

Development of a Safety Inspection System for University Campuses

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Abstract: This study is aimed to assess the performance of the Occupational health and safety system (OHS) at the university campuses. The study applied at the king Abdulaziz university (KAU). KAU is one of the largest universities in Saudi Arabia. First, the study will implement a gap analysis to assess and evaluate the current OSH system at KAU campus. Then the enhancement of the performance proposed based on the result of the analysis.

Keywords: Safety, System, Inspection, University Campuses, Optimization

I. INTRODUCTION

The Occupational health and Safety system in any workplace (OSH) are very important. It is keen to keep the employees safe and healthy during the work, as well as it will reduce the risks and the accidents possibilities [1].

The study assessed the performance of the OSH in the university campuses. Then it proposed an optimization solution based on the assessment result. For that, the study objective can be summarized as (1) Conduct a thorough gap analysis for universities Occupational Safety and Health administration. (2) Compare the current universities OSH situation with the international benchmark in similar environment. (3) Design an efficient OSH inspection system application for universities OSH department especially reporting the hazardous acts and conditions, incidents, near misses, accidents, as well as, investigation, etc. reports and their management. (4) Actively involves staff and pupils in university safety reports and inspection. (5) Develop an electronic medium proposal to increase the efficacy of the developed system.

At the end, implementing a good safety culture For King Abdulaziz University (KAU) will help to keep the campus safe from unexpected hazard. In addition, It Contributes to improve the role of the university as an example for the students and society [2].

II. METHODOLOGY

a) *Scope of the Study*

The study focused in the OSH managements where it can be classified to nine major scopes: (1) Quality Management Process (2) Internal Communications Process (3) Document Control Process (4) Record Keeping Process (5) Training Process (6) Internal Audit Process (7) Management Review Process (8) Measuring and Monitoring Process and (9) Continual Improvement Process [3].

b) *Study location*

The king Abdulaziz university was established in 1387 H / 1967 G as a national university aiming at spreading higher education in the western area of Saudi Arabia. The university started its first year in (1388h- 1968g) by inaugurating the preparation study program with a few numbers of students (68 male students and 30 female students,). Now, King Abdulaziz University (KAU) is one of the largest universities in Saudi Arabia. it covers an area of 5.48 km² and located on the south of Jeddah city. It has now more than 180212 students (males and females), 6148 faculty members, administrative and technical staff in addition to a big library equipped the most up to date technology to serve students and the teaching staff. It also includes hospitals, restaurant, stadium, sport tent, conference hall and many other buildings. Within four decades [4].

Recently, The Occupational health and safety Administration (OSH) at king Abdulaziz university was spilt from the security department. But still Most of the OSH work is done manually, and it has shortage of staff with low competencies. Also, the system of recording data such as reporting accidents and near misses, inspections... etc. was carried out manually and by OSH employees only. This creates many problems such as increasing errors and mistakes as well as increasing the probability of losing data and doubting the integrity of information being collected. In addition, the system is not well documented, and the leaders are taking the role of its management, since there is no clear framework to maintain the system or to sustain the process of its improvement.

Majors performance shortage discovered in the first investigation. most of the item are not working probably which obviously impact the quality process as well. These items can be summarized as (1) All department communication done by email or phone, the KAU email is the official way of the communication with department with no clear protocol. (2) As the process carried out manually the documentation process is done also manually where there is no any special department or employee for this propose. (3) The recoding method are done separately also, there is no Record control department or employee. (4) There is no plan

for training in OSH department. The OSH relay on bringing an experienced people who already know their responsibilities. (5) The audit is carried by the OSH unit manually for each building. However, a specific check list has been designed by the OSH unit for this purpose but it still manually and changed according to individuals. (6) The management Review only shorted to the head of OSH departments at king Abdulaziz university, knowing that the structure of the university based on its function makes this limitation as major problem where each faculty has a separate management that the safety management has no control or power over it. (7) The main obstacle for KAU structure is that the OSH unit have limited power over the OSH committees which causes non-effective operation. (8) Improvement in the OSH unit is subjected to the people who takes the responsibilities.

c) *Gab anylsis*

The initial statues Gab analysis done in this study using two methods. Survey and benchmarking. However, the analyses covered the nine major scopes [5].

- Survey

Survey implemented to evaluate the performance of OSH system at the kind Abdulaziz university. Also, the survey covered all king Abdulaziz candidate and stakeholders. However, the survey has three main objectives: testing the evaluation of the current OSH system, testing the knowledge level

for all the candidate about OSH in general. also, collecting some suggestion and recommendation to improve the current system.

The survey question categorized to three main categories: Evaluation question, open-end question and multi choices questions. The aim of evaluation question is to test the satisfaction of the candidate about the OSH system they will include nine scope of the study [6]. For that, Net Promoter Score (NPS) method used in the evaluation questions to measure the employee satisfaction and opinions about the occupational health and safety level in the king Abdulaziz university [7]. see figure 1.



Figure 1 NPS scoring

In addition, the questions tested three main aspects, first is the satisfaction of the candidate to the occupational health and safety within the university campus. also, they tested their knowledge level in the occupational health and safety. also, it tested if the candidate knows how to report an accident or incident if there is any.

Finally, the google form software were used for collecting the survey. the links of the survey distributed using, official KAU email, manually through some of KAU academic or administrator staff, adding Advisement in the halls and classes and manually visit to collect the data the survey using tablet.

