Health, Safety and Ergonomically Risk Assessment of Mechanicians using Job Safety Analysis (JSA) Technique in an Iran City

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Keywords: Accident, Automotive Industries, Control Measures, Hazard

Abstract

Backgrounds: Automobile and automotive industries in developed and developing countries are important. There are many harmful factors in mechanics workplaces such as chemical and physical agents, ergonomics factors, mechanical and biological factors. Objectives: This study aimed to identify safety, health and ergonomically hazards and recommend the control measures in the automotive repair shops in Tekab city in Iran. Methods: Sixty-three car repair shops in the Tekab city were identified. The researchers with the participation of employees broke any of jobs into their constituent tasks and steps. Then the researchers identified each step hazards and calculated related risks. Finally based on the risk assessment and risk priorities, the control measures were recommended. Findings: Nine jobs were identified. Inhalation of acid and soldering mist vapor and contact with unsafe equipment is the most important accident in the battery repairing and lathing job respectively. Fire caused by thinner, gasoline, paint and resin, severe trauma to the hands and feet, and contact with welding flame is the most important accident in the painting, car smooth working and repairing radiator job respectively. Fire caused by gasoline and motor oil is the most important accident in the oil changes and tire change and mechanical technician jobs. Falling car on person is the most important accident in the front part of car repair and absorbers and exhaust repair jobs. Application/Improvements: Job safety analysis is a useful method for identifying hazards at vehicle mechanics job. Using this method can identify hazards and finally recommends appropriate control measures.

1. Introduction

Industrialization process has led to the increasing use of technical tools and machinery. Due to failure to comply with the proper principles of the construction or use of these devices, work accidents increased. On one hand, the use of mechanical and electrical driving force turned the manual activities to machine works; and on the other hand, the division of work, increased production and speed of the work. As a result of this, the risk is increased in industrial environments¹². Occupational accidents have a negative impact on economic indicators and cause workers injury. Despite all efforts, although the evaluation of all aspects of the human costs such as suffering and grief of victims and their relatives, it is impossible to come, but some of the cost dimensions are measurable. Costs of unsafe conditions and workforce pain are not easily tangible but its value in the Gross National Income

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is calculable. Automotive and automotive industries in developed and developing countries are important. Many experts are associated with this industry. Mechanics is one of them. Automobile mechanic is a person who repairs and overhauls cars and other automotive vehicles, or their systems and parts. He/she examines them, makes necessary repairs, emplacements, adjustments, and presents the repaired vehicle to his/her superior or to the customer. Auto mechanics work in environments that have high probability of risk in it. There are many harmful factors in Mechanics workplaces such as chemical and physical agents, ergonomics factors, mechanical and biological factors. Prank and et al. in two studies surveyed the levels of isocyanate compounds in car repair workshops and industrial painting companies. In this study was concluded that the risk of exposure to painting particles during painting process is significant. Also it was determined that the main route of exposure is skin. Delgado and et al examined the potential exposure of skin with non-volatile compounds in painting process in car repair workshops.

Risk assessment is a reasonable method to determine the qualitative and quantitative risks and evaluate the potential consequences arising from possible accidents to people, materials, equipment and environment. In fact, the effectiveness of the existing control methods is specified and the valuable data for decision-making on risk reduction, improve and control systems are provided. In this method, every step of the job is carefully checked, potential risks of each step are identified and assessed, and the best solution to eliminate or reduce hazards is recommended. JSA is a systematic study to identify and assess existing or potential risks in any process or job. In the world many studies have been done to reduce accidents in different fields that each of them leads to reduce accidents with some interventions. Given that very few studies have been conducted to assess the risks in Auto mechanic and hardly can find a comprehensive study in this area, this study aimed to identify hazards and assess risks in the automotive repair shops in Tekab city (a city with more than 44,000 people in the North West of Iran).

2. Methods and Materials

2.1 The Study Population

This study was a descriptive study that aims to identify safety, health and ergonomically hazards and recommend the control measures in the automotive repair shops in Tekab city. The study population was all staff of the automotive repair shops in Tekab city. Accordingly, 63 car repair shops in the Tekab city were identified whom were the all car parts repairman. The general characteristics of these people are shown in Table 1. To accomplish this study, after coordination, the researchers went to the workshops. They observed the activities in detail and after interviews with staff, information relating to any part of the job were recorded in the form of JSA (Figure 1).

