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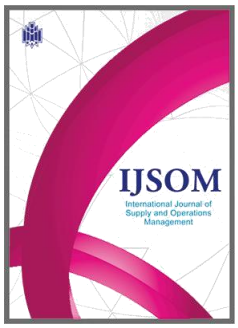

Presenting a Comprehensive Smart Model of Job Rotation as a Corporate Social Responsibility to Improve Human Capital

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Abstract

Providing job rotation schedules among certain individuals of organizations has been the research focus in the field of job rotation. Obviously, any movement of people will cause a change in the position of others and if there are no properly defined criteria for movement, the resulting job rotation not only is not effective in the long run but also may cause serious damage to the organization. In this regard, the main purpose of this research is to find the best model developed for job rotation and solve the "job rotation scheduling problem" with respect to the factors influenced by the job. So, Health and Safety Executive (HSE) standard questionnaire was used for measuring job stress among the population of nurses in Iranian health centers (n=1221 of a 6148 population) to form databases required for the implementation of data mining. In order to make a smart model, the use of internal rules and patterns of existing data is considered and with the development of meta-heuristic models for this kind of problem, the model is solved with genetic algorithms. The current job rotation model has been developed compared to previous models because of using smart limitations resulting from the process of knowledge discovery by data mining method. In contrast with the results of the previous studies on job rotation, our results are applicable to all organizations need to have different leadership styles in order to practice corporate social responsibility(CSR) and use capabilities to identify rules that allow easy use of meta-heuristic algorithms.

Keywords: Job rotation; Genetic algorithm; Data mining; Job stress; Corporate social responsibility (CSR); Leadership style.

1. Introduction

1.1 Problem definition

Today, people spend more than half of their waking time at the workplace and therefore are affected by different factors at their workplace. These factors can lead to problems such as: job anxiety, job stress, career plateau, burnout, career inertia, job boredom and so on. That summarizes the factors influenced by job and workplace. But a responsible manager aims to reduce these factors and trys to practice corporate social responsibility(CSR) in her/his management to improve employee productivity and firm's productivity consequently.

On the other hand, where a lack of staff performance is observed, it should be noted that the current organizations (especially public sector) are not often allowed to quickly dismiss and replace their personnel, as a result, one of the best solutions for such organizations is personnel job rotation.

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It is very difficult to change the entire structure of an organization, but if job rotation programs are slowly and deliberately performed they can be effective in improving working conditions. As a result, if one can acquire knowledge on the magnitude of the factors influenced by job useing effective tools for decision-making (such as data mining), there will be the possibility of finding a suitable model for the implementation of job rotation to control the factors influenced by job and increase employee productivity.

Providing job rotation schedule among certain individuals of organizations has been special focus of researchers in the field of job rotation, or merely career has been taken into consideration. However, this approach will ultimately lead to transient changes in a particular sector or possible satisfaction for specified individual. Obviously, any movement of people will result in a change in the position of others and if there is no defined criteria for movement, the resulting job rotation is not only effective in the long-term, but also may cause serious damage to the organization.

As a result, the main question that has led to the present study is stated in one senetence as follows:

What is the best model developed for job rotation and solving "job rotation scheduling problem" with regard to the factors influenced by job?

The main hypothesis of this study is also defined as follows:

"The developed appropriate model for job rotation with regard to the factors influenced by job based on meta-heustric algorithms is better than the classic methods."

1.2 The research method

The defined study is Practical and developmental in purpose and descriptive -comparative analysis. Data collection tools in this research include: questionnaire, database, experts interview to verify data mining output; and Spss software, Spss Clementine, Matlab and Excel are used to analyze the collected data.

The approach used in this study giving a smart feature to the proposed model, is the use of data mining techniques to identify factors for job rotation that discover the underlying patterns of databank by smart algorithms and provide the best data interpretation based on the training and test data. Obviously, this structure will be a basis for job clustering in several index groups allowing more suitable scheduls and job rotation programs according to the defined algorithm based on job stress measuring.

1.3 Study population and sample

The population that is used in this study for the implementation of data mining and to design the model is as follows:

"All nurses in hospitals and health centers across the country."

Number of cases investigated in the study is 1221, this sample is obtained from approximately 11,000 nurses who are members of the Nurses Association and the questionnaire was sent to them, among these questionnaires 6148 answers were copmpletely right and applicable. A variety of factors were involved in the given society, including:

- Proper frequency of working people in this occupational group
- Proper distribution in cities all over the country
- Remarkable ability to generalize the results to other occupational groups in similar studies
- The availability of appropriate statistical sample of the total population of the occupational group
- The significant relationship between employees of the group and clients that affects criteria related to job rotation and job stress.
- The job rotation capability according to the level of expertise and skill with the lowest education
- Actual implementation of job rotation in this type of job

2. Research Background

2.1 Job rotation

Some definitions given for job rotation include:

- A system in which personnel take training and empowerment courses for short periods to gain new work experience.
- A development strategy in which a person is temporarily placed in another working position.
- Job rotation is defined as a strategy to diversify tasks assigned to individuals as well as the development of related skills. (Dargo & Garvey, 1998) and (Lincoln & Kalleberg, 1990).
- Job rotation alone can not change occupational risk factors, but simply distribute risk factors among all staff. Thus, the risk increases or decreases for some employees. (Rashid, Asili and Farhadi, 2001)

2.2 Job Rotation Schedule Problem (JRSP)

JRSP is a subset of human resource scheduling problem, which plans to allocate tasks to the operators within the specified period of time as a result, costs of allocation, including labor costs and opportunity will be minimal (Burke & Moore, 2000) and (Sekiner & Kurt, 2007). Therefore, integration of human factors in human resource scheduling problem absolutely necessary (Lodree, Geiger, & Jiang, 2009). Nembhard and Norman argued that there is no clear guidelines for human task-work sequencing problem so they support productivity-worker modeling as a function of human learning and forgeting. (Nembhard & Norman, 2006). Aryanezhad et al highlighted the force to use multi-objective models to match with the actual setting (Aryanezhad et al., 2009). The following table is a summary of studies in the field of job rotation and job rotation schedule problem with the relevant criteria.(See Table 1)

2.3 Choosing the factor best influenced by job rotation

As can be seen in research related to job rotation, a number of indicators and criteria has been used, which were evaluated in the research background. In simple words, all researchers in the field have always had the desire to improve the proposed measures by implementing a job rotation schedule in the organization. According to the criteria taken into account as well as studies on the population of the present study, we have tried to select a factor for this study, which in addition to being affected by the implementation of job rotation, is in a proper associated with the other factors influenced by job rotation, therefore, measure of job stress has been selected as a factor that influenced by job rotation. This association has been fully investigated and proven in research by Azar et al., (2014).

2.3.1 What is job stress?

Job stress is a situation that can result from the interaction between individuals and jobs and it is characterized by the changes that occur within the individuals and force them to deviate from their normal practice (Beehr & Newman, 1978). In 1992, the United Nations declared job stress as the disease of the twentieth century and later the World Health Organization (WHO) called it a rampant problem in the world. International Association of Employment estimates costs incurred to countries due to job stress by 1 to 3.5 percent of GDP. Job stress affects human health, reduces quality of life and increases the risk of injury caused by work (Michalos & Et. Al., 2010). Many studies demonstrate the role of job stress in causing signs of disease, a lot of labor movement and early retirement (Hong & Kuo, 1999).The British Health and Safety Executive (HSE) said that the following seven factors could be involved in the creation of job stress:

- Demands
- Control
- Managerial support
- Peer support
- Relationships
- Role
- Change

Table 1. Summary of studies on job rotation

Researcher(s)	Result of Research	Criterion (s) intended for job rotation model
H. Lynn et al. (1993)	• Job Rotation of employees in Japanese International Company is better than American Company	
M. Cosgel And J. Miceli (1998)	• Increasing of enterprise benefit	
Paul et al. (1999)	• A significant reduction of perceived load and energetic load and a slight decline of Postural load • Reduce the amount of work done by job rotation	• Energetic load • Perceived load • Postural load
Carnahan et al. (2000)	• The employment intensity control using improved genetic algorithm in job rotation	• Job Severity
Richard M. Malinski (2002)	• Increasing job satisfaction and job enrichment	• Job Analysis
Tharmmaphornphilas (2004)	• Reducing job stress and harm potential of workers	• Job Severity Index (JSI)
Hsieh A, Chao H (2004)	• Implementation of job rotation to consider of occupational specialty that leading to a decrease job burnout (a case study in the Taiwan)	• Job burnout
Bhadury, J., Rdovilsky (2006)	• Designing a model to reduce the number of job rotation and cost of implementing job rotation	• Job boredom
Butkovi˘C And Lewis (2007)	• Computational problem solving in some special cases of polynomial models of job rotationat a matrix N*N	
Ulusam Seckiner and Kurt (2008)	• Minimizing the work load	• Work load
Michalos et al. (2010)	• Reducing the distance traveled, cost and operators repetition and Reduce job boredom with the use of dynamic models	• Competence • Operators fatigue accumulation • Distance travelled • Cost • Repetitiveness of tasks
Kaymaz (2010)	• Increasing Job motivation by Job rotation	• Job motivation
Ayough et al. (2011)	• Decreasing of innovative cost calculation for Job boredom by ICA algorithm	• Job boredom
Delpasand (2012)	• No significant relationship between job rotation and Job boredom	• Job boredom
Mohsan et al. (2012)	• Job rotation reduce motivation and increase job commitment in different departments	• Job motivation • Job commitment
Mayron (2013)	• Implementation of job rotation with hybrid algorithm for assembly line worker	
Sotiris Makris (2013)	• Decreasing of workers assembly errors	• Assembly errors
Michalos et al. (2013)	• Enhanceing product quality	• Assembly errors
Otto and Battaia (2017)	• Lowering ergonomic risks and examine ways to modify workplaces	• Work load
Dickhout et al. (2018)	• Mitigating the onset of muscle fatigue and engaging distinct muscle groups	• Job boredom • Work load
Han et al. (2020)	• Decrease side effects of working in high-altitude regions in health	• Work load

2.3.2 HSE Job stress questionnaire

Having the right tools for measuring job stress is the first and the most important step to identify the factors affecting it, for this purpose, HSE standard questionnaire was used.

This questionnaire with 35-item in seven categories was designed in the late 1990s by the Institute for health and safety in order to measure job stress of English workers in seven categories (demands, control, managerial support, peer support, relationships, role and change). The validity and reliability have been reviewed and approved by Azad Maezabady Azad Maezabady & Gholami Fesharaki, (2010). Answer to each question is determined on the basis of 5-item Likert scale. On the other hand, in order to assess the relationship of job rotation of respondents a question as "Have you ever had a job rotation in your job?" has been added to the questionnaire.

After analyzing the results of the questionnaire on 35 key questions to assess job stress, Cronbach's alpha of 78.7 percent was obtained, which indicates the validity of the questionnaire.

2.4 Corporate Social Responsibility (CSR)

Some definitions given for CSR include:

- CSR as a responsibility towards human development in two complementary ways: (a) a holistic responsibility shared by companies together with other actors to safeguard humanity and (b) a direct liability of each company for its impact on stakeholders' capabilities. (Renouard C. & Ezvan C., 2018)
- CSR is a self-regulating business model that helps a company be socially accountable-to itself, its stakeholders, and the public. By practicing corporate social responsibility, also called corporate citizenship, companies can be conscious of the kind of impact they are having on all aspects of society, including economic, social, and environmental.(Chen J., 2020)
- CSR is an evolving business practice that incorporates sustainable development into a company's business model. It has a positive impact on social, economic and environmental factors.(Schooley S., 2019)

In a context where many human needs and rights remain unsatisfied and where businesses may have both a positive and a negative impact on the quality of life of human beings may even lead to irreversible damage, Needing to enhance a corporate social responsibility (CSR) framework leads us to study more on relevant researches in order to help managers to manage their company more efficiently.

