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Safety Management System of Construction Activities in AUE Infrastructure Project

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Abstract - Accidents are a major public health concern, resulting in an estimated 1.2 million deaths and 50 million injuries worldwide each year. UAE in particular experiences a high rate of such accidents. Research on road safety has been conducted for several years, yet many issues still remain undisclosed and unsolved. Specifically, the relationships between drivers' characteristics and road accidents are not fully understood. In this work, we started by collecting a dataset between 2011 and 2013 for construction sites. The accident occurs in the period of 2011 to 2013 cause more equipment damage in the construction site or in store/workshop. The comparison data from 2011 to 2013 shows that the incident rate decrease from 80% to 10 % due to the proper monitory from the higher authorities of the concern department in UAE.

Keywords: Accident, Health, Safety, Construction sites, workshop.

I. INTRODUCTION

Construction work covers many activities, techniques, materials and hazards and it is this diversity that increases the probability of accidents' occurring. In fact, the construction industry has the most dismal record of safety among all industrial segments [1, 2] with a risk of fatality that is 5 times higher than in any other industry [3]. The higher rate of accidents and fatalities in the construction industry could be due to the nature of the work. Nonetheless, factors such as poor planning, inadequate safety training, lack of supervision, lack of safety incentives, and insufficient incident investigation are likely to amplify the problem [4]. Health and safety is relevant to all branches of industry. It is particularly important for the construction industry which is among the most exposed sectors when it comes to occupational accidents. In spite of the high costs of work accidents, many construction companies adopt as their only health and safety management strategy the compliance with mandatory regulations. However only being in compliance with these regulations might not be sufficient to guarantee excellence in health and safety performance as they cover only minimal preventive measures. Based on occurred accidents, the technical weaknesses of the designs were reduced by adding new requirements [5]. But after that it became apparent that many accidents still occurred and that the root causes of these accidents were hardly the result of technical failures but much more the consequence of inadequate organizational issues. It was evident that these efforts are not sufficient truly to curb the occurrence of unsafe acts on construction sites [6].

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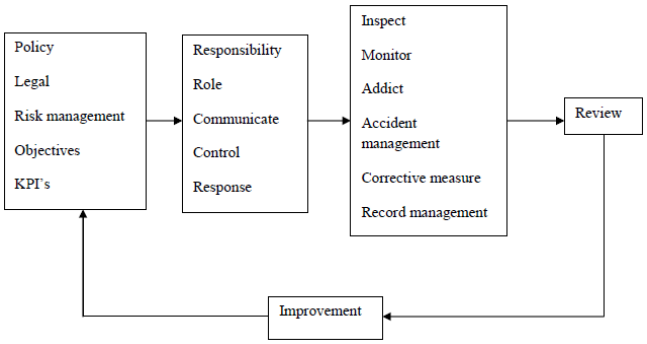
The rapid development of projects employing large numbers of expatriates has often outstripped the ability of education, health and labor ministries to train and deploy adequate numbers of industrial hygienists and safety inspectors to protect workers' health and safety [7].

The Abu Dhabi Emirate EHSMS

In 2009, the ECAD issued Decree 42 to follow up the development and implementation of the Emirate EHSMS framework across all sectors. The decree commissioned the Department of Municipal Affairs (DMA) as the regulatory authority of the B&C Sector. In 2010, the Abu Dhabi EHS Center was established for the purpose of overseeing and monitoring the implementation of the Emirate EHSMS as well as managing occupational health and safety issues. The EHS Center also aims to ensure integration of requirements across sectors and to build capacities in the EHS field within the Emirate [10, 11].



In January 2010, a 3-year project was commenced to develop and implement the EHSMS for the B&C Sector. The project includes establishment of the EHS Department, staff recruitment, and staff personal development and training. The EHS Department is responsible for the approval of entity-developed EHSMS, site inspection and accident investigation [12, 13]. Other components of the project include marketing, establishment of rewards scheme, identification of income streams, and accreditation of its own department.

