



UNIVERSITI
TEKNOLOGI
MARA

F|S|P|U
FACULTY OF ARCHITECTURE,
PLANNING AND SURVEYING

FULL PAPER
PROCEEDING



3RD UNDERGRADUATE SEMINAR

BUILT ENVIRONMENT & TECHNOLOGY

SEPTEMBER
2018

ISBN 978-967-5741-67-8

FACULTY OF ARCHITECTURE, PLANNING & SURVEYING
UNIVERSITI TEKNOLOGI MARA PERAK BRANCH
SERI ISKANDAR CAMPUS

UiTM PERAK @ *Seri Iskandar*

THE INFLUENCE OF DOMINO THEORIES IN PREVENTING CONSTRUCTION ACCIDENTS

Muhammad Afiq Rahiman¹, Noor Aisyah Asