ISSN(Online) :2319-8753
ISSN (Print) : 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2015

Evaluation of the Relationship between Occupational Accidents and Usage of Personal Protective Equipment in an Auto Making Unit

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ABSTRACT: One of the problems thatencountereach work society is occupational accidents. Today, despite the improvements of facilities and working conditions, the possibility of accident occurrence in workplaces andespecially in industrial places is inevitable. Since the non-use or misuse of PPE is one of the main causes of accidents in industrial units, the aim of this study is to evaluate the association between occupational accidents and the use of PPE in the body section of a vehicle manufacturing unit. In order to do this descriptive – analytical study, after the general review of the unit, works of the workerswere divided in three categories: work at height, hot work and work with chemicals, and then 60 person are picked from 200 workers of the morning shift randomly, then a checklist ofPPE was provided and they were asked some questions in this regard. Also two factors of safety equipment and training system were asked about. After getting the results, descriptive statistical methods were usedto classify answers and drawtables and inferential statistics (Pearson correlation coefficient) were used to evaluate the hypothesis. The results showed that there is a meaningful positive relationship betweenthe factor ofinadequate PPE and probable hazards of the industrial workplace. Also among the five factors, standard factor has been the cause of the most damages. While improvements of the quality of working life will be very effective in reducing occupationalinjuries.

KEYWORDS: Accidents, occupational accidents, personal protective equipment (PPE)

I. INTRODUCTION

Whenever we speak about industry and industrial programming, people's consideration usually switches to the final product and its characteristics and quality always are evaluated more than the manpower for its production. While the manpower is the basic pillar of industrial purposeful system and country's production depends too much on using expert and efficient manpower. But doing each work entails accepting its probable accidents. In the past accidents were just limited to fall from a tree or height, to be wounded by wild or domestic animals, poisoning by plants or animal's poison, and something like this, but today due to the considerable progress in industrial matters, using electricity and machines, contacting with chemicals and etc., man is being faced with a great flood of accidents. In fact, industrialization of human societies and establishment of large manufactures, great changes that machines create in industrial progress and also increasable and quick technology development in the world cause that human is being exposed to danger of things that he himself makes them. Every year millions of accident takes place in the world that the more human injuries are in industry and industrial workshops and places. In fact we can.

say that one of the problems that encounter each work society is occupational accidents. Some of these accidents causing employees' death and some more disabling them a little or totally. But in general, all accidents will entail pain and suffering for their victims and financial loss for employer. Developing technical protections and improving workshops environments shows the importance of humans and their decisions in accidents incidence more than ever.

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Although different inspections and instructions, taking attention to ergonomic correspondence (work's facilities and environments with operator) and other tricks decrease human errors in work arena to some extent, they never reduce the human errors importance in accidents incidence outcomes which sometimes are severe. It causes that protection experts take a deeper look at reducing human errors in order to prevent loss. (Arghami, 2001)

When we read statistics which indicates the amount of injuries in occupational accidents and their bad effects on employees' morale which is an important parameter in efficiency, productivity and production, we conclude that manufactures and workshops management should consider employees' protective matters as much as quality or quantity of production, and even more than it. Until the manager was not pioneer in hygiene and protection, administrators, engineers and other responsible people cannot gain effective results in this matter. On the other hand, controlling theuse of PPE by employees can be one of actions for preventing much occupational accidents (Rahmani, 2009). Because countless occupational accidents occur every day as the result of using damaged equipment, unsuitable work place and employees' mistakes that origins from not using PPE correctly. So, since in each country particularly in developing one, workforces are a very important part of the national capital and they have been considered as a pillar of economic and social development, protecting their health and reforming work place have a remarkable importance. Because weundoubtedlycannothave developed economicsand self-sufficient industry without healthy workforces (Hoseini, 2011).The purpose of this study is to evaluate the relationship between occupational accidents and using PPE in body section of one of the vehicle manufacturing companies, which proceed accidents take place for employees in one year and its relation with not using PPE correctly. For this purpose, 60 person are picked from 200 personnel of the morning shift randomly and since each worker of this section dominated all three work arenas- work at height, hot work (welding, cutting, grinding) and work with chemicals- they have been asked about using or not using of PPE in all three arenas after providing a questionnaire that professors of this field have been confirmed its accuracy and permanence. Also they have been asked about PPE and training system characteristics. On the other hand, accidents that had occurred during one year have been evaluated.

II. ACCIDENT AND OCCUPATIONAL ACCIDENT

Accident is an unforeseen, unexpected and unplanned event caused by human error and management weakness that results in loss and injury. In past, it had been supposed that accident is the result of dangerous actions or situations and it is unplanned, unforeseen and unexpected event that causes suspension of regular process of an activity or usual process of a work and it entails bodily injury or financial loss. While today, the exact analysis of accidents' indicators confirms the strong effects of human aspects on it (Soltaninasab& et al, 2007). As a reason of limitation of using the word accident in industry, most of the organizations use the word event for one or a successive series of unexpected and unplanned incidents. These events may bring about human, social or industrial damages that it will have meaningful effect on productivity and production by reducing work efficiency. The more important point is social bad effects and following it, psychic effects on workforce. Reducing occupational accidents and injuries increase workers and managers efficiency and at last it cause economic and social prosperity (Arghami, 2001).

III. PPE

It contains a wide range of facilities that are designed, made and presented for protecting different parts of body from hair to sole in work places and include:

- Head protective facilities
- Hand and armprotective facilities
- Footprotective facilities
- Eye and faceprotective facilities
- Respiratory system protective facilities
- Body protective facilities
- Ear protective facilities
- Protective facilities against falling
- Emergency washing facilities according to the ANSI Z89.1-2003 standard

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1-3- Employer duties and Responsibilities

- Article 85: It is a must for all workshops, employers, workers and trainees to obey instructions have been compiled by Supreme Technical Protective Council (for securing technical protection) and Ministry of Health and Medical Education (for preventing professional disease and securing work and worker and work place hygiene) in order to protect manpower and financial sources of country.
- Article 91: Employers and responsible people in all units which are subject of Article 85 of this law according to Supreme Technical Protective Council regulations must provide and offer essential facilities for securing workers protection, health and hygiene in work place, and teach them how to use them and they should monitor protective and hygienic provisions consideration. Aforesaid people also must use and keep personal protective and hygienic facilities and perform workshop-related instructions. (Regulation of Ministry of Labor and Social Welfare).
- Article 95: The responsibility of performing technical and work hygiene regulations is in charge of employer or responsible people in units which are subject of Article 85 of this law. Whenever due to the lack of consideration to these regulations by employer or responsible people an accident takes place, they are responsible according to the penal and legal view and also according to the punishments mentioned in this law.
- Note: whenever employer or managers of units which are subject of Article 85 of this law offer worker the essential facilities for technical protection and work hygiene and the worker in spite of needed training andprevious reminding, does not care the existing instructions and does not use them, the employer has no responsibility. If they have a disagreement, Dispute Resolution Council's opinion is valid (Regulation of Ministry of Labor and Social Welfare).

IV. PROBLEM STATEMENT

In 1999 International Labor Organization[1] in Brazil Conference proclaimed that 250 million occupational accidents occur yearly that one million of them cause death. But other outcomes of it contain: permanent or temporary disabling, wasting work days, physical or psychic harms and also financial loss.

Safety affairs developed seriously after World War II. The range of occupational accidents became vast especially in chemical industry so it is clear that work safety has more importance and necessity in this industry and other ones. This study evaluate accidents occurring factors in three work arenas(work at height, hot work and work with chemicals) and standardization of PPE and training system and their role in preventing organizational accidents.

Since payingattention to the safety regulations and preventing occupational accidents in workshops should be a high priority in all industrial societies especially in our developing country, so protecting manpower and financial sources and securing workers, entrepreneurs and employers health have a great importance in both aspects of paying attention to manpower and preventing financial sources wasting. Chapter 4 inIran labor law has been allocated to technical protection and work hygiene, so it seems that there is no deficiency in law foundations but according to the official reports of responsible organizations, more than 90 % of occupational accidents occur due to human errors that 70 % of which are as the result of not considering safety regulation by employer and 20 % are relate to workers (Yousefi, 1381). However we evaluate reasons ofaccidents in workshops and industrials units to consider safety and preventive regulations for reducing accidents, to prevent similar accidents in work place and finally to reduce direct and indirect expenses and increase work efficiency.

V. NECESSITY OF STUDY

44 years after Safety and Hygiene Congress law approval in 1970, employers had to provide a safety place without any possibility of accidents like death or physical injuries for workers. Because occupational accidents in US were increasing remarkably so that according to the Bureau of Labor Statistics[2] reportabout 4500 person have been died because if accidents yearly. According to the employers statistics about three million occupational accidentsa various

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disease had been recorded that contain: wound- amputation- back, waist, hand and foot injuries that cause absences from work or disabling and also other serious and even deadly injuries. Despite the fact that occupational accidentslash the economics of nations, companies and persons mortally, but unfortunately they have been overlooked but evaluating work place generally, recognizing probable dangers, using PPE, profiting past occurred accidents and choosing a suitable workforce can lead to a decrease in accidents and human errors and as a result they lead to a reduction in expenses and an increase in production and product's quality (OSHA, 1999). Training workers and familiarizing them with different aspects of safety are another main factor in accidents' and human errors' reduction. Training increases the ability ofunderstanding analysis and recognizing people. It is necessary to start training with exact planning at the beginning of the employment and will be continuing all along service.

Preventing occupational accidents is important from human, social and economic dimensions. Economic dimensions of an accident include direct expenses like delay of work, taking injured to remedial center, damages expenses and … (Arghami and Pouya, 2001). The manager also should endeavor to provide a safety place and acquire job satisfaction, because dissatisfaction is grounds for accidents. Due to the subject importance, in this study we evaluate the relationship between occupational accidents and using PPE in a vehicle manufacturing unit.

VI. PURPOSES AND QUESTIONS OF STUDY

Purposes of this study include:

Main purpose:

- Evaluating the relationship between occupational accidents and using PPE

Secondary purposes:

- Evaluating safety condition in industrial unit
- Evaluating the effects of not using PPE on occurring occupational accidents in industrial units

6-1- Study questions

This study has looked for answering these questions:

- How was the safety condition in industrial unit?
- What factors have causedoccupational accidents in three work arenas in this industrial unit?
- Have PPE been used during work?
- How much was the role of not using PPE in occupational accidents' increase?
- What was the effect of training on accidents reduction?

VII. CAUSES OF ACCIDENTS

Different causes effect on accidents incidence like kind of the work, working time, materials that workers dealing with, workshop environment and etc, and each of them cause its individual accidents. These things have a great role in accidents incidence:

1- Lack of training in work place about doing works, lack of familiarizing workers with machineries and etc.

2- Lack of protective equipment in some machinery.

3- Opening some machinery's guards by workers for repairing and not setting them on their places.

4- Lack of some employers' attention to safety and hygienic regulations which had been told them by work and safety inspectors. It should be noted that some employers are not aware of accidents harms and they do not show that much interest about safety programs and regard them as superfluous and restrictive things, so they delay providing safety equipment, replacing old ones and etc.

5- Experienced workers improper pride and confidence. They think that considering safety regulations and taking the precaution of doing works are the reason for their fear and it is unworthy of them and these regulations is for inexperienced workers. It causes accidents to them most of the times.

6- In some workshops lack of hygienic conditions like air pollution, lack of a suitable ventilator, unsuitable moisture, little light, much noise, ill materials in the air and etc., cause that workers become indisposed psychotically and accidents happen.

7- In some workshops workers' stresses like familial anxieties, troubles of finding job, fear of job loss, bad relations betweenworker and employer, which cause psychotic worries, can make accidents to happen.

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8- Some workers and employers think that destiny dominates all events, so they do not consider safety and hygienic regulations which cause carelessness and accidents incidence.
9- Lack of considering to the correct arrangements in workshop, unavailability of essential facilities, puttingfeedstocks and products in workshop irregularly cause untidiness and accidents incidence.
10- Unsuitable starting and finishing of work, much over time work and etc., make the workers tired and cause lack of considering work order and precipitance in doing them and accidents incidence.
11- Incorrect kidding and behaviors in work place and inapt interferences of workers in works that are not related to them and etc., have an effective role in accidents incidence (communication workers of America, 2002).