The Abu Dhabi Emirate EHSMS framework calls for self-regulation, which allows entities to tailor their system to fulfill their specific needs. However, there are some key features that all entity systems share including: (1) development of an EHS policy that reflects management commitment, (2) development of plans to minimize risk to EHS, (3) implementing the EHS plans, (4) monitoring outcomes of implementation activities to check effectiveness of plans, (5) undertaking audits to identify areas of non-compliance and improvement, and (6) reporting outcomes, achievements and areas of improvement [14-17].

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Safety Status in the Construction Industry

The B&C sector is a key source of the Emirate employment. The sector employs the largest proportion (19.9%) of the employed population in the Emirate [18]. Nonetheless, several challenges face construction-related safety issues in the Emirate, including: (1) culture diversity and language barriers of workers, (2) workers illiteracy or low educational level, (3) turnover of immigrant workforce, (4) inadequate awareness, (5) insufficient capacity for provision of occupational safety, and (6) existence of multiple partners with inadequate coordination. Also, there is a lack of an official reporting system and inadequate statistical data on accidents in the construction business in the Emirate. In this regard, records on injuries and fatalities of construction workers in the country are not comprehensive [19-21].

Key Drivers for Success

For a successful safety management system (SMS) in Abu Dhabi Emirate, the system should demonstrate leadership and management responsibilities and provide the tools to implement safety policy. Meanwhile, significant changes in cultural norms and accountability are required among employers and employees. In that sense, safety considerations in project design and delivery should be given a priority, and should not be looked at as a burden. Also, construction accidents should be considered preventable and therefore unacceptable, rather than unavoidable consequences. Several previous studies have been conducted to identify the important factors that affect safety on construction sites [22- 24]. While there are some similarities in what controls construction safety in different countries, there are some factors that could be specific or more important than others in certain countries or for certain projects. As such, many challenges are envisioned in the implementation of the SMS in the B&C Sector in the Abu Dhabi Emirate. The most critical factors for the success of the system and for the enhancement of safety culture in the B&C Sector are outlined below. The sequence in which these factors are listed does not imply their importance as all are probably essential to various degrees for success [26, 27].

Table 1 shows the accidental report from 2003 to 2005 in UAE.

Incident Type	UAE (McGrath, 2009) [8]	UAE* (Barss et al., 2009) [10]	Kuwait (Al-Humaidi and Tan, 2010) [2]	Kuwait (Kartam and Bouz, 1998) [6]	USA (ENR, 2001) [11]
Falling objects	8.3	15.0	25.0	10.2	
Run over	8.7				21.1
Powered machinery	5.7	11.0	18.0		9.9
Collapse of structure				8.5	5.0
Slipping and tripping	7.5				
Lifting or carrying	3.0			8.7	5.4
Cutter puncture	7.8			7.3	

* Includes all occupational health cases reported at Al Ain City Hospital from March 2003 to April 2005

Method

Using the appropriate variables, occupational injuries, defined as injury during work-related activity, were selected. The data file was reduced by restricting fields to prevention-oriented variables including external causes and type of incident; personal factors of age, sex, nationality and marital status; time of day; occupation and place of injury where available; nature of injury including anatomical location and severity score, and hospitalization duration [28]. Data on the industries in which injuries occurred and on any safety measures employed were not available, nor could traffic injuries during work be reliably distinguished from other occupational injuries.

The number of injuries by injury severity score (ISS) region was calculated for each main external cause. Category six, superficial injury (external in ISS), was excluded. As another indicator of severity for falls, the number of spinal injuries was assessed together with calcareous fractures of the body [29].

Results and discussion

Accident deaths plummeted 25.5 % in the UAE, and 19% in Abu Dhabi, by the end of 2011 (as shown in table 2) compared to 2009, in a remarkable achievement which reflects the great efforts exerted by the concerned authorities, most prominently the Traffic Departments across the country. Our research report, the accidents in construction office in the past three years became the focus of attention for researchers as well as decision-makers in different countries owing to the heavy causalities in life and properties annually [30-35]. Accidents in construction factories are now one of the most important areas of research and analysis for economists who are measuring and assessing direct and indirect socioeconomic cost of accidents. According to the social and psychological impacts of accidents in factories or in industries are difficult to calculate the social cost, the report recommended that all possible efforts must be exerted to curb such accidents, and thus ward off and avoid related negative impacts, stressing that this requires more profound studies to be conducted based on analyzing different long periods in a manner that enables researchers to develop indicators in accordance with scientific research criteria [36].

