



**fDesign of a Fuzzy based Intelligent System to mitigate the Challenges of Outcome-based Education faced by Students: A Case Study of Khuzdar Region**

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**ABSTRACT**

Outcome Based Education (OBE) is a concept that is spreading fast across the globe. In this regard various accords are also signed. They include Washington Accord, Sydney Accord, Dublin Accord and Seoul Accord. Pakistan through Pakistan Engineering Council has adopted OBE through Washington Accord. Although the system has many advantages as being precise, clear, involving three domains of Bloom's Taxonomy including Cognitive, Psychomotor and Affective domains, still implementing it unanimously across the country is big challenge. This is due to different terrains of provinces, diversity of facilities and types of students, their understanding of the system to name a few. In this research, the challenges of OBE faced by Students of remote areas with a case study of Khuzdar have been investigated by creating a fuzzy inferencing system assisting to combat these challenges. Fuzzy logic has been selected to represent the confusions among students of various categories and types in an efficient manner. Based on the findings of the fuzzy system, mitigation can be more pragmatic and might be helpful in achieving SDG-4 of quality education particularly in context of Pakistan and specifically for Balochistan through quality tertiary education based on outcome-based education.

**Keywords:**

*Artificial Intelligence,  
Outcome Based  
Education,  
Challenges, Khuzdar*

**1. Introduction**

In modern times, education is becoming more scientific and Outcome Based Education (OBE) is a method which is becoming popular and affective throughout the world. However, implementing it in remote areas and in third world countries is a challenge. Balochistan Province of Pakistan also faces this challenge.

Accreditation accord is a shared harmony agreement via which two or more accrediting bodies accept to identify the accreditation credentials of each other. As Washington Accord (WA) is an international accord which is established for engineering programs, currently it has 20 members. Pakistan has become a full Signatory of Washington Accord, in its General Assembly scheduled meeting was on 21st June 2017 at USA. PEC was denoting the country to secure full-Signatory of Washington Accord since 2010 [1].

The Sydney Accord which was founded by the Engineering Council of the UK (ECUK) and signed in 2001, to supplement the Washington accord. The Sydney accord is established for engineering technologies. Another accord called as Dublin Accord has been accepted for the international identification of Engineering Technician qualifications. Seoul Accord was achieved in 2008 along with the purpose of implementing shared identification of equivalent professional training for Alumni of educational Programs in the Computing and IT-related disciplines accredited by the member agencies, to lead enhanced mobility of professionals [2].

The signatory Countries of all the above-mentioned Accords have considerable correspondence in Outcome based Education (OBE) System. In this regard the main benefit is the shared approval of degree among signatory countries regarding Alumna Engineers and Alumna Technicians, due to their higher studies and employment [3].

Eman Ghanem Nayef et al., introduced research on taxonomies for educational objective domain including the Wilson's, Bloom's, and Lorin Anderson's. These three taxonomies have been compared in this study. The findings imply that the Bloom's Taxonomy is more appropriate as an examining and analyzing tool for the domain of educational objectives. There are six confitures in hierarchal level relating to the complexities of cognitive which are evaluation, synthesis, analysis, application, comprehension, and knowledge. Bloom's Taxonomy is an efficient and effective tool in helping the students to teach the higher-level skills of thinking. This procedure require a less interval of time for the instructor to formulate of higher-level queries. Wilson's classification of level in the domain of cognitive is reflected as add-on of Bloom's Taxonomy that's why called as a dilated model. The aim of this model is to sort out the problems on curriculum, learning techniques and assessment. The goals in the cognitive domain are categorized into four stages which are memorizing, comprehension, implementation and examination or analysis implies that the stages in the Bloom's taxonomy's cognitive domain is not always acceptable, making non-natural questions and including misperception in mathematical idea. These three taxonomies are used as an analyzing tool for educational domain taxonomies and it has concluded that the Bloom's taxonomy can be used as an analyzing tool to determine the stages of objectives. Educators and Facilitators have a shared frame of reference that clarifies various sorts of learning outcomes according to Bloom's Taxonomy. It can be used to serve as an easiest way for learning outcomes [4].

In the 1990s, William G. Spady put forward the idea of an Outcome-based Education System by the means to make sure the learning quality of Students in Educational institutions in America. The Expositor of this system, "OBE means to measure the student's performance that

is the outcome at the end of the program". It is an Achievable approach adopted across the board [5].

Even though Outcome Based Education (OBE) has many benefits, it is considered very difficult for the students to go after this new method of learning. Educational institute that adopted the OBE system, find out some challenges regarding outcome-based Education.

Liliya et al., has proposed a study to face the challenges in implementation of OBE system they declared the transformation between traditional verses OBE it's an effect to bring and initiate this modern system which is outcome-based Education system in Mechatronic system Engineering (MSE) program at Simon Fraser University. They created a scope of obstacles to teaching staff and learners. In this review, the authors receive responses of MSE faculty staff by interviewing them, proceed towards teaching methods allow them to adjust their tutoring approaches to fit both learners and the facts and figures identify by that different learners learn in different ways. An inconsistency existed in between teacher and learner's perception of learning can give on to the old learning method here the instructors recognized that motivation can be an important element which is necessary for the learners to be attentive in the classroom and they described that the main obstacles that should be tackle is to motivate the learners of 1st and 2nd year students and less challenging for 3rd and 4th year students as compared to 1st and 2nd year learners [6].