Table 2. Summary of studies on CSR

Researcher (s)	Result (s) of Research
Nave & Ferreira, 2018	• Four key categories related to CSR strategies of companies: 1. *Dimensions*: An increasing concern for companies that have focused on reducing the impact of their activities on the environment but also implement activities at the level of social and economic dimensions. 2. *Benefits*: Benefits integrate reputation, as well as performance and competitive advantage. 3. *Value creation and stakeholders*: An important element for internal and external stakeholders 4. *Motivations*: Motivations can be strategic or altruistic
Asgary & Li, 2016	• The integration of CSR into the prevailing strategies has become a fundamental characteristic of companies. • Development of ethical consumerism has an important role in pressuring private sector companies to deal with CSR.
Asmussen & Fosfuri, 2019	• Investment in social brands and CSR helps avoid irresponsible practices across the Multinational enterprises (MNEs) network
Mussell, H., 2016	• CSR is problematically grounded in liberalist thinking. • The author advanced the thesis that SR has emancipatory ends, of meeting human needs and flourishing
Forcadell F. J., & Aracil E., 2017	• They analyzed the effect of having a reputation for CSR on performance of the European banks listed in the DJSI for the period 2003–2013 economic crisis. • Suggest that banks' efforts to build a reputation for CSR benefits performance.
Gond J. P. et. al, 2017	• They Aimed to consolidate the psychological microfoundations of CSR by taking stock and evaluating the recent surge of person- focused CSR research
Al-Reyaysa M. et.al, 2019	• The use of project management to organize, implement, align, and monitor CSR activity supports capacity development in CSR and can contribute to its sustainability. • CSR is claimed to be implemented more in the West than in the Gulf Cooperation Community (GCC) and Middle East and North Africa (MENA) region

Table 2. Continued

Researcher (s)	Result (s) of Research
Nyuur R.B et.al, 2019	• Export orientation, firm strategy, structure, and firm size play moderating role between CSR and competitive advantage (CA) • Proper integration of CSR into firms' activities is more important in enhancing firm competitiveness. • Continuous CSR engagement and integration in a firm's strategic activities is an essential ingredient in achieving and sustaining competitive advantage (CA).
Alonso-Almeida M. M. et.al, 2017	• Spanish women may be more adaptable and effective at pursuing company sustainability than Spanish men in various dimensions of CSR by focusing on the leadership styles-transformational and dual perspectives.
Vallaster Ch. 2017	• Strategic CSR can have a positive impact on crisis recovery and promote the revision of established practices required to manage a company crisis • Improved CSR practices to recover can find a way back to a healthy state. • Effective crisis recovery demands the development of CSR practices, which are continuously used and adapted within the company in feedback loops: 1.Observing crisis signals within the internal and external company environment 2.Identifying opportunities to get out of the crisis 3.Repairing the company by aligning the entire organization with business and social needs 4.Using stakeholders to learn and evolve through feedback loops
Jackson G. et. al, 2018	• Many business management scholars have embraced CSR as a more human approach to capitalism that takes on board the notion that social legitimacy is a central prerequisite for profitability and that environmental sustainability is critical for the long-term economic development. • CSR may be seen as a tool of symbolic management or even an active form of corporate "greenwashing" aimed to distract stakeholders from unsustainable or unethical activities. • CSR may be associated with state deregulation and the rise of neo-liberalism, which have led to the erosion of social standards globally.

3. Design and implementation of model

3.1 Implementation of data mining and determination of model constraints

In order to make a smart study model, the use of internal rules and patterns of the existing data was considered as a measure to choose options. As one of the best methods to extract hidden patterns and rules of database is data mining method, thus using data mining technology it has been trying to extract the desired rules and the same rules are used as constraints of the model.

3.1.1 Database formation and data preparation

Data preparation include all stages preparing records and variables for creating model and tree in data mining process. This starts from the definition and collection of records and includes all operations of data clearing, data removal, restoration of lost data, data transform, data integration and data extension.

As in this study, a questionnaire was used to collect data and form the database, the process of data preparation is guided and conducted to implement the desired data mining. At first and according to the selected criteria of job rotation (ie, "job stress") mentioned in the previous sections, the questionnaire required for the database was prepared.

The results of the questionnaire have the following variables that are summarized in the following table.

Table 3. Variables defined in the database

Variable	Kind of Variable
Gender	Flag
Age	Ordinal
Marital Status	Nominal
Education	Ordinal
The Whole Experience	Ordinal
Total Experience In Job	Ordinal
Type Of Contract	Nominal
Job Rotation Status	Nominal
Demands Score	Continuous
Control Score	Continuous
Managerial Support Score	Continuous
Peer Support Score	Continuous
Relationship Score	Continuous
Role Score	Continuous
Change Score	Continuous
Stress Score	Continuous
Demands Status	Nominal
Control Status	Nominal

3.1.2 Creating data mining trees and modeling

For creating tree in the first place, several questions arise, including:

- Should all variables be involved in the creation of the tree at the same time?
- Does the tree accuracy depend on the number of variables or records?
- What combination of variables will form the best tree?
- Is the selection of the objective variable important in the tree creation?
- Which data mining algorithm will result in the best results?
- And...

To answer these questions and other questions in this regard, is should be noted that the number of variables is not important, the important thing is their type and the inherent dependence between the dependent variables and the objective variable. The number of records can also be too high or low, but many repetitive and strong relationships may lie the same small number of records. In fact, the number of records depends on the number of events recorded in the database. On the other hand, the objective variable should be the variable that is linked directly to the goals of data mining.

In this study, and from the output of the data mining results, we tend to answer the following two questions:

• *What are the relationships between nurses' professional and personal variables and their job stress?*

• *What is the effect of nurses' current job rotation and job rotation type on their job stress, and to which professional and personal characteristics of them they are basically related?*

The purpose of answering to the above questions is to form the limitations of the comprehensive smart model of this study. Therefore, in order to answer the second question, some part of the records (individuals) is important for us to have job rotation (of any kind). As a result, this group's data bank includes records (individuals) that all have job rotation. In this regard, and since the variables of "job stress" and "job rotation type" are the only variables that reflect the functional status of a nurse during his or her service, thus, they are selected as objective variables.