Table 2: Shows that the incident occurs to UAE construction office from 2011 to 2013

Date	Incident description	Location	ADEHSMS Classification	Incident case	Category	Route cause
10/03/2011	While Reversing hit to other vehicle	Office	Equipment / Property Damage	Not paying attention while reversing	Traffic	Not following safe driving procedure
10/31/2011	Oil spill near Excavator	Site area	Environmental spill	No drip tray	Plant and Equipment	Failure to provide drip tray
11/14/2011	Pickup hit Safety cone while reversing	Office	Near Miss	Not looking back when reversing	Traffic	Negligence of the employee
12/3/2011	Oil spill near Generator	office	Environmental spill	No drip tray provided	Plant and Equipment	Failure to provide drip tray
12/5/2011	Minor dent on parking roof pole	Office	Equipment /Property Damage	Not paying attention while driving	Traffic	Negligence of the employee

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12/8/2011	Crane tilted to the side while being loaded	Near office	Equipment /Property Damage	Ignoring Supervisor Instructions	Lifting Operation	Not following Safe loading Procedure
12/8/2011	Crane tilted to the side while being loaded	Near office	Environmental spill	Ignoring Supervisor Instructions	Lifting Operation	Not following Safe loading Procedure
2/2/2012	Unauthorized car overturned at site	Site area	Equipment /Property Damage	Watchman allowed unauthorized vehicle in site	Traffic	Not following gate control procedure
2/2/2012	While loading blocks Injury to left index finger	Site area	First Aid	Not wearing hand gloves	Manual Handling	Failure to comply with Personal Protective Equipment
2/8/2012	Wood piece penetrated to right pointer finger	Site yard	First Aid	Not wearing hand gloves	Housekeeping	Risk taking attitude
2/29/2012	Truck stuck in sand	Site area	Near Miss	Not driving on designated access routes	Traffic	Risk taking attitude of the driver
3/18/2012	Tripper truck hydraulic oil leak	Site area	Environmental spill	Frequent Maintenance of accesses	NA	Lack of inspection
3/18/2012	Two employees fight at site area	Site area	First Aid	Horse play / Indiscipline	NA	Failure to comply with company procedure
4/5/2012	Vehicle hit the safety pole in parking lot	Office	Equipment /Property Damage	Not paying attention while parking	Na	Negligence of the employee
4/8/2012	Wheel loader came in contact with pickup	Office	Equipment /Property Damage	No safe distance maintained by pickup, and no flagman	NA	No flagman provided by foreman
5/2/2012	Tele Handler Stuck in sand	site area (ARB)	Near Miss	Driving on uncompacted area	NA	Negligence of the operator
5/2/2012	Truck stuck over foot path	office	Near Miss	Careless Driving	NA	Negligence of the employee
7/9/2012	Employee fell unconsious at site due to Hyper tension	office	Medical Treatment Case	Not taking prescribed medication	NA	Not following safe working procedure
2/26/2013	Manhandling between two employees	Office	Medical Treatment Case	One labor punched the other on his face hitting his nose	NA	Failure to comply with the project EHS rules

The most accident cases are in construction places are due to the negligence of the employee while deriving or not following the safe working procedure and sometimes the failure to comply the EHS rules. In most of the cases we observed that the in heavy load vehicle hit the due to negligence while turning or over taking others vehicles, few cases we notice that heavy vehicles tilt because of uneven field as well as some employee fell unconscious at hyper tension and taking the proper medical treatments [37]. The manhandling is another on off the major issue in construction work as more illiterates work in the construction field. The major incident occurs at the construction site area and in the office of around 47.4 % and 36.5 % respectively from 2011 to 2013 and in all the cases major equipments damaged and minor to the labors. A very few issues were occurs near the office and site yard of about 5 to 10 % (as shown in the figure 1) but found that more than 70% of the victims of construction accidents in UAE sustain permanent disabilities [38]. Figure 2 and 3 shows that the accident occurs from 2011 to 2013in UAE. On average there are major incident observed in the year of 2011 and 2012 of 57.3% and 36.8% respectively in construction office and the percentage of incident cut down to 5.26 % in the year 2013 indicates that the UAE authorities implicated that the EHS rules for making better safety and monitoring systems.

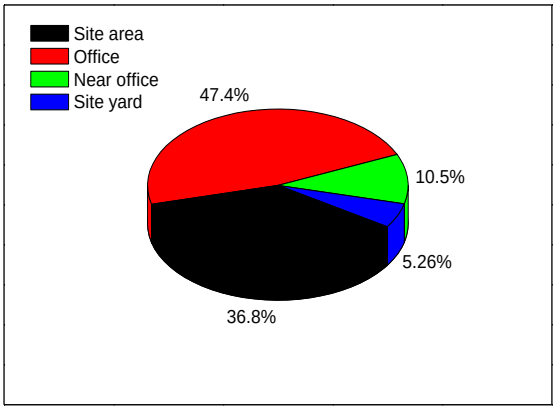

Figure 1 shows the Pie plot of % of incidents occurs at UAE construction office during 2011 to 2013

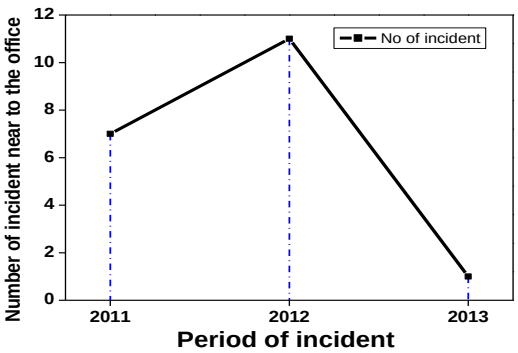

Figure 2 shows the incidents occurs at UAE construction office during 2011 to 2013

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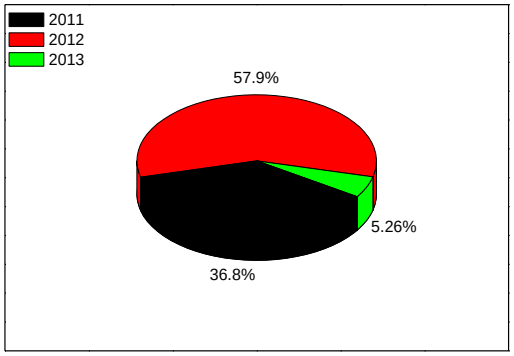

Figure 3 shows the Pie plot of ration of incidents occurs at UAE construction office during 2011 to 2013

The important factor in eliminating unsafe conditions is doing so before an accident occurs. Near-miss occurrences need to be investigated and corrected as they are a warning of a condition that may eventually lead to an accident as details is given in table 3. A near-miss occurrence is an incident resulting in neither an injury nor property damage. However, a near-miss occurrence has the potential to inflict injury or property damage if its cause is not corrected. Too often an unsafe condition is allowed to exist simply because it has not caused an accident yet.

Table 3: shows the accident occurs on workshop, damping area and store in UAE.