- *Benchmarks Comparison*

A comparison was conducted to compare between the performance of Occupational Safety and Health Administration at King Abdulaziz University and oxford University where it is according to the Times Higher Education World University [8] is considered one of the best universities around the world. Figure (2) illustrates the steps followed by the researcher to carry out the bench marking.

Oxford university based in United Kingdom, it has 38 colleges, which are financially independent and self-governing, but relate to the central University in a kind of federal system. There are also six permanent private halls, which are like colleges except that they tend to be smaller and were founded by Christian denominations. The colleges and halls are close academic communities, which bring together students and researchers from different disciplines, cultures and countries. This helps to foster the outstanding research achievement that has made Oxford a leader in so many fields [9]. according to Times Higher Education World University Ranking, Oxford university has a population with more than 20000 people. It also ranked 1st best university in the world for 2018 with overall score of 94.3 that is better than Cambridge university at 93.2 [8].

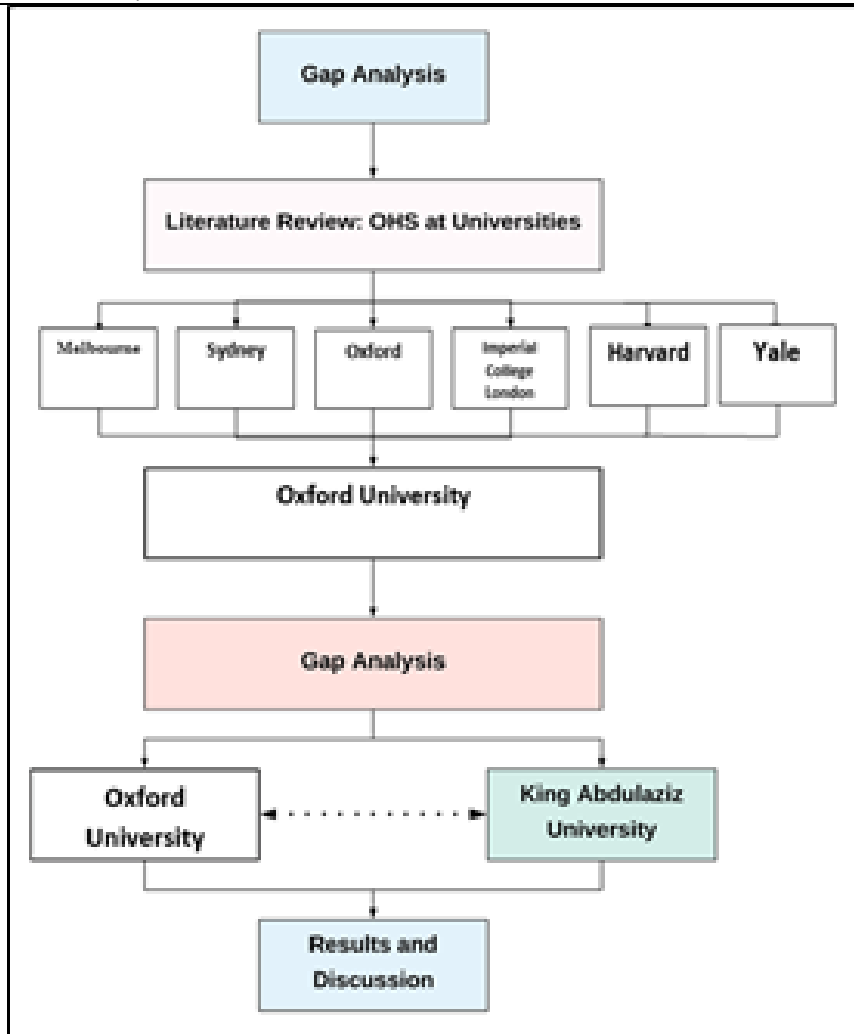


Figure 2 Steps of choosing the benchmarks

At the end, there was no ranking for the OSH system in university. for that reasons, the overall ranks considered in the research as the based for the benchmark’s selection.

The comparisons of the benchmarks covered the nine scope of the research which related to Management Processes. In addition to some of OHS-related Operation Standards such as: (1) Vision and Mission. (2) Objectives. (3) Main Tasks (4) University Health and Safety Policy (5) Safety Courses. (6) Buildings and Facilities. (7) Equipment and (8) Reporting.

There is no qualitative ranking for the OSH system in the university, the assessment was done by the researcher manually. For KAU, a physical visit held to the OSH administration of the university to assess the OSH system. While for Oxford university, the phone call was made to the administration of Oxford to make the assessment.

The assessments relative weights of each scope were as shown in table 1

Table 1 Relative Weights of the Checklist scopes

#	Domain	Relative Weight %
1	Management Leadership.	13.79
2	Worker Participation.	19.21
3	Hazard Identification and Assessment.	17.57
4	Hazard Prevention and Control.	11.23
5	Education and Training.	15.44
6	Program Evaluation and Improvement.	12.02
7	Communication and Coordination.	10.74
Total		100

Finally, the assessments contained four grades as follow: Not implemented with 2 score, partially implemented with 5 score, implemented with only Minor Deficiencies with 8 score and Fully Implemented with score of 10.

d) *Sampling size and data collection*

According the official KAU website, the size of the employee is about 6,148 [10] staff (academic and administrator). Also, the university has a population of 180212 [11] students (male and female). However, these number are reflecting the number of the main campus and all other branches campus’ which recently they become independent campuses. Because of the official Resources and channel of the KAU did not reflect the updated number and the real number is less, the study must follow these number that has no any negative impact on the study. Anyway, Sampling distribution cannot be controlled accurately but the study tried to meet the 60% of sampling from the staff (including academic, administrator and auditing staff) and 40% of the sample will be from the student. Also, the sample covered different collages and departments see table (2).

