

# **An Electronic Registration for Undergraduate Students with Department Selection Based on Artificial Neural Network**

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## **ABSTRACT**

The objective of the present research is to facilitate the administrative procedures associated with student registration process, and to ensure equal opportunities for all applicants in college. It aims to assist students in identifying appropriate alternatives available to the departments electronically anytime and anywhere saving time and effort for the student. For this purpose, an intelligent e-government system named "An Electronic Intelligent Registration with Department Selection" (E-IRDS) is designed as one of the intelligent e-services in Iraqi e-governance by using many tools and programming languages which are (PHP, MYSQL, HTML, CSS, XML, NOTPAD++, C#). Artificial neural networks (ANNs) technology is applied, notably Kohonen's self-organizing map (SOM) as one of the important unsupervised classification algorithms of machine learning for classifying and distributing the students automatically into the college academic departments based on their desires, their total degrees, and according to scientific plan for each department, in addition to the specific and personal student information. The applied results based on international standards demonstrated the accuracy of Kohonen's SOM algorithm in classification and distribution methods at least time and possible learning ratio. The system test and assessment results confirmed that it is characterized with a very high security and reliability and accuracy. It is also distinguished with very high efficiency and transparency as well as flexibility and high performance speed. The results also emphasized the ease and availability of the system to all students, besides the possibility of troubleshoot and correct errors easily .

**Keywords:** E-Government, Kirkuk, E-Registration, unsupervised machine learning, Kohonen's self-organizing map (SOM).

## التسجيل الإلكتروني لطلبة الجامعات مع تحديد القسم بالاعتماد على الشبكات العصبية الاصطناعية

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### الملخص

الهدف من البحث الحالي هو تسهيل الإجراءات الإدارية المرتبطة بعملية تسجيل الطالب الجامعي، وضمان فرص متساوية لجميع المتقدمين في الكلية. ويهدف إلى مساعدة الطلاب في تحديد البدائل المناسبة المتاحة للأقسام إلكترونياً في أي وقت وفي أي مكان موفراً الوقت والجهد للطالب. ولهذا الغرض، تم تصميم نظام حكومة إلكترونية ذكية يسمى "التسجيل الإلكتروني الذكي مع اختيار القسم (E-IRDS) كواحدة من الخدمات الإلكترونية الذكية في الحكومة الإلكترونية العراقية باستخدام العديد من الأدوات التي هي (NOTEPAD++C#, PHP, MYSQL, HTML, CSS, XML, ) تم تطبيق تكنولوجيا الشبكات العصبية الذكية ANN، وبالأخص Kohonen's self-organizing map (KSOM) كواحدة من خوارزميات التصنيف المهمة الغير خاضعة للإشراف ضمن التعليم الآلي لتصنيف وتوزيع الطلاب آلياً إلى أقسام الكلية بالاعتماد على رغباتهم ومجموع درجاتهم وبحسب الخطة العلمية لكل قسم، بالإضافة إلى معلومات الطلاب المحددة والشخصية. اثبتت النتائج التطبيقية والاعتماد على المعايير العالمية دقة خوارزمية Kohonen's SOM في التصنيف والتوزيع بأقل وقت ونسبة تعلم ممكنين. اكدت نتائج فحص وتقييم النظام بأنه ذو دقة و وثوقية وأمنية عالية جداً، ويتميز بشفافية وكفاءة عاليين جداً فضلاً عن تميزه بالمرونة وسرعة الأداء. كما برهنت النتائج سهولة وتوفير النظام لجميع الطلبة وإمكانية معالجة المشاكل وتصحيح الأخطاء بسهولة.

**الكلمات المفتاحية:** الحكومة الإلكترونية، كركوك، التسجيل الإلكتروني، تعليم الآلة الغير خاضعة للرقابة، خريطة التنظيم الذاتي كوهنن.

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## 1. Introduction

In the latest decades, the use of Information and Communication Technologies (ICT) has actually obtained the increasing attentiveness in the public sector represented by e-governance services, especially within latest years when the developing countries have improved access to the provided services by the government for the purpose of reducing the costs as well as increasing the effectiveness of an organization [1].

Currently, the higher education sector in Iraq is playing an important role in the society improvement and development. The e-services implementation had really become the critical goal in universities context in worldwide [1]. E-Governance indicates to the public sector's use of ICT by government agencies to transmit information and deliver services to the citizens anytime and anywhere [2, 3]. E-government provides opportunities for citizens to participate in the decision-making process in democratic life that lead to increase transparency and efficiency making government more accountability [2, 4]. For more than 15 years, the European Union built infrastructure of e-government, and supported research to how delivering e-government's services efficiently and effectively [4].

The Iraqi government began to use e-government technology in 2004 when the Iraqi Ministry of Science and Technology afforded the contract for the building up of an Iraqi e-government project to an Italian company [5]. Iraqi e-government systems have been defined as the use of websites, e-mail, or any interaction method via the internet for the delivery of government services to citizens, the business sector, and civil society organizations [5]. Thus, most Iraqi universities (public or private) actually strived to exploit the modernistic technologies like (web 2.0, mobile applications) in improving the students-universities interaction [1]. It can be also benefit from modern machine learning technologies in e-government systems for predict new knowledge from huge amounts of distributed data depending on the hidden relationships and patterns of events that cannot be directly discovered by immediate human search [6].

Today, machine learning is an indispensable used technique in roughly most researches and developments. ANNs is one of the variant approaches are used to learn from data [7]. For many years, ANNs has been studied and utilized to model information processing systems

rely on biological neural networks. It provides improved solutions with high performance in comparison with traditional problem-solving methods [8].

Learning methods are classified into supervised, unsupervised, reinforcement learning. Unsupervised learning method finds the correlations and relations among the input features to discover the subtle structure of unlabeled data such as the SOM model that utilizes unsupervised learning algorithms [7]. Among different present neural network architectures and learning algorithms, Kohonen's SOM is one of the most common neural network models [8]. It is a spontaneous classification method which is the origin of SOM. Actually, SOM is an unsupervised learning algorithm with a simple structure and computational form which projects high-dimensional data onto a low-dimensional grid which called a topological map [8, 9].

In this paper, due to the difficulty of administrative procedures associated with Undergraduate students' registration process that requires manual recording and which often lead to loss of time and effort in Kirkuk University's colleges, Kohonen's SOM is applied as one of the important ANN algorithms in supplying e-government service.

The purpose of this study is to assist students to identify appropriate alternatives available for academic departments electronically anytime and anywhere saving student time and effort. It aims to supply automatic classification by applying Kohonen's algorithm for distributing students to desired departments relying on scientific plan of each department and students' total degrees as well as recording choices of students.

## **2. System Analysis**

The analytical study about registry mechanism in Kirkuk University's colleges has proved the existence of several disadvantages and obstacles that restrict the registry process which are including :

- 1- Busyness of large number of staffs for a long time by routine students' registration and distribution them to college's academic departments
- 2- Students waiting and their families in long queues for the registration process completion.
- 3- Unreliable Registration and distribution processes.
- 4- Frequent questions of students as well as the overwork of registration staff .

Therefore, this paper aims to consolidate the positive points of traditional classic registration process and manipulate negative ones by designing an electronic intelligent registration system as a service in Iraqi e-governance which is E-IRDS System. For the purpose of designing and implementing the E-IRDS System, hardware and software requirements have been determined which are:

Hardware requirements include local or global server computer to install and run the E-IRDS System program as well as to build and save database. It can be used different communication nodes as clients such as (desktops, laptops, PDA, Intelligent pads, intelligent phones) to connect with the server and access the system website.

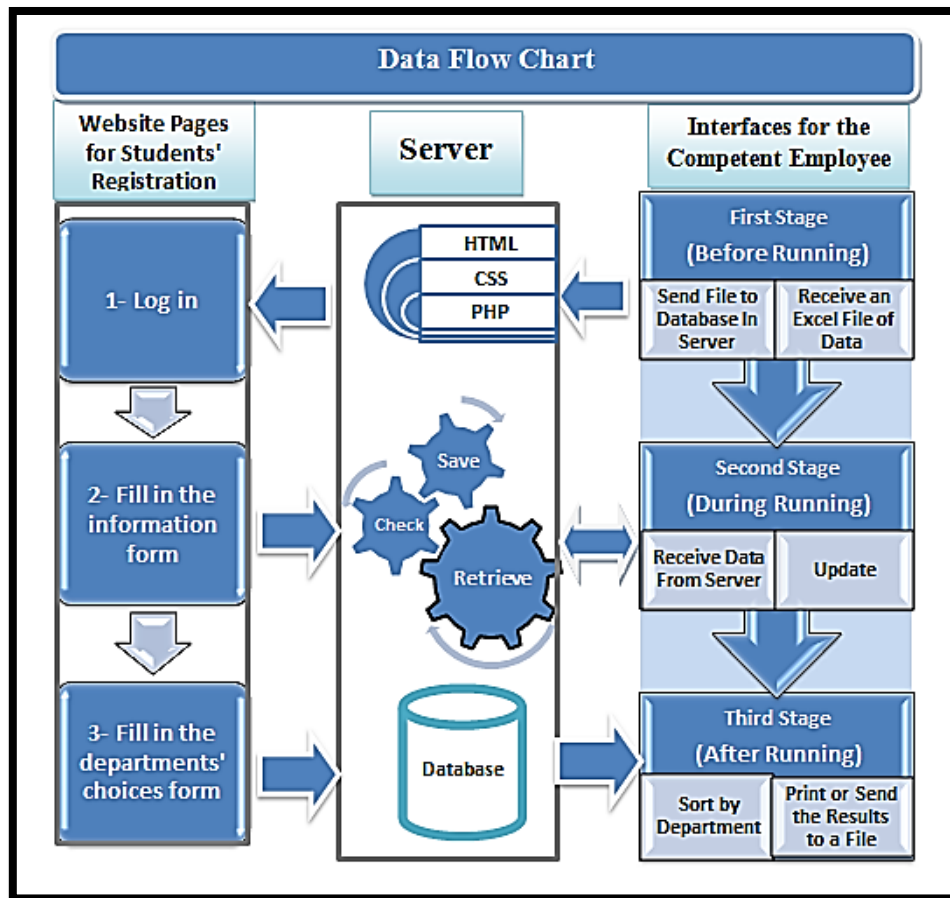
Software requirements include using a number of tools, and programming languages to build system portions which are: MYSQL for building and managing the database, WAMP Server program as a local server for experimenting and testing the system. HTML for displaying internet information, CSS for designing webpages style, PHP for creating and developing dynamic websites, XML for sharing data, C#.NET for programming the application, and finally Notepad++ application as a text editor for writing source code of PHP, HTML, CSS.

### **3. System Design:**

After analyzing the traditional registration procedures in Kirkuk University's colleges and diagnosing the prevailing disadvantages as well as specifying the requirements for the proposed system, the E-IRDS system is designed especially for the Registration Department in Science College so as to facilitate its paperwork that often lead to loss of time and effort. The E-IRDS system is consisted of two major parts which are students' part and employees' part. Students' part represents system website that includes the registration forms. Employees' part represents the main program special for registration department. Where, the system website is configured and linked with the main registration program.

For the appropriately design and run of the system, many tools and programming languages have been using as explained in section (2). The flowchart shown in **Fig. (1)** illustrates the system architecture and demonstrates data transmission paths among system

portions. It also demonstrates system work mechanism including run phases as will be minutely explained in section (4).



**Fig. (1):** Flow Chart of E-IRDS System

#### 4. System Implementation

The implementation of the system begins to work continuously from the students' accepting until classifying and distributing them to college academic departments. It consists of the following sub phases:

##### 4.1 Data Import and Collection

Dislike other electronic systems that need to collect and enter data into the database before implementation in this system, data is collected during the implementation phase from different sources. The essential part of data which includes (student's name, exam number, average, total degrees, and sex) is imported to the database from an Excel file or Access file at the start of the system implementation. Where, after the announcement of the central admissions results by the Ministry of Higher Education and Scientific Research, the registration department receives a file from University Presidency containing essential data

which is about students accepted in the college. The other necessary part of data is collected by entering the students their personal data which are (gender, address, birthdate, phone number, e-mail) and their choices for departments into the database in the server. This is done by accessing students to system website which will be available only during the registration period as will be explained in section (4.2).

The database is built by using MYSQL DBMS in the server framework. It is consisted of one entity which contains 16 attributes as shown in Table (1). Where, the first four attributes will be filled from the beginning of the system execution by importing from files. The next eleven attributes are filled online by the undergraduate students. The last attribute is filled eventually by the result of distribution method. Other additional attributes can be also added according to the registration management needs in order to get further information such as (nationality number, residence card number, ration card number ... etc.). Details of DB entity and its attributes are demonstrated in the table below.

**Table (1): Details of E-IRDS Database.**

No.	Attribute Name	Programmed Name	Type	Length	Description
1	Exam number	std_id	Int	11	obtained from a file
2	Student name	Stdname	Varchar	125	obtained from a file
3	Average	avg_degree	Decimal	5.2	obtained from a file
4	Total degrees	sum_degree	Int	5	obtained from a file
5	Gender	Gen	Varchar	50	obtained from online registration
6	Address	Address	Varchar	200	obtained from online registration
7	Birthdate	Birthdate	Varchar	100	obtained from online registration
8	Phone number	mobile_no	Int	11	obtained from online registration
9	Electronic mail	Email	Varchar	100	obtained from online registration
10	First choice	Chs1	Varchar	20	obtained from online registration
11	Second choice	Chs2	Varchar	20	obtained from online registration
12	Third choice	Chs3	Varchar	20	obtained from online registration
13	Fourth choice	Chs4	Varchar	20	obtained from online registration
14	Fifth choice	Chs5	Varchar	20	obtained from online registration
15	Sixth choice	Chs6	Varchar	20	obtained from online registration
16	Admission	Accepted	Varchar	20	obtained from sorting and distributing by Kohonen's SOM execution

## 4.2 Online Registration

In this phase, the e-governance is applied. The electronic registration is being provided for undergraduate students as an e-government service. The students part of the system which represents registration website is activated for a limited period of time (registry period) specified by the college. The website pages include multiple forms filled in by undergraduate students with their personal special data as well as specifying their choices of desired college departments, and then saving the entered data to the database as shown in Fig. (2). Undergraduate students use their exam number as ID to enter into the website pages. Where, it is used a local host of the type WAMP on a computer with a normal specification in the testing phase for getting experimental results and then uploaded to a real server for implementation. The website pages involving structure, forms, and style are designed by using tools like HTML, CSS as a sequential style site in order to receive data in the desired sequence.