To solve the problem of selecting variable type, algorithm, and objective variable type the best available tool is the accuracy of the created tree. In this study, based on the conceptual developed model and to create the tree and evaluate what types of objective variable and independent variables are available for database, the following steps have been taken in order and the following results have been achieved.

Step 1) With regards to two groups' identification of independent variables (personal and proffesional) as well as the presence of two types of objective variables (job stress and job rotation type), knowing that each objective variable can also be an independent variable for the other objective variable, and the presence of different algorithms for decision tree creation, first all possible models that can be formed by using this database were examined. Due to the presence of 4 states of independent variable, 2 objective variables and 4 proposed algorithms for decision tree technique (Quest, Chaid, C5.0, C & RT and Ordered), the possibility of creating 144 trees was evaluated as below:

$$(2x - 1) * y * A * Db \quad (1)$$

Where, x is the number of groups of independent variables, y is the number of objective variable, A is the number of algorithms and Db is the number of data banks. As a result of (1):

(22-1)*4*4*3=144

Step 2) since number of training records (by random selection) is 70% of all records, number of test records is 25% and number of confirming tree records is 5%, every 144 model identified with these records were trained by using the software Clementine and their accuracy was assessed based on three accuracies including training, testing, and validation Accuracy.

Step 3) According to the obtained results (of the 144 desinged model), the number of created trees was only 69 that with regards to errors, only trees have been selected that have the following conditions at the same time:

- Training Accuracy $\geq$ 80%
- Testing Accuracy > 70%
- Validation Accuracy > 70%

In this case only 13 trees have met all conditions which were developed by C5.0 algorithms and are presented in the following table.

Step 4) According to the results of the craeted trees, a number of 121 rules with Rule Accuracy over 50% was extracted from the 13 selected trees that with definition of the measure's accuracy, RTA is as follows:

*RTA= Rule Accuracy * Training Accuracy* (2)

All rules having more than 85% of RTA were selected as the final rules and limitations of the model. Considering that over 85% of reliability in data mining is a quite reasonable value, it can be expected that limitations of these rules can be very effective in creating a strong and smart model.

According to the assumed conditions, only rules having Rule Accuracy of 100% were placed in this framework and the number of final rules extracted was 52.

Of these 52 rules, 33 rules (constraints) represent job rotation type's relationships and 19 rules (constraints) represent relationships between personal/professional variables and job stress of the studied population. Finally, with regards to the definition of these 52 constraints (examples of these constraints are presented in Table 3.) and definition of the following objective function:

$$\text{Min } Z = \sum_1^n xi \quad (3)$$

The final model has been formed in which x_i is the level of job stress of each n personnel selected for implementing of job rotation.

Then, the model has been solved by using meta-heuristic genetic algorithm and the results have been presented as follows:

Table 4. The selected rules (constranits) indicating relationships of the type of job rotation

Rule Code	Model Name	RTA	If	Sex	Age	Marital status	Education	The whole experience	Total Experience in current job	Type of Contract	Stress Score	Then	Job Rotation Status
M-6-4	M-6	93.36%	If	F				Less than 3		Official	> 1.850	Then	2 to 5 JR in Year
M-6-1	M-6	93.36%	If			Divorced			Above 4			Then	Yearly JR
M-6-3	M-6	93.36%	If					Less than 3			<= 1.850	Then	Monthly JR
W-6-1	W-6	93.07%	If		Less than 32			11to15			<= 2.600	Then	2 to 5 JR in Year
W-6-3	W-6	93.07%	If		Above 33		AD	11to15		Contractual		Then	Daily JR
W-6-8	W-6	93.07%	If		Above 33			Less than 10 & Above 26	4to7 & 11to25		> 2.820	Then	Yearly JR
W-6-4	W-6	93.07%	If		Above 41			11to15		Other		Then	Yearly JR
W-6-6	W-6	93.07%	If		Above 47			16to25	4to7 & 11to25			Then	Yearly JR
W-R-6-2	W-R-6	92.44%	If		Less than 46				4to25	Didactic	> 2.940	Then	Yearly JR
W-R-6-1	W-R-6	92.44%	If		Less than 46				4to25	Official	<= 2.940	Then	2 to 5 JR in Year
W-R-6-3	W-R-6	92.44%	If		Less than 46				4to25	Official	> 2.940	Then	Daily JR
W-R-6-4	W-R-6	92.44%	If		Above 47				4to25			Then	Yearly JR
W-R-6-5	W-R-6	92.44%	If						Above 26		<= 3.090	Then	2 to 5 JR in Year
W-R-6-6	W-R-6	92.44%	If						Above 26		> 3.090	Then	Monthly JR
W-R-4-8	W-R-4	90.73%	If					Less than 10 & Above 26	11to25	Official		Then	Yearly JR
W-R-4-10	W-R-4	90.73%	If					Less than 10 & Above 26		Official		Then	2 to 5 JR in Year
W-R-4-12	W-R-4	90.73%	If					Less than 3 & 8to10 & Above 26		Other	<= 1.850	Then	Monthly JR
W-R-4-1	W-R-4	90.73%	If					11to15	Above 4	Contractual	<= 2.850	Then	Daily JR
W-R-4-9	W-R-4	90.73%	If					11to25		Official		Then	Daily JR
W-R-4-7	W-R-4	90.73%	If						Less than 3	Didactic	> 3.340	Then	Daily JR
W-R-4-13	W-R-4	90.73%	If						11to25	Other	> 3.230	Then	Yearly JR
W-R-4-14	W-R-4	90.73%	If						Above 26	Other	> 3.230	Then	Monthly JR
W-R-4-6	W-R-4	90.73%	If						Above 4	Didactic	<= 3.020	Then	Yearly JR

