Ranking Epileptic Patients' Perceived Intelligence Parameters in Data Envelopment Analysis

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Abstract: In the course of improving various abilities of Data Envelopment Analysis (DEA) models, many investigations have been carried out for ranking Decision Making Units (DMUs). This is an important issue both in theory and practice. There exist a variety of papers which apply different ranking methods to a real data set. This study wants to rank the perceived intelligence parameters for People With Epilepsy (PWE) based on Gardner's theory by considering the demographic, illness background, and Awang's database using Enhanced Russell Measure (ERM) and ERM super-efficiency in DEA. The study has determined the priority of eight perceived intelligence parameters skills by considering epileptics' demographic and used this priority to enhance the employability of PWE since employment is one of the most challenging issues facing by PWE. Previous studies have shown that PWE have high unemployment rates, underpaid, and cannot keep their jobs because of stigma, seizure severity and other psychological deficiencies. The results from this study are important and may improve the employment opportunities of PWE.

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1. Introduction

Intelligence is defined as a distinct collective ability that can act and react in response to the surrounding environment. The question of the existence of one or more intelligences was explored during the previous two centuries. Howard Gardner, a contemporary psychologist, believes the Multiple Intelligences (MI) theory, which asserts that each person possesses a combination of several intelligences of different strengths. In the first statement of Gardner MI theory in 1983 (Gardner, 1983), he introduced musical, kinesthetic, verbal, mathematical/logical, spatial, interpersonal, and intrapersonal elements of intelligence. Later, Gardner added a naturalist form of intelligence (Gardner, 2004).

Epilepsy, which is one of the oldest diseases in history, has affected many people over several centuries (Yu, et al., 2009) (Samir, et al., 2000). Epilepsy is not a mental disorder, but it is highly related to the brain. Awang classified people with epilepsy's (PWE's) intelligence patterns and characteristics based on an intelligence scale known as the Ability Test in Epilepsy (ATIE©) (Awang, et al., 2011). The Ability Test in Epilepsy (ATIE©) is a psychometric test that was developed using the Multiple Intelligence (MI) theory proposed by Howard Gardner to measure eight types of intelligence (Awang, et al., 2009). In Awang's work, she characterized several intelligence parameters that PWE could improve. However Awang did not consider patient capabilities and other demographics and illness background, such as educational level, age, employability status, age of onset, gender, seizure type, ethnicity, and marital status in her model.

DEA is a non-parametric linear programming design that was first proposed by Charnes et al. (Charnes, et al., 1978). Charnes et al. (Charnes, et al., 1978) introduced the efficiency of a decision making unit (DMU) in the DEA original model that can be achieved as the highest ratio of weighted outputs to weighted inputs, by considering that the same ratio for all DMUs should be equal to or less than one. In DEA, DMUs are divided into two different categories namely efficient and inefficient DMUs. The DMUs of the efficient category possess the same efficiency scores but they do not perform the same action in real practice. This paper present the evaluation of the performance and rank the intelligence parameters for epileptics by considering the demographics and illness background based on Gardner's theory and Awang's database using Enhanced Russell Measure (ERM) and ERM super-efficiency ranking method in DEA. The results from this study are important and may improve the employment opportunities of PWE.

The rest of this paper is organized as follows: in Section 2, the ranking methods of decision making units are reviewed, the ranking of epileptics' multiple intelligences are presented in Section 3. Finally, the paper is concluded in Section 4.

2. Ranking Decision Making Units (DMUs) in Data Envelopment Analysis (DEA)

Charnes et al. (Charnes, et al., 1978) introduced the efficiency of a DMU in the DEA original model (CCR model) that can be achieved as the highest ratio of weighted outputs to weighted inputs, by considering that the same ratio for all DMUs should be equal to or less than one. The CCR model uses a constant return to scale (CRS) assumption in which a relative enhancement in inputs leads to a proportionate enhance in outputs. Banker et al. (Banker, et al., 1984) improved the CCR technique and introduced the BCC model using a variable return to scale (VRS) assumption to evaluate the DMUs' pure practical efficiency based on the efficient frontier.