Table 2 Population size

	Entire Population size (people)
KAU Students (Males and Females)	180,212
Total Staff	6,148
OSH Staff	25

To identify the number of students' sample, equation (1) was applied with a confidence interval of 5 and a confidence level of 95%. Sample Size calculated based on [12]:

$$\frac{Z^2 * (p) * (1-p)}{c^2} \quad (1)$$

Z = Z value (e.g. 1.96 for 95% confidence level)

p = percentage picking a choice, expressed as decimal

(.5 used for sample size needed)

c = confidence interval, expressed as decimal

Based on equation (1), the number of student's sample is 383 minima.

However, the survey was able to reach to 635 samples, that is exceeding the target.

Data analysis was done following the descriptive method using SPSS. Tables and charts were prepared to analyze data by computing the percentages just to show the relationships. The multiple choices question will be displayed using the pie chart, while the evaluation question will be displayed using histograms. Each question was followed by a summary to discuss the result.

e) Developing Electronic Medium for Inception

Based on the result of the gab analysis, the study proposed an electronic frame for inspections and reporting OSH hazards in the campus as part of enhancing the OSH system performance and reducing the gab.

First, the specification of the frames decided, then a concept design generated based on the specification, a detail design come after showing all details needed to start construction. Then, the construction explained in programing and implementation.

The specifications of the software covered the nine scopes of the study, in addition to technical specifications and functional specifications to achieve a durable m effective and easy to use software.

Second, the concept design of the software explained in two stages:

f) The expected scenario

The expected scenario generated to demonstrate the all expected behavior of user and OSH employee.

g) The activity diagrams

An activity diagrams generated based on the expected scenario showing the all expected behavior. A StarUML apps used in generating the diagrams.

Third, a Detailed Design designed to go deep into each component to define its internal structure and behavioral capabilities, and the resulting design leads to natural and efficient construction of software.

The major tasks identified for carrying out the detailed design activity include: (1) Understanding the architecture and requirements. (2) Creating detailed designs (3) Evaluating detailed designs. (4) Documenting software design. (5) Monitoring and controlling implementation

Finally, Programing and Implementation designed using normal website pregaming tools to test the model performance and functionally. The programing also considered compatibility to work in several different operating system platforms (e.g., iOS, Android, Windows 7, etc.) and compatibility to work in different hardware makers (Apple, HTC, Samsung, Google, etc.).

III. RESULTS

h) Gab anylsis

- Survey

The first five questions are representing the personal information section. While the 21 following questions representing general information section. Then questions divided to Four section A, B, C and D where the software will direct the surveyors to the correct section based in their answer in the first and second section. Starting with section A which representing the health questions to the employee, B section representing the safety questions to the employee, the C section are representing the health questions to the student and D section representing the safety questions to the student.

In next figures, a summary of answers to some of the survey questions

The result figure 3 show 49% of were attached to KAU between 1 to 5 years, 36% were attached more than 5 years and 15% only were attached less than 2 years .that mean 85% of the answers were more than 1 years.

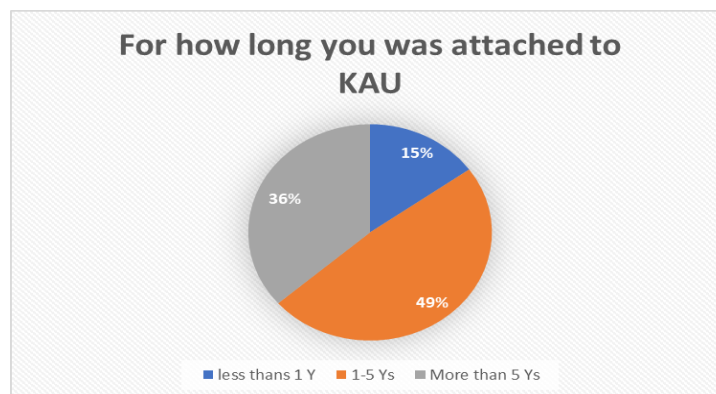


Figure 3 AVG attached period to KAU

This question in the figure 4 is testing the knowledge of the people about the OSH reporting system channel in the campus. 56% says No they don't know any channel for reporting OSH issue while 44% says yes, they know.

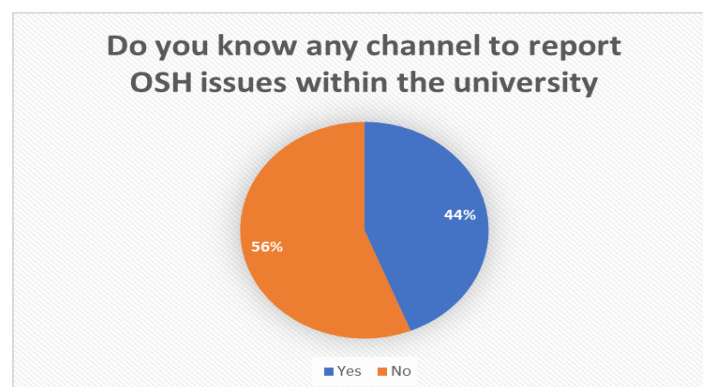


Figure 4 reports Channel

This question in figure 5 shows that 83% of the people did not use any reporting channels before.

