Implementation of Safety Management System in Kuwait International Airport

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Abstract

In any aviation facility, safety is the most sensitive issue to consider. This is because any single accident can significantly affect the whole airport. In this paper, a successful implementation of Safety Management System (SMS) is done at the Kuwait International Airport (KIA). The paper shows an implementation of such a system reduces the rate of accidents along with their costs, increases the productivity of the place, and meets the legal specifications needed to insure safety at airports. Several hazards happening currently at KIA were illustrated in this paper with the suggested preventions to control these hazards. The five step DMAIC methodology was used to describe the hazards and how they should be improved and controlled. A Fault Tree Analysis (FTA) technique was applied to investigate the hazards. At the end, SMS was proved to be an effective system to apply at KIA and which reflects the NEWKUWAIT vision towards a better and safer place to live in.

Keywords
Safety, Safety Management System, Hazard Analysis, Risk Analysis, DMAIC

1. Introduction
Occupational safety and health issue is a serious action that is considered by many countries and is taken into account from many years ago (Abrey & Smallwood, 2014). Kuwait is one of those countries that consider the employees' safety and health as one of the fundamental issues that needs to be upgraded, improved, and developed every now and then. In this paper, we chose Kuwait international airport (KIA) as a real case facility related to safety and health issues. KIA is opposed to dangerous safety and health issues where both employees and passengers are under high risk. The most hazard problems at KIA are musculoskeletal disorders, temperature extremes, noise, and being affected due to cleaning materials. Therefore, proper safety and health assessment, preventions, controls, and methodology are necessary to be followed in order to avoid these hazards (Müller, Wittmer, & Drax, 2014). Many tools, techniques, and approaches such as Failure Tree Analysis (FTA), risk analysis, and safety management system (SMS) helped safety and health managers to make further judgment of hazards (Baig, Ruzli, & Buang, 2013). SMS is an approach that is applied in (KIA) to manage safety risks that are associated with operational organization and activities performed by employees. The secret behind SMS implementation in KIA is that the International Organizational Civilization (IOC) has mandated (SMS) to be implemented in all sides of all airports in order to increase safety awareness and safety communication (Yuling and Guldenmund, 2018). It is a system that manages activities in a clear processed way and documented manner (Thompson & Stephen, 2016). A successful implementation of SMS resulted in a significant reduction of risks and the severity of the accidents, as well as their cost; thus, reducing the injuries and the lost days away from work resulting from the accidents. (Stolzer & Goglia, 2008)

2. Literature Reviews

2.1 Airport Safety Starts with Safer Working Conditions

Occupational Safety and Health Administration (OSHA) and The New York Committee for Occupational Safety and Health (NYCOSH) focused on the dangers associated with airline and airport environment. It emphasizes the need of private contractors operating at airports to enhance the safety and efficiency of airports. Unsafe hazardous working conditions may put workers, airport visitors, and passengers at huge risk of injuries or death. Contractors and airport management play an important role in reducing and preventing these risks. This is done by committing and applying OSHA's and NYCOSH's recommendations such as conducting workplace hazard assessments, providing health and safety training, providing personal protective equipment (PPE), and notifying employees of any hazardous substances and chemicals. (Newman, Obernauer, & Straka, 2012)

2.2 The Relationship between the Implementation of a Safety Management System and the Attitudes of Employees towards Unsafe Acts in Aviation.

A Safety Management System (SMS) has been successfully implemented in Al- Sharjah International Airport, UAE, in a way that improved the attitudes, behaviors, culture, and the practices of employees in the airport, and enhanced safety and health. The International Civil Aviation Organization (ICAO) requires all international airports to implement a SMS to ensure safety practices in the airports, and to reduce the occurrence of accidents and incidents. A Safety Culture Survey (SCS) was conducted in Al-Sharja airport to measure the impact of the power of SMS on the employees' attitudes. The results showed that the implementation of SMS enhanced and improved workers' attitudes, communication between workers, committing to safety rules and regulations, and work environment. The paper showed that committing SMS must be done in all the international airports in the world to ensure a safe and efficient environment for workers and passengers.

Well, based on these literature reviews, the approach of SMS was applied in KIA to ensure safety and health. Additionally, policies, guidelines, and supervision were conducted to make sure that the workers are working under safe conditions. (Remawi, Bates, & Dix, 2013)

3. Methodology

DMAIC is an acronym that refers to Define, Measure, Analyze, Improve, and Control phases. These five phases provide a comprehensive improvement method in order to enhance the selected system or process. Consequently, we applied this methodology to improve the level of safety and health in KIA.

3.1 Define Phase:

In this phase, the problem should be addressed and defined clearly. Fig. 1 illustrates the flowchart of KIA safety process of hazards reporting.

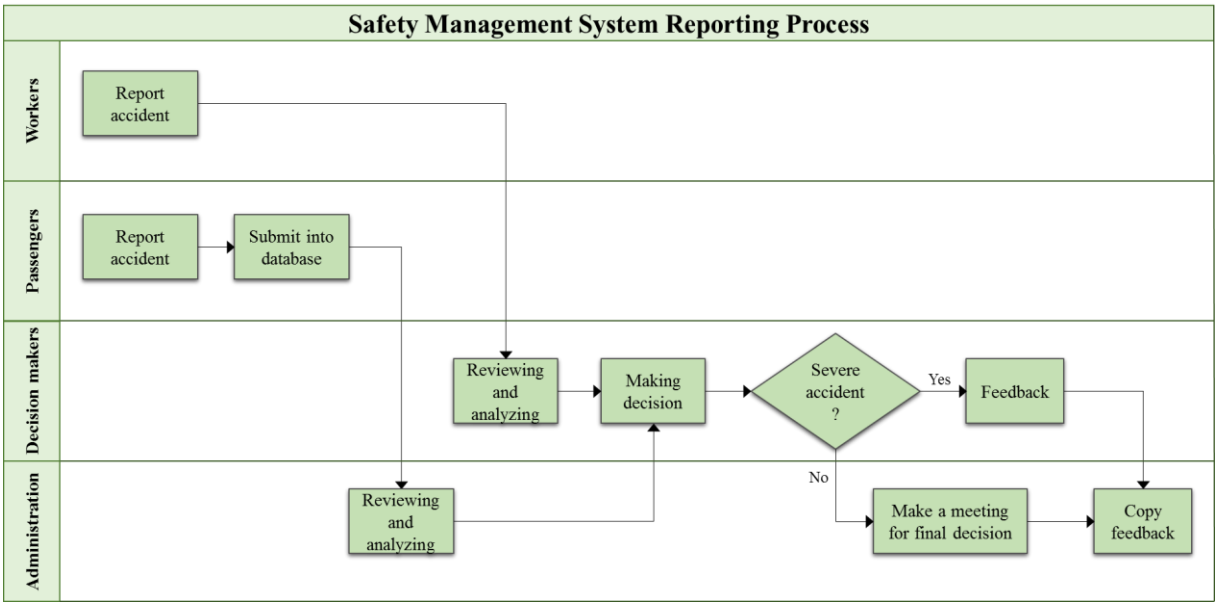


Figure 1: KIA SMS Process Swim Lane (Flowchart)

After understanding KIA SMS process, we conducted brainstorming sessions to identify the hazards types of each safety activity type, as shown in fig. 2. Moreover, we used cause and effect diagram to categorize and analyze the main causes of the hazards and their roots that were generated from the brainstorming sessions, as shown in fig. 3.

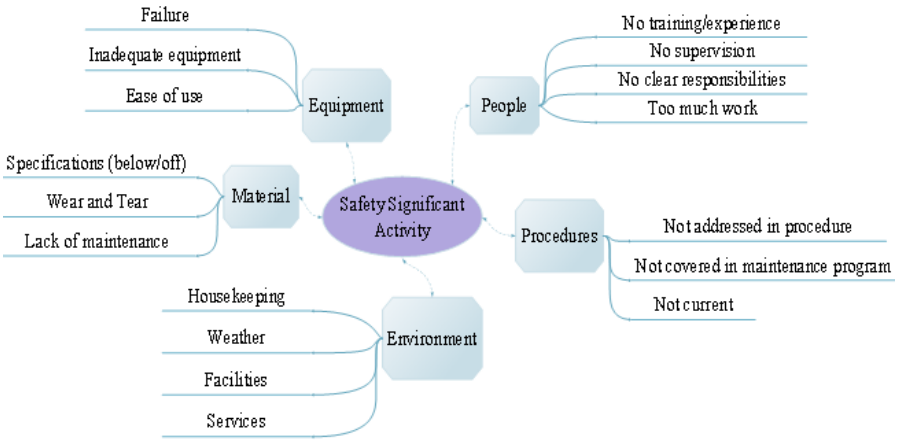


Figure 2: KIA Hazard Identification Brainstorming Tool

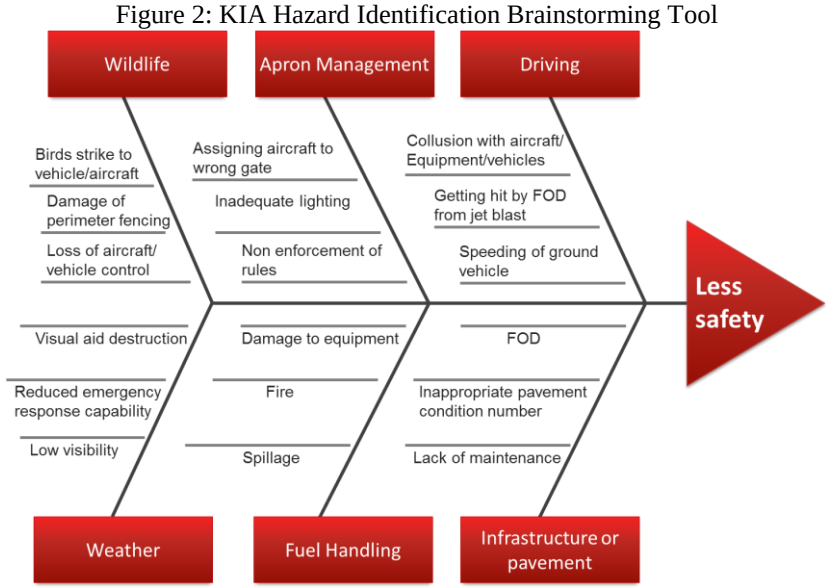


Figure 3: Cause and Effect Diagram of the Important Hazards in KIA

So, KIA area is divided into four main sections and each of these sections has a type of hazard and risk, as shown in table 1.

Table 1: KIA Sections

Section No.	Section Name	Section Description	Hazards type
1	**Airside**	The section in which aircraft stands on	➢ Chemicals ➢ Physical hazard
2	**Airstrip**	The section in which the aircraft lands or leaves	➢ Weather conditions
3	**Arrivals**	The section for arrived passengers	➢ Radiation ➢ Ergonomics hazard
4	**Departures**	The section for leaving passengers	

1) In this section, chemical hazard are used to clean the leakage of the airplanes diesel, clean any foreign material, and other usages like cleaning the airplanes tires if necessary (Kirwan, Carthey, Heminga, & Halea, 1997). Moreover, physical hazard, which is the present of Foreign Object Damage (FOD), is the objects that increase the risk level as they are dangerous obstacles against the airplanes and workers movements. (Al-Humaidi & Tan, 2010)
2) In this section, the type of hazard is related to the Kuwait climate that usually provides extreme high temperature degrees and dusty weather.
3) The last two sections are combined together due to the similarity of their hazards types. The first type of hazard is the radiation of the screening machines. These machines allow increase in safety but decrease in health conditions (Xianfeng, & Shengguo, 2012). Fig. 4 shows the level of the risk in terms of the frequency and energy in which X-ray or screening machine waves is in the dangerous zone.

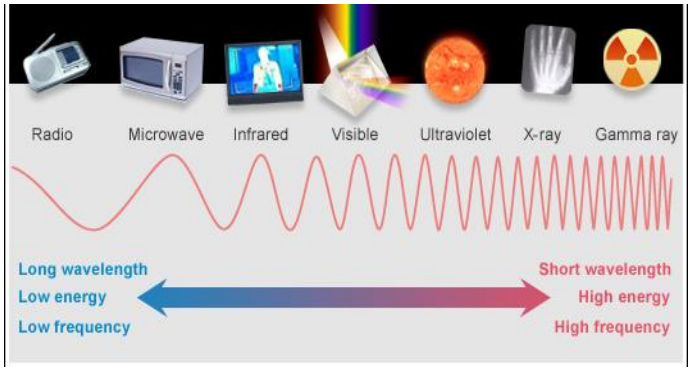


Figure 4: The Electromagnetic Spectrum

The second type of hazard is the ergonomics hazard. This type is related to the weight lifting that is exposure by the KIA workers. Although the movement of passengers stuff is fully automated, but in reality that most of times KIA uses its workers to move the passengers and other needed stuff in order to accelerate its service, help people, and financially benefit from it. Thus, the risk will increase by the repeated weight lifting. (Kirschenbaumab, 2013)

3.2 Measure Phase:

In measure phase, the required baseline of the system's current performance should be drawn. This is a very beneficial step in which we can determine the significant of the problem, especially reflected in loss of money, time, and effort. In this paper, we considered the assessment of hazards from the most risky to the lowest risky hazard. Table 2 shows the hazards with their probabilities and assessments that are organized and explained for later improvements.

Table 2: Summarizes the Hazard Assessments at KIA

Hazard Assessments					
Type of Hazards	**Symptoms**	**Causes**	**Diseases**	**Probability (Risk Matrix)**	**Control**
1. Cleaning Materials Hazard	a. Cough b. Rash c. Nails broken d. Asthma	a. Improper training b. Lack of awareness c. Managers orders to use chemicals for cleaning	a. Respiratory system diseases b. Eyes and skin allergy c. Hardness in breath d. skin burns	High	a. Ventilation b. Regular wash c. Proper training d. Offer PPE
2. Temperature Extremes	a. Collapsing b. Inability to think c. Confusion d. Dizziness e. Vomiting f. Headache	a. Exposure to extremely high temperatures b. Lack of ventilation c. Excessive exposure to coldness	a. Heats strokes b. Heat exhaustion c. Hypothermia d. Mental illnesses	Medium	a. Offering gloves b. Proper AC systems c. Heat systems d. Proper clothing
3. Noise	a. Hypertension b. Unable to hear	a. Engines of the airplane b. Alarms	a. Psychological stress b. Hearing loss	Low	a. Earplugs b. Noise limit exposure
4. Transportation (speed)	a. No symptoms	a. No enough seats and belts b. Supervisor orders to reach quickly c. Assigning planes to wrong gates d. Careless Workers	a. Partial disability due to accidents. B. Total disability c. Mental disorder	High	a. Speed limit signs b. Penalties c. Cameras and radars
5. Musculoskeletal Disorders	a. Back pain b. Body discoloration	a. Fall b. Handling c. Office environment	a. Moving disability	Medium	a. Maximum weight= 30 Kg b. Provide conveyers c. Use robots for handling and automobiles d. Record keeping
6. Infection	a. coughing b. Eyes and skin discoloration c. Vomit	a. Using restrooms b. Breathing polluted air c. Coughing of sick person d. Vomiting e. Cleaning and touching dirty areas	a. AIDS b. Flu c. Tuberculosis d. Cholera e. Hepatitis	Medium	a. Use PPE b. Hygiene c. Regular wash d. Record keeping

3.3 Analyze Phase:

Analyzing the root causes is essential for the system improvements. Thus, the impact of analyzing the hazards on passengers and workers helped us in determining the failures (Dan, 2001). Therefore, we constructed FTA and used risk matrix to analyze hazards and measure their levels. (Naji & HusseinAli, 2017)

FTA is a tool for accidents' investigations (Yi-nan, 2016). Fig. 5 shows the first type of accident, which is burned skin that is caused by the chemical hazard.

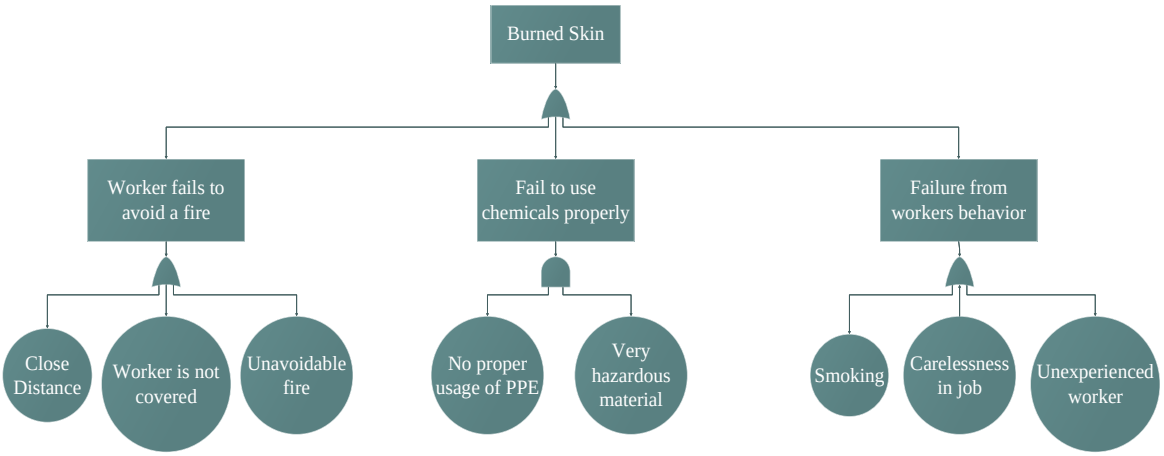


Figure 5: Chemical Hazards FTA

In addition, fig. 6 shows the second type of KIA hazards, which is physical hazard in which it causes aircraft collapse.

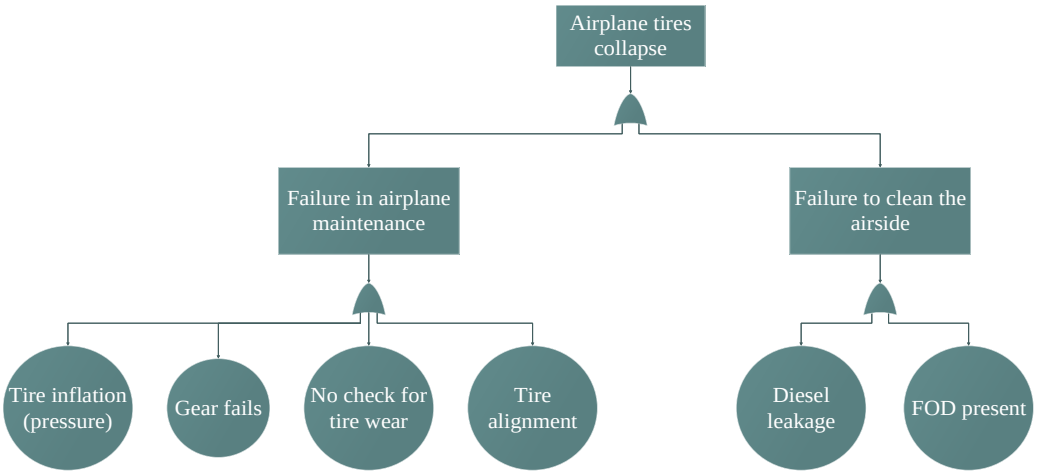


Figure 6: Physical Hazards FTA

Moreover, fig. 7 shows the third KIA hazard type, which is the weather hazard. High temperature in Kuwait causes heat syncope or fainting, especially for female workers.

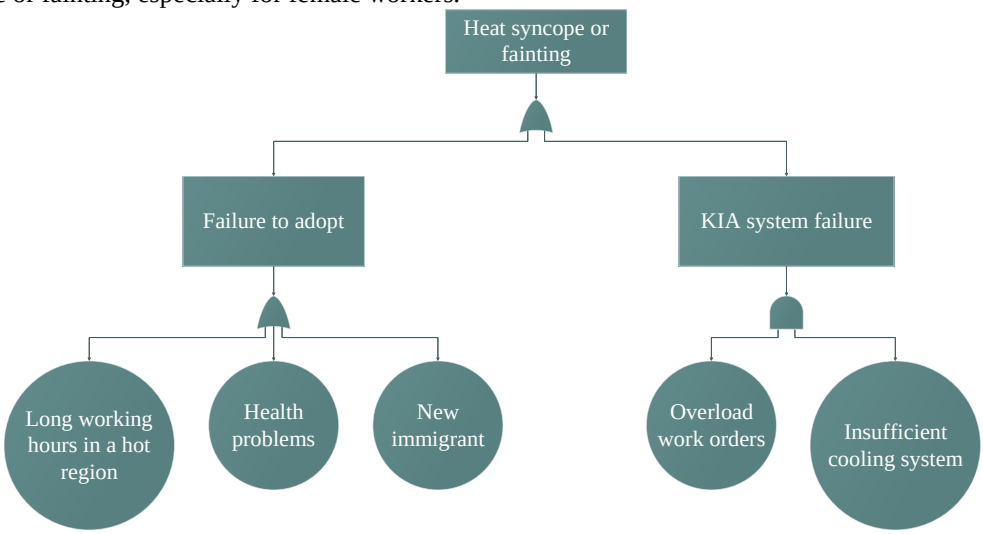


Figure 7: Weather Hazard (High Temperature) FTA

Furthermore, fig. 8 explains the fourth type of hazards, which is the radiation hazard. The effects of these hazards are very dangerous in which they cause health diseases such as cancer.

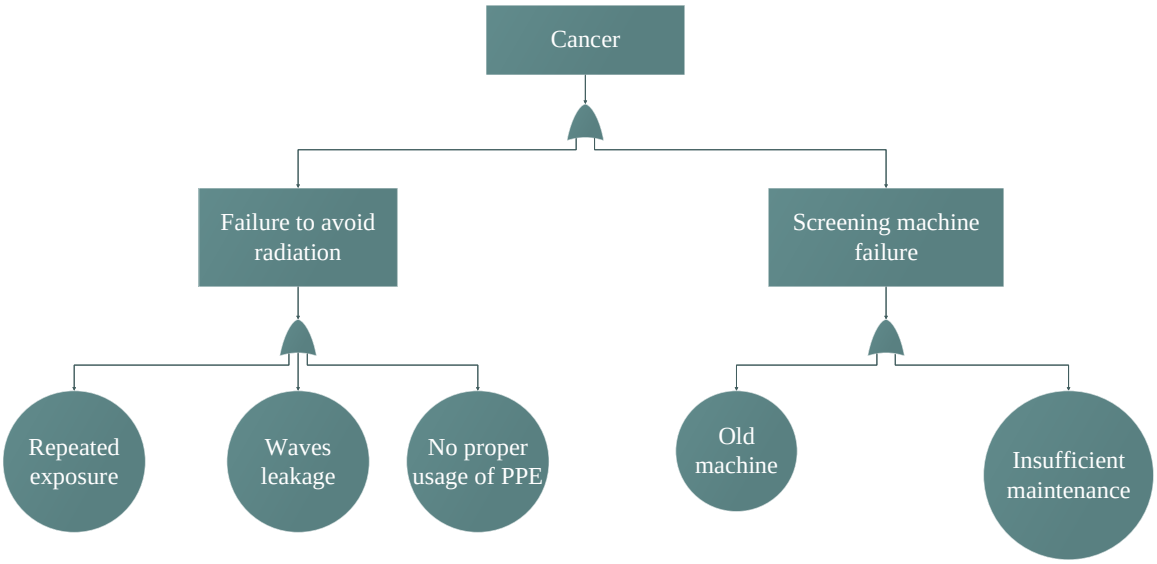


Figure 8: Radiation Hazard FTA

The last and fifth type of hazards is the ergonomics hazard. Fig. 9 shows the main accident of this hazard which is back problems. This type of health problems is very common here in Kuwait, especially for old workers and pregnant women.

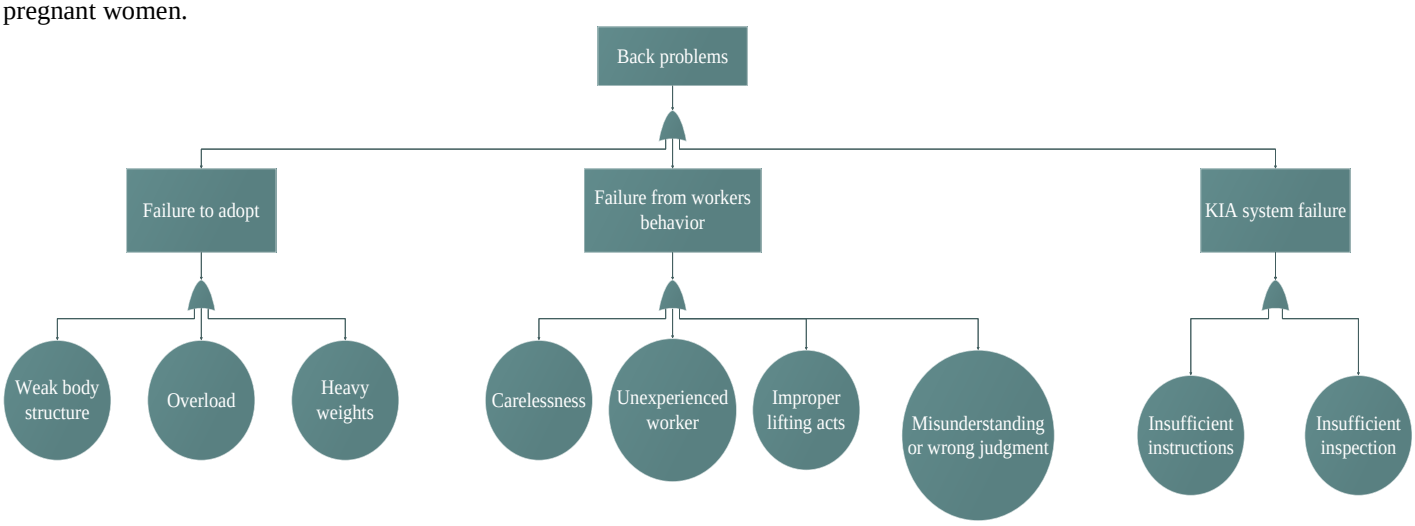


Figure 9: Ergonomics Hazards FTA

After better understanding of the causes and the sub-causes of each problem, we analyzed the risk of each hazard in terms of its severity, probability of occurrence, and level of risk, as shown in fig. 10. Table 3 shows KIA risk levels that help KIA management, employers, and employees to analyze the risk of different hazards and therefore control them.

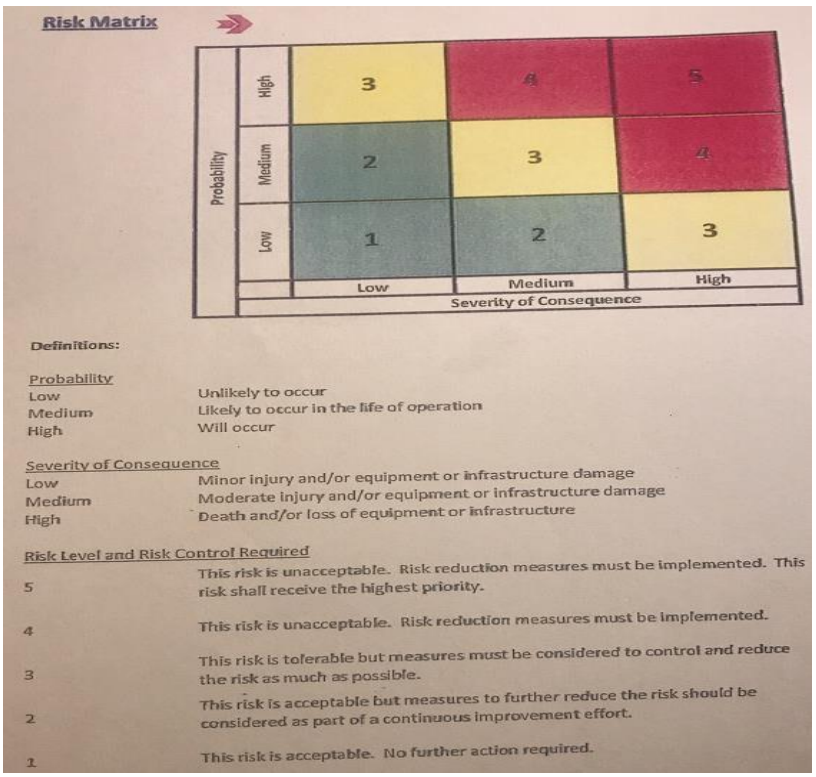


Figure 10: KIA Risk Matrix

Table 3: Accidents Risk Level

Problem	Probability	Severity	Risk level
Burned skin	medium	medium	3
Airplane tires collapse	low	high	3
Heat syncope or fainting	medium	medium	3
Cancer	medium	high	4
Back	high	medium	4

3.4 Improve Phase:

In improve phase, potential solutions could be recommended in order to achieve our main goal of enhancing safety and health level and commitment among workers. Thus, KIA has prevention actions could be taken whenever the worker works inside hazardous environments, as shown in table 4. However, fig. 11 explains the essentiality of reporting hazards and their accidents has an impact on prevention effectiveness. Consequently, the improvements are reflected in the decreasing of hazards exposure and hazardous acts comparing to the baseline of the system performance (Chang, Shao, & Chen, 2015). Thereby, the safety and health service quality are significantly increased.

Table 4: KIA Hazards Prevention Checklist

Room:		**Kuwait International Airport Hazard Prevention Checklist** Department of Civil Aviation		
Building:				
Date:				
Hazard Name	Hazard Prevention Description	Yes	No	Inspection Notes
	Section Name:			
	PPE is provided			
	Automatic controls are used (if possible)			
	Train KIA employees from exposure (if possible)			
	Periodic health check is enforced and reinforced			
	Safety polices are clearly understood and applied while handling with or performing any hazard tasks			
	Workplace cleanness and self-cleanness			

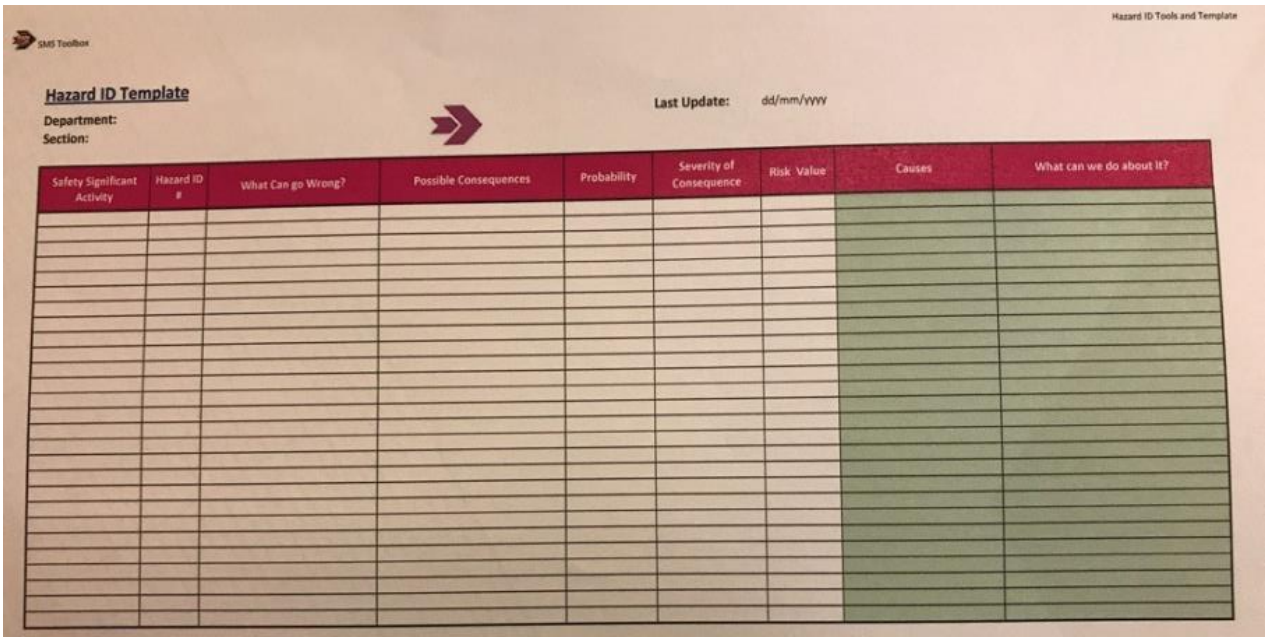


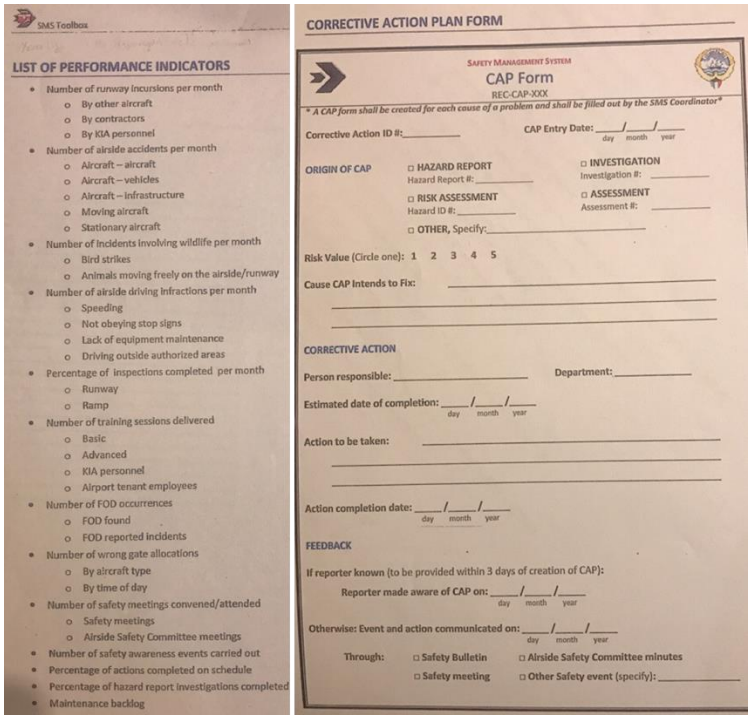
Figure 11: Hazard Reporting Tool

3.5 Control Phase:

In this phase, the improvements should be sustained and developed periodically, if possible. As a result, we recommended an action plan based on several KIA policies and rules. Fig. 12 shows some basic controls as a periodic checklist against KIA hazards. In addition, fig. 13 shows the Corrective Action Plan (CAP) that is used in KIA for supervision and reporting. As a result, KIA is reducing risk levels as much as possible.