Although complete ranking of the DMUs is necessary in many cases, the DEA efficiency models fail to rank DMUs comprehensively. Therefore, various methods with various attributes have been proposed to obtain the full ranking of DMUs (Hosseinzadeh Lotfi, et al., 2013). On the other hand, each technique may be appropriate in specific area, and none of them is prescribed as comprehensive solution for all the question of ranking. For instance, the majority of them are not capable to rank non-extreme efficient DMUs, and do not rank DMUs with imprecise data.

In assessing DMUs through DEA technique, more than one unit acquired efficiency score equals to one that necessitates some principle for ranking these DMUs. A quite number of researches have been done and various ranking methodologies have been proposed in the DEA (Hosseinzadeh Lotfi, et al., 2013). The Anderson and Peterson (AP) model (Andersen & Petersen, 1993), MAJ model (Mehrabian, et al., 1999), l_1-norm (Jahanshahloo, et al., 2004), and ERM super-efficiency (Ashrafi, et al., 2011) were introduced as DEA ranking methods that can be used for ranking the efficient DMUs. AP is a ranking method for assessing the efficient units. This ranking method indicates the DEA efficiency measured by eliminating the DMU under assessment from the constraints of DEA models. This method has been deeply researched in the literature (Andersen & Petersen, 1993) (Chen, 2004) (Li, et al., 2007) (Lovell & Rouse, 2003).

2.1 Enhanced Russell Measure (ERM) and ERM Super-Efficiency

The Enhanced Russell Measure (ERM) proposed by Pastor et al. (Pastor, et al., 1999) is a non-radial non-oriented efficiency measure that indicates the ratio of the average efficiency of inputs over the average efficiency of outputs. In ERM, the measure is well-defined and can be simply calculated by a linear programming. Due to the probable infeasibility of radial super-efficiency DEA model (Seiford & Zhu, 1999) (Chen, 2005), a super-efficiency model was introduced in (Ashrafi, et al., 2011) depends on the Enhanced Russell Measure (ERM) of efficiency. The super-efficiency model proposed in (Ashrafi, et al., 2011) is always feasible in both Variable Returns to Scale (VRS) and Constant Returns to Scale (CRS) hypothesis.

2.1.1 Enhanced Russell Measure (ERM) and ERM Super-Efficiency

Consider matrices $Y=(y_{rj})\in R^{s\times n}$ and $X=(x_{ij})\in R^{m\times n}$ as the respective outputs and inputs of n DMUs which are positive, i.e., $X>0$ and $Y>0$, and DMU_j is denoted by (X_j, Y_j). Under the CRS assumption, the production possibility set, T_C, is stated as follows:

$$T_C=\{(x,y)\,|\,x\geq\sum_{j=1}^{n}\lambda_j x_j,\ y\leq\sum_{j=1}^{n}\lambda_j y_j,\ \lambda_j\geq 0,\ j=1,\dots,n\}.$$

The ERM model (Pastor, et al., 1999) for measuring the relative efficiency of DMU_o *(o=1,…, n)* is given as follows:

$$\begin{aligned} \min\ \ & \Theta_{ERM}=\frac{1}{m}\sum_{i=1}^{m}\theta_i \Big/ \frac{1}{s}\sum_{r=1}^{s}\varphi_r \\ s.t.\ \ & \sum_{j=1}^{n}\lambda_j x_{ij}\leq\theta_i x_{io},\quad i=1,\dots,m, \\ & \sum_{j=1}^{n}\lambda_j y_{rj}\geq\varphi_r y_{ro},\quad r=1,\dots,s, \\ & \lambda_j\geq 0,\qquad j=1,\dots,n, \\ & 0\leq\theta_i\leq 1,\quad i=1,\dots,m, \\ & \varphi_r\geq 1,\qquad r=1,\dots,s. \end{aligned} \tag{1}$$

The objective function in (1) indicates the ratio of the average efficiency of inputs over the average efficiency of outputs in which $0<\Theta_{ERM}\leq 1$.