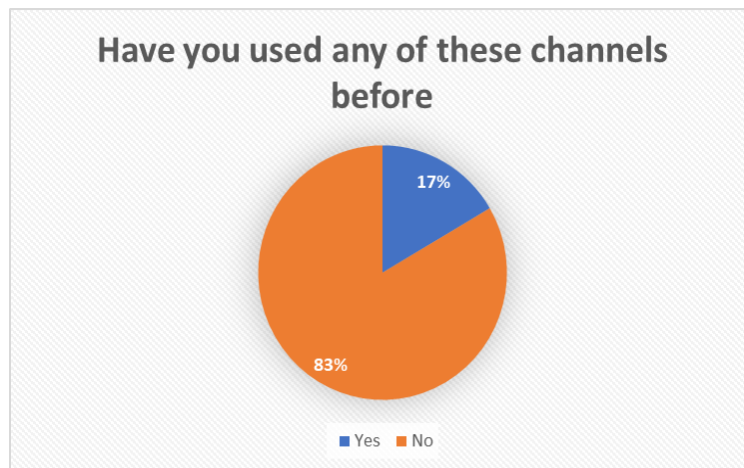


Figure 5 channel usage

As per Occupational Safety and Health Administration (OSHA). When new employees enter the workplace, they need to successfully transition into safe work routines from day one. This requires having safety induction procedures that give a full overview of your company’s safety and health programs, policies and work practices. Safety induction procedures employee to raise the awareness about health and safety accidents possibilities in the industry. In KAU campus the result show that 67% of the people have no any induction course, 26% had it from 1-3, 4% had it from 4 to 10 times and only 2% had it more than 10 times. See the figure (6)

Having 67% candidate with no induction plan at all is big percentage that is exceeding more than half of the population.

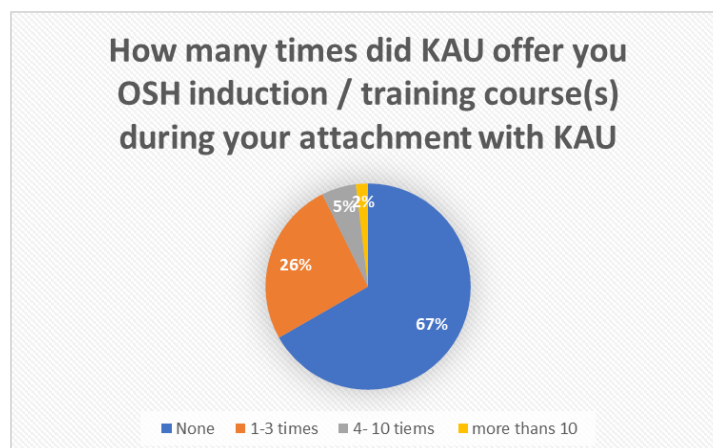


Figure 6 induction training

In the following, some of NPS evaluation question where the people will evaluate a statement that represent the performance of KAU OSH.

The statement: KAU has OSH vision, mission and objectives

The satisfaction percentage is about -41.7 % according to Net Promoter score, where NPS = 18.1%-59.8% =- 41.7%. See figure (7).

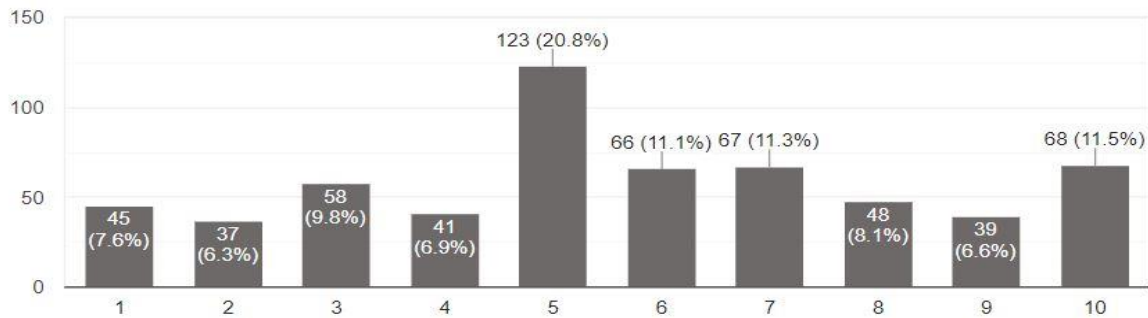


Figure 7 the satisfaction AVG for vision , objective

The statement: How much do you score the overall performance of OSH at KAU main campus?

The satisfaction percentage is about -44.7 % according to Net Promoter score, where NPS = 15.8% - 60.5% = - 44.7%. See figure (8)

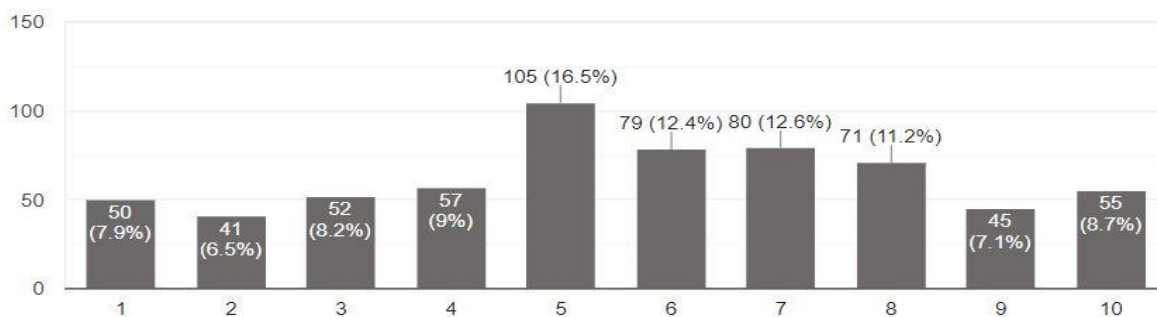


Figure 8 overall performance

Based on the result as shown above, the result of the survey shows not satisfactory performance for OSH in KAU.