Table 4. Continued

Rule Code	Model Name	RTA	If	Sex	Age	Marital status	Education	The whole experience	Total Experience in current job	Type of Contract	Stress Score	Then	Job Rotation Status
W-R-4-2	W-R-4	90.73%	If							Contractual	> 3.600	Then	2 to 5 JR in Year
W-R-4-3	W-R-4	90.73%	If							Didactic	<= 1.850	Then	Monthly JR
W-R-4-4	W-R-4	90.73%	If							Didactic	> 1.850	Then	Daily JR
W-4-10	W-4	87.74%	If					Less than 10 & Above 26	Less than 3 & 8to10 & Above 26	Official		Then	Weekly JR
W-4-6	W-4	87.74%	If					Less than 10 & Above 26	4to7 & 11to25	Didactic		Then	Yearly JR
W-4-7	W-4	87.74%	If					Less than 10 & Above 26	4to7 & 11to25	Official	<= 3.140	Then	2 to 5 JR in Year
W-4-8	W-4	87.74%	If					Less than 10 & Above 26	4to7 & 11to25	Official	> 3.140		Weekly JR
W-4-4	W-4	87.74%	If					11to15		Official	> 3.450	Then	Daily JR
W-4-3	W-4	87.74%	If					11to15		Official	<= 3.450	Then	Weekly JR
W-4-5	W-4	87.74%	If					16to25	Less than 3 & 8to10 & Above 26			Then	Yearly JR

3.2 Genetic model design

In order to define the chromosome in this study, we assume job rotation for a 4-subject sample by genetic algorithm. Accordingly, first a solution vector must be defined. Vector defined in this study is as follows.

0.689215	**0.748152**	**0.083821**	**0.450542**	**0.114488**	**0.456669**	**0.810268**	**0.651362**

This vector consists of two parts in which the share of each main vector is exactly half. The first part of this vector represents those interchanging their positions and the second part represents the type of job change.
The following vector means that the first person interchanges his/her place with the third person and also the second person with the fourth person. In this way, the definition of the initial vector, one of the constraints of the model that every person can change his/her place with just one person, is established.

3	**4**	**1**	**2**

As the genetic algorithm is continuous, the random key method is used to generate initial population and the vector is generated continuously in the range of zero and one, then vector generation numbers are arranged from smallest to largest. According to the initial vector, if the first part is arranged from smallest to largest, it changes into the above vector. However, in the generated random vector one individual may not change his/her job.

Thus, initially the generated vector is continuously and randomly between zero and one, and is sorted as desired after arranging.

But the second part of the vector is corresponding to the type of job that everyone accepts. In this study the type of job rotation are defined as follows:

- Daily
- Weekly
- Monthly

- Seasonal (2 to 5 times a year)
- Annual

According to the vector, the space between 0 and 1 is divided into five parts. If a random number is between 0 and 0.2 that will be the first type of job rotation that is "daily". If the random number is between 0.21 to 0.4 that will be the second job rotation that is weekly. If the random number is between 0.41 to 0.6, that will be the third type of job rotation that is "monthly". If the random number is between 0.61 to 0.8, that will be the fourth type of job rotation that is "seasonal" and finally, if the random number is between 0.81 to 1, that will be the fifth type of job rotation that is "annual". Therefore, at the first step of the algorithm a chromosome is created to generate initial population and twice as the number of individuals who we want to run job rotation for them, that all elements of the chromosome have random numbers between zero and one.

3.2.1. Population size

As the first step of the genetic algorithm it is necessary to create a set of possible solutions as the initial population. The elements of this set are usually selected randomly but in optimized algorithms, bounds are used to avoid excesive scatteing of the population. The number of members of the population depends on the type of problem. Based on the experience a population between 10 and 160 members is prefered, so in this study n=50 is considered for population size.

3.2.2. Fitness function

After generating the initial population, how to calculate the fitness of produced vector should be defined. At this stage, the produced solution vector is first transformed in accordance with what was described to become suitable for the calculation.

The first constraint that is considered in this section is the constraint of heterogeneous change of individuals. According to the analysis of the chromosome, in the following vector for example, the third person should interchange his/her place with the first person while the first person should interchange his/her place with the second person.

3	**1**	**2**	**4**

As a result, for answering to this question, which one of the random recommendations of chromosomes are selected as the main job change and other values are modified accordingly, the option of change should be selected that the total job stress of all possible changes should be minimum and accordingly the change is selected that after an examination of all cases, the best value is obtained.

The best value means that the new job of individuals in the first place has the greatest similarities to personal/perfossional features and then their job stress is reduced compared to the current level and regarding to the constraints of the model.

After modifying unbalanced job changes in the first step, the fitness vector (solution vector) is calculated in the next step by considering that all the defined constraints are satisfied.

If a person is placed in a job with best situation in terms of personal ability and also job stress, he or she will receive the best pre-specified score otherwise per row spacing from proper job rotation, 10% of the original score (0.5) is reduced.

According to this mechanism the score of each individual is calculated in accordance with the following equation and thus the total change score is calculated by summing up the individual scores after job rotation.

$$\text{Score (i)} = (S0 + (Ei * S\ damp)\ ) * \text{score (i)} \quad (4)$$

3.2.3 Crossover operator

The most important operator of the genetic algorithm is crossover operator. The crossover is a process in which the older generation of chromosomes are mixed together and combined to create a new generation of chromosomes.

Pairs considered as parents in the selection part exchange genes with each other in this part and generate new members. Crossover in genetic algorithm causes loss of distribution or genetic diversity of population because it allows good genes find each other. Here crossover liklihood is assumed 80%.

In this study, arithmetic crossover that used as cut-off point of chromosomes was randomly selected and then crossover operator cuts two chromosomes of parents. Arithmetic crossover is summarized as follows.

If A and B are two members of the current population that have been selected as parents, two children, a and b are produced as follows:

$$a = \delta A + (1-\delta)B \tag{5}$$

$$b = \delta B + (1-\delta)A \tag{6}$$

Value of parameter δ is in the range of [0,1] that can have different values in each crossover and here are determined randomly.

In this method, a child is generated by copying genes 1 ... (P1-1) of the first parent chromosome and genes P ... N of the second chromosome, and another child is generated similarly, by copying genes 1 ... (P1-1) of second parent and genes P ... N of the first parent. In this type of crossover of the two parents, two children are produced. For example, the crossover is shown in Figure (1) with P = 4.