Williamson has put forward a relative examination, it has carried out for the implementation of Performance-based Education based on OBE in Australia and South Africa. The establishment of Students-Centered Learning has been identified by the challenges concerning to the establishment procedure. For this reason, a relative analysis of outcome-based Education was organized in Australia. Minor Scale model inquiry was executed in 11 South African and 11 Australian Classroom. Moreover, the teachers help, small classroom, and some structures that support will develop the establishment of outcome-based Education in Australia. Nevertheless, the measurements regarding the establishment of outcome-based Education, the skeleton of outcome-based education, evaluation, describing and some additional workload that relates to outcome-based education are specified the same challenges which have appeared in south Africa and in Australia. In their review, it has implied that there are some challenges in the implementation of outcome-based education. Some of the challenges are the establishment of students centered learning seems to be enhancing the procedure of education for the sake of students. Jasnen has rightly said that most of the teachers have no command and access about the OBE system. In their literature it has clearly identified that the text OBE itself is unfriendly for the instructors and the designers who will design the curriculum. As their too

much complexity in the languages and structure and have very tough terminologies. There should be a better training for the teachers. Teachers should have skills like assessors. Instructors are needed to restructure the curriculum, schedule time for students so that they may be able to ask something about the course and understand the course learning outcomes. Some other challenges like cultural breaks, financial restrictions, Disturbance in classes etc. [7].

Sun et al., investigated the significance and obstacles of Outcome based Education which is case study in an institute of private higher education. The objective of this review was to examine the procedure of implementing an OBE system in a private institute in Malaysia where the significance and issues of outcome-based education system were described. This review gives the recommendations for the establishment of OBE to the HEIs in Malaysia to calculate the learning outcomes and academic achievements of learners. As to restructure the syllabus to modify the learner's knowledge and experience towards the real-world challenges for this sake the objectives from the outcome-based education procedure were more important. Moreover, to be hopeful that the accreditation bodies and HEIs may discover various academic and course procedures to approach the system which was OBE though researchers might explore the different methods to calculate the academic attainments of students. The worth of teaching may be secured by the appropriate establishment of outcome-based education procedure and later on there would be a modification in the position of HEIs [8].

Rajaei et al., in their review explained that what are the problems and challenges of implementation of Outcome Based Education in Engineering Education especially in faculty of Engineering, UNIMAS, Malaysia. In Implementation of Outcome based Education the main challenge was defining and explaining the term Outcome Based Education itself. Although it highlighted the attainment of outcomes, also referred to the learning outcomes for a specific course and further map the Learning Outcome to Program outcome. The idea of outcome-based Education doesn't offer any particular technique to monitor an idea in attaining the outcomes which lead the way of confusion that how these curricula should be implemented. During the building of learning objectives for a specific course an uncertainty also comes in notice [9].

Eyman Alyahyan et al., reviewed the literature by calculating the academic achievement of students in higher educational institutions of Saudi Arabia. The main aim of this review was to supply a bit-by-bit set of methods for instructors who want to use data mining techniques to forecast the academic achievement of students. For this reason, a review of the literature was conducted. In this work, data mining methods were used to access the instructors, enabling full potential for their use in the educational sector [10].

Abuhassna et al., developed a model on applying virtual learning platforms to modify the academic performance and pleasures of students. The main aim of this research was to investigate and explore the relevant variables that may have an impact on the academic achievements and performance of students and gratified with using the virtual learning environments. Based on Transactional Distances Theory (TST) and Bloom's Taxonomy. This proposed study was quantitative research and was carried out on 243 learners who are utilizing the virtual learning stage in HEIs in Malaysia [11].

P.Dy et al., analyzed the effect of students personal and educational aspects on outcome based education on the 3rd year engineering program carried using the full online mode in the University of Santo Tomas, Philippines Asia. This paper presented the analysis that how the student's personal and educational involvement under unusual online system produce an effect on their wellness as a solitary. Furthermore, the outcome of this study not only helped the engineering program but also act as a basis for other learning programs in modifying the system they use to totally operate the capacity of learners [12].

Zhang et al., proposed a study on the tutoring process setup on a blended system computer course that has established an international model of Outcome-based learning. The aim of this study was to enhance the competencies of students. The main aim of this study was to prepare learners' general knowledge about the basics of computer, set up on the modern system (outcome-based Education) which should help in gaining development [13].

Maaddawy et al., implemented a modern Education system in Civil Engineering Education. They proposed a system in regard to getting and estimating the opinions of students about the impact of implementing Outcome-based education in Civil Engineering Education. Collecting Data about the opinions of students as regards as the implementation of OBE through Questionnaires which was given out to students at the last of the semester. The results showed that using Outcome based learning to assist students to learn and obtaining understanding of course materials is both efficient and achievable [14].

Parsad et al., designed a teaching Methodology which was based on Computer for modern Engineering Education. They designed and implemented a System named as Computer Based Teaching Methodology (CBTM) in department of ECE, Vidya Jyothi Institute of Technology (VJIT), Hyderabad, India which was used for the attainments of outcomes. The results show that by the use of this software the learners will be more well-known about the courses [15].

Shyamalapasanna et al., focus of the research was on learning and teaching actions which has planned to facilitate the learners. By revealing the nature of OBE system and its levels that has an effect in learning and education for the learners. It helped in the improvement of OBE. In

this review they have used likert scale for outcomes where the outcomes implies that more than 70% of students are willing to adjust themselves in OBE system despite of this 24.2% are weak to adjust in OBE system. By the end of the next few decades, the Daring Journey of OBE will produce a diverse group of graduates. More specifically, there would be a great increase in the number of professional graduates, in 2013 the number of professionals is 137 million that would be increased to 300 million professional learners in 2030 [16].

Different researchers have focused on educational challenges. In Pakistan, the Outcome based Education has been adopted by Pakistan Engineering Council under Washington Accord. PEC has made the implementation of OBE compulsory to get the accreditation for all engineering institutes. National Technology council (NTC) has accredited all the engineering technology programs under Sydney accord. The National Technology council has tackled an important task to promote the curriculum for the engineering technology program built on Outcome based education in a massive notice with Sydney accord. NTC's main purpose is to reinforce the field of technology with assurance of quality education that provides skilled graduates. By doing so there will be strong factor to enhance a powerful production in the development of Pakistan [18]

Muhammad et al., analyzed the comparisons between OBE and Non-OBE systems for the students and faculty members of Mechanical Engineering. They dealt with the requirements of competent graduates and Experts. They aimed to establish the OBE in Mechanical Engineering curriculum in private institutions of Pakistan. They took 10 courses from Mechanical Engineering program and compared the results of both OBE and Non-OBE system. It has been observed that conventional method was pleasant for students but they couldn't approach the accurate knowledge and didn't get their goals. They concluded that OBE System may be tough for students but at the end they get better outcomes [19].

Qadir et al., presented a report about OBE in accords of international accreditation and Assessment practices. They selected different institutions from nine different countries including Pakistan. They claimed that the OBE system is better as compared to traditional where the quality totally depends on facilitators while the whole system not playing any role and they disclosed that to resolve the inefficiencies of students using a modern system. The survey has conducted where the authors has given their feedbacks about OBE implementation [20].

Khan et al., reflected upon a fundamental change after the implementation of OBE in engineering Education in Pakistan. They declared that the conventional method now has varied in some courses of Undergraduates and postgraduates of Chemical and Civil Engineering. They

aimed to enhance the motivation and achievements for learners. They proposed this study to explore the ideas of Complex Engineering problem which is required to be internalized by learners and facilitators in Higher Education Institutions which offer Engineering Education. Their study analyzed, understanding the solution of problems for learners during their study, developing skills, by enhancing the smart ideas. They proposed a system by online surveys, some observations, and feedbacks. To enhance the attainment of learning outcomes especially for the learners who were facing the pitfalls, having tough time and benefited from the instructions. For this sake a Performance-based Learning via cooperative learning and Program based learning [21].

Dewani et al., examined unveiling the introductory outcome-based education system in Engineering Education. In their study, they examined the modern system and traditional system. On the subject of learning outcomes of learners and academic attainment level in Engineering Institutions of Pakistan. They used Bachelor of Software Engineering as example. On the basis of performance, they compared the results of OBE and Conventional methods. The results using OBE are better for future productivity. It is simple paradigm shift from outcome-based education and traditional method. In their review, they installed this system for Engineering Education of Pakistan and unveiling the preparatory for competing for OBE adoption in Pakistan [22].

Zeb et al., proposed their study about the OBE model in accords of learners and instructors' fears in outcome process. They explored the fears of medical students and faculty members in result process and to measure the inconsistency among their point of views about the factors. Students have fear about getting negative comments, most of them considering it a time-consuming process, and some claimed that it's not an important process. They concluded the challenge which are faced, the weak students, their fears, weak staff skills, and no involvement of students due to self-efficacy [23].

Asim et al., proposed a study regarding the OBE and the factors of OBE affecting the learning outcomes of students in higher education. The main goal of this review was to draw attention to Pakistan's tertiary education system and the necessity of switching from a teacher-centered to an outcome-based system of education. The review discussed the key elements that influence the results of student learning as well. A number of databases, including Cochrane and Medline, were searched. The search approach was developed by fusing important phrases associated with review objectives and Boolean operators. Regarding the efficacy of outcome-based education across several subject areas, the study includes seven studies. The results pointed to five key elements from the literature that have an impact on students' learning outcomes,

including assessment methodologies, learning objectives based on degree of complexity, preferred learning styles of the students, English language proficiency, and employer requirements [24].

Saad et al., proposed a system for the explicit evaluation of outcomes attainment in Students Centered Learning model by using standardized computerization. The purpose of this study was to establish a self-regulating outcomes assessment. Therefore, they proposed an efficient self-regulating outcome assessment technique with various ways of finding the outcomes of the course. This technique was carried out by using Visual Basic for Application Coding in MS Excel. They also used indirect assessment (Surveys, Questionnaires, etc.). Currently, East West University is using the 2nd version of this technique [25].

According to UNICEF, Balochistan is less literate province of Pakistan. With 60-70% of children not attending school due to issues like poor connection within the province, security concerns, and a lack of political will and desire to improve the region's educational circumstances. 78% of school-aged females and 67% of males aren't studying in school currently, of the schools, 884405 students are currently enrolled in Balochistan Institutes. Primary education with the highest enrollment 79% followed by steep decline of only 14% children. Only 7% are enrolled in the secondary school and make up the upper secondary level [26].

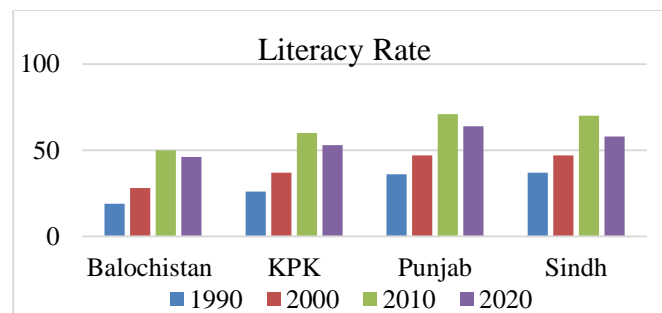


Fig. 1: Literacy Rate of Balochistan

As shown in Fig. 1, the literacy rate in Balochistan from 1990-2020 [27] which is very low as compared to other provinces. The total literacy rate in Balochistan is 46%.