2.2 Job Safety Analysis Process

Job Safety Analysis Process includes below steps:

| Job title: | Work-hours: day week | Work condition: routine nonroutine |
|------------|-----------------------|----------------------------------|
| Assessment team members: |

| Task | Step | Hazard | Incident | Cause | Consequence | Probability | Severity | Risk number | Risk level | Required action |
|------|------|--------|----------|-------|-------------|-------------|----------|-------------|-----------|-----------------|

Figure 1. A sample of Job Safety Analysis (JSA) form.
2.2.1 Breaking the Job

First the jobs in car repair shops were found. Accordingly nine jobs were identified (Table 1). The researchers with the participation of employees broke any of these jobs into their constituent tasks. Then all steps of each task listed. The observations and interviews results were recorded in JSA form. To ensure a correct list of tasks and steps is provided, the completed form for each job was reviewed with staff again.

| No. | Job                                | The average age of each group | Average work experience in each group | Education (Majority)         | Marital status (majority) | Working hours per week |
|-----|------------------------------------|-------------------------------|--------------------------------------|-----------------------------|--------------------------|------------------------|
| 1   | Mechanical technician              | 35.3                          | 13.8                                 | Guidance school             | Married                   | 65.6                   |
| 2   | Oil changes and tire change Repairing radiator | 31.2                          | 12.1                                 | Secondary school            | Married                   | 67.6                   |
| 3   | Repairing radiator                 | 23                            | 8                                    | Guidance school             | Single                    | 60                     |
| 4   | Battery repair                     | 31.8                          | 12                                   | Guidance school             | Married                   | 68                     |
| 5   | Car smooth working                 | 34.3                          | 13.6                                 | Diploma                     | Married                   | 66.3                   |
| 6   | Painting                           | 35.3                          | 15.5                                 | Guidance school             | Married                   | 64.8                   |
| 7   | The front part of car repair       | 28                            | 10                                   | Guidance school             | Married                   | 65                     |
| 8   | Lathing                            | 40.3                          | 22                                   | Guidance school             | Married                   | 66                     |
| 9   | Absorbers and exhaust repair       | 34.6                          | 16                                   | Guidance school             | Married                   | 67.3                   |

Table 2. Accident severity classification

| Description | Class | Hazard type          |
|-------------|-------|----------------------|
| Death or disappearance of the entire system | 1 | Catastrophic |
| Severe injuries, illnesses and damage to the system | 2 | Critical |
| Small injuries, illnesses and damage to the system | 3 | Marginal |
| Very small injuries, illnesses and damage to the system | 4 | Inconsiderable |

Table 3. Accident occurrence probability criteria

| Description | Hazard level | Occurrence probability |
|-------------|--------------|------------------------|
| Frequently occurs | A | \(X > 10^{-3}\) |
| Several times occurs during the life of the system | B | \(10^{-3} < X < 10^{-1}\) |
| Occasionally occurs during the lifetime of the system | C | \(10^{-1} < X < 10^{-3}\) |
| Its Occurrence probability is very low during the lifetime of the system | D | \(10^{-4} < X < 10^{-3}\) |
| Its occurrence probability in the life of the system is minimal | E | \(X < 10^{-4}\) |

Table 4. Decision making criteria based on risk levels

| Risk classification | Risk criteria                   |
|---------------------|---------------------------------|
| 1A, 1B, 1C, 2A, 2B, 3A | Unacceptable                   |
| 1D, 2C, 2D, 3B, 3C | Undesirable                     |
| 1E, 2E, 3D, 3E, 4A | Acceptable but needs reconsideration |
| 4C, 4D, 4E | Undesirable                     |
2.2.2 Hazard Identification

In this step the researchers identified each step hazards using a pre-prepared checklist\textsuperscript{16}, activities observing and interviewing with the repairman, then recorded identified hazards in JSA form.

2.2.3 Risk Assessment

To calculate risks, the following factors were identified and using equation 1 each accidents risk estimated:

- Accident Occurrence Probability (P)
- Accident Consequence Severity (S)

Equation 1: \[ \text{Risk} = P \times S \]

Information related to the above two factors were obtained based on interviews; review of accidents records, Mechanics experience and observation their activities. In all of these steps, the assessment tool was a set of structured questionnaires. To calculate the probability of occurrence, consequences severity and decision-making based on the level of calculated risk, Tables 1-4. were used respectively\textsuperscript{16}.

2.2.4 Control Measures

Based on the risk assessment and risk priorities, the control measures were recommended. According to risk priority can insure that effective control measure are provided and implemented.

3. Results

Tables 5-7. show the results of this study. As can see in Table 5, the mechanical technician has two hazards with “unacceptable” risk level. In this job, there are 6 hazards with “undesirable” risk level, 4 hazards with “acceptable but needs reconsideration” risk level and one hazard with “inconsiderable” risk level. Fire caused by gasoline and motor oil is the most important accident in this job. The battery repairing job has one hazard with “unacceptable” risk level. In this job, there are 5 hazards with “undesirable” risk level, one hazard with “acceptable but needs reconsideration” risk level and one hazard with “inconsiderable” risk level. Inhalation of acid and soldering mist vapor is the most important accident in this job. According to Table 6, the painting job has 4 hazards with “unacceptable” risk level. In this job, there are 4 hazards with “undesirable” risk level. Fire caused by thinner, gasoline, paint and resin is the most important accident in this job. The car smooth working job has 7 hazards with “unacceptable” risk level. In this job, there are 5 hazards with “undesirable” risk level, one hazard with “acceptable but needs reconsideration” risk level. Severe trauma to the hands and feet is the most important accident in this job. The absorbers and exhaust repair job has 5 hazards with “unacceptable” risk level. In this job, there are 5 hazards with “undesirable” risk level, Falling car on person is the most important accident in this job. According to Table 7, the repairing radiator job has 2 hazards with “unacceptable” risk level. In this job, there are 7 hazards with “undesirable” risk level. Fire caused by thinner, gasoline, paint and resin is the most important accident in this job. The front part of car repair job has one hazard with “unacceptable” risk level. In this job, there are 8 hazards with “undesirable” risk level.

4. Discussion

The main incident in the mechanical technician job is fire. In this job, given that a lot of gasoline and motor oil poured on the floor of the shop, the probability of fire is high. Also in these workplaces, the housekeeping principles do not followed by workers, as a result the splurge on the floor is high. Heat sources that may be exposed to gasoline and motor oil and caused the fire are smoking, heater, sparks from the car starters and etc. The only incident with unacceptable risk in battery repairing job is inhalation of acid and soldering mist vapors that could eventually lead to respiratory and other diseases. On the one hand, due to the nature of the job, use of acid and soldering is inevitable. On the other hand, usually due to a lack of monitoring, workers don't use personal protective equipment, local ventilation or other control measures. As a result, risk of exposure to these harmful agents is very high. In lathing job, due to use of rotating and moving equipment the risk of contact with the equipment is unac-
### Table 5. Hazards, risks and required actions for mechanical technician, battery repairing and lathing jobs