Date	Incident description	Location	ADEHSMS Classification	Incident case	Category	Route cause
1/26/2012	PVC pipe slip while loading Pipe	store 2	Near Miss	Used one sling for unloading / Training	Lifting Operation	Unsafe slinging
1/31/2012	Foreman tripped and injured his ear	store 2	First Aid	Poor housekeeping	House keeping	Lack of attention while walking
2/13/2012	Edge of Trench collapsing under Excavator	Ph1 ARB	Near Miss	Working close to edge of trench	Excavation	Risk taking attitude of operator
2/23/2012	Trapped the finger between rebar and machine	Store area 2	First Aid	Operator Not Authorized	Rebar	Risk taking attitude of the employee
3/17/2012	Truck stuck in sand	Dumping area	Near Miss	Driving on uncompacted area	Traffic	Risk taking attitude of the driver
4/7/2012	Damaged Fibre optic cable	Ph 1	Equipment /Property Damage	No cable detector used	NA	Failure to comply with the Method statement
4/8/2012	Truck stuck in sand	Ph2 ARM Rd	Near Miss	Driving on uncompacted area	NA	Access road not compacted properly
5/8/2012	Vehicle stuck in the sand	Ph1 ARC Rd	Near Miss	Driving on uncompacted area		Access road not compacted properly
5/5/2012	Concrete dumped on the ground	ARC Rd	Environmental spill	Washing the mixer in undesignated area		Driver failed to comply the environment rules
5/8/2012	Vehicle stuck in the sand	Ph1 ARC Rd	Near Miss	Driving on uncompacted area		Access road not compacted properly
5/8/2012	Leakage from sewerage pipe	Workshop 2	Environmental spill	Worker / vehicle movement on top		Area was not marked properly
5/9/2012	Damaged Fibre optic cable	Ph 3	Equipment / Property Damage	Cable laid in the wrong location		Failure to comply with the Method statement
5/20/2012	Oil spill under the shovel	Ph 2	Environmental spill	Mechanical Failure		Not providing waste collection bin before starting maintenance
5/27/2012	Truck stuck in sand	Ph 2	Near Miss	Driving on uncompacted area		Negligence of the employee
5/30/2012	Hydraulic leak on ground	Workshop 1	Environmental spill	Not providing spill containment while being maintained		Negligence of the employee
6/17/2012	Diesel Leak on ground	Workshop 1	Environmental spill	Operator not paying attention while filling the Diesel tank		Negligence of the employee
7/11/2012	Heat Exhaustion	Ph 1	Medical Treatment Case	Not drinking enough water		Lack of self care while working at hot weather conditions
7/26/2012	Person Fall in deep excavation	Ph 2	Reportable Serious Injury	misjudgment from operator	Spine	Operator-Not following excavation method statement
8/1/2012	Pickup hit another vehicle	Ph 3	Equipment /Property Damage	Attempting to stop the other vehicle		Negligence of the employee
8/4/2012	Applying the brakes and sudden stop of the pickup	Ph 1	Near Miss	Another vehicle was coming from other direction		Not following safe driving procedure
8/5/2012	Flagman narrowlly being hit by grader	Ph 1	Near Miss	Reversed without looking in his rear view mirror		Negligence of the employee