In Balochistan, the Mekran division has highest literacy rate *i.e.*, District Kech has 62.66%, District Panjgur has 59.22% and District Gwadar has 51.9% of literacy rate. According to the 2017 census, the overall literacy rate is 43.58 percent. In Balochistan, six districts out of 34 have improved their literacy rates [28].

District Khuzdar in Kalat Division of Balochistan has 45% of literacy rate. The male literacy rate is 60% and female literacy rate is 26 % in Khuzdar [29].



According to the Pakistan Social and Living Measurement Survey (PSLM) 2008-09, the literacy rate for those aged 10 and older in the Khuzdar District was 46% overall and 66% for men and 21% for women. In this poll, the term "literacy" has been loosely defined as the ability to read and write with understanding. If the literacy rate were calculated according to worldwide norms, it would be significantly lower [30].

The overall picture of Balochistan indicates that Balochistan even lacks primary and secondary education and very limited number of students enter into tertiary education. The quality and background of students belonging to diversified areas of the largest province by area of Pakistan adds to the complication of the situation. The OBE system requires that students are at least of at par level of understanding before getting used to the OBE system. However, in case of Balochistan, its implementation itself is a challenging task.

BUIITEMS (Balochistan University of Information Technology, Engineering and Management Sciences) in all of its activities, BUIITEMS places a high focus on quality assurance. An overview of outcome-based Education and its importance to PEC has been given to the students of BUIITEMS Quetta, Balochistan. Implementation of OBE in engineering program has been a top priority of BUIITEMS which has tried hard to sync university degrees with international standards [31].

BUETK (Balochistan University of Engineering and Technology Khuzdar) has both Engineering and Technology programs. There are 12 programs under OBE in BUETK among which 8 programs are under Washington accord and 4 programs are under Dublin accord [32]. The Pakistan Engineering Council given No Objection Certificate after zero visit of the Department of Civil Engineering at LUAWMS (Lasbela University of Agriculture, Water and Marine Sciences, Uthal Balochistan) to implement the most recent Outcome-Based Education (OBE) and Outcome-Based Assessment (OBA) systems (PEC) [33].

Outcome-based Education System is a learner-based Education System that mainly focused on what a student should be able to do in the real world upon completion of their course or program. The main aim of an Outcome-based Education System is to link education and employability. The Outcome is a Peak illustration of Education.

PEC is a regulatory body to regulate the engineering profession which includes the quality of education in Pakistan. Accreditation by PEC is mandatory for you to get HEC attested engineering degree in Pakistan.

*Program Educational Outcomes (PEOs)*

It is the comprehensive statement that explain the desired attainments of graduates in their career, and also in specific attainments of students in their career, what the students are desired to carry out and attain during the first and achieve during a couple of years after graduation.

*Program Learning Outcome (PLOs)*

PLOs are the taper statements which explained what learners are desired to know Graduates Attributes (GA) and learners be capable to do the time of Graduation.

*Course Learning Outcomes (CLOs)*

Course Learning Outcomes explained the multiplex performances of a learners that should be capable of learning, gaining and dealing with problems and experienced within a course [34]

Table 1: Technologies used for OBE

S. No	Technology	Used in OBE
1.	Web based Application	Students' Outcomes can be observed and compared to the program learning outcomes to meet targets by using the OBE [35]
2.	AQG (Automatic Question Generation) System	For repeated testing to modify the learning outcomes of students by using AQG system [36]
3.	Blockchain technology	For applying the OBE system [37]
4.	AI	Analyzing AI application in OBE (Curriculum) [38] .
5.	AI & Machine learning	Using AI and Machine learning to analyze the teaching and learning Outcome [39].

Fuzzy logic is an area of AI which has been used to deal with the ambiguities of the data. As this research aims at dealing with the complexities faced by students while learning OBE in the context of Balochistan, next we provide a review of fuzzy logic and related research in OBE.

Fuzzy logic is also considered related with the concept of Artificial Intelligence. It is described as a multivalued logic where degree of membership lies in between 0 and 1. Zadeh in 1965 through his research work introduced this concept. The advantage of fuzzy logic over traditional crisp logic or Boolean logic is that as values can be in between 0 and 1, therefore, it facilitates in dealing with ambiguities involved in data. It has been very successful in dealing with complex data sets and getting valuable information out of them [40]. Fuzzy inference system (FIS) is also called Fuzzy Expert System (FES) and Fuzzy Logic Controller (FLC) depending upon the area of its application. It is a rule-based system that uses fuzzy logic, rather than Boolean logic, to reason about data.

Varghese designed a fuzzy inference system for the assessment of modern Education system that is OBE. In their study, they used a productive way for evaluating the Course learning Outcomes (CLOs) by applying fuzzy inference system [41].

Anifah et al., designed a computerized program that has applied via fuzzy logic for the assessment of learner's outcome to determine and analyze the massive amount of data, compiling comprehensive information which can used to tackle out the complex problems and also help out in decision making. They have studied and designed a system to calculate the Program Learning Outcome (PLO) attainments of learners in the courses of Digital Electronic. Results proved, the use of fuzzy as a substitute perform well, and for this study it is appropriate to apply fuzzy with Gaussian membership function parameters and centroid Fuzzification process [42].

Sahagun implement a fuzzy logic system for the assessment of course outcomes in Computer-Aided Design in five parts of Electronics Engineering Program. Survey Questionnaires are used to collect the data. This Fuzzy Logic System had three input variables having 3 membership function and one output variable having five membership function. In Fuzzy Inference System Mamdani method has used and obtain the crisp output the centroid defuzzification was considered. Results are achieved and compared this new method to the old method. This system gives lower values than the old method if an evaluation is low, and gives a higher value than the classical method if the evaluation is high [43].