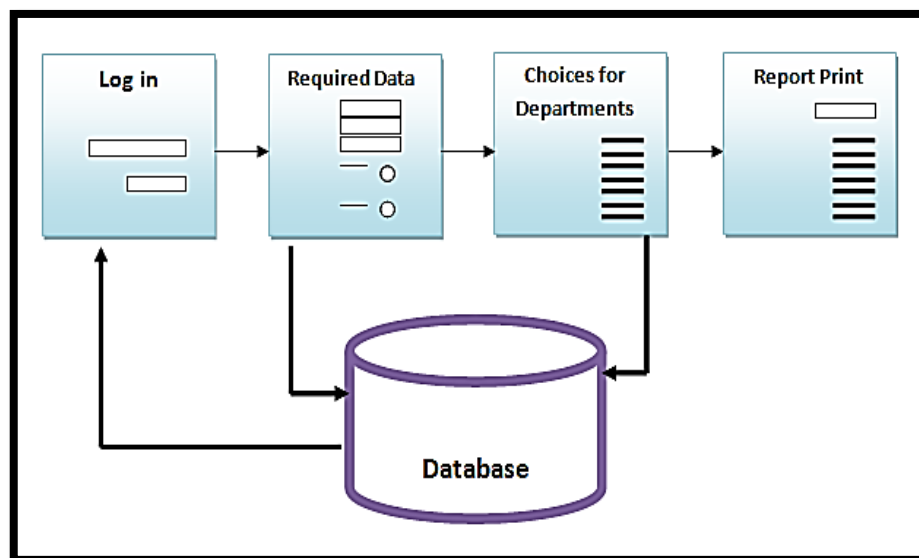


Fig. (2): Structural Scheme of Registration Website

## 4.3 Distribution Method

After successfully completing the electronic registration process and fill in most of the database attributes with data, the final phase of system implementation will start which is students' distribution to the academic college departments. It is the most important phase of



the system execution. Distribution process is done by applying ANN method, especially Kohonen's SOM algorithm. Where, accepted undergraduate students in the college are being distributed to departments by executing Kohonen's SOM algorithm according to the student total degrees and scientific plan in each department. It should be noted that there are some exceptions such as lecturers' sons/daughters, or those excluded by the official books, and unsuccessful students of the past year. The excepted students are not included in the distribution process competition but are accepted directly into desired departments.

Kohonen's SOM shown in Fig. (3) is an effective method in the unsupervised classification domain, due to its interesting and high quality. This famed method contained within the framework of algorithms quantification vector and the method of k-means algorithm. More accurately, the SOM is considered an extension of the pattern recognition algorithms and algorithms of the automatic classification. The Kohonen's SOM algorithm "is an unsupervised partitioned classifier (i.e. it treats with unlabeled inputs and provides classes with no overlap)". The unsupervised classifier gathers the similar information with same features in a specific cluster and the variant ones in other different clusters that lead to save a lot of important time [9].

By applying this algorithm on the training database of 100 students, it learns its parameters such as (weights and learning rate) as in the algorithm's steps explained below. Where, in this paper the total number of the accepted students in the college through a certain academic year is identified as input vectors. The number of academic departments (i.e. clusters) is identified which represents (6) departments in this paper. Also, the admissions' minimum limit of each department is specified as initialized weights. Through the executing of algorithm's steps, admissions' minimum limits of departments are updated till the departments' scientific plan are covered. Finally, the algorithm classifies and distributes the students to the academic college departments depending on students' total degrees and scientific plan of each department. By using training data which is database of (100) students in learning process so as to predict or to estimate, the correct output for any new input created in generalization process [7]. The final output neurons are considered clusters. In this paper, each cluster refers to independent academic department containing a number of students with converged total degrees and guarantee of booking available seats. Summarizing text of used Kohonen's SOM algorithm [8, 10] is illustrated below.