- Benchmarks

The results of the benchmarks shown the table 4, 5 and 6.

The difference of the assessment was clear where KAU average answer between 40 – 60 score and oxford assessment were almost 95 score.

The average weighted score of Oxford university were about 970.273% while KAU score only 470.175 %

The gap analysis has indicated that OHS administration at King Abdulaziz needs to be developed especially in terms of communication, documents control, record keeping, training, reporting system, and equipment.

Now, with quick development in the technology the gap can be reduce by developing an electronic software to enhance the system, monitor the performance and keep the data records for future developments in the system. The next section will discuss the proposed software.

Table 3 Comparison score

	Management-Related Processes					
	Oxford University			King Abdulaziz University		
	Ready 95	Nearly Ready 60	Work to Do 40	Ready 95	Nearly Ready 60	Work to Do 40
Quality Management	☐				☐	
Internal Communications	☐					☐
Document Control	☐					☐
Record Keeping	☐					☐
Training	☐					☐
Internal Audit	☐				☐	
Management Review	☐					☐
Monitoring and Evaluation	☐				☐	
OHS-related Operation Standards						
Vision and Mission	☐				☐	
Objectives	☐				☐	
Main Tasks	☐				☐	
University Health and Safety Policy	☐					☐
Safety Courses	☐				☐	
Buildings and Facilities	☐			☐		

i) *The Electronic Reporting Medium (Software)*

j) *Software specification*

The specification of the software demonstrated in detail where it covered all study scope.

k) *The expected Scenarios*

The app is object to allow the all the university candidate including employee, student and labor to participate in safety investigation by reporting the incidents to the specialized authority, they also can follow up their reports using the app.

The user needs to register in the first time, they must provide his personal information such ID, Mobile number ...Etc. then he needs to choose to verify his account using mobile or email. after verification, the account then will be ready to use. To start reporting, the user needs to re-login again using his user ID and password.

Table 4 Summary of comparison result

	Management-Related Processes	
	Oxford University	King Abdulaziz University
Quality Management	95%	60%
Internal Communications	95%	40%
Document Control	95%	40%
Record Keeping	95%	40%
Training	95%	40%
Internal Audit	95%	60%
Management Review	95%	40%
Monitoring and Evaluation	95%	60%
OHS-related Operation Standards		
Vision and Mission	95%	60%
Objectives	95%	60%
Main Tasks	85%	60%
University Health and Safety Policy	95%	40%
Safety Courses	95%	60%
Buildings and Facilities	95%	95%
Equipment	95%	40%
Reporting	95%	40%
Average score	94.3%	44.7%

The average score of Oxford university were about 94.3% while KAU scored only 44.7%

Table 5 comparison Weighted score

#	Domain	Relative Weight %	Oxford		KAU	
			Score	Weighted score	Score	Weighted score
1	Management Leadership.	13.79	9.6	132.384	5.6	77.22
2	Worker Participation.	19.21	9.8	188.258	5.4	103.734
3	Hazard Identification and Assessment.	17.57	9.4	165.158	5.3	93.121
4	Hazard Prevention and Control.	11.23	9.8	110.053	4	44.92
5	Education and Training.	15.44	10	154.4	6.12	94.4928
6	Program Evaluation and Improvement.	12.02	10	120.2	2	24.04
7	Communication and Coordination.	10.74	9.3	99.882	3	32.22
Total		100			970.273	470.175

The user can report any incidents or accident using the app by uploading a picture, describing the case and specify the location. The user also has the ability to check the case of previous reports. in addition, the user can change some app setting, profile and preferences.

The Osh employee can register to the app with specific account that has the feature of the user accounts in addition to reply and follow up with action reports to the outstanding reports that were created by normal users.

1) Activity Diagrams

Based on the expected Scenarios, an activity diagram has been generated as follow [13]. see figure 9, 10,11,12 and 13:

For the first entry, users must log in or register see figure 9

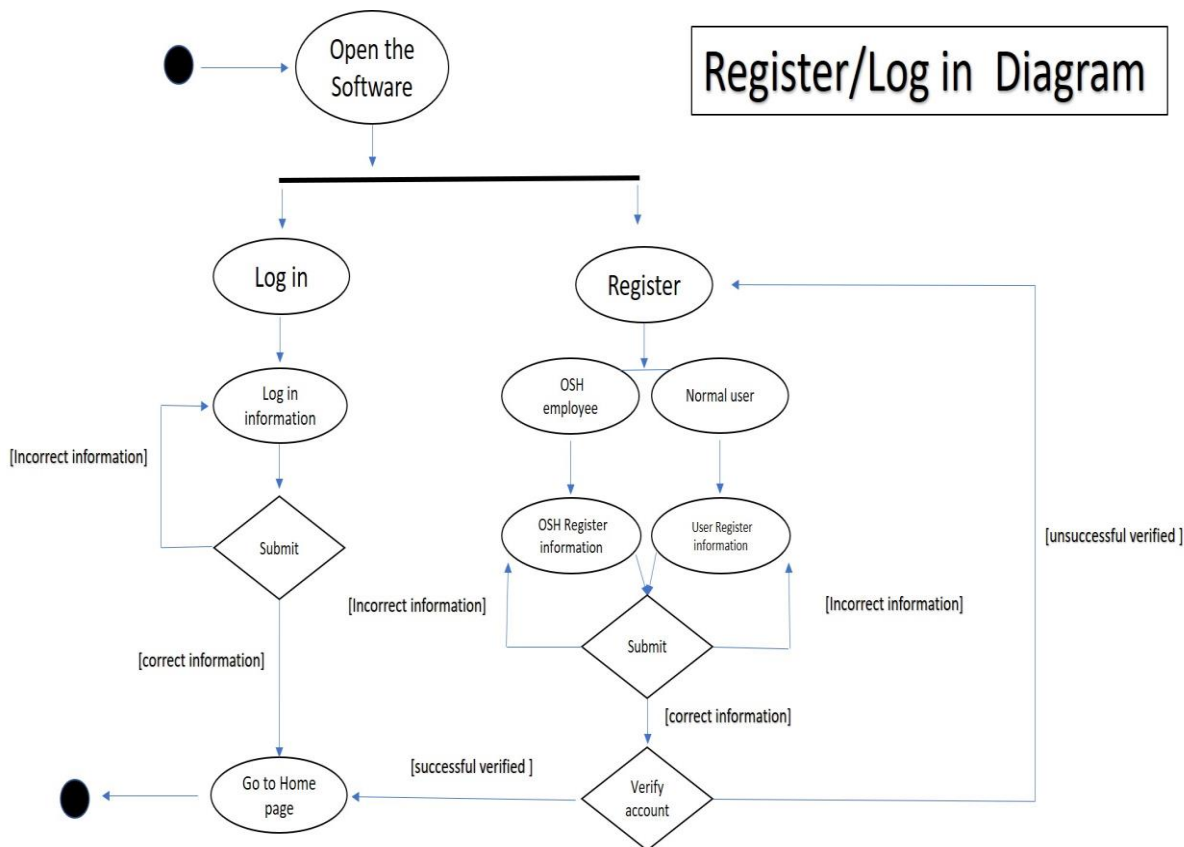


Figure 9 The first entry diagram

For the reporting, all type of user can proceed with the same methodology. See figure 10

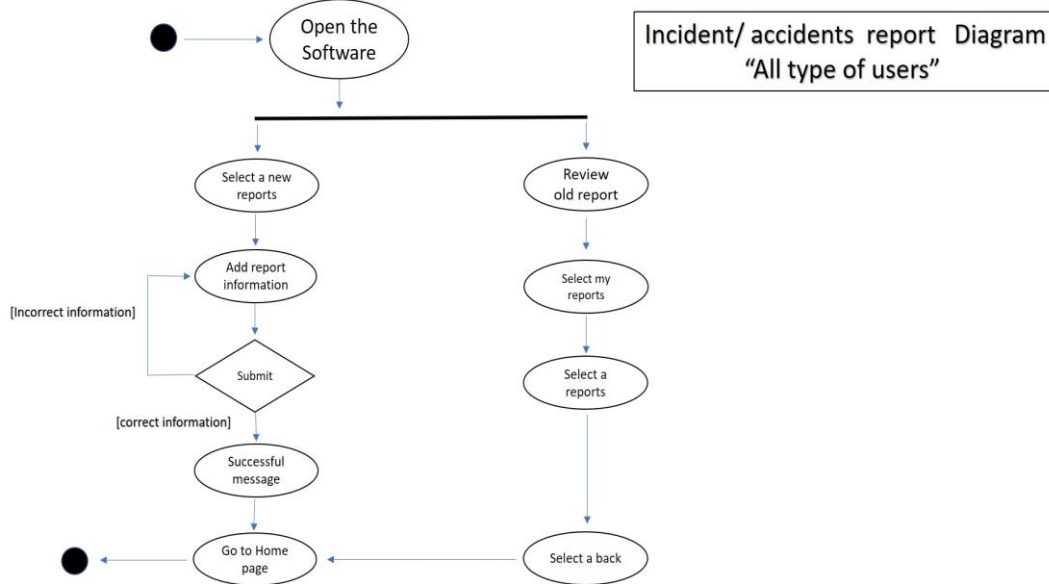


Figure 10 reporting diagram

To modify your personal information, for all type of user, profile or software setting see the figure 11