Definition 1: (Pastor, et al., 1999) A DMU_o (o=1,.., n) is ERM-efficient if and only if $\Theta^*_{ERM} = 1$.

In any optimal solution, the $\Theta^*_{ERM} = 1$ is equivalent to $\theta^*_i = 1, (i = 1,...,m)$ and $\varphi^*_r = 1, (r = 1,...,s)$.

In actual performance evaluation, it is necessary to rank *n* DMUs based on their efficiencies. Therefore the efficiency of DMUs is obtained by the ERM model (1). Then, DMUs are categorized into two categories efficient and inefficient DMUs. All the efficient DMUs have $\Theta^*_{ERM} = 1$ and all the inefficient DMUs have $\Theta^*_{ERM} < 1$. Inefficient DMUs with higher Θ^*_{ERM} have a better rank position. However, usually more than one DMU is assessed as DEA efficient. This makes the DEA efficiency methods incapable to rank or compare the efficient DMUs.

2.1.2 ERM Super-Efficiency

Consider $DMU_o = (x_o, y_o)$ as an ERM-efficient DMU with $\Theta^*_{ERM} = 1$. For assessing the efficient DMUs, first of all, the DMU_o is eliminated from the reference set of model (1). The new Production Possibility Set (PPS), T'_C, for the lasting DMUs is defined as follows:

$$T'_C = \{(x,y) \mid x \geq \sum_{j=1,\neq o}^{n} \lambda_j x_j,\ y \leq \sum_{j=1,\neq o}^{n} \lambda_j y_j,\ \lambda_j \geq 0, j=1,...,n,\ j \neq o\}.$$

According to the new PPS, model (1) must be modified. As the DMU_o should reach to the new frontier, its inputs must be increased while its outputs must be decreased, non-proportionally. For this purpose, the following model, ERM super-efficiency, is introduced by Ashrafi et al. (Ashrafi, et al., 2011):

$$\begin{aligned} \min \quad & \Omega = \frac{1}{m}\sum_{i=1}^{m}\theta_i \Big/ \frac{1}{s}\sum_{r=1}^{s}\varphi_r \\ s.t. \quad & \sum_{j=1,\neq o}^{n} \lambda_j x_{ij} \leq \theta_i x_{io}, \quad i=1,...,m, \\ & \sum_{j=1,\neq o}^{n} \lambda_j y_{rj} \geq \varphi_r y_{ro}, \quad r=1,...,s, \\ & \lambda_j \geq 0, \quad j=1,...,n, j \neq o, \\ & 0 < \varphi_r \leq 1, \quad r=1,...,s, \\ & \theta_i \geq 1, \quad i=1,...,m. \end{aligned} \qquad (2)$$

In this model, $\theta_i \geq 1$ and $0 < \varphi_r \leq 1$, substitute, $0 \leq \theta_i \leq 1$ and $\varphi_r \geq 1$. From the objective function, this is evident that $\Omega^* \geq 1$. This model is under CRS assumption. By adding the constraint $\sum_{j=1,\neq o}^{n} \lambda_j = 1$, the model (2) will be under VRS assumption. The introduced model (2), which is a nonlinear programming problem, is converted to LP problem applying the Cooper et al. (Cooper, et al., 2007) transformation. It is stated that, the model (2) is always feasible under both CRS and VRS assumptions (Ashrafi, et al., 2011). This model is also a non-radial model that is suitable for ranking the efficient DMUs when inputs and outputs are changing non-proportionally. Therefore, a comprehensive ranking of efficient DMUs can be achieved through employing the ERM super-efficiency model.

3. Ranking of epileptics' multiple intelligences

In this paper the ATIE© scores for the eight multiple intelligences (musical, bodily/kinesthetic, mathematical/logical, spatial, linguistic, interpersonal, intrapersonal and naturalist) of PWE are used. With regard to the existing database, every patient's demographic information was also considered.