**Input:** vectors of row data (ranges of students' total degrees)

**Output:** clusters of classified and distributed data

- 1- Initialize  $N$  of weight vectors  $W_{ij}$
  - 2- Set topological neighborhood parameters such as:
    - a- Learning rate  $\alpha$  where ( $\alpha < 1$ )
    - b- Geometric schedule  $f$  for decreasing  $\alpha$  where ( $0 < f < 1$ )
  - 3- Initialize input vectors  $X = V^{(i)}$
  - 4- Start iterations
  - 5- For each step (iteration)  $k= 1, 2, \dots$  **do**, (step a - step d) by cycling through training set until weight vectors converge
    - a- Set one of the training vectors (input vector  $X = V^{(i)}$ )
    - b- For each cluster unit  $Z = 1, \dots, N$  where (no. of  $Z =$  no. of  $N$  vectors) **do**, compute the Euclidean distance  $dz$ 
$$dz = \sum_{i=1}^m (X_i - W_{ij}(k))^2$$
    - c- Indexing the computed distances by  $Z'$  to find the *minimum dz'*
    - d- For all cluster units  $Z$  within the specified neighborhoods of  $Z'$ , update the weight vectors
$$W_{ij}(k+1) = W_{ij}(k) + \alpha [X_i - W_{ij}(k)], \text{ where } i = 1, \dots, m.$$
    - e- Update learning rate  $\alpha$ .
    - f- Reduce radius of topological neighborhood at specified times by:
$$\alpha(k+1) = \alpha(k) * f$$
- End iterations **when** the map is converged

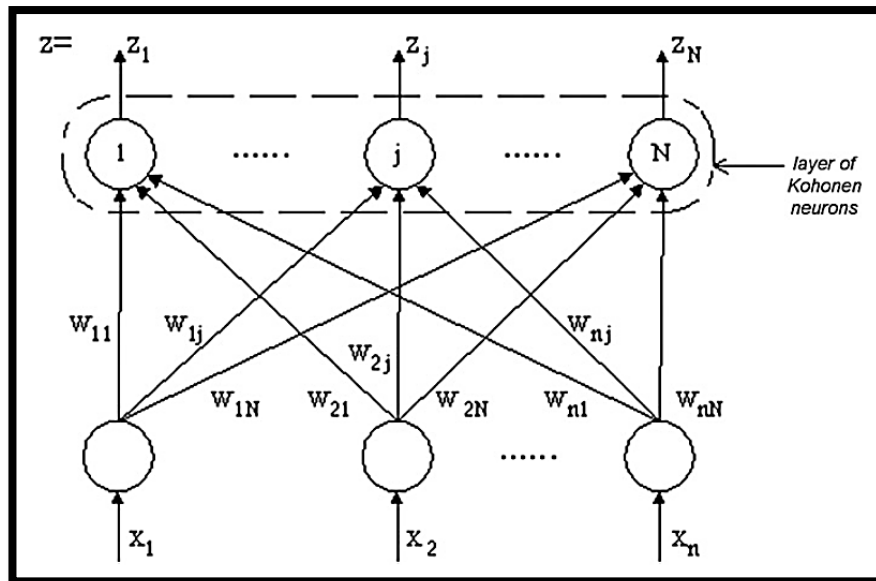


Fig. (3): Architecture of Simple Kohonen's SOM network [10]