| Job | Hazard | Incident | Consequence | Risk number | Risk level | Required action |
|-----|--------|----------|-------------|-------------|------------|-----------------|
| Gasoline and Motor Oil | Fire | Burning | 2A | Unacceptable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Car Falling risk | Falling car on person | Death, injury and fracture | 2B | Unacceptable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Moving parts of the vehicle | Hand caught in moving parts | Injury and amputation | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Slippery workplace | Slipping and falling | Injury and fracture | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Vapors of gasoline and motor oil | Inhalation of vapors of gasoline and motor oil | Respiratory diseases and other diseases | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Press machine | Hand caught in press machine | Injury, amputation and fracture | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Lubritorium | Falling into a pit of service | Bone fracture and Head injuries | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Lighting | Exposure with inadequate lighting | Vision loss | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Unsuitable workplace | Awkward posture | Musculoskeletal Disorders | 4B | Acceptable but needs reconsideration | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Hot parts of the vehicle | Contact with hot parts of the vehicle | Burning | 4B | Acceptable but needs reconsideration | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Improper tools layout | Individual collisions with variety of tools | Injury | 4B | Acceptable but needs reconsideration | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Noise | Noise exposure | Hearing loss | 4B | Acceptable but needs reconsideration | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Vibration | Vibration exposure | Physical disorders | 4C | Inconsiderable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Acid and soldering mist vapor | Inhalation of vapors | Respiratory diseases and other diseases | 2A | Unacceptable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Exist various acids | Battery explosion and throwing acid | Burning | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Acid spilling | Contact | Burning | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Lack of warning signs | Lack of knowledge and accident occurrence | Injury | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Improper ventilation | Exposure to heat and acid vapors | Heat stress and other diseases | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Lighting | Exposure with inadequate lighting | Vision loss | 3B | Undesirable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Improper workplace layout | Individual collisions with variety of tools | Injury and low efficiency | 4B | Acceptable but needs reconsideration | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Unsafe equipment | Electrocuton | Injury | 1C | Inconsiderable | - Spill prevention - Training - Provide the fire extinguishers - Use the proper jacks - Training - Use of an auxiliary base - Check and repair the vehicle when the vehicle is turned off - Use of appropriate equipment - Use of appropriate shoes - Clean the workplace floor continuously |
| Job Hazard | Incident | Consequence | Risk number | Risk level | Required action |
|------------|----------|-------------|-------------|------------|-----------------|
| Thinner, gasoline, paint and resin | Fire | Property damage | 1C | Unacceptable | - Training  
- Install safety labels  
- Isolation solvent from the fire source |
| Paints and chemical solvents | Exposure to paints and chemical solvents vapours | Skin and respiratory diseases | 2B | Unacceptable | - Use of personal protective equipment  
- Training |
| Aerosol | Exposure to aerosol | Respiratory diseases | 2B | Unacceptable | - Use of personal protective equipment  
- Training |
| Lubritorium | Falling into the pit of Service | Bone fracture and head trauma | 3A | Unacceptable | - Use the shield and cover the hole of service  
- Redesign Lighting  
- Paint and clean the workplace walls |
| Lighting | Exposure with inadequate lighting | Vision loss | 1D | Undesirable | - Redesign Lighting  
- Paint and clean the workplace walls |
| Inappropriate standing | Inappropriate posture at work | Musculoskeletal disorders | 3C | Undesirable | - Redesign workstation |
| Noise | Noise exposure | Hearing loss | 3C | Undesirable | - Use of personal protective equipment  
- Training  
- Air compressor isolation |
| Splurge the materials and tools on the floor | Contact with materials and tools | Body injury | 3C | Undesirable | - Housekeeping  
- Training |

**Table 6.** Hazards, risks and required actions for painting, car smooth working and absorbers and exhaust repair jobs
| Smooth out the crumpled metal | Severe trauma to the hands and feet | hands and feet fracture | 2B | Unacceptable | - Use of personal protective equipment | - Use of appropriate tools |
| Noise | Noise exposure | Hearing loss | 2B | Unacceptable | - Use of personal protective equipment | - Training |
| Fume | Inhalation of fumes | Respiratory diseases and other diseases | 2B | Unacceptable | - Use of appropriate protective masks |
| Sharp pieces of objects | Hands encounter with sharp metal pieces | Hands injury | 3A | Unacceptable | - Use of personal protective equipment | - Use of appropriate tools |
| Welding torch | Contact the body with flame | Burning | 3A | Unacceptable | - Use of personal protective equipment | - Training |
| Lubritorium | Falling into the pit of Service | Bone fracture and head trauma | 3A | Unacceptable | - Use the shield and cover the hole of service |
| Welding | Look up the pieces when welding | Eyes injury | 3A | Unacceptable | - Use the welding glasses | - Training |
| Metal filings | Entry the metal filings in the eyes | Damage to eyes | 1D | Undesirable | - Redesign Lighting | - Paint and clean the workplace walls |
| Lighting | Exposure with inadequate lighting | Vision loss | 1D | Undesirable | - Redesign workstations |
| Inappropriate standing | Inappropriate posture at work | Musculoskeletal disorders | 3C | Undesirable | - Providing safety equipment | - Training |
| Unsafe equipment | Electrocuttion | Death and injury | 3C | Undesirable | - Use of personal protective equipment |
| Hot metals | Contact with hot surfaces | Burning | 3C | Undesirable | - Ventilation system redesign |
| Heat | Heat exposure | Heat stress | 1E | Acceptable but needs reconsideration | - Redesign workstations |
| Car Falling risk | Falling car on person | Death, injury and fracture | 1C | Unacceptable | - Use the proper jacks | - Training | - Use of an auxiliary base |
| Metal vapours | Inhalation of metal vapours | Respiratory diseases and other diseases | 2B | Unacceptable | - Use of appropriate protective masks |
| Working with electric sanding machine | Contact with the body | Amputation and hand injury | 3A | Unacceptable | - Training | - Use of protection devices |
| Shock ventilation system | Caught hands between and inside equipment | Amputation and injury | 3A | Unacceptable | - Use the Interlock Devices | - Training | - Use of protection devices |
| Lubritorium | Falling into the pit of Service | Bone fracture and head trauma | 3A | Unacceptable | - Use the shield and cover the hole of service |
| Metal filings | Entry the metal filings in the eyes | Damage to eyes | 1D | Undesirable | - Redesign Lighting | - Paint and clean the workplace walls |
| Explosion risk | Explosion | Death, injury and amputation | 2C | Undesirable | - Keep cylinders away from fire source |
| Splurge the materials and tools on the floor | Contact with materials and tools | Body injury | 3C | Undesirable | - Housekeeping | - Training |
| Unsuitable workplace | Akward posture | Musculoskeletal Disorders | 3C | Undesirable | - Redesign workstations |
| Hot parts of the vehicle | Contact with hot parts of the vehicle | Burning | 3C | Undesirable | - Use of personal protective equipment | - Use of tools |
Table 7. Hazards, risks and required actions for repairing radiator, oil changes and tire change and the front part of car repair jobs

