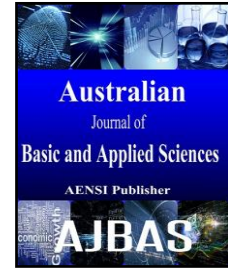




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### Factors Contributing To Slips and Falls: An Exploratory Study

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#### ABSTRACT

Slips and falls are frequent incidents that occur everywhere either in an office, school, factory, public building or at the warehouse, inside and outside. This research focuses on to identify the main factors of slips and falls incidents at workplace. Although this incident seldom occur but the effect of this accident surely because various kind of problems such as fractures, sprained joints, back injuries, contusions and lacerations either to victim or employer. The effects of slips and falls not only cause a small or simple injury, instead it might result in serious injuries such as permanent injury and fatalities. Besides the injuries, the victim also has to support the medical cost and at the same time the victim will lose their jobs or salary result of the slips and falls incident. Although victim may get their compensation claims from that accident, it would commensurate for victim or victim's family. Because of such reason, this project will identify the main cause of slips and falls incident among workers at workplace.

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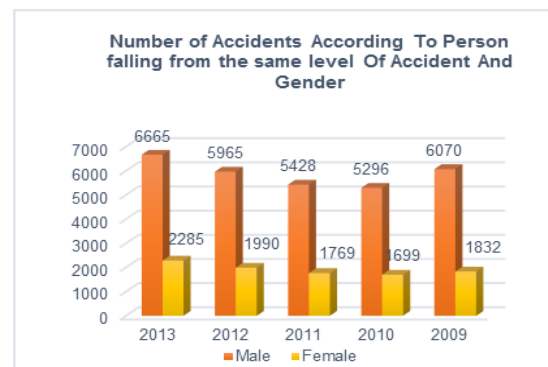
#### INTRODUCTION

Slips and falls are one of the frequent types of accident which occur at workplace that can contribute to serious impact when it occurs especially to people or employees. Normally employees are trained before they enter a workplace. Employer will give them training about safety and supply them with proper clothes or safety clothes suitable to their tasks. Even though they are trained and wear proper clothes, accidents still occur at workplaces especially in manufacturing industries. Why does this accident still exist? Sometimes the number of such accidents increase every year and it became more serious when there are fatalities.

Figure 1 shows the number of accident cases in Malaysia is about 38,999 cases accident cause from Person falling from the same level are reported to SOCSO from year 2009 until 2013. Figure 1 shows the slips and falls accidents which had increased from year 2010 until year 2013. An increase of 5% is seen from year 2010-2013. Cases on slips and falls keep on increasing from year to year.

The SOCSO Annual Report (2009-2013) shows the number of accident for Male is higher than female workers. In 2013, there are 2,285 cases reported on females' slips and falls accident compare to male which are 4,380 cases. There number of accident shown that every year slips and falls

incident will influence the employees or employer at workplace.

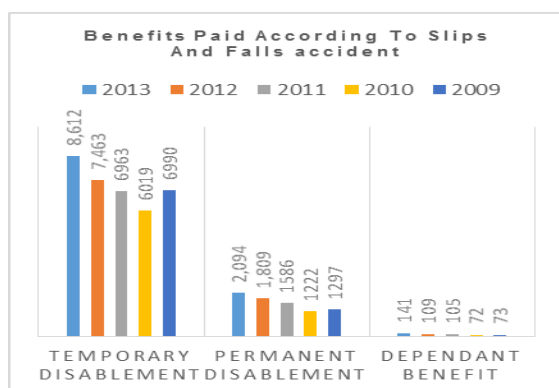


**Fig. 1:** Number Of Accidents According To Cause of Accident and Gender: Source (Annual report from SOCSO)

Figure 2 shows the Benefits Paid according to person falling from the same level of accident and gender. The higher benefit paid is for temporary disablement and the lower benefit paid is for dependant benefit. The 2D-column benefit paid for temporary disablement shows an increase from 2010 until 2013.

In this case, the workplace has high potential and risk to attend the hazard and cause the injuries to

the employees. If the employees are not sensitive or avoid the safety rules or put on proper safety apparatus, they might be the victims of slips and fall accident.



**Fig. 2:** Benefit Paid According To Slips and Falls Accident:Source (Annual report from SOCSO).

Besides injuries, employer may face the loss of manpower. Their employees might not fit well to their jobs and get the medical certificate or leave the jobs. So by that time factory will face the less manpower especially if it involves skill workers. So these problems will affect the production department. On the other hand, if there are a lots of slips and falls problems, the company also could spend plenty of money for compensation claim from employees.

So, this study is carried out to identify the factors why slips and falls occur at work place. What are the main causes of slips and falls? Why these accidents happen and how to reduce the number of cases.

#### Factors:

From the survey conducted at factory visit on 3<sup>rd</sup> September 2009 at SCA Hygiene Malaysia Sdn. Bhd. at No. 3, Jalan Gicing Hulu 28/33, Hicom Industrial Estate Sektor C, Seksyen 28, Taman Alam Megah, 40400 Shah Alam Selangor there are several factors

that contribute to slips and falls at the workplace. The factors are floor, footwear, cleaning process, human or people and environment. Most of the respondents agreed that these 5 factors are closely related to slip and fall accidents.