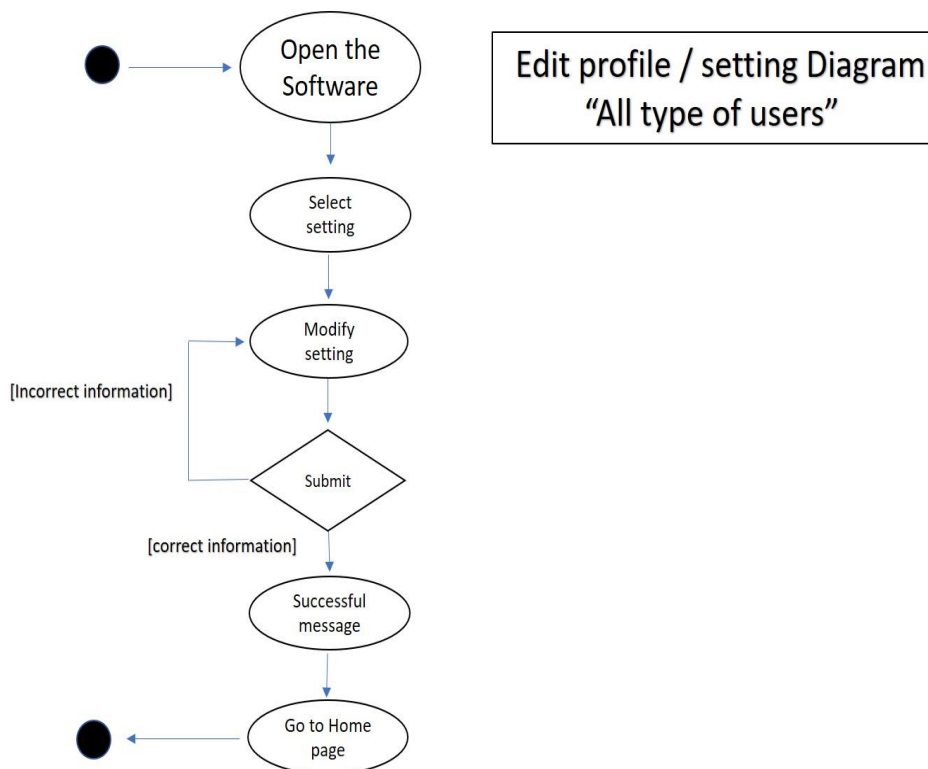


Figure 11 Edit setting diagram

To check the emergency call number, for all type of user see the figure 12.

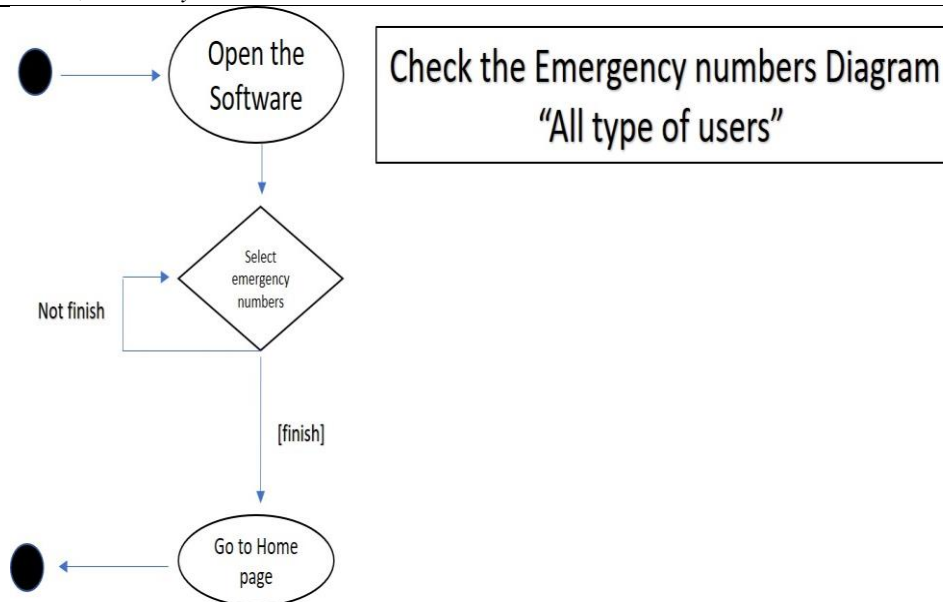


Figure 12 finding emergency numbers in the app

For OSH employee only, they can follow any outstanding reports created by the normal user also they have to add a reply reports stating the actions done by the authority, see the figure