VIII. GATHERING DATA

For accessing the data 60 person are picked from 200 workers of morning shift randomly in body section, then a two part questionnaire was provided which first part contains questions about PPE in three work arenas- work at height, hot work (welding, cutting, grinding) and work with chemicals, and second part contains questions evaluating standardization of PPE and training system,and they answered them. 54 of them were returned, 50 of which were evaluated. Also the factory offered a proper detailed report about accidents has been occurred during one year. All workers were male which age was 31.6 years and they were working there for t 7.3 years in average. After evaluating the results, Cronbach's alpha values for the check list of PPE in three work arenas (first part) and standardization of PPE and training system (second part) were 64% and 79% respectively.
Tables and graphs 1 to 5 show the evaluation results and table 6 shows the proper report of accidents have been occurred during one year in body section 5.

8-1- Check list of PPE for work at height
H1: Is it specified that which places need safety belt?
H2:Is safe belt given to individualsfor work at height?
H3:Are suitable facilities for work at height given to individuals?
H4: Are the individuals trained to use safe belt correctly?
H5: Is there any suitable stool and liftfor work at height?

Table 1: Evaluation outcomes of using PPE for work at height

H5		H4		H3		H2		H1		Work at height
%22	11	%78	39	%58	29	%84	42	%56	28	**Agree1**
%87	39	%22	11	%42	21	%16	8	%44	22	**Disagree2**

According to the results, the most agreement of workers with 84% is related to (giving safe belt for work at height) which shows the special attention of employer to it, and after that H4 and H3 with 78% and 58% have the more agreement with using PPE that are about training how to use safe belt correctly and giving suitable facilities for work at height. But in negative answers, H5 with 78% has the most disagreement which is related to using suitable stool and lift for work at height and after that H1 with 44% shows it is not specified properly that which places need safety belt, which can cause physical damages and financial loss. Graph 1 shows the results of this estimate.

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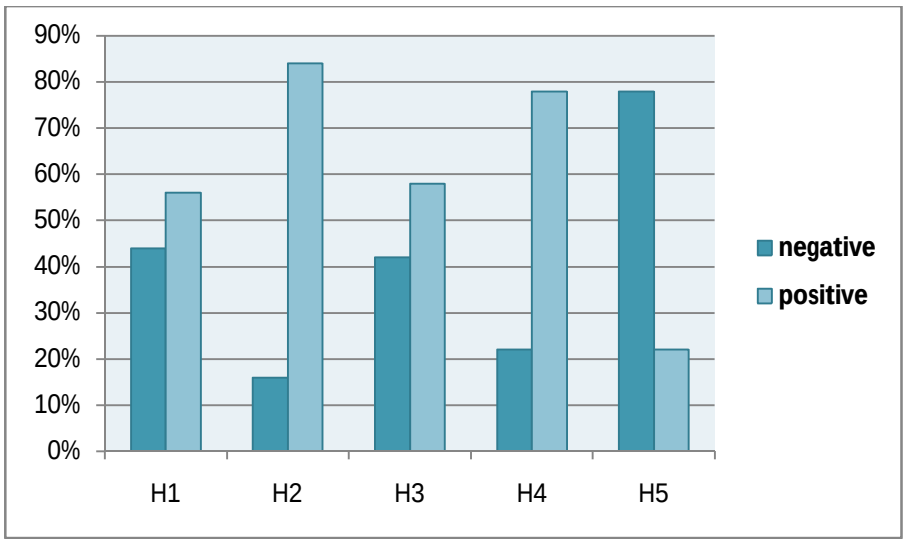

Graph 1: The results of evaluating agreeing or disagreeing with the manner of using PPE for work at height

There is no relationship between H5 and the past years accidents because no accident occur due to the lack of stool and lift's safety for work at height, just it may damage soon for overusing of it by miscellaneous people who are not aware of its function.

8-2- Check list of PPE for hot work

W1: Is the specific welding glove given to individuals?
W2: Do the workers have specific hat, shoes, glasses and safety facilities?
W3: Is the suitable overalls given to individuals?
W4: Is there a proper control over using PPE correctly?
W5: Is it time-consuming to use PPE?
W6: Are the instructions of welding, cutting and grinding given to individuals?
W7: Is there a suitable place for working safe?
W8: Is specific glove for sharp things given to workers?