Sharma et al., implement a System for the analysis of learning skills of teachers in an academic institution. They designed a fuzzy Inference System using Mamdani method. Major purpose of faculty performance is to identify strength & weakness of professional development of a teacher. This soft computing technique by using Fuzzy Mamdani Inference System (FMIS) for evaluating faculty teaching performance will be useful for management of organization for evaluate faculty abilities with student outcomes [44].

Cervero et al., evaluated the quality education achievements on the online campuses using Fuzzy inference System (FIS). Main aim of this study was to examine the satisfaction of students by using the online campuses in higher institutes with the purpose of discovering the main reasons that are affecting the online learning procedure. Questionnaires were used to collect the data for the descriptive analysis, fuzzy inference system and trees classification by using MATLAB software and SSPS. Findings showed that there are four main variable which are affecting the quality of online education: Students got satisfactory answers from teachers about their confusions, a good approach towards the use of the information communication and

technologies, students having Digital skills, performing different activities to enhance the creative ideas and debate [45].

After the detailed literature review it can be said that there is a need for an intelligent system which can help the learners in dealing with the certain level of complexities found in the difficulties of understanding of Outcome based Education in context of Khuzdar city, Balochistan. For this reason, we are going to adapt an intelligent system to mitigate the challenges of Outcome based Education that are faced by students a case study in Khuzdar region.

The aim of the research is to mitigate the challenges of Outcome Based Education by designing a fuzzy logic based Intelligent System a case study of Khuzdar region. The research objectives are,

- I. To analyze the challenges of the OBE implementation among students in the Khuzdar region
- II. To develop a fuzzy logic-based system that can be used to mitigate the challenges in execution of OBE among students.

## 2. Methodology

This research is based on the quantitative research paradigm. In this research, the data variables are taken from the literature that would be useful for designing such system for the mitigation of Challenges of OBE. This Fuzzy inferencing system based on quantifiable rulesets, input, output variable.

### 2.1. Variable and Membership Functions Selection

In this study, what needs to be mitigated are the challenges of OBE. This starts with input factors. After a deep review of literature, we were able to select the Input factors and their membership Functions for designing a Fuzzy Inference System. The 2nd input is “Concept of CEP/OEL” which has taken from survey question of [17], where it has clearly identified that by solving the CEP/OEL/PBL and many engineering tasks will enhance the higher- Order thinking of students.

#### *Membership Functions for 1<sup>st</sup> & 2<sup>nd</sup> Input Factor*

- A. Very High (0,0,0.2,0.4)
- B. High (0.2,0.4,0.4,0.6)
- C. Low (0.4, 0.6, 0.6, 0.8)
- D. Very Low (0.6,0.8,1,1)

The 3<sup>rd</sup> input is “Fear to Dropout” which has taken from the literature [46]. The main cause for the student’s fear to dropout is Teacher’s Behavior which has significant effect on Attendance.

The negative behavior of a teacher with students and his/her oppressive attitude influences learner's absence and dropout rates [47]. The reviewers have described the educational disparity in the whole country Pakistan, and they investigate that educational disparity is very in Balochistan, Pakistan.

*Membership Functions for 3rd input are:*

- A. Teachers Behavior
- B. Attendance
- C. Educational Disparity

The 4<sup>th</sup> input is a big challenge that is "Teacher's Understanding Level of OBE" where the understanding Level of Teachers matters most as compared to the understanding level of student. The Development of any Academic institution depends on the excellent performance of teachers, strong support from parents and the most important point is about the willingness of a student [48].

*Membership Functions for 4<sup>th</sup> input are:*

- A. Low
- B. Medium
- C. High

A survey was conducted and the reason behind this was, to create a link between a Normal Education System and Outcome based Education System. We conduct the survey for the Localization of factors, so that the results can be authentic, the design can be more reliable and to local problems. The survey was anonymous, the Identities of respondents were confidential and no any personal information was included. The survey results were only used for research purposes.

The data in the result was collected in the Google forms and Google database. With the help of the Google form result analysis system, the results were calculated. A total of 221 students responded to the Survey and no response was rejected. As the university was closed, a huge number of students couldn't submit the form because they haven't any internet access at their villages. However, this number has been considered sufficient for the pilot study to complete the Research. According to the survey nearly 72.7% of the students said that OBE is better Education system as compared to Traditional Education system. It shows that active participation has been reasonable though not good.

The majority of students selected Balochistan UET Khuzdar, BUITEMS Quetta, SBK sub campus Khuzdar, UOB Quetta, and LUAWMS. Most of the students who participated in

survey belonged to Balochistan UET Khuzdar which was predictable as they might have better understanding of Outcome Based Education System.

Fig. 2 shows the challenges of OBE faced by students. The challenges may be the understanding level of CLO/PLO, solving concept of CEP/OEL/PBL and the last but not the least which is fear to Dropout.