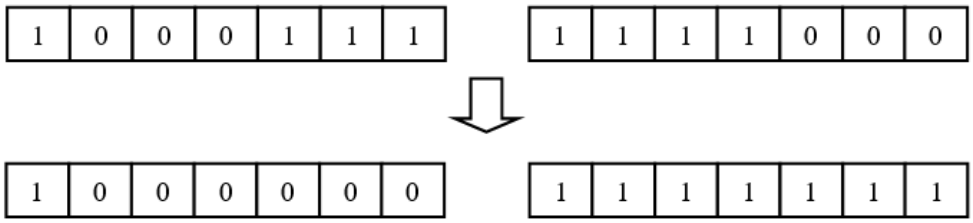

Figure 1. Single Point Crossover

It should be noted that if P = 1(the length of the chromosomes), then the two parents entered into the next population unchanged.

3.2.4 Mutation operator

Mutation is another operator that produces other possible solutions. In the genetic algorithm, after creating a new member in the new population, every gene mutates with mutation probability. The probability of mutation in this study is 10% of the population that is calculated by the following equation:

$$P_m = \frac{1}{N} \tag{7}$$

In the above equation, P_m is mutation probability and N is the number of initial population.

3.3 Setting genetic algorithm parameter

In order to ensure selection of the best values for the parameters of a meta-heuristic algorithm, one of the most appropriate methods provided so far is parameter setting with the Taguchi method. In this study, four main genetic algorithm factors that include the number of initial population, the maximum number of iterations, the percentage of crossover and the percentage of mutations have been selected in order to set parameters that their defined levels are as follows:

Table 5. Setting the levels of genetic model factors for parameter setting

Elements	Level 1	Level 2	Level 3
Popsize (The Number Of Initial Population)	25	50	100
Maxiter (The Maximum Number Of Iterations)	100	200	500
Pc (Percentage Of Crossover)	0.8	0.9	0.95
Pm (Percentage Of Mutations)	0.01	0.05	0.1

Also with regards to the number of raised levels and different states of their crossover and to determine the number of scenarios required to run the Taguchi method, one must first determine the number of orthogonal array. To select the appropriate orthogonal array, it is necessary to calculate the degree of freedom. For this purpose, a degree of freedom for the total mean and two degrees of freedom is considered for each three-level factor that we have.

$$df = 1 + (2*4) = 9 \quad (8)$$

Since the degree of freedom has been obtained equal to 9 meaning that at least 9 scenarios are considered with integration of different levels of defined factors. These scenarios are shown in Table 4-5.

Table 6. Scenarios designed to set the parameters of the genetic algorithm

Senario Name	Element Level No. Popsize	Element Level No. Maxiter	Element Level No. Pc	Element Level No. Pm
Senario 1	1	1	1	1
Senario 2	1	2	3	2
Senario 3	1	3	2	3
Senario 4	2	1	3	3
Senario 5	2	2	2	1
Senario 6	2	3	1	2
Senario 7	3	1	2	2
Senario 8	3	2	1	3
Senario 9	3	3	3	1

Indices of Fitness, S/N and RPD are calculated for every 9 scenarios. For each scenario and based on 3 different data groups, each was repeated for 30 times, and the obtained mean value for each index is recorded. Then each index and the result of the calculations are presented.

Table 7. The results of genetic algorithm parameter setting for the index S/N

	S/N			Fitness			RPD		
	Level 1	**Level 2**	**Level 3**	**Level 1**	**Level 2**	**Level 3**	**Level 1**	**Level 2**	**Level 3**
Popsize	19.861-	19.835-	19.857-	96.85	96.277	96.769	0.507	0.487	0.479
Maxiter	19.810-	19.825-	19.918-	95.716	96.058	98.122	0.513	0.475	0.484
Pc	19.822-	19.843-	19.888-	95.991	96.446	97.458	0.515	0.464	0.494
Pm	19.861-	19.858-	19.833-	96.87	96.786	96.239	0.522	0.465	0.486