A conceptual model for ranking multiple intelligences of people with epilepsy considering demographics and illness background has been introduced (Rezaie, et al., September 2012) (Rezaie, et al., 2013). This model suggests using the Analytic Hierarchy Process (AHP) to obtain the local weights score for intelligence parameters considering demographic of epileptics. Rezaie et al. (Rezaie, et al., 2014) obtained the local weights score for intelligence parameters using AHP considering demographic of epileptics by Expert Choice software. The considered demographics are educational level, gender, marital status, seizure type, employment status, and ethnicity. Table 1 shows the local weights obtained from AHP. For example, the local weight assigned to musical intelligence for secondary level of education is 0.123, and similarly these local weights for other intelligence parameters are obtained by considering different demographic aspects.

Table 1 (a). Local weights of intelligence parameters based on epileptics demographics

Demographic / Intelligence Parameter	Marital status		Educational level			Gender	
	Married	**Unmarried**	**Primary**	**Secondary**	**College**	**Male**	**Female**
Musical	0.119	0.125	0.113	0.123	0.125	0.121	0.123
Body -kinesthetic	0.121	0.121	0.113	0.125	0.118	0.124	0.119
Mathematical\Logical	0.119	0.116	0.117	0.110	0.129	0.121	0.115
Visual	0.129	0.124	0.120	0.124	0.130	0.121	0.129
Verbal	0.115	0.118	0.119	0.118	0.116	0.111	0.121
Interpersonal	0.138	0.139	0.139	0.138	0.138	0.138	0.138
Intrapersonal	0.143	0.138	0.139	0.143	0.134	0.141	0.139
Naturalist	0.116	0.119	0.140	0.119	0.110	0.123	0.114

Table 1 (b).

Demographic / Intelligence Parameter	Seizure type			Employment status			Ethnicity			
	Generalized	**Partial**	**Others**	**Employed**	**Student**	**Unemployed**	**Chinese**	**Indian**	**Malay**	**Others**
Musical	0.122	0.123	0.123	0.121	0.128	0.123	0.143	0.132	0.118	0.141
Body –kinesthetic	0.123	0.118	0.130	0.122	0.123	0.117	0.107	0.121	0.122	0.135
Mathematical\Logical	0.116	0.118	0.130	0.118	0.120	0.114	0.122	0.115	0.118	0.106
Visual	0.124	0.128	0.128	0.127	0.124	0.125	0.127	0.119	0.127	0.114
Verbal	0.118	0.115	0.118	0.115	0.124	0.120	0.118	0.118	0.117	0.104
Interpersonal	0.143	0.134	0.129	0.139	0.136	0.137	0.144	0.144	0.136	0.138
Intrapersonal	0.140	0.141	0.132	0.141	0.135	0.140	0.129	0.136	0.142	0.140
Naturalist	0.115	0.123	0.109	0.117	0.110	0.123	0.110	0.116	0.119	0.122

Each demographic aspect is divided into different categories that each patient belongs to one of these categories by considering its status quo. In this work, the different local weights for each intelligence parameters of epileptic patient are assigned based on the epileptic's demographic. For each epileptic patient the sum of local weights for each intelligence parameter is considered as the score for that special intelligence parameter because each patient's demographic is categorized under different categories of these 6 demographic aspects. The implementation for patient 1 is illustrated in Table 2.There are 158 epileptic patients whereby their relative performances of their intelligence parameters are presented. However, only studies on 30 epileptic patients are presented.

A patient's age of onset and the total score of each intelligence parameter are considered as two outputs. A patient's real age is also determined as input for this DMU. The data for 30 epileptic patients are shows in Table 3.