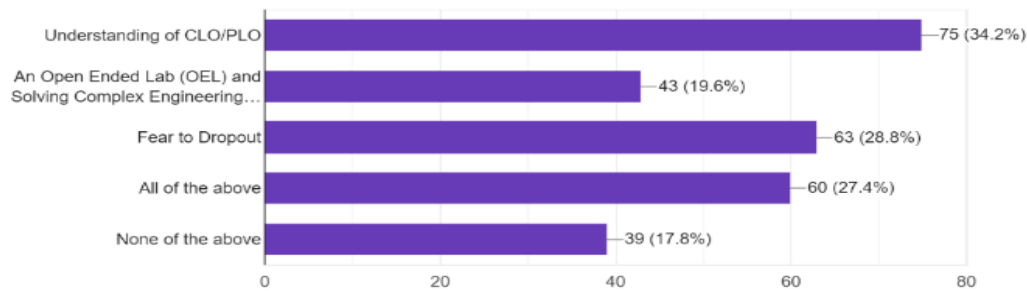


Fig. 2: Challenges of OBE

## 2.2. System Design

For the design of the system, we have following options Fuzzy Mathematics, Type-2 Fuzzy Logic System, R Programming and many others. Fuzzy Mathematics is a maintaining concept of Semi-Truthfulness where the values are present either on zero or one (Yes/No) [49]. The Type-2 Fuzzy Logic System can be used in minimizing the difficulties which are in used for the modeling a system based on Rule. Another tool that we may have been R Programming which is perfect tool that can be applied efficiently in AI and Machine Learning field [50]. The reason why we don't use the R Programming is that it occupies a huge space of memory, may need any physical memory for data. It is also a complex language and very slow as compared to MATLAB [51].

There are four input variables in Fuzzy Inferencing System. Input 1 and 2 has four membership functions while input 3 & 4 has three membership functions, all inputs have triangular membership functions which is based on Mamdani and Sugeno System.

### *FIS in Mamdani System*

The develop FIS in Mamdani System can be seen in Fig. 3.

### *FIS in Sugeno System*

There are four input variables in Fuzzy Inferencing System. Input 1 and 2 has four membership functions while input 3 & 4 has three membership functions, all inputs have triangular membership functions, and the scaling is 0-1 which is based on Mamdani and Sugeno System.

The development of FIS in Sugeno System can be seen in Fig. 4.

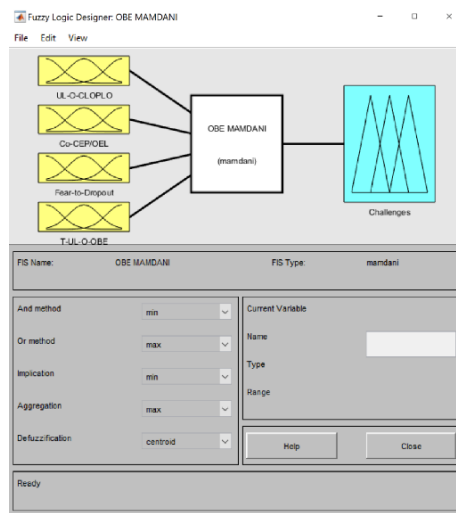


Fig. 3: FIS in Mamdani

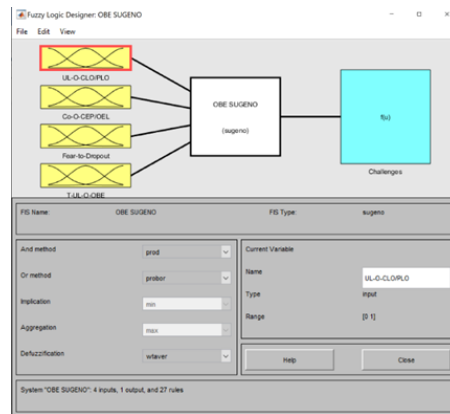


Fig. 4: FIS in Sugeno

In Table 2, the three membership functions are Weak challenge, Moderate Challenge and Strong Challenge that indicate Challenges of OBE which caused by the variable inputs. The parameter values are shown in Table 2.

Table 2: Output Variable and its Ranges Mamdani

S. No	Membership Function Name	Type	Parameters
1	Weak Challenge	Triangular	[0,0,0.4]
2	Moderate Challenge	Triangular	[0.1,0.5,0.9]
3	Strong Challenge	Triangular	[0.9,1,1]

27 Rules were created for the system. Rules were connected through AND operator, Majority vote was used to fire a rule. The general format is given by equation as

1. IF (input 1 & 2 membership functions are very high/ high) THEN Challenge is Strong Challenge
2. IF (input 1 & 2 membership functions are Low/ very low) THEN Challenge is Weak Challenge

3. IF (Input 4(Teacher’s Understanding Level of OBE) is Low membership functions) THEN Challenge is Moderate Challenge

### 3. Results and Discussion

We have created datasets based on literature and survey to obtain the output. We compare the outputs of both Mamdani and Sugeno FIS.

#### 3.1. Data Analysis of BUETK Responses

##### *Mamdani Method*

For Mamdani system, 91 data points’ data has been created. The input given to the system is different values of the data set on which fuzzy rules are executed using the Mamdani inferencing system. The output of the system is shown in Fig. 5. It can be seen from the plot that student difficulty level has been well represented by the output. The minimum output is 0.162 whereas maximum output is 0.9 the result is based on defuzzification method of centroid.