Table2: Evaluation outcomes of using PPE for hot work

W8		W7		W6		W5		W4		W3		W2		W1		Hot work
46%	23	68%	34	38%	19	44%	22	84%	42	50%	25	86%	43	90%	45	**Agree 1**
54%	27	32%	16	62%	31	56%	28	16%	8	50%	25	14%	7	10%	5	**Disagree 2**

According to the results, the most agreement of workers with 90% is related to (giving specific welding gloves) which shows the special attention of employer to it, and after that W2 and W4 with 86% and 84% have the more agreement which are using PPE like specific hat, shoes and glasses andproper employer's control over using PPE correctly.
But in negative answers, W6 with 66% has the most disagreement which is related to not having instructions of welding, cutting and grinding and after that W5 with 56% shows it is time-consuming to use PPEwhich can be surmounted by suggesting the culture of using PPE continually during work. Graph 2 shows the results of this estimate.

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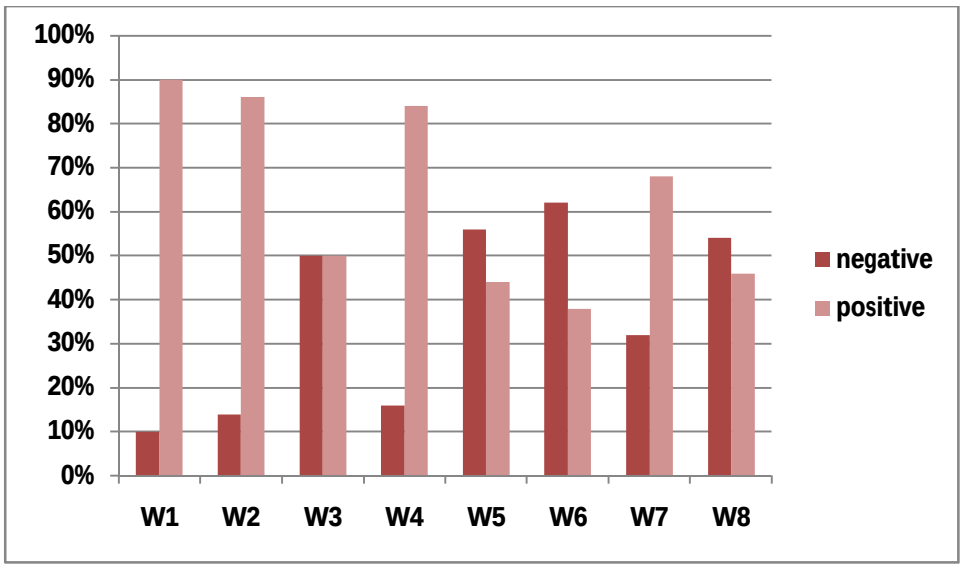

Graph 2: The results of evaluating agreeing or disagreeing with the manner of using PPE for hot work

Also in this case there is no relationship between giving instructions of welding, cutting and grinding and the past years accidents, and if they are not given to a worker, it was probably because of organizational chart problems, since the instructions were sent to administrators by automation system.

8-3- Check list of PPE for work with chemicals

CH1: Is the storage of chemicals inappropriate?
CH2: Does the chemicals have appropriate MSDS[3]?
CH3: Is the specific glove for working with chemicals given to individuals?
CH4: Are the alarm signs set in their specific places?
CH5: Are the materials kept in special container?
CH6: Is the work place suitable for keeping chemicals?
CH7: Is the transportation of chemicals standardized and with low risk?

Table 3: Evaluation outcomes of using PPE for work with chemicals

CH7		CH6		CH5		CH4		CH3		CH2		CH1		work with chemicals
86%	43	62%	31	68%	34	40%	20	46%	23	72%	36	50%	25	**Agree 1**
14%	7	38%	19	32%	16	60%	30	54%	27	28%	14	50%	25	**Disagree 2**

According to the results, the most agreement of workers with 86% is related to CH7 (with low risk and standardized transportation of chemicals) which shows the special attention of employer to it, and after that CH2 and CH5 with 72% and 68% have the more agreement which are the simplicity of MSDS and keeping chemicals in especial containers. But in negative answers, CH4 with 60% has the most disagreement which is related to lack of setting alarm signs in specific places which can be a reason of accidents incidence. Graph 3 shows the results of this estimate.