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8/6/2012	Exhaust fan caught on fire	Store area 2	Fire	Electrical Shortage / Weather		No regular inspection conducted by electrical team
8/28/2012	Loose Hook for crane while driving	Ph 2	Near Miss	Loose hook might hit the body of the crane		Negligence of the employee
8/29/2012	Shutter hit shoulder of labor while being lifted	Store area 2	First Aid	Improper rigging		Risk taking attitude of the employee
9/10/2012	Concrete mixer hit car	Ph 2	Equipment / Property Damage	Narrow access / Training		Negligence of the employee
9/22/2012	Oil spill found behind the shed	Work Shop 2	Environmental spill	Dumping of used oil filters in collection barrels		Pump not provided
9/23/2012	Pickup hit another pickup	Store 1	Equipment / Property Damage	Reversed without looking back		Negligence of the employee
10/2/2012	Revolving light plastic base melted causing damage to shovel roof.	Store 2	Equipment /Property Damage	Overheating of revolving light		Original bulb replaced with halogen-source of heat
10/13/2012	Six Axle tipper truck overturned while unloading aggregate	Store 1	Equipment/Property Damage	Uneven ground		Ground to be leveled on regular basis
10/14/2012	Pajero (11386) hit parked Boom Truck (59156)	Ph 3	Equipment /Property Damage	Not paying attention while driving		Negligence of the employee
10/18/2012	Spill near toilet	Ph 2	Environmental spill	Overflow of septic Tank		Failure to regular clean up of Septic tank
10/18/2012	Mobile Crane hit Hiab while reversing	Ph 2	Equipment /Property Damage	Not paying attention while driving, not flagman		Failure to provide flagman
10/21/2012	Spill near toilet	CSC Store 2	Environmental spill	Overflow of septic Tank		Failure to regular clean up of Septic tank
10/23/2012	Shovel hit water tanker while reversing	Area 2 Q rd	Equipment /Property Damage	Not paying attention while driving, not flagman		Failure to provide flagman
11/18/2012	Labor fell from top of manhole to ground	Ph 3	Near Miss	Using excavator for transport of manhole without flagman		Not following safe lifting procedure
11/21/2012	Pickup overturning	Ph 4	Equipment /Property Damage	Over speeding		Negligence of the employee
12/3/2012	Boom Truck hit JCB from behind while overtaking	Ph 3	Equipment /Property Damage	Overtaking		Not following safe driving procedure
12/9/2012	Shovel trapped its wheel in the loose soil close to the excavation edge	Ph 1	Near Miss	Access road not compacted		No regular maintenance to the access road
12/10/2012	Pickup front tire stuck in the shallow trench	Ph 1	Near Miss	Driving too close to the edge		Negligence of the employee
12/12/2012	Sewerage leaking from underground tank	Ph 2	Environmental spill	Tank damaged during installation		No inspection done after installation
12/31/2012	Pickup was hit by a trailer at al faya rd junction with Shamkha Project	Outside	Journey Incident	Attempting to turn left from project exit on the highway		Employee failure to ensure the road is clear prior to enter the main road
2/2/2013	Hiab hit the gate while exiting	Store 2	Equipment / Property Damage	Security not manning the gate		Negligence of the employee
2/10/2013	Septic tank overflew	Store 1	Environmental spill	No regular monitoring for septic tank level		Not following waste management Procedure
2/14/2013	Engineer Fell on his back while walking at site	Ph 3	Medical Treatment Case	Uneven ground		Negligence of the employee
2/16/2013	JCB carrying GRP pipe hit pickup	E RN	Equipment /Property Damage	Improper lifting technique		Lack of competent supervision
2/21/2013	Recovery van exiting project to al faya road was hit by another crossing vehicle	Al Fayah Rd	Equipment /Property Damage	Weather Condition (fog)		Not following safe driving procedure in Fog weather conditions

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2/23/2013	Manhandling between two employees	3 tent area	Medical Treatment Case	One labor hit the other on his private parts		Failure to comply with the project EHS rules
2/24/2013	Trailer hitting the gate while exiting	North gate	Equipment /Property Damage	Driving too close to the edge of road		Negligence of the employee
2/26/2013	Manhandling between two employees	Office	Medical Treatment Case	One labor punched the other on his face hitting his nose		Failure to comply with the project EHS rules
2/27/2013	Separation of Round table from base for 7 ton crane mounted on self loading truck rented from blue line.	Ph 3	Reportable Serious Injury	Mechanical Failure of crane base		Failure to provide regular maintenance to the crane

Regardless of the degree of safety built into a job, unsafe actions on the part of employees will always be a cause of injuries. Teaching employees safe work habits means showing them how to do their tasks with less risk to themselves and less damage to equipment. Much of this instruction can be boiled down to a few simple principles or job rules.

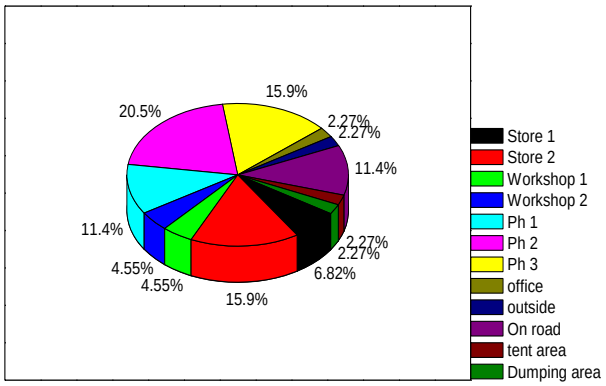

Figure 4 shows the Pei structure of accident in workshop, stores, dumping areas of UAE

By concentrating on these safe habits, by showing "why" as well as the "how" of safety and by constantly supervising employees' safe work habits, they will become the accepted method for the employee to perform tasks. Actual demonstrations of the right way of doing tasks should be conducted, accompanied by the basis for preferring one work habit to another. Equally important as this initial instruction, is the review of subsequent performance. When the right way has been presented and agreed to by the individual worker, it is essential that failure to comply be corrected [39].