Name of individual:		Individual position:		Name of supervisor:		
Responsible Department:		Section being supervised:		Date & time:		
Instruction Number	Instruction				Yes	No
1	Do workers have **legal impact** on the workplace safety and health?					
2	Do employers have authority to **assess the hazards**?					
3	Are **employers and employees trained** very well before they assigned for this type of jobs?					
4	Do employers **provide PPE** to reduce hazards exposure?					
5	Do employers aware of the **hazard type and information** related to the material composition, task height, or weight effects?					
6	Do employers have a **control plan** against hazards exposure?					
7	Are employers aware of **Kuwait weather changes**, ventilation, and protective clothes in both summer and winter?					
8	Are employers aware of the acceptable **level of noise**?					
9	Do employers control **fall hazard**?					
10	Do employers have a control plan on the **transportation method and its condition**?					
11	Does KIA provide **good working environment** inside and outside offices?					
12	Does KIA provide **treatmen**t in the nearest hospital (Farwaniya hospital)?					
13	Do employers **keep recording** the trend of hazards?					
TOTAL:						
Comments:						
Signatures:		Supervisor:		Individual being supervised		

Figure 12: KIA Policies and Rules Checklist for Controlling Hazards



SMS Toolbox

LIST OF PERFORMANCE INDICATORS

- Number of runway incursions per month
  - By other aircraft
  - By contractors
  - By KIA personnel
- Number of airside accidents per month
  - Aircraft – aircraft
  - Aircraft – vehicles
  - Aircraft – infrastructure
  - Moving aircraft
  - Stationary aircraft
- Number of incidents involving wildlife per month
  - Bird strikes
  - Animals moving freely on the airside/runway
- Number of airside driving infractions per month
  - Speeding
  - Not obeying stop signs
  - Lack of equipment maintenance
  - Driving outside authorized areas
- Percentage of inspections completed per month
  - Runway
  - Ramp
- Number of training sessions delivered
  - Basic
  - Advanced
  - KIA personnel
  - Airport tenant employees
- Number of FOD occurrences
  - FOD found
  - FOD reported incidents
- Number of wrong gate allocations
  - By aircraft type
  - By time of day
- Number of safety meetings convened/attended
  - Safety meetings
  - Airside Safety Committee meetings
- Number of safety awareness events carried out
- Percentage of actions completed on schedule
- Percentage of hazard report investigations completed
- Maintenance backlog

CORRECTIVE ACTION PLAN FORM

SAFETY MANAGEMENT SYSTEM

CAP Form

REC-CAP-XXX

** A CAP form shall be created for each cause of a problem and shall be filled out by the SMS Coordinator**

Corrective Action ID #:_____ CAP Entry Date: ____/____/____ (day month year)

ORIGIN OF CAP
- □ HAZARD REPORT — Hazard Report #: _____
- □ RISK ASSESSMENT — Hazard ID #: _____
- □ OTHER, Specify: _____
- □ INVESTIGATION — Investigation #: _____
- □ ASSESSMENT — Assessment #: _____

Risk Value (Circle one): 1 2 3 4 5

Cause CAP Intends to Fix: _____

CORRECTIVE ACTION

Person responsible: _____ Department: _____

Estimated date of completion: ____/____/____ (day month year)

Action to be taken: _____

Action completion date: ____/____/____ (day month year)

FEEDBACK

If reporter known (to be provided within 3 days of creation of CAP):

Reporter made aware of CAP on: ____/____/____ (day month year)

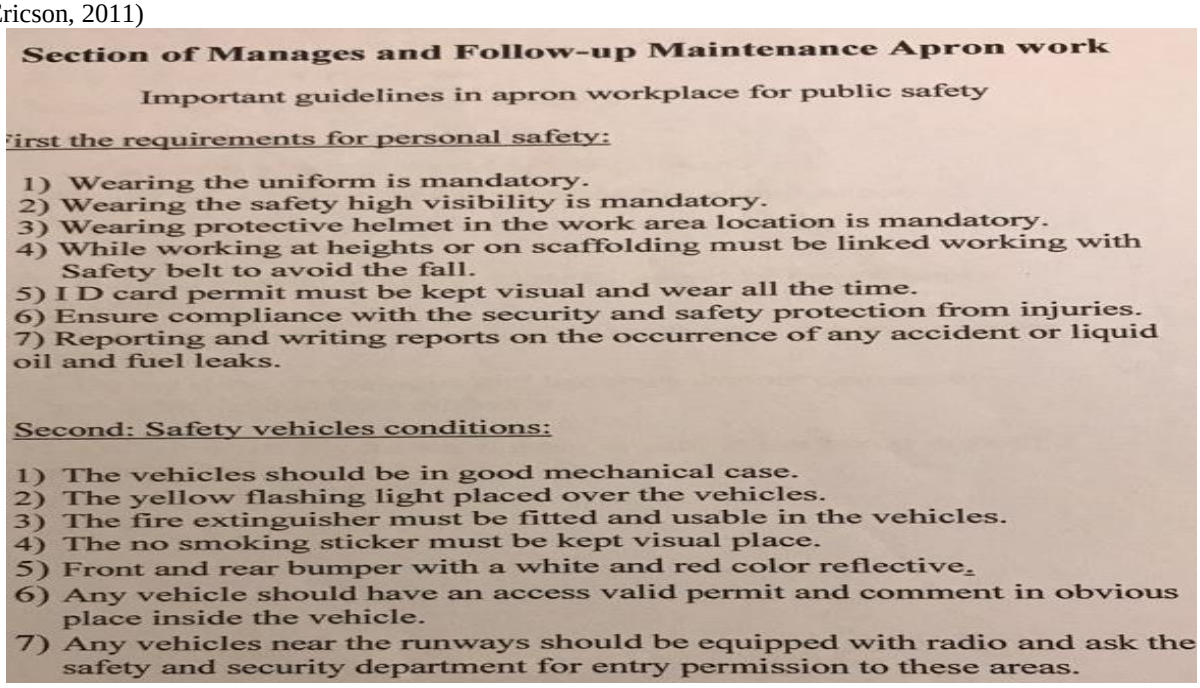
Otherwise: Event and action communicated on: ____/____/____ (day month year)