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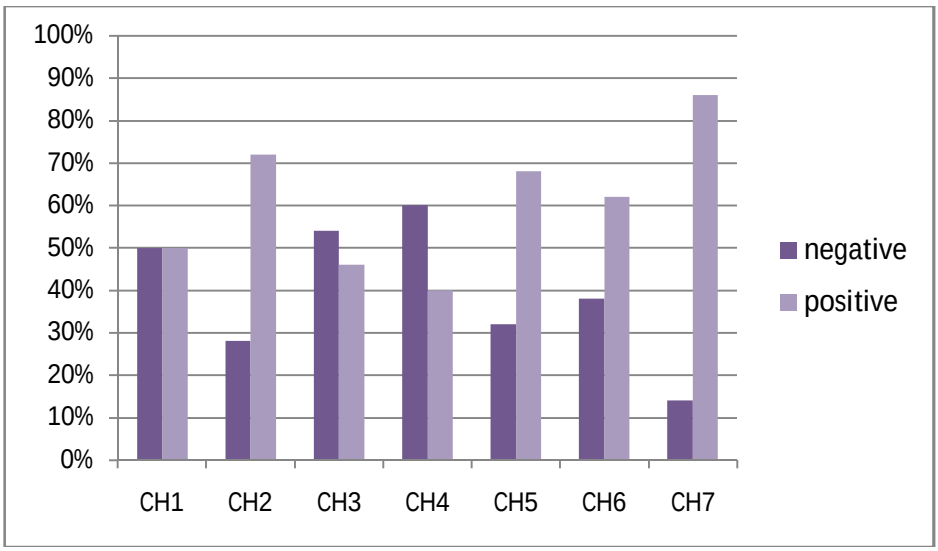

Graph 3: The results of evaluating agreeing or disagreeing with the manner of using PPE for work with chemicals

According to weekly audit, all places have alarm signs. Except one fall from height sign which is set recently, the others have been existed in workers work place.

8-4- Evaluating whether PPE meet the standards

Std1: Does PPE have good quality?
Std2: Is the manner of keeping PPE appropriate?
Std3: Is PPE determined under the viewpoint of safety counselors?
Std4: Are the safety coverings and facilities audited and are they all right?
Std5: Is PPE distributed on time for workers' use?
Std6: Is PPE sufficient for probable dangers?
Std7: Are hearing protective facilities provided according to kind of the work?

Table 4: Outcomes of evaluating whether PPE meet the standards

Std7		Std6		Std5		Std4		Std3		Std2		Std1		How Much PPE Meet the standards
42%	21	36%	18	72%	36	86%	43	64%	32	70%	35	34%	17	Agree 1
58%	29	64%	32	28%	14	14%	7	36%	18	30%	15	66%	33	Disagree 2

According to the results, the most agreement of workers with 86% is related to Std4 (on time auditing of safety coverings and facilities and being certain that they are all right) which shows the special attention of employer to it, and after that Std5 and Std2 with 72% and 70% have the more agreement which are on time distributing of PPE and the manner and conditions of keeping it correctly.But in negative answers, Std1 and Std6 with 66% and 64% have the most disagreement which is related to lack of good quality of PPE and insufficiency of it for probable dangers. Graph 4 shows the results of this estimate.

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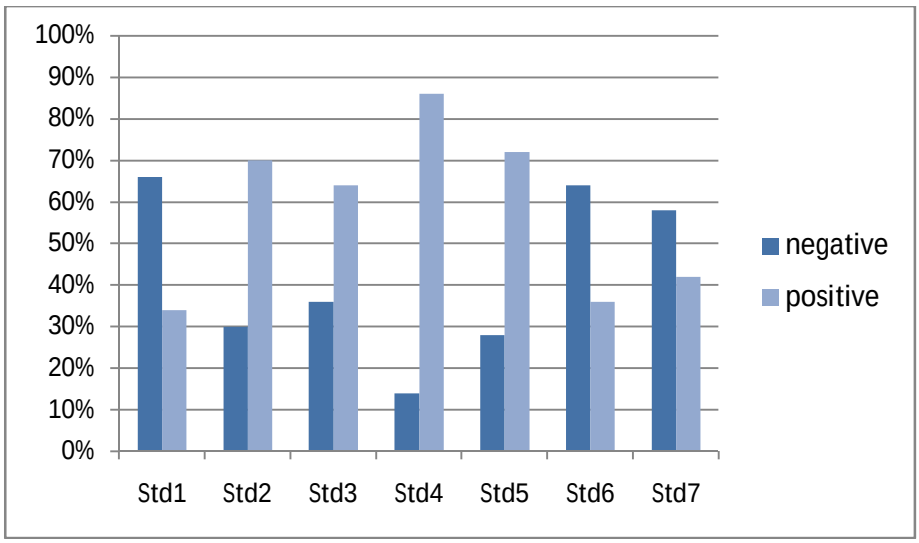