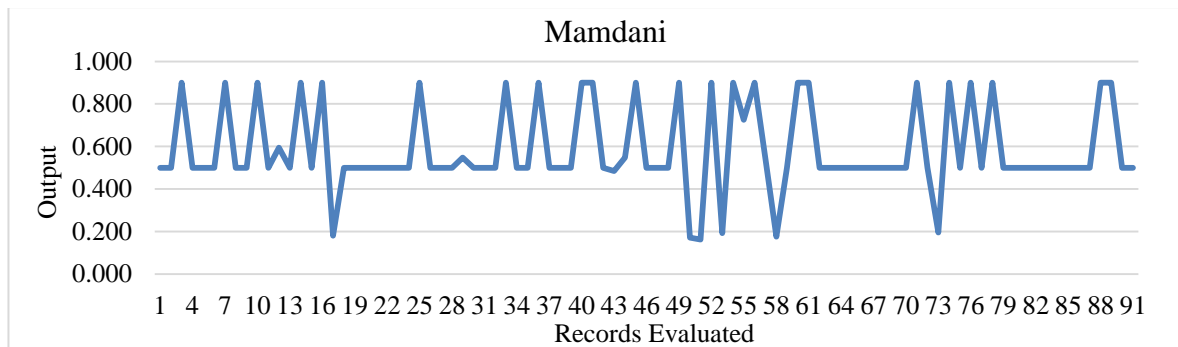


Fig. 5: Output of Mamdani from BUETK Data

##### *Sugeno Method*

The result of Sugeno system on data set is shown in Fig. 6. It can be seen that the variance is high in this system as compared to Mamdani system. It also shows that output is diversified based on complexity faced by students in terms of CLO/PLO and other parameters. Weighted average method was used for defuzzification.

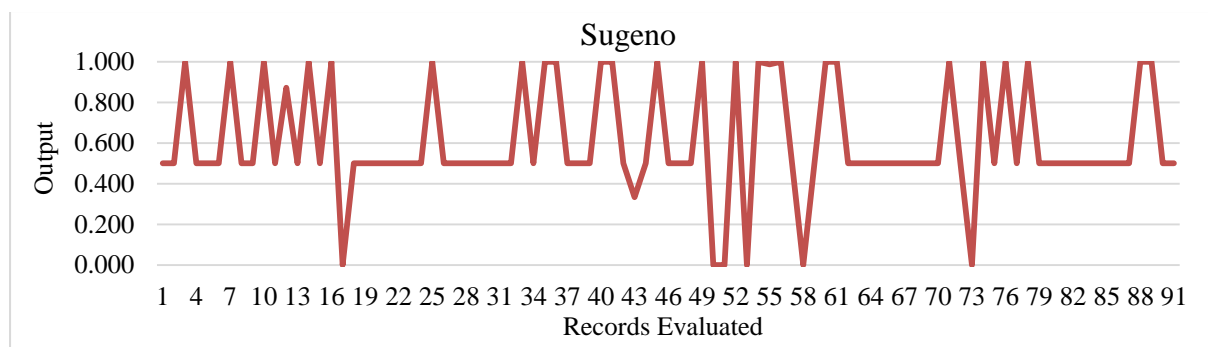


Fig. 6: Output of Sugeno from BUETK Data



*Difference Plot of outputs of both Mamdani and Sugeno*

The difference plot of both Mamdani and Sugeno has been shown in Fig. 7. It also shows that generally both systems were able to reflect well the complexities found in data set as expression of fuzzy values.

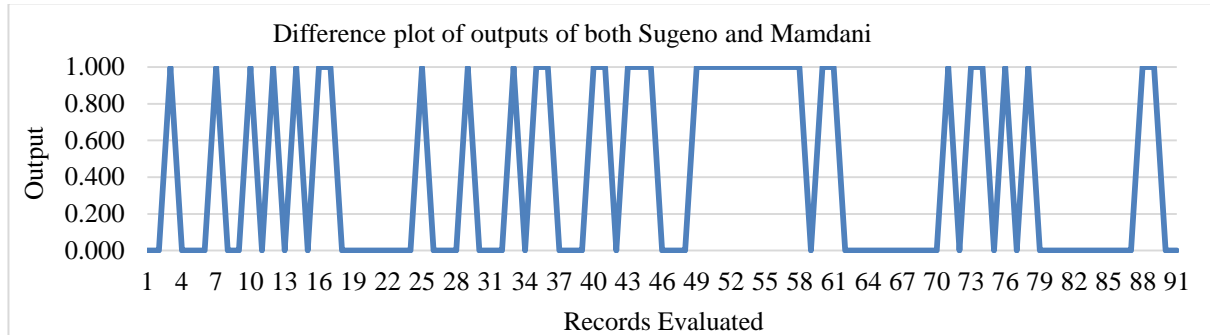


Fig. 7: Difference plot of outputs of both Sugeno and Mamdani BUETK Data

The Percentage Improvement is found out by taking the average of difference of both Mamdani and Sugeno outputs. The average percentage Improvement is 13% from BUETK responses.

3.2. Data Analysis of BUIITEMS-Quetta Responses

*Outputs of Mamdani Method*

For Mamdani system, 22 data points data have been created. The input given to the system is different values of the data set on which fuzzy rules are executed using the Mamdani inferencing system. The output of the system is shown in Fig. 8. It can be seen from the plot that the student difficulty level has been well represented by the output. The minimum output is 0.181 whereas maximum output is 0.9 the result is based on defuzzification method of centroid.

*Outputs from Sugeno Method*

The result of Sugeno system on data set is shown in Figure 9. It can be seen that the variance is high in this system as compared to Mamdani system. It also shows that output is diversified based on complexity faced by students in terms of CLO/PLO and other parameters. Weighted average method was used for defuzzification. The minimum output is 0.0 whereas maximum output is 1 the result is based on defuzzification method of centroid.

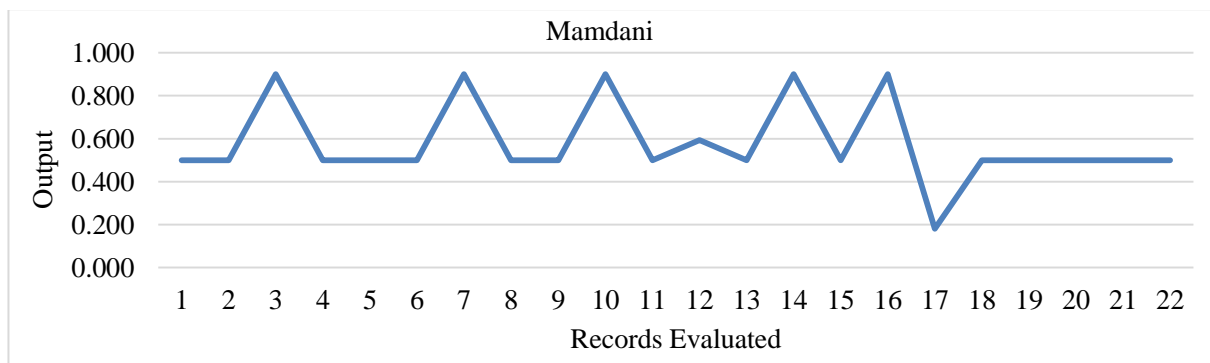


Fig. 8: Outputs of Mamdani Method from BUITEMS-Quetta

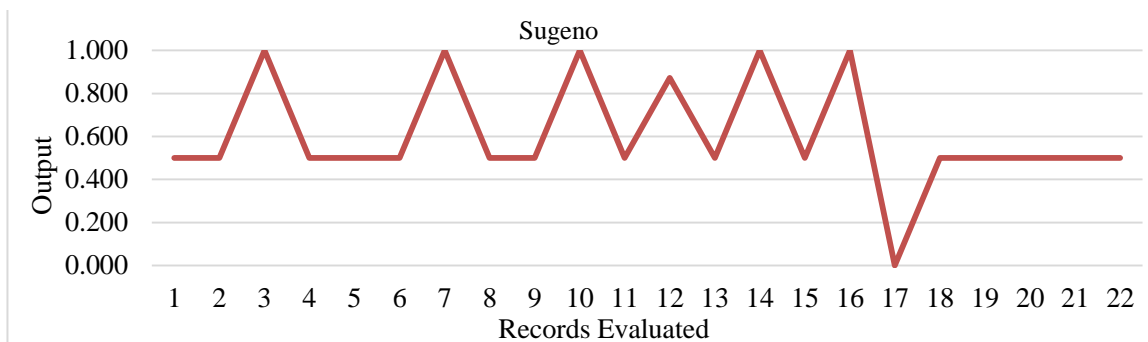


Fig. 9: Output of Sugeno from BBUITEMS-Quetta

*Difference Plot of outputs of both Mamdani and Sugeno*

The difference plot of both Mamdani and Sugeno for BUITEMS-Quetta has been shown in Fig. 10. It also shows that generally both systems were able to reflect well the complexities found in data set as expression of fuzzy values.

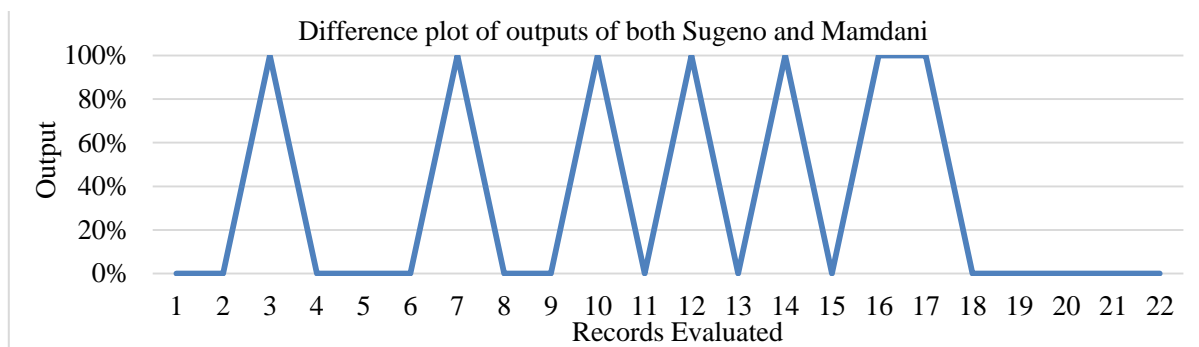


Fig. 10: Difference Plot of Outputs of both Mamdani and Sugeno from BUITEMS-Quetta

The Percentage Improvement is found out by taking the average of difference of both Mamdani and Sugeno outputs. The average percentage Improvement is 14% from BUITEMS-Quetta responses.

The findings are useful as they can be used to design a complete strategy or framework which can be helpful in mitigating the challenges of OBE system in Khuzdar region in general that can be expanded to other areas of the country as well.

**4. Conclusions and Future Work**

In this research work, we have investigated the student view of challenges in OBE system implementation with a case study of Khuzdar region. Four variables were identified with the help of existing literature and mapping that with the regional problems with the help of survey. Membership functions were developed of triangular type, the rules were created based on local scenario as well as with reference from the literature. Both Mamdani and Sugeno types of FIS were created and their results were compared. The results indicated that Mamdani system

performed slightly better than the Sugeno system. The output was divided into three categories where higher category showed more challenges and low category showed less challenges to mitigate. The results showed that fuzzy inferencing can be used to mitigate the challenges of OBE.

Following future works are proposed:

- We have used default membership function settings for the variables of all FIS. Heuristics search algorithms like Hill Climbing and Simulated Annealing can be used to find the efficient membership functions suited to the problem.
- More reliable data sets from across Balochistan, Pakistan and globally available can be used to test the system and it might result in different.
- Other soft computing schemes like Neural Networks, Deep learning etc. can be explored for mitigating the challenges of OBE faced by students and their results can be compared.

Following are limitations of the work carried out during this capstone project:

- Survey was limited to mainly Khuzdar city students.
- Each category of the output further required explanation which could not covered due to time limitations

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