Flooring is a main factor to contribute to slips and falls among workers. Ralph L. Barnett, Suzanne A. Glowiak and Peter J. Poczynok (2003), Ralph L. Barnett and Peter J. Poczynok (2004) and Ralph L. Barnett and Suzanne A. Glowiak (2005) highlighted that the more active pathways and the longer pathways will produce the most slips. The surface roughness of the floor is measured and identifies to prove that if the surface roughness less than  $10\mu\text{m}$  means that floor have high potential for slips and falls to occur. However from the experiment, it shows that most of the surface roughness at the company and also at the Fitting laboratory is less than  $10\mu\text{m}$ . Although the surface roughness value less than  $10\mu\text{m}$  it does not mean that those person or people walking on that surface will experience slips and falls incidents immediately. Slip and fall incident will occur with combination other factors too.

Second factor is footwear. Roughness of footwear was measured to identify the potential slips and falls. This will affect friction and slip resistance. From both sample of footwear's, new and old footwear. So, both types of footwear are used in the experiment slips and fall at the Fitting laboratory. The roughness of the new footwear is higher than the old footwear. According to Research by the Health and Safety Laboratory (HSL) on behalf of Health and Safety Executive (HSE), table 1 Dr Marianne Loo-Morrey (2007) show Slips potential classification related to floor surface slipperiness in water-contaminated conditions. If there are other contaminated, differing levels of roughness will be needed to lower slip potential. As a general rule, a higher level of surface roughness is needed to maintain slip resistance with a more viscous (thicker) contaminant.

**Table 1:** Slips potential classification, based on Ra micro roughness values

Ra surface roughness	Slip Potential
Below $10\mu\text{m}$	High
$10 - 20\mu\text{m}$	Moderate
$20 + \mu\text{m}$	Low

Cleaning process is a third factor that contributes to slip and fall incident. Cleaning involve cleaning procedure at the workplace. Normally they used water, detergent and oil as a source. On the other hand if there is some leaking from the machine or there is some spill on the floor, cleaning jobs are carried out to make sure that slip and fall incident can be avoided by proper and immediate action from housekeeping department. By using similar material such as water, water and detergent and oil as a liquid,

the third factor will be tested together with the two factors mentioned earlier.

The fourth factor is human or people. Human vary widely to relate them to slips and falls incidents. This is because of several criteria that can be expected such as gender, weight, height, ageing, personal health, style of walking and so on. Every person has different criteria personality. Rarely among human or person have the same criteria even though they are twins. Sometimes if they are in the

same weight and age, but maybe their health condition is not similar. Meaning those factors contribute and cause different incident in slip and fall.

Finally environment is the fifth factor that contribute to slips and falls incident at the workplace. Temperature, lighting and arrangement of apparatus or machine are criteria in the environment. This factor can contribute to slips and falls incident such as insufficient lighting level especially near the office area or walkway is littered with thick wires or spill with oily or water that create an obvious slippery

hazard. Hence, this factor also need to be considered to avoid or reduce slip and fall incident at workplace.

#### Experiment:

The floor is used as a main factor but human, footwear and types of liquid are used as a variable method. There are three persons who are subjects in the testing, four types of liquid, each type of liquid is tested in five different quantities from 100ml to 500ml and the test involve two different type of footwear. However there is also an experiment on a person who has to walk on targeted step without any footwear.

**Table 2:** Water and Combination Water + Detergent testing result.

Quantity Liquid/ Person/ Footwear	Water			Water + Detergent		
	Person 3			Person 3		
	WOF	NF	OF	WOF	NF	OF
100ml	20cm	NS	NS	NS	NS	NS
200ml	15cm	NS	NS	15cm	NS	13cm
300ml	25cm	NS	NS	NS	NS	15cm
400ml	30cm	NS	NS	NS	NS	NS
500ml	35cm	NS	8cm	NS	NS	NS

WOF - Without footwear, NF - New footwear, OF - Old footwear, NS - Non Slipping

**Table 3:** Sharlu oil testing result.

Quantity Liquid/ Person/ Footwear	Sharlu oil (cm)						
	Person 1	Person 2			Person 3		
	WOF	WOF	NF	OF	WOF	NF	OF
100ml	57	43	NS	25	70	17	33
200ml	62	53	30	25	62	21	12
300ml	81	71	29	30	102	22	23
400ml	63	49	NS	35	83	25	24
500ml	64	51	5	36	89	18	28

WOF - Without footwear, NF - New footwear, OF - Old footwear, NS - Non Slipping

**Table 4:** Castrol oil testing result.

Quantity Liquid/ Person / Footwear	Castrol oil (cm)						
	Person 1	Person 2			Person 3		
	WOF	WOF	NF	OF	WOF	NF	OF
100ml	30	79	NS	NS	55	5	15
200ml	46	56	NS	NS	68	2	3
300ml	59	63	25	28	85	3	17
400ml	60	71	25	30	90	50	36
500ml	64	48	NS	32	98	28	27