Table 2. Demographic local weights and total intelligence parameters scores of patient 1

Intelligence \ Demographic	Seizure type (Generalized)	Employment status (Employed)	Ethnicity (Malay)	Marital status (Married)	Educational level (College)	Gender (Female)	Summation (Total Score)
Musical	0.122	0.121	0.118	0.119	0.125	0.123	**0.728**
Body	0.123	0.122	0.122	0.121	0.118	0.119	**0.725**
Mathematical	0.116	0.118	0.118	0.119	0.129	0.115	**0.715**
Visual	0.124	0.127	0.127	0.129	0.130	0.129	**0.766**
Verbal	0.118	0.115	0.117	0.115	0.116	0.121	**0.702**
Interpersonal	0.143	0.139	0.136	0.138	0.138	0.138	**0.832**
Intrapersonal	0.140	0.141	0.142	0.143	0.134	0.139	**0.839**
Naturalist	0.115	0.117	0.119	0.116	0.110	0.114	**0.691**

Table 3. The input and outputs for 30 epileptic patients

DMU \ Data	Age Input	Onset age Out 1	Music. Out 2	Body Out 2	Math. Out 2	Visu. Out 2	Verb. Out 2	Inter. Out 2	Intra. Out 2	Natural. Out 2
1	33	13	0.728	0.725	0.715	0.766	0.702	0.832	0.839	0.691
2	23	1	0.732	0.730	0.718	0.753	0.695	0.833	0.836	0.703
3	27	17	0.727	0.727	0.698	0.764	0.701	0.823	0.849	0.708
4	27	18	0.733	0.727	0.695	0.759	0.704	0.824	0.844	0.711
5	28	10	0.726	0.730	0.721	0.758	0.692	0.832	0.841	0.700
6	32	13	0.732	0.730	0.718	0.753	0.695	0.833	0.836	0.703
7	33	15	0.726	0.730	0.721	0.758	0.692	0.832	0.841	0.700
8	36	12	0.728	0.725	0.715	0.766	0.702	0.832	0.839	0.691
9	40	33	0.724	0.737	0.702	0.752	0.694	0.832	0.850	0.709
10	28	26	0.758	0.722	0.736	0.757	0.696	0.827	0.815	0.688
11	28	12	0.742	0.724	0.712	0.758	0.703	0.840	0.833	0.688
12	28	12	0.760	0.705	0.718	0.765	0.703	0.832	0.822	0.693
13	30	3	0.760	0.705	0.718	0.765	0.703	0.832	0.822	0.693
14	30	20	0.726	0.732	0.696	0.760	0.704	0.832	0.848	0.700
15	34	20	0.727	0.725	0.723	0.762	0.689	0.823	0.842	0.708
16	34	30	0.728	0.725	0.715	0.766	0.702	0.832	0.839	0.691
17	35	16	0.725	0.732	0.704	0.756	0.691	0.823	0.851	0.717
18	35	18	0.735	0.732	0.726	0.765	0.705	0.819	0.826	0.688
19	36	10	0.732	0.730	0.718	0.753	0.695	0.833	0.836	0.703
20	45	12	0.751	0.738	0.703	0.753	0.689	0.834	0.837	0.694
21	26	18	0.732	0.732	0.693	0.755	0.707	0.833	0.843	0.703
22	22	5	0.732	0.732	0.693	0.755	0.707	0.833	0.843	0.703
23	23	16	0.735	0.720	0.714	0.765	0.702	0.824	0.835	0.702
24	23	5	0.732	0.732	0.693	0.755	0.707	0.833	0.843	0.703
25	24	18	0.732	0.730	0.718	0.753	0.695	0.833	0.836	0.703
26	24	17	0.730	0.737	0.699	0.747	0.697	0.833	0.845	0.712
27	25	14	0.731	0.732	0.701	0.751	0.694	0.824	0.846	0.720
28	25	5	0.730	0.737	0.699	0.747	0.697	0.833	0.845	0.712
29	26	13	0.733	0.725	0.720	0.757	0.692	0.824	0.837	0.711
30	26	15	0.728	0.725	0.715	0.766	0.702	0.832	0.839	0.691

Using Enhanced Russell Measure, the relative performance of each DMU in each category of intelligence parameters is determined. The results are shown in Table 4.

All DMUs with ERM efficiency less than 1 are automatically ranked. All DMUs that have higher Θ^*_{ERM} will have a better rank. For discriminating and ranking all DMUs with, $\Theta^*_{ERM} = 1$, we apply ERM super-efficiency model. In Table 4 the scores of applying ERM-efficiency model are illustrated. Consider column 2 of Table 4, which is related to the musical intelligence. Three DMUs (DMU_{10}, DMU_{22}, and DMU_{23}) are evaluated as efficient ERM and are assigned $\Theta^*_{ERM} = 1$. For these three efficient ERM DMUs, we carry out the ERM super-efficiency model to discriminate and rank them. The results are shown in Table 5. DMUs that have higher value in Ω^* will be in a better rank position. Other DMUs in this column assigned the ERM efficiency less than 1. As seen in Table 6, each intelligence parameters is ranked for all 30 patients. Tables 4, 5, and 6 show each intelligence parameter for these 30 PWE is evaluated and ranked separately, i.e., the performance of each intelligence parameters for these 30 patients is evaluated and ranked without considering other intelligence parameters. On the other hand, in Table 4, for example for DMU_7, we can interpret that the patient number 7 has eight relative ERM-efficiency scores for each own intelligence parameters, which we can prioritize them as high to low intelligence parameters respectively. The relative musical ERM-efficiency score is 0.6110 among 30 patients, and for body, math, visual, and so on this patient has got the scores of 0.6233, 0.6162, 0.6211, respectively. The priority of intelligence parameters for patient number 7 based on relative ERM-efficiency scores is as below (Table 7):

Intrapersonal $\succ$ Naturalist $\succ$ Body $\succ$ Interpersonal

$\succ$ Visual $\succ$ Verbal $\succ$ Mathematical $\succ$ Musical

where symbol "$a \succ b$" represents that the "a" has higher performance and better rank with respect to " b" for patient under evaluation. These priorities show that patient number 7 is strong in intrapersonal intelligence and weak in musical intelligence. In other words, the rank of intrapersonal intelligence is 1 and the rank of musical intelligence is 8 for this particular patient.

Let consider DMU_{18} in Table 7, as we can see this patient has rank 1 in body intelligence, rank 5 in naturalist intelligence, and rank 8 for musical. The priority of intelligence parameters for this patient is as follows:

Body $\succ$ Intrapersonal $\succ$ Verbal $\succ$ Visual $\succ$ Naturalist

$\succ$ Interpersonal $\succ$ Mathematical $\succ$ Musical

Similarly, for DMU_{27}, the naturalist intelligence has assigned rank 1 and mathematical intelligence is in position 8 in this ranking procedure. The priorities of DMU_{27}'s intelligence parameters are as bellow:

Naturalist $\succ$ Intrapersonal $\succ$ Body $\succ$ Verbal

$\succ$ Interpersonal $\succ$ Visual $\succ$ Music $\succ$ Mathematical

Table 4. The result of applying the ERM efficiency model

Intelligence / DMU	Musical	Body	Mathematical	Visual	Verbal	Interpersonal	Intrapersonal	Naturalist
1	0.5580	0.5664	0.5602	0.5679	0.5673	0.5668	0.5711	0.5665
2	0.1167	0.1368	0.1551	0.1146	0.1157	0.1339	0.1193	0.1200
3	0.8064	0.8316	0.8027	0.8334	0.8324	0.8254	0.8478	0.8419
4	0.8377	0.8595	0.8285	0.8574	0.8629	0.8540	0.8725	0.8723
5	0.5488	0.5604	0.5524	0.5561	0.5547	0.5582	0.5684	0.5627
6	0.5765	0.5855	0.5785	0.5823	0.5831	0.5847	0.5883	0.5875
7	0.6110	0.6233	0.6162	0.6211	0.6195	0.6222	0.6279	0.6248
8	0.4849	0.4919	0.4867	0.4931	0.4926	0.4922	0.4957	0.4919
9	0.7630	0.7858	0.7624	0.7736	0.7758	0.7800	0.7918	0.7872
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	0.6273	0.6329	0.6249	0.6322	0.6364	0.6391	0.6410	0.6316
12	0.6332	0.6268	0.6266	0.6366	0.6364	0.6345	0.6352	0.6347
13	0.1932	0.1926	0.1926	0.1933	0.1933	0.1932	0.1933	0.1932
14	0.7963	0.8164	0.7918	0.8130	0.8156	0.8137	0.8256	0.8177
15	0.7031	0.7174	0.7106	0.7182	0.7130	0.7146	0.7262	0.7250
16	0.8633	0.8828	0.8687	0.8870	0.8856	0.8843	0.8930	0.8814