Through: □ Safety Bulletin □ Airside Safety Committee minutes □ Safety meeting □ Other Safety event (specify): _____

Figure 13: CAP used for Hazards Reporting and Supervision

4. Results and Discussions

The DMAIC process illustrated the sequence of defining the problem, finding the causes, planning for a correction plan, applying this plan and ensuring that the corrections are perfectly done at the end. As mentioned above in the methodology, we have reached improvements for each hazard at KIA. Polices were set to eliminate the problems and improve safety at the place (Rick & Wright, 2013). The results were successfully completed and each department at KIA was given a certain procedures to reduce the hazards probability. Fig. 14 shows the management part for how to control safety for people who are working inside the airport as well as workers who drives vehicles. (Ericson, 2011)



Section of Manages and Follow-up Maintenance Apron work

Important guidelines in apron workplace for public safety

First the requirements for personal safety:

1) Wearing the uniform is mandatory.
2) Wearing the safety high visibility is mandatory.
3) Wearing protective helmet in the work area location is mandatory.
4) While working at heights or on scaffolding must be linked working with Safety belt to avoid the fall.
5) I D card permit must be kept visual and wear all the time.
6) Ensure compliance with the security and safety protection from injuries.
7) Reporting and writing reports on the occurrence of any accident or liquid oil and fuel leaks.

Second: Safety vehicles conditions:

1) The vehicles should be in good mechanical case.
2) The yellow flashing light placed over the vehicles.
3) The fire extinguisher must be fitted and usable in the vehicles.
4) The no smoking sticker must be kept visual place.
5) Front and rear bumper with a white and red color reflective.
6) Any vehicle should have an access valid permit and comment in obvious place inside the vehicle.
7) Any vehicles near the runways should be equipped with radio and ask the safety and security department for entry permission to these areas.

Figure 14: Management Section for Personal and Vehicles Safety

5. Conclusion

To sum up, in this paper a real life problem was studied by using methods and materials related to safety course. Many work places often suffer from lack of safety requirements which would cause hazards and would sometimes lead to series health problems or even death (Charles, 2003). KIA is one of the important facilities in Kuwait where not only local people work in it but it is also visited by global people from all around the world. Therefore, KIA needs to insure a safer environment which guarantees a better working place. This paper showed different hazard types that happen at KIA. It also described the main causes of these hazards. At the end, a methodology was constructed to show the steps of finding the problems and how they were eliminated and controlled. A fault tree analysis technique was applied. The results showed that SMS application guaranteed a better and safer environment to work at. (Liou, Yen, Tzeng, 2008)

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Biographies

Alaa Alshammari is an industrial engineer graduated from the American University of the Middle East, Eqaila, Kuwait. She was an honor student along all academic years. Ms. Alaa had a senior project in "Quality Improvements in Plastic Injection Molding Using Six Sigma" that was categorized as the best senior project for the academic year 2016-2017. She did another qualified six sigma project in a service sector. Ms. Alaa achieved certificates in many fields such as Robotics club, financial management training, site engineer training, and many more. Furthermore, she has completed many projects such as dual axis solar tracker, distances optimization, analyzing safety issues in Kuwait International Airport, analyzing power plant system, simulating and analyzing a real application, forecasting a local company production, analyzing a local facility layout and location, analyzing economically a production of a local company, and many more. Besides, Ms. Alaa has other interests such as chemistry.

Nadine Awadah was born in Kuwait, in 1994. She received her Bachelor degree in Industrial Engineering from the American University of the Middle East, Eqaila, Kuwait, in 2018. She had continuous AUM honor scholarship 2014-2018. She won the 1st place for the Best Capstone Project in Industrial Engineering Competition- 2018. She joined as an official candidate for AUM's elections-2016. She won the 3rd place in International Day Expo Competition at AUM-2017. Her main interest areas are researching in topics related to renewable energy resources, optimization, and safety. She had worked with many softwares during her undergraduate study period such as Minitab, MATLAB, SCILAB, AutoCAD, Arena, Jack, Visual Studio, and MS office programs. She was a participant for AUM Academic Activities Day, 2014-2018. She won the 2nd place for both Calculus 2 and CS-programming Competitions.

Sahar Redha is a fresh graduated from the America University of the Middle East, Eqaila, Kuwait (May 2017). Attended AutoCAD 2D professional course (23 hours course) .Applied Quality improvement project 'Lean Six Sigma' approved by Farwania Hospital. Certified for Best Graduation Project of the quality improvement in plastic injection molding industry using six sigma approved by host company. Additionally, she applied safety principles and guidelines in a project of Applying Safety Management System (SMS) in Kuwait International Airport (KIA). Ms. Sahar worked as front office in Jumira Hotel. Also, she had a career experience in customer service in Early Bird restaurant.

Zahraa Kamal is a senior industrial engineering student in American University of the Middle East, Eqaila, Kuwait. She had a High School Diploma (science section); she graduated from Al-Sharqiya High School, Kuwait. Zahraa had a senior project in Quality Improvements in Plastic Injection Molding Using Six Sigma that was categorized as the best senior graduation project for the academic year (2016-2017). She did another qualified lean six sigma project in a service in Al-Farwaniya Hospital, Kuwait. She achieved certificates in AutoCAD 2D Professional Training program (23 hours course). She completed a project of Thermal Analysis of a Steam Power Plant using cyclepad software. She had a project of Improving Emergency Department Services in Al-Addan Hospital Using Simulation, and she had an academic activity of Weightlifting competition by using JACK. Besides, Ms. Zahraa had a career experience of customer service in a kindergarten as a receptionist.