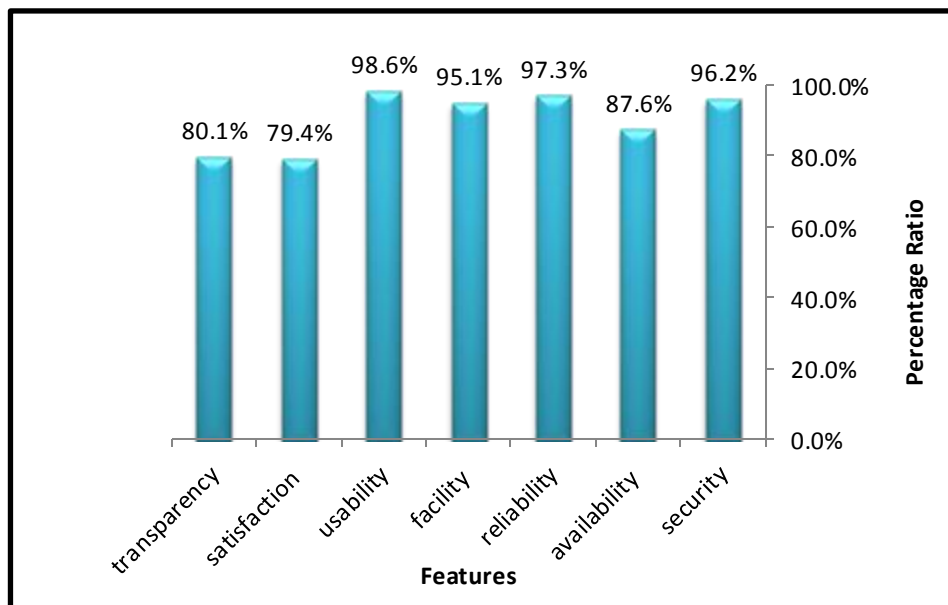
## 5. System Testing and Evaluating

For testing the system, it has been applied on experimental database of (100) undergraduate students in Science College of Kirkuk University as a testing data. The server program framework (WAMP server) has been used as a local server that facilitates database building and running of the system webpages of students' registration. As far as the quality of e-services is affected by the system performance, and consequently affects directly or indirectly on user satisfaction [1], therefore, it has been using questionnaire forms for evaluating the quality of E-IRDS system parts by both the students and registry employees.

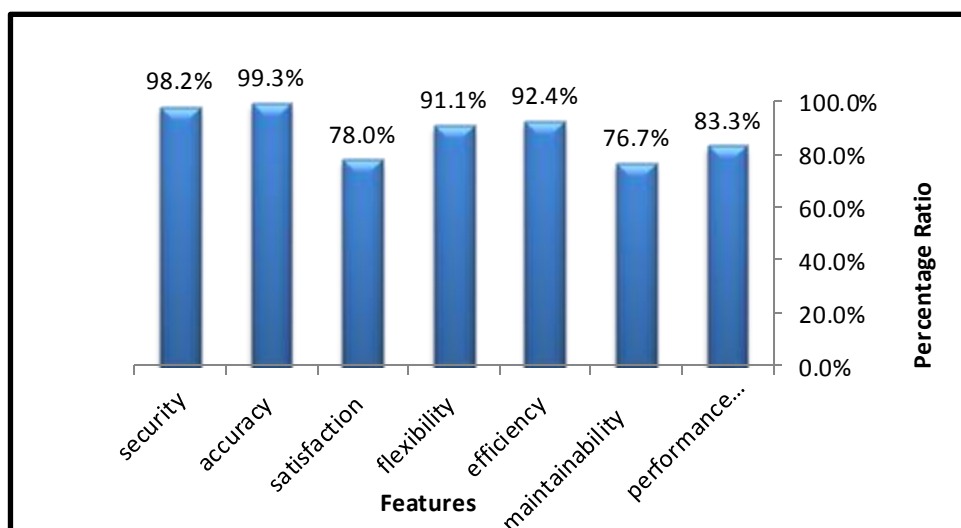
For system quality evaluating, it is based on (12) international standard features and important quality performance measurements publically adopted in the evaluation of e-services which are security, reliability, accuracy, efficiency, flexibility, availability, transparency, satisfaction, facility, maintainability, performance speed as well as functional & usability aspects [11,12] that illustrated in Fig. (4) and Fig. (5). The results of system evaluation are calculated by applying Weighted Scoring Model (WSM). WSM is a very useful and easy tool for evaluation, comparison, and prioritize alternatives.