WOF - Without footwear, NF - New footwear, OF - Old footwear, NS - Non Slipping

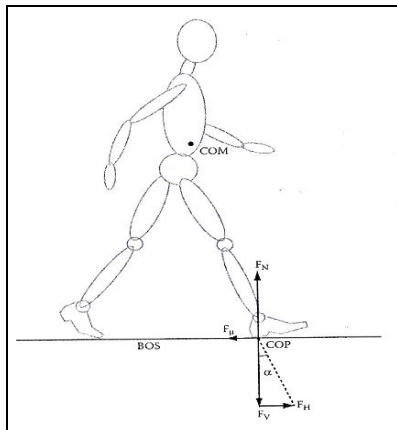
The result from the testing show that by using water as a liquid, there are no slip for person no. 1 and person no. 2. But for the third person, slip occur for him when he is not wear any footwear and with wearing old footwear (Table 2). There are slips potential when the person no 3 wearing old footwear and without wearing any footwear especially by using combination of water and detergent as a liquid (Table 2). For liquids like Sharlu oil (Table 3) and Castrol oil (Table 4), there are some differences compared to water and combination water and detergent as a liquid. This type of oil result in slip for all the three person when they walk without wearing any footwear. However, when wearing old footwear and new footwear, only person no. 2 and person no. 3 face slip during testing.

From the result, there are four main criteria that can be discussed in detail. The first condition is

wearing either new footwear, old footwear or without wearing any footwear. The second criterion is weight of human or person which are the weight of three different person from 65kg, 70kg and 80kg. A third criterion is aging for each person which is the subject no. 1 and no 2 who are 22 years old. However subject no. 3 is 34 years old. Fourth criteria is different type of liquid that were four different type of liquid such as water, water and detergent, Sharlu oil and Castrol oil.

The result shows that human will have high potential to slip and fall when they are not wearing any footwear especially when they are walking on oily surface. On the other hand, if they were wearing new footwear the risk is less compared to wearing an old footwear. This is because footwear became polished during walking on oily and wet floor surfaces. The old footwear will reduce friction.

Coefficient of friction (COF) means the ratio of the weight of an object being moved along a surface and the force that maintains contact between the object and the surface. For this case slip is the opposite of friction. "High slip" denotes low COF and low slip denotes a high COF. From Figure 3 by Roger Haslam and David Stubbs (2006), slip may begin when the ratio of horizontal and vertical force component ( $F_H/F_V$ ) exceeds the Friction force divide the normal Force ( $F_\mu/F_N$ ).



**Fig. 3:** Minimum friction coefficient for slip avoidance based on the equilibrium of force at heel contact. (From Gronqvist, R., Chang, W.R., Courtney, T.K., Leamon, T.B., and Strandberg, L., 2001c, *Ergonomics*, 44, 1102-1117.)

Second condition is the weight of human or person. From the test, it clearly shown that subject no. 3 almost occur slip in every type of liquid and while not wear any footwear and wear an old footwear. However with wearing new footwear sometimes there was slip especially for oily surface but rarely to new footwear. This means that weight of human is a factor to cause a slip and fall incident. When somebody is heavy by weight, that person have high potential to experience slip and fall compare to person who is less heavy by weight. The weight for subject no. 3 is 80kg compare to other persons on who weights 65kg and 70kg. Meaning, when a person is heavy by weight the person might face a balance problem hence difficulty to control or balance of themselves. Besides that overweight also cause lower body weakness and sometime every person have their own style of walking or gait.

Third criterion is aging. These three people have different age which is the first and second person; their age is around 22 years old compare to third person which is 34 years old. Among older people, the risk of falling increases with age. Meaning that older person will have high potential to occur slip and fall compare to younger people. This is because when the person became older, the body strength,

stamina, balance and other risks could be experienced also. As claimed by Bailer, Stout, Reed & Gilbert (2001) that age, sex and frailty is relate to fall.

Fourth criteria is different type of liquid which consisted of four different type of liquid such as water, water and detergent, Sharlu oil and Castrol oil. These type of liquid, oil has high potential to occur slip compare to water and combination water with detergent. Normally when there was spill of water, if the spill of water is not immediately cleaned, after some time the water will dry itself. However if there was spill of oily, after some time it will not dry itself and it will effect of mossy surface. The mossy surface is dangerous for everybody who walks through such an area because oil will adhere on the surface either floor or footwear surface.

### Conclusions:

Slip and fall accidents resulted in permanent serious injuries and fatalities. The effect factors to slip and fall include floor, footwear, cleaning process, human or people and environment. Everyone or all employees who may be required to work in a higher risk area must be trained on the recognition of potential hazards associated with working in a higher risk area and use of control measures to prevent slip, trip and fall related accidents.

### Recommendations:

- Study include both gender among employees in factories, therefore comparison either male or female have a high potential to slip and fall at work place.
- The weight can be expand from 40kg until 90kg would give different results to show the relationship between weights and potential of slip and fall.
- Make a study about slips and falls at school area at the same time can give pupils basic knowledge on slip and fall and teach them to avoid the incidents.

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