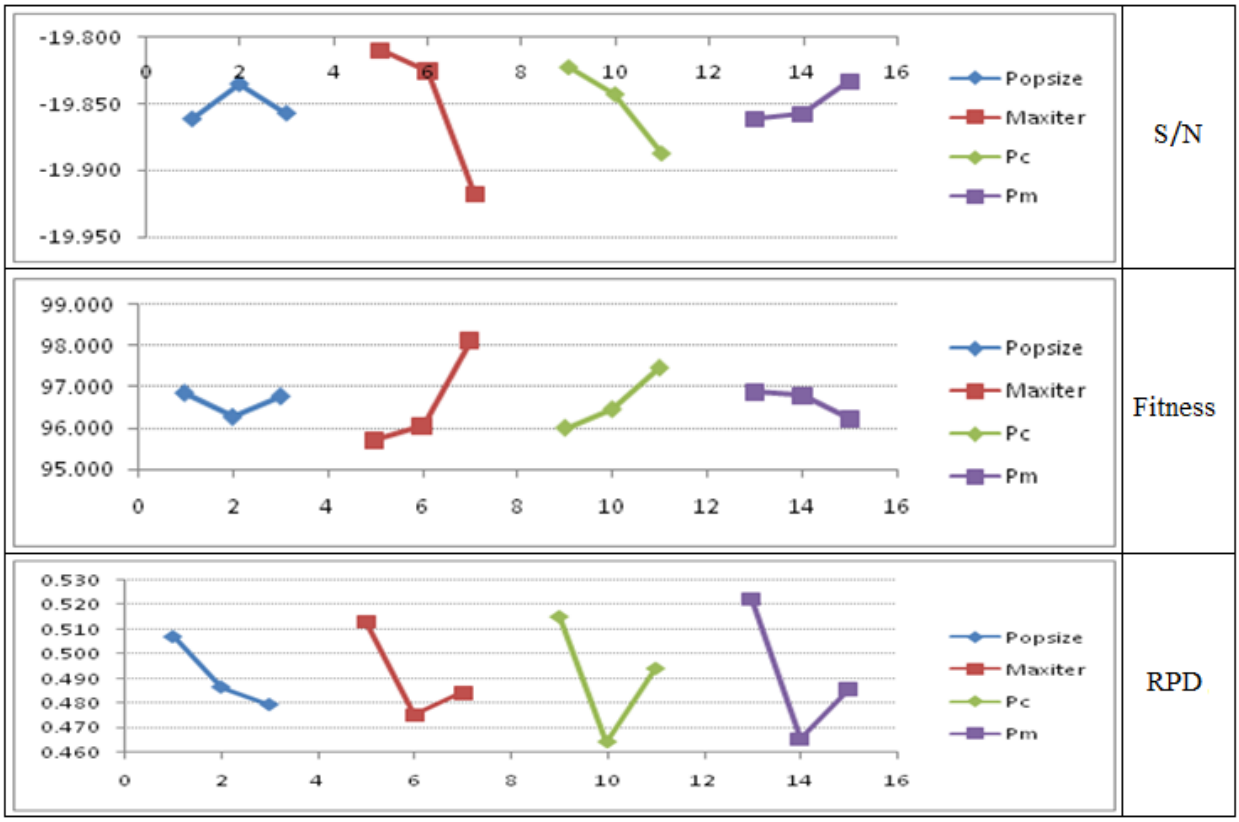

Figure 2. Diagram of the results of the calculation of indices to set parameters

According to obtained values and calculations for setting parameter by Taguchi method, as it is clear from the results, the best value obtained for each of the four parameters in genetic algorithm for the designed model is as Table 4-9.

Table 8. Approved values of factors after genetic algorithm parameter setting

Elements	**Element Amount**
Popsize (The Number Of Initial Population)	50
Maxiter (The Maximum Number Of Iterations)	100
Pc (Percentage Of Crossover)	0.8
Pm (Percentage Of Mutations)	1

3.4. Implementation of job rotation for a practical case with designed model

To evaluate the performance of the genetic algorithm as the selected algorithm, in this section a practical example has been used. In this example, 11 nurses were selected as candidates for job rotation and while receiving their personal and professional information, scores obtaining from job stress questionnaires were calculated for each of them that are presented in the following table.

Table 9. initial information of individuals for job rotation

Employee No.	Gender	Age	Marital Status	Education	The Whole Experience	Total Experience In Job	Type Of Contract	Job Rotation Status	Stress Score
1	Male	26	S	B.S.	4	4	Official	Daily	4.12
2	Male	24	M	M.S.	3	3	Didactic	Weekly	2.25
3	Female	29	M	M.S.	4	4	Formal	Monthly	2.5
4	Female	30	S	B.S.	4	4	Didactic	Daily	4.12
5	Male	31	M	B.S.	3	3	Formal	Yearly	3.37
6	Female	32	S	B.S.	4	4	Official	Seasonal	4.75
7	Female	25	S	M.S.	3	3	Formal	Yearly	2.87
8	Male	36	M	B.S.	25	25	Official	Yearly	3.62
9	Female	45	M	B.S.	4	4	Official	Yearly	3.25
10	Female	36	M	B.S.	8	8	Didactic	Weekly	3.87
11	Male	25	M	B.S.	11	11	Official	Daily	2.87

As in this example, we have 11 candidates for job rotation, as a result soltion vector will have 22 elements that the designed algorithm was run with a population of 50 people and a maximum of 100 iterations, and finally, after 100 iterations and during 2.5997 seconds the best amount of fitness was 8.9432 that in the following diagram, descending trend of the objective function of best solution, as well as the performance of the algorithm are presented.