In this model, the Decision Making Matrix (DMM) is used for ranking the important features and measurements, and then interpreting the results. Where, the resulted ratios of standard features are calculated by using the simple weighted equation shown in Eq. (1).

$$\text{Feature Ratio} = \frac{\text{count of weights for each feature}}{\text{count of evaluation forms}} * 100 \quad (1)$$



**Fig. (4):** Evaluation Results for Students Part of E-IRDS System



**Fig. (5):** Evaluation Results for Employees Part of E-IRDS System

## 6. Results and Discussion

The Kohonen's SOM algorithm is the most popular ANN method used for classification and distribution [8], therefore in this paper it has been applied to classify and distribute Undergraduate students into academic departments. In order to gain the results of algorithm execution, the system has been implemented on the database of the accepted students within the academic year (2016-2017) in Science College of Kirkuk University. Where, the admissions' minimum limit for Science College was student's total degrees (537) with student's average (76.71), and the weights' vector which represents the accepted minimum totals of degrees in each department has reached to as shown in [Table \(2\)](#) after few iterations to cover the scientific plan. The result of distribution process except the excepted students is shown in [Table \(2\)](#).

The result of evaluating students' part of the E\_IRDS System (system website) is visualized by using column chart as illustrated in [Fig. \(4\)](#). The result of evaluating employees' part of the E\_IRDS System (distribution program) is visualized by using column chart as illustrated in [Fig. \(5\)](#). The results of system test and evaluation proved that it is distinguished with very high security (98.2% & 96.2%) and reliability (97.3%) because each accepted student has a unique ID (exam number) to access the system and perform the registration process, and due to the registration staff user accounts, where no one else can access the system and change the data, in addition to Database encryption. The system is as easy as user interfaces are designed for this purpose, therefore it is more facility (95.1%) for students. It has a high proportion of usability (98.6%) because of including registration instructions and video tutorial of the registration process. It is enough fast (83.3%) so that many students capable of recording at the same time, besides automatically classification and distribution of undergrads to academic departments that increases the speed of registration process. This system is distinguished by very high accuracy (99.9%) due to using KSOM algorithm in distribution process which is an unsupervised learning method with no desired output in training data and no errors counted to direct learning process.

The results of test and evaluation phase emphasized the moderate satisfaction (79.4% & 77.0%) of students and registry employees to this system for the reason of dissatisfaction of some users that has been occurred when conversion is done from an ordinary traditional

service (face-to-face) to e-service, as everybody may not prefer to utilize e-service and most of them are already familiar with the traditional service that is by dealing with people and not ICT. It has been also emphasized that the system is very high efficient (92.4%) by decreasing the time and effort. It is also enough flexible (91.1%) to control the DB design and modify its fields, in addition to the ability of update system structure with its interfaces and webpages such as adding or deleting further options of academic departments according to the college. It has been proved the availability (87.6%) of the system by activating its website during registry period and possibility of using its pages anytime and anywhere. Eventually, the results have proved that the system is moderate maintainability (76.7%) for the capability of troubleshoot by professionals. It also improves data access across system website and encourages students to participate in decision making process in e-registration that lead to increase transparency (80.1%).

**Table (2):** Result of Kohonen's SOM algorithm in E\_IRDS System

Cluster No.	Clusters (Department Name)	Cluster Content (Number of Accepted Students)	Final Weights (Minimum Accepted Total degree)
1	Biology	64	596
2	Chemistry	60	576
3	Computer Science	59	557
4	Physics	50	548
5	Mathematics	56	541
6	Applied Geology	45	537

## 7. Conclusions

In this paper, it is concluded that the E-IRDS is an integrated electronic system. It can be connected and merged with other electronic systems in Iraqi e-governance to reduce the boring routine of a series of reviews in scientific and civilian institutions. This system is enough flexible to be used in other universities and institutes. The registration process by using the designed system as an e-government application is done smoothly and lightness making it easier for the competent committees to register students with sorting and distributing them to the college departments. The system includes a good mechanism for users' accounts to control the adding and deleting of users, which increases the system control

capability and efficiency. It is inferred the accuracy of Kohonen's SOM algorithm in classification and distribution to clusters with minimum learning rate and without error rate. It was found that the system is very high security and reliability. It is distinct with high transparency and high performance speed, in addition to students and employees well satisfaction to the system.

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