17	0.5991	0.6127	0.5991	0.6092	0.6078	0.6084	0.6195	0.6191
18	0.6463	0.6582	0.6509	0.6574	0.6580	0.6519	0.6581	0.6545
19	0.4279	0.4334	0.4291	0.4315	0.4319	0.4330	0.4351	0.4347
20	0.3918	0.3957	0.3872	0.3923	0.3917	0.3940	0.3963	0.3941
21	0.8823	0.9052	0.8638	0.8956	0.9080	0.9023	0.9124	0.9064
22	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
23	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
24	0.4730	0.5511	0.4540	0.4679	0.5115	0.5282	0.5225	0.4837
25	0.9900	1.0000	0.9995	0.9893	0.9934	1.0000	1.0000	1.0000
26	0.9589	0.9835	0.9458	0.9547	0.9671	0.9714	0.9807	0.9826
27	0.8086	0.8273	0.7985	0.8139	0.8180	0.8173	0.8352	0.8430
28	0.3895	0.4056	0.3822	0.3913	0.3983	0.4008	0.4072	0.4079
29	0.7272	0.7420	0.7355	0.7403	0.7373	0.7385	0.7505	0.7555
30	0.7896	0.8100	0.7979	0.8156	0.8141	0.8123	0.8201	0.8071

A number of DMUs like DMU_{10}, DMU_{22}, and DMU_{23} are ERM efficient in all intelligence parameters, i.e., they have taken the value 1 for all intelligence parameters in relative to other DMUs. It shows that these DMUs have high performance in all intelligence parameters in relative to other patients. As shown in Table 5, after applying the ERM super-efficiency, for example for DMU_{10}, it can be interpreted that musical, mathematical, visual, and verbal intelligence have higher ERM super-efficiency score. The mentioned parameters have also higher rank with respect to other parameters such as body, interpersonal, intrapersonal, and naturalist intelligence.

For DMU_{22} based on ERM super-efficiency score, body intelligence is situated in rank 1, interpersonal is located in rank 2 and intrapersonal, verbal, naturalist, musical, visual, and mathematical intelligence are placed in rank 3 to 8 respectively.

For DMU_{23} visual intelligence is located in rank 1, verbal, mathematical, musical, naturalist, intrapersonal, interpersonal, and body intelligence are placed in rank 2 to 8 respectively. For DMU_{25}, body, interpersonal, intrapersonal, naturalist, mathematical, verbal, musical, and visual intelligence are ranked 1 to 8. Table 7 shows the ranking intelligence parameters for each patient as an DMU.

Table 5. The result of applying ERM super-efficiency model

Intelligence / DMU	Musical	Body	Mathematical	Visual	Verbal	Interpersonal	Intrapersonal	Naturalist
10	1.1434	1.1064	1.1434	1.1434	1.1434	1.1064	1.1064	1.1064
22	1.0202	1.0305	1.0073	1.0156	1.0258	1.0277	1.0270	1.0229
23	1.0463	1.0095	1.0512	1.0607	1.0562	1.0111	1.0155	1.0159
25		1.0066				1.0051	1.0030	1.0027

Table 6. The result of ranking each intelligence parameter among 30 epileptics

Intelligence / DMU	Musical	Body	Mathematical	Visual	Verbal	Interpersonal	Intrapersonal	Naturalist
1	22	22	22	22	22	22	22	22
2	30	30	30	30	30	30	30	30
3	10	9	9	9	9	9	9	10
4	8	8	8	8	8	8	8	8
5	23	23	23	23	23	23	23	23
6	21	21	21	21	21	21	21	21
7	19	19	19	19	19	19	19	19
8	24	25	24	24	25	25	25	24
9	13	13	13	13	13	13	13	13
10	1	1	1	1	1	1	1	1
11	18	17	18	18	17	17	17	18
12	17	18	17	17	18	18	18	17
13	29	29	29	29	29	29	29	29