| Job                     | Hazard                                     | Incident                                      | Consequence          | Risk number | Risk level | Required action                                                                 |
|-------------------------|--------------------------------------------|-----------------------------------------------|----------------------|-------------|------------|--------------------------------------------------------------------------------|
| Repairing radiator      | Welding flame                             | Contact with the body                        | Burning              | 3A          | Unacceptable | - Use of personal protective equipment  
|                         |                                            |                                               |                      |             |            | - Training                                                                                  |
|                         | Hot water                                 | Throw hot water on the face and body          | Face and body burning | 3A          | Unacceptable | - Training  
|                         |                                            |                                               |                      |             |            | - Check the radiator when is cooling                                                        |
|                         | Radiator falling risk                     | Falling the Radiator on feet                  | Feet injury          | 1D          | Undesirable | - Use safety shoes.  
|                         |                                            |                                               |                      |             |            | - Training                                                                                  |
|                         | Lighting                                  | Exposoure with inadequate lighting            | Vision loss          | 1D          | Undesirable | - Redesign Lighting   
|                         |                                            |                                               |                      |             |            | - Paint and clean the workplace walls                                                      |
|                         | Metal filings                             | Entry the metal filings in the eyes           | Damage to eyes       | 1D          | Undesirable | - Use of personal protective equipment                                                       |
|                         | Slippery workplace                        | Slipping and falling                          | Injury and fracture   | 3C          | Undesirable | - Use of appropriate shoes  
|                         |                                            |                                               |                      |             |            | - Clean the workplace floor continuously                                                    |
|                         | Splurge the materials and tools on the floor | Contact with materials and tools             | Body injury          | 3C          | Undesirable | - Housekeeping  
|                         |                                            |                                               |                      |             |            | - Training                                                                                  |
|                         | Radiator hot parts                        | Contact with hot parts of the radiator        | Burning              | 3C          | Undesirable | - Use safety gloves                                                             |
|                         | Heavy radiators                           | Improper handling of the heavy radiators      | Musculoskeletal Disorders | 3C          | Undesirable | - Use the proper equipment to carry heavy radiators  
|                         |                                            |                                               |                      |             |            | - Training                                                                                  |
|                         | Motor oil, gasoline and other petroleum products | Fire                                      | Burning and financial costs | 1B          | Unacceptable | - Separation of combustible materials from fire sources  
|                         |                                            |                                               |                      |             |            | - Training  
|                         |                                            |                                               |                      |             |            | - Use of warning signs   
|                         |                                            |                                               |                      |             |            | - Provide extinguisher                                                              |
|                         | Car Falling risk                          | Falling car on person                         | Death, injury and fracture | 1C          | Unacceptable | - Use the proper jacks  
|                         |                                            |                                               |                      |             |            | - Training                                                                                  |
|                         | Gasoline and motor oil vapors             | Inhalation of vapors of gasoline and motor oil | Respiratory diseases and other diseases | 2B          | Unacceptable | - Use of appropriate protective masks                                                   |
