascimento, C.A.O., Giudici, R., (eds) "*Neural Net Based Approach for Optimization of Industrial Chemical Process*", Computer and Chemical Engineering, NO.24, 2000, pp. 2303-74.

[38]   Hosoz, M., Ertunc, H.M., (eds) "*Performance Prediction of a Cooling Tower using Artificial Neural Network*", Energy Conversion and Management, NO.48, 2007, pp.1349-59.

[39]   Balzer, W. K., Kihm, J. A., Smith, P. C., Irwin, J. L., Bachiochi, P.D., Robie, C., et al. " *Users' Manual for the Job Descriptive Index and the Job in General (JIG) Scales*". Bowling Green, OH: Bowling Green State University1997.

[40]   Rumelhart, D.E., Hinton, G.E., (eds) "*Learning Internal Representations by Back- Propagating Errors*", Nature, NO.23, 1986, pp.533-6.

[41]   Georgiadis, P., Vlachos, D., Iakovou, E. "*A System Dynamics Modeling Framework for the Strategic Supply Chain Management of Food Chains*", Journal of Food Engineering 70 ,2005,pp. 351–364.