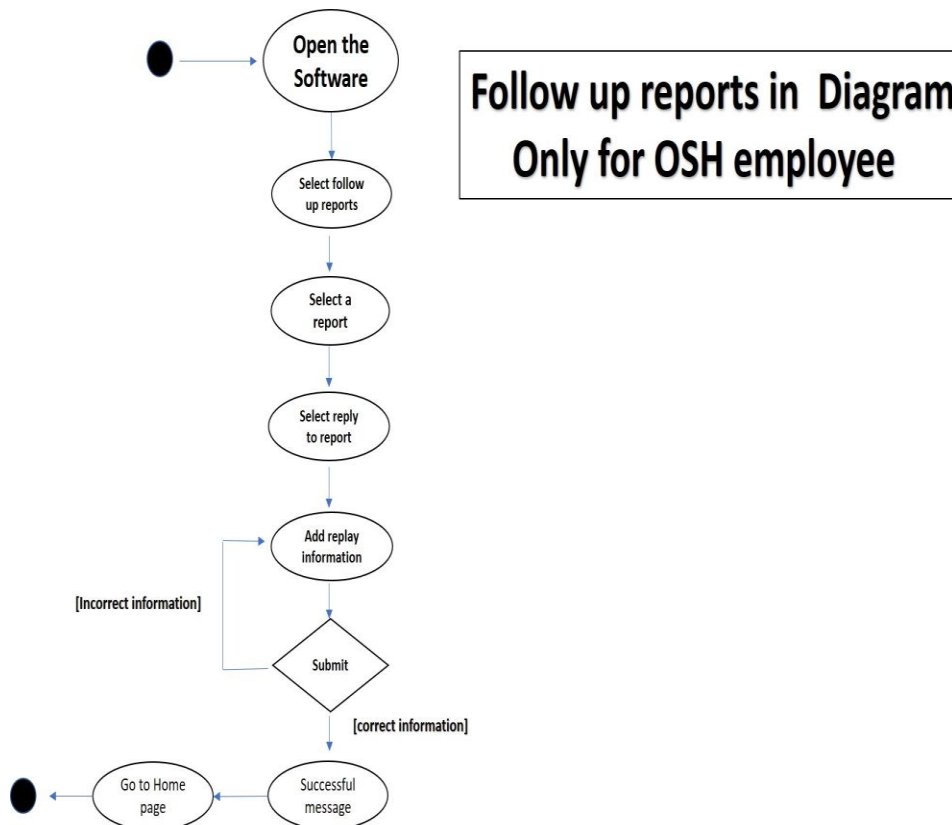


Figure 13 Follow up outstanding reports

The link of the software created is <http://Kauoosys.com>. A detail the of work mechanism of the safety inspection system described as follow:

- Creating the Account:

This stage involves creating the account, where the user adds his/her basic information including name, email mobile number, and user's permissions as shown in the following screen see figure 14:

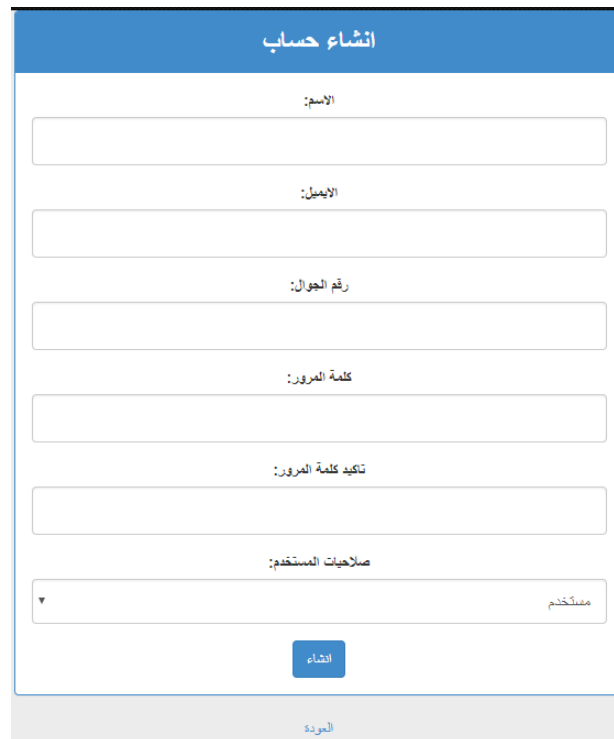


Figure 14 creating account

After creating the account successfully, the following window appears for the user confirming that the account has been created successfully figure 15:



Figure 15 user registered screen

The system will then direct the user to a user sign-in window, where the user will be requested to enter his/her Email and password as shown in the screen below see figure 16:

Figure 16 sign in page

After logging into the system, the user will be directed to the main screen of the system, where the user will be able to:

- 1- Add a new report
- 2- Follow up previous reports

The following screen shows the main window of the system. figure 17:

ID	الوقت	البلاغ	الحالة	الردود
11	18:09:49 2018-12-04	مشكلة بين احد الطلاب ومكثور مانه الرياضيات	متابعة	0

Figure 17 currents reports

If the user opted to add a new report, he/she can press the button labeled “new report”, this will automatically direct the user to the following screen see figure 18:

Figure 18 creating reports

The user can add the details of the report including the address, and the exact details of the incident, in addition to that, the user has the choice to upload related files. After adding the required information, the user can submit the report.

In case the user wants to follow up old reports, he/she can press the report. The system will automatically direct the user to the report as shown in the screen below:

The management user can follow up the reports and can reply to any of these reports, as well as determining the status of the reports by pressing on any of these reports see figure 19.

Figure 19 Following Up the Reports

IV. CONCLUSION

The gap analysis of occupational health and safety in King Abdulaziz university were done using two assessments methods, a survey for KAU population and comparing KAU campus with benchmarks. The result of the two assessments showed the deficiencies in the KAU campus. It showed that occupational health and safety system has no enough record of the data which shorting the quality control and quality insurance in the system. All these deficiencies lead to low performance of the systems References

The study proposed a solution to solve the problem and create a system model that will reduce the deficiencies, it creates a enough recording process and Facilitate the enhancement process. To achieve that, the study suggests Adapting the latest Technologies in the OSH system.

The proposed system will be an electronic frame for the system that will allow all the KAU candidate to be involved in the OSH inside the university. it allows them to create a report for any accident or hazard for the OSH inside the campus, following this report until it solved and evaluating the solving actions which done by OSH employees. In the meanwhile, the frame will allow the OSH employees to follow up the reports and create an action reports for them showing the action in detail. The frame will also have the features of automatic recording of all data in the specific's servers. These data will include all the reports and the actions details such as date, location description etc.

The software is a big step to improve the OSH system inside the university, however it also needs for OSH management in the university to establish a clear policy, organization structures, and process to enhance the systems.

Conflict of interest: The authors declare that the authors do not have any conflict of interest.

Ethical statement: The authors declare that they have followed ethical responsibilities.

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This volume is dedicated to Late Sh. Ram Singh Phanden, father of Dr. Rakesh Kumar Phanden.