|                         | Slippery workplace                        | Slipping and falling                          | Injury and fracture   | 3A          | Unacceptable | - Use of appropriate shoes  
|                         |                                            |                                               |                      |             |            | - Clean the workplace floor continuously                                                    |
|                         | Hot motor oil                             | Splash hot oil on the person                  | Burning              | 3A          | Unacceptable | - Use of appropriate equipment  
|                         |                                            |                                               |                      |             |            | - Use of appropriate protective gloves                                                    |
|                         | Moving parts of the vehicle               | Hand caught in moving parts                   | Injury and amputation | 1D          | Undesirable | - Check and repair the vehicle when the vehicle is turned off  
|                         |                                            |                                               |                      |             |            | - Use of appropriate equipment                                                            |
|                         | Lubritorium                               | Falling into the pit of Service               | Bone fracture and head trauma | 1D          | Undesirable | - Use the shield and cover the hole of service                                              |
| Lightening | Exposre with inadequate lighting | Vision loss | 1D | Undesirable | - Redesign lighting  
| - Paint and clean the workplace walls |
| Lubiritrium with insufficient space | Akward postture | Musculoskeletal Disorders | 1D | Undesirable | - Redesign lubiritrium  
| Heavy tires | Improper handling of tires | Musculoskeletal Disorders | 3C | Undesirable | - Use the proper equipment to carry heavy tires  
| - Training |
| Aerosol | Exposure to aerosol | Respiratory diseases | 3C | Undesirable | - Use of personal protective equipment |
| Hammer of batting | Heavy hitting the legs | Bruises and bone fracture in the foot | 3C | Undesirable | - Use of appropriate equipment  
| - Use of appropriate shoes |
| Motor oil, gasoline and other petroleum products | Dermal contact | Dermal disease | 1E | Acceptable but needs reconsideration |
| The sudden movement of the vehicle | Collision the car with person | Bone fracture and injury | 1E | Acceptable but needs reconsideration | - Warn when the car is turning  
| - Ensure that the vehicle is not in gear. |
| Metal parts under the car | Collision the head with them | Head injuries | 1E | Acceptable but needs reconsideration | - Construct lubiritrium with appropriate height  
| - The use of helmets in lubiritrium |
| Noise | Noise exposure | Hearing loss | 1E | Acceptable but needs reconsideration | - Use of personal protective equipment  
| - Training  
| - Air compressor isolation |
| Car Falling risk | Falling car on person | Death, injury and fracture | 1C | Unacceptable | - Use the proper jacks  
| - Training  
| - Use of an auxiliary base |
| Unsuitable workplace | Akward postture | Musculoskeletal Disorders | 2B | Undesirable | - Redesign workstations |
| Moving parts of the vehicle | Hand caught in moving parts | Injury and amputation | 1D | Undesirable | - Check and repair the vehicle when the vehicle is turned off  
| - Use of appropriate equipment |
| Lubiritrium | Falling into the pit of Service | Bone fracture and head trauma | 1D | Undesirable | - Use the shield and cover the hole of service |
| Lighting | Exposre with inadequate lighting | Vision loss | 2C | Undesirable | - Redesign Lighting  
| - Paint and clean the workplace walls |
| Unsafe equipment | Electrocution | Injury | 2C | Undesirable | - Providing safety equipment  
| - Training |
| Horsepaly | Caught clothing and hands between and inside equipment | Amputation and injury | 2D | Undesirable | - Monitoring  
| Hot parts of the vehicle | Contact with hot parts of the vehicle | Burning | 3C | Undesirable | - Use of personal protective equipment  
| - Use of tools |
| Noise | Noise exposure | Hearing loss | 3C | Undesirable | - Use of personal protective equipment  
| - Air compressor isolation |
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Indian Journal of Science and Technology

Vol 8 (28) | October 2015 | www.indjst.org

5. Conclusion

Job Safety Analysis (JSA) is a useful method for identifying hazards at various jobs including vehicle mechanics. As shown in the results, this method can identify hazards, incident causes and incident consequences and finally recommends appropriate control measures. Also it is possible using results of this study, determining the training needs of automotive mechanics and writing a health and safety operation procedure for automotive mechanics. Generally to improve health and safety conditions of automotive workshops, the following suggestions are offered:

- Continues monitoring of occupational health and safety in automotive workshops;
- Writing a health and safety operation procedure for automotive mechanics;
- Providing safe equipment;
- Providing personal protective equipment and using them;
- Redesigning the work station based on ergonomically rules;
- Implementation of recommended technical-engineering measures in this study.

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