Flagrant or repeated disregard of safety rules should be met with appropriate disciplinary action. No matter how skillful an employee may be in performing their duties, if the employee does not perform them safely, that employee is placing themselves and others at risk. The major accident occurs in workshop, phases (I, II, II), store of 22.5 %, 19.9 and 11.4% respectively as shown in figure 4. It is observed that this accidents mainly because negligence deriving the heavy vehicle, a poor housekeeping Poor housekeeping due to the lack of conscious while walking, unauthorized operators deriving in compact area. The driving on uncompacted area and washing the mixer in undesignated area causes minor incidents. Sometimes a mechanical failure causes due to the risk taking factor of materials.

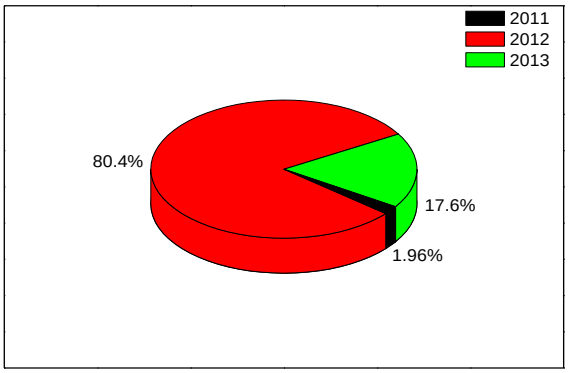

Figure 5 shows percentage of accident occurs from 2011 to 2013 in UAE

Figure 5 and 6 indicates the decrease in the accident ratio as a function of time period. It is notice that the accident ratio is 17.6 % in 2011 at UAE and it is increased to 80.4 % of the incidents due to the failure in the mechanic or carless derive on rood or working in the field. It is interesting to note that the incident cases are suddenly dropped in to 1.96 %, is very negligible and these due to the improving in safety and used for improving the quality of construction system.

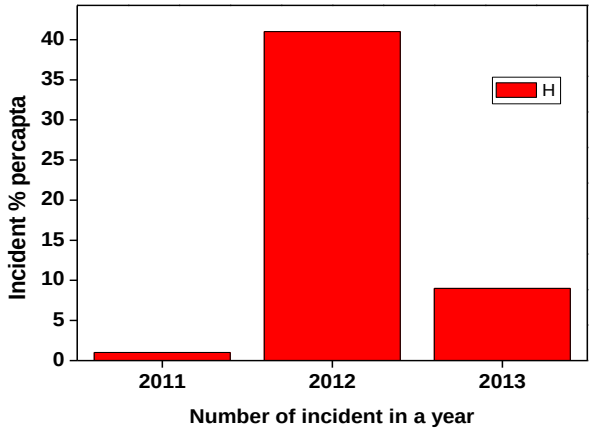

Figure 6 shows the incidents occurs at UAE in store, workshop and various phases during 2011 to 2013

II. CONCLUSION

Implementation of a safety management system in the construction Sector in the UAE is of great importance given the anticipated enormous economic and infrastructural expansion, together with the predominance of vulnerable migrant workers from low income countries.

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Based on a thorough review of pervious work related to construction safety and the existing conditions in the Emirate, we identified the challenges that could be encountered in system implementation. The key drivers for success of the system in the Emirate fall into six major categories, including organization, stakeholders' involvement, technical, financial, procedural, and external. The different factors within each category were explored. Overall, a successful safety management system in the construction Sector in the Emirate should outline leadership and management responsibilities and provide the tools necessary to implement the Emirate safety policy.

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