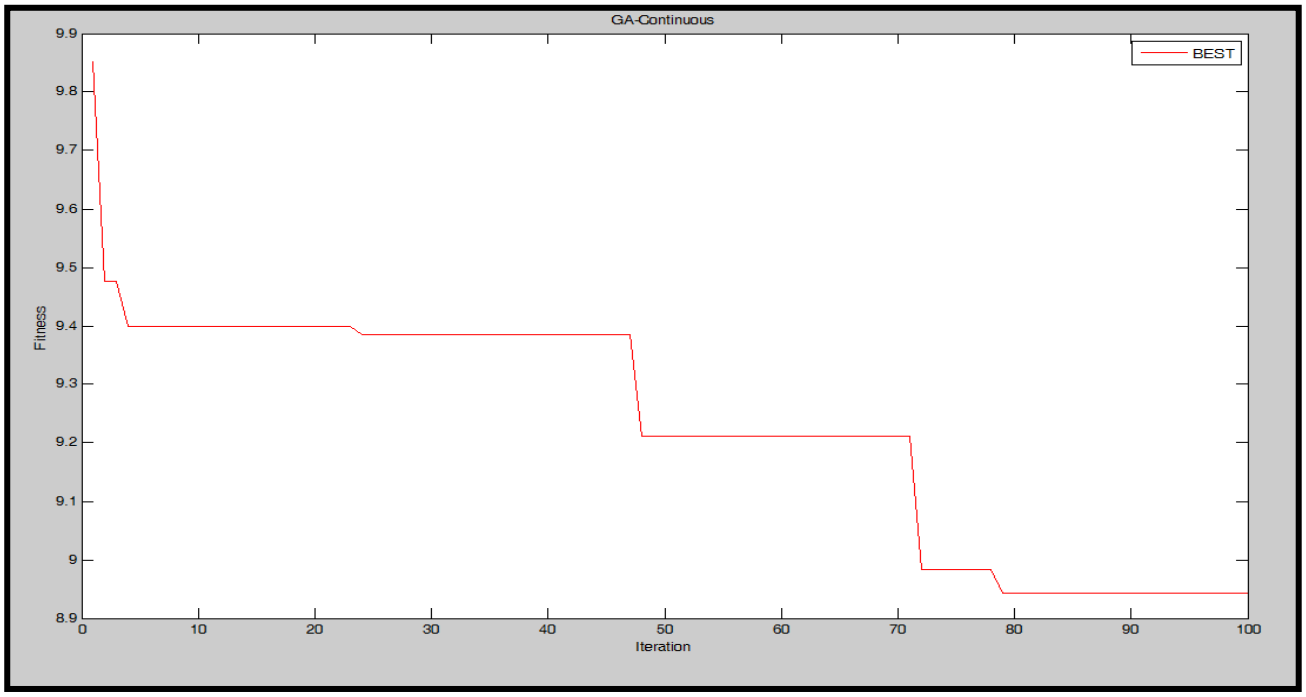

Figure 3. Diagram of the best solution and performance of genetic algorithm

In Figure 4, the output and the solution of the genetic algorithm are presented of which the interpretation is given in Table 9.

```
Iter = 100 BEST = 8.9432
Best Solution = 0.43836  0.37005  0.43384  0.4631  0.39693  0.62768  0.49774  0.45368  0.38963  0.39282  0.56566
0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.5  0.5  0.4
 Best Fitness = 8.9432
 Time = 2.5997
-------------------------------------------------------------------------------------------------------------
 Case 1 Exchange by Case 6|| By JR = Weekly
-------------------------------------------------------------------------------------------------------------
 Case 2 Exchange by Case 11|| By JR = 2 to 5 JR in Year
-------------------------------------------------------------------------------------------------------------
 Case 3 Exchange by Case 7|| By JR = Monthly
-------------------------------------------------------------------------------------------------------------
 Case 4 Fixed || By JR = 2 to 5 JR in Year
-------------------------------------------------------------------------------------------------------------
 Case 5 Exchange by Case 8|| By JR = 2 to 5 JR in Year
-------------------------------------------------------------------------------------------------------------
 Case 9 Exchange by Case 10|| By JR = Yearly
-------------------------------------------------------------------------------------------------------------
```

Figure 4. Output and solution provided by the genetic algorithm for the practical example

Table 10. Interpretation of the job rotation status of subjects based on model output

Employee No.	Gender	Do you have a job rotation?	Alternative job rotation	Job rotation period
1	Male	Y	6	Weekly
2	Male	Y	11	Seasonal
3	Female	Y	7	Monthly
4	Female	N	---	---
5	Male	Y	8	Seasonal
6	Female	Y	1	Weekly
7	Female	Y	3	Monthly
8	Male	Y	5	Seasonal
9	Female	Y	10	Yearly
10	Female	Y	9	Yearly
11	Male	Y	2	Seasonal

Presented results according to the model output are certainly the best type of job rotation of subjects in practical example so that the total job stress of these subjects will be reduced and consequently other factors affecting the human resource and ultimately, total productivity of the organization will increase .

4. Discussion

Here respecting the obtained results, it is necessary to stress that the current job rotation model has been developed compared to the previous models and this is because of the use of smart constraints resulting from the existing database. In response to the research hypothesis it was also observed that the model developed for job rotation is a model based on solving genetic algorithms which is a meta-heuristic model.

As the title of this article is "designing a comprehensive smart model of job rotation" it is necessary to address two presented concepts and to express the reasons of the researchers to take these two words as characters of the designed model leading the innovation in research, after the presentation and a full description of the research process and its results.

- **The comprehensive feature of the model:** Considering that in the studied population (nurses all over the country), the assumed sample (1221 subjects) can be generalized to the total population. Thus, it has an acceptable generability to all health centers and hospitals of the country. In other words, this model can be used for every problem of job rotation and if the personal information and job stress test score are received and entered into the model, the appropriate solution is obtained.

- **Smart feature of the model**: Since all constraints and rules extracted for the model have been extracted by data mining methods and final model has been solved using meta-heuristic method (gnetic algorithm), so the results are smart and there is no direct human intervention, even in the definition of the rules. So, latent and inherent patterns of database are obtained by data mining algorithms quite smartly.

It is obvious that the precodures of this research can be carried out for other study populations and the model output can be used for each option of the population. Thus, one can argue that a comprehensive smart model is also achieved for a new population.

5. Conclusion

One way to increase efficiency and productivity of the organization is the implementation of proper job rotation as a corporate social resposnibility(CSR) by their managers. As the employee is a key corporate stakeholder, CSR can be defined as corporate actions oriented toward the welfare of stakeholders. In most studies, job rotation models are presented only for a particular organization or a particular case study, but the results of this study contrast to other previous studies can be applicable to all organizations that include the studied population. Also, it re-emphasizes that CSR holds relevance both for the public and the private sector.

With this description, and as the database provided in the research includes a sample of the country's nurses and patterns have been extracted from the samples (all hospitals, medical and nursing eductional centers, clinics and medical centers across the country as the target organizations of this study) can make useing the model presented in this research for proper implementation of job rotation with the approach to reduce job stress of nurses as a social responsibility and to increase organizational productivity in larger dimentions, consequently.

In addition, the way to achieve smart model and solving the model presented in this study can be applied to other organizations with similar population characteristics. For example, data mining studies for similar database for jobs including security, workers of melting furnaces, flight attendants, communication center operators, maintainers and installers of after-sales service centers, etc. can be defined and designed in accordance with the procedure presented in this study.

The present study design, according to a study conducted in the context of earlier researches on several aspects, is innovative and considered a new study. These include:

- Many job abnormalities have been mostly of interest to psychologists, that have been of less interest to researchers in the field of management. On the other hand, taking into account some of these factors (such as job stress) and combining this issue with the discussion of job rotation as a background and basis for providing job rotation by human resources managers, will be specially innovative.
- Inclusion of a standard basis (such as job stress) with other factors that are influenced by job rotation in job rotation schedule problem.
- Emergence of data mining science for identifying and clustering factors influenced by jobs and discoverying rules, patterns and knowledge available in it will be an original approach in the field of human resource management (HRM) ensuring a smart model.
- Designing constraints of model using the ability to identify rules and patterns of data mining allows for using meta-heuristic algorithms to solve it.
- The use of meta-heuristic methods for modeling job rotation schedule with multi-criteria approach based on a specified criteria has never had research experience.

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