14	11	11	12	12	11	11	11	11
15	15	15	15	15	15	15	15	15
16	7	7	6	7	7	7	7	7
17	20	20	20	20	20	20	20	20
18	16	16	16	16	16	16	16	16
19	26	26	26	26	26	26	26	26
20	27	28	27	27	28	28	28	28
21	6	6	7	6	6	6	6	6
22	3	2	3	3	3	2	2	2
23	2	3	2	2	2	3	3	3
24	25	24	25	25	24	24	24	25
25	4	4	4	4	4	4	4	4
26	5	5	5	5	5	5	5	5
27	9	10	10	11	10	10	10	9
28	28	27	28	28	27	27	27	27
29	14	14	14	14	14	14	14	14
30	12	12	11	10	12	12	12	12

Table 7. The result of ranking intelligence parameters for each patient

Intelligence / DMU	Musical	Body	Mathematical	Visual	Verbal	Interpersonal	Intrapersonal	Naturalist
1	8	6	7	2	3	4	1	5
2	6	2	1	8	7	3	5	4
3	7	5	8	3	4	6	1	2
4	7	4	8	5	3	6	1	2
5	8	3	7	5	6	4	1	2
6	8	3	7	6	5	4	1	2
7	8	3	7	5	6	4	1	2
8	7	5	6	2	3	4	1	5
9	7	3	8	6	5	4	1	2
10	1	2	1	1	1	2	2	2
11	7	4	8	5	3	2	1	6
12	6	7	8	1	2	5	3	4
13	2	3	3	1	1	2	1	2
14	7	3	8	6	4	5	1	2
15	8	4	7	3	6	5	1	2
16	8	5	7	2	3	4	1	6
17	7	3	7	4	6	5	1	2
18	8	1	7	4	3	6	2	5
19	8	3	7	6	5	4	1	2
20	6	2	8	5	7	4	1	3
21	7	4	8	6	2	5	1	3
22	6	1	8	7	4	2	3	5
23	4	8	3	1	2	7	6	5
24	6	1	8	7	4	2	3	5
25	7	1	5	8	6	2	3	4
26	6	1	8	7	5	4	3	2
27	7	3	8	6	4	5	2	1
28	7	3	8	6	5	4	2	1
29	8	3	7	4	6	5	2	1
30	8	5	7	2	3	4	1	6

Employment is one of the most challenging issues facing PWE. Based Awang (Awang, 2011) the majority of PWE under study have jobs but only about one-third among them hold jobs that are commensurate with their actual capabilities. Using the proposed procedure, the performance evaluation and ranking of the intelligence parameters for PWE under study, their strengths and weaknesses in the context of employability in the job market can be identified. On the other hand, the employers need to be aware about the PWE's potential as well as their limitations. As the majority of those employed held jobs that were not commensurate with their intellectual abilities (Awang, 2011), so that they can contribute to the organizations effectively. The ranking of PWE's intelligence parameters would describe the status quo of epilepsy sufferers with respect to their intelligence level. Based on Gardner (Gardner, 2004) it is important to mention that to perform a specific task a combination of skills is required. Therefore, training the various intelligences in an individual is important to be successful in the workplace. Gardner introduced activities, which may enhance one's intelligence parameters (Gardner, 1983) (Gardner, 2004).

4. Conclusion

The performance evaluation and ranking of intelligence parameters can be used to assist PWE identify their levels of competencies, strengths, and weaknesses. The study has successfully determined the priority of eight intelligence parameters skills by considering epileptics' demographic and used this priority to enhance the employability of PWE. One way to assist PWE to be competitive in the job market is by promoting their inherent skills. With this assessment, it is now possible to improve the skills of PWE.

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