Graph 4: The results of evaluating agreeing or disagreeing with whether PPE meet the standards

Std1 with 66% shows that PPE has not good quality and the reason of the most accidents in factory in past year was lack of good quality of ear plugs and thread gloves. Std6 with 66% is correct exactly because PPE is not given to the workers fully.

8-5- evaluating training system

Edu1: Are the workers have been trained to familiarize with PPE?
Edu2: Are the workers have been trained the manner of using PPE?
Edu3: Is there a suitable place for training (theory- field)?
Edu4: Does the given training have its necessary effects?
Edu5: Does the workers show an interest in using PPE?
Edu6: Is there any alarm sign and poster for using PPE in the unit?

Table 5: Outcomes of evaluating suitability of training system

Edu6		Edu5		Edu4		Edu3		Edu2		Edu1		Training system
86%	43	62%	31	64%	32	32%	16	82%	41	78%	39	**Agree1**
%14	7	38%	19	36%	18	68%	34	18%	9	22%	11	**Disagree 2**

According to the results, the most agreement of workers with 86% is related to Edu6 (existence of alarm sign and poster for using PPE in the unit) which shows the special attention of employer to it, and after that Edu2 and Edu1 with 82% and 78% have the more agreement which are training the manner of using PPE and training for familiarizing with it.But in negative answers, Edu3 with 68% has the most disagreement which is related to not havinga suitable place for theory- fieldtraining which can be a reason of accidents incidence. Graph 5 shows the results of this estimate.

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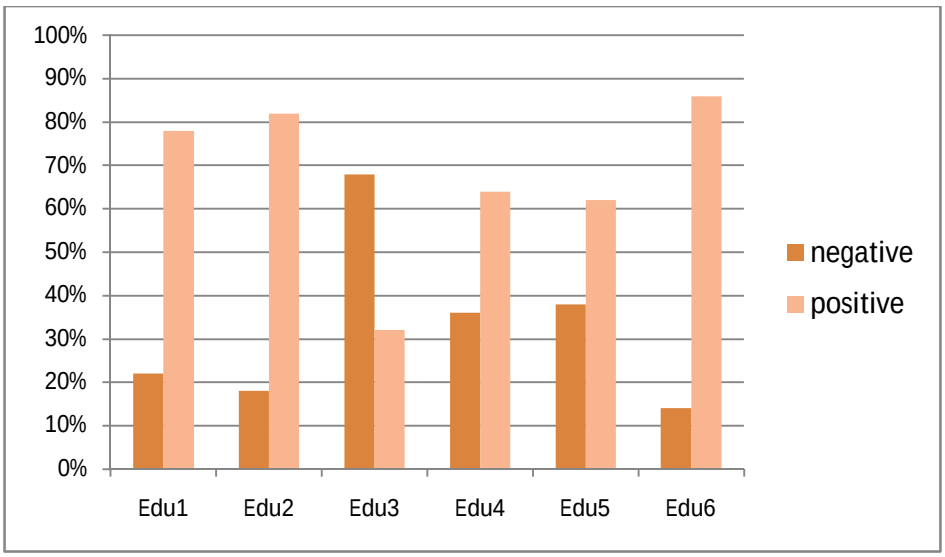

Graph 5: The results of evaluating agreeing or disagreeing withsuitability of training system

Training place is a 20 meters room that contains chair, white board and video projector. Of course there is nothing to eat. Table 6 shows the proper report of accidents has been occurred during one year in body section 5 of this vehicle manufacturing factory. According to the table's data, accidents like strike against objects and cutting body parts are seen in 8 cases with 61.53% of all accidents and after that sprain and slip with 3 cases and 23.07% are some accidents of this industrial unit.

Table 6: the proper report of accidents have been occurred during one year in body section 5

Explanation of accident	Years of working	Resting duration	Result of injury	Kind of injury	Injured body part	Kind of accident	Cause of accident
Hammer striking against pointer finger	10 years	3 days	Send to hospital	strain	Left hand finger	strike against objects	Hit hand with a hammer
His hand is cut because of striking against duct	5 years	7 days	Send to hospital	cutting	Hand	strike against objects	strike against objects
Slipping the stairs and the foot is sprained	11 years	20 days	Send to hospital	sprain	Foot	sprain	Same-surface falls
The thumb is cut	11 years	21 days	Send to hospital	cutting	Hand	cutting	strike against objects
Striking against bus	9 years	14 days	Send to hospital	Tendon strain	Hand	strain	strike against objects
He is regulating the balancer and automatic movement of railing band during which he	13 years	7 days	Send to hospital	Contusion	Hips and thigh	strike against objects	Same-surface falls

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stroke against with a sudden movement							
Striking against pallet while passing line side	7 years		It was bandaged	cutting	Trunk	strike against objects	strike against objects
Striking head against panel during reparation	8 years	0	Send to hospital	cutting	Head	cutting	strike against objects
Falling of panel and striking against workers' hands and arms	7 years	0	It was bandaged + send to industrial services	cutting	Hand	Cutting+ strain	strike against objects
While walking on dressing room stairs	11 years	0	Send to hospital	Strain	Hand finger	strain	Same-surface falls
While walking in the unit	4 months	14days	Send to hospital	sprain	Foot	sprain	Same-surface falls
While he is repairing inside of the line, he slips from duct and get injured	10 years	0	Send to health and safety unit	strain	Hand	slip	slip
While he is solving the problem of BS 525RI RH robot, his hand strikes against the panel on the robot and has got injured	6 months	0	Send to health and safety unit	cutting	Hand	cutting	strike against objects

Table 7 shows the outcomes of Pearson correlation test between high risk factors which are gotten from the opinion poll and the last year accidents.

Table 7:The outcomes of Pearson correlation coefficient between high risk factors which are the reasons of factory's accidents

variables	Correlation coefficient	Level of meaning
H5	0.26	0.01
W6	0.21	0.01
CH4	0.13	0.01
STD1	0.62	0.01
STD6	0.68	0.01
EDU3	0.18	0.01

According to Pearson correlation coefficient and level of meaning which are reported, there is a positive and meaningful relationship between the occurred accidents and evaluated factors. So, the relationship between

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occupational accidents and using PPE shows that the most amount of correlation was between accidents with Std1 and Std6 factors which mean the main cause of accidents incidence in this industrial unit is that PPE does not meet the standards.

IX. CONCLUSION

By training, the ability to analyze and understand people increase. It is necessary to start training with exact planning at the beginning of the employment and will be continuing all along service (Hoseini, 2011). This study in addition to offer a proper report of accidents have been occurred during one year in vehicle manufacturing industrial unit, evaluate the relationship between occupational accidents and using PPE, and the major purpose of the study is achieved. Moreover, by offering the gathered data from the questionnaires which were given to the unit's workers, it proceeds the evaluation of safety conditions in three levels which were related to employees work, and also two levels of standardization of PPE and training system, so the first minor purpose is achieved. Then finally by offering the outcomes of Pearson correlation coefficient test between factors with high risk which were the cause of factory's accidents, it evaluates the results of lack of using PPE on occupational accidents in industrial, units and the second minor purpose is achieved. In general, according to obtained evidences, body section of this industrial unit has a suitable safety level and PPE are used during work, except few cases which cause cutting. In general, causes of accidents like strike against objects and cutting are 61.53% of all accidents and after that sprain and slip with 3 cases are 23.07% of all accidents of this industrial unit. We cannot say that lack of using PPE has a role in accidents increase because it is not seen in this industrial unit. But training workers has effect on accidents decrease naturally. So experts inthis area should persuade workers to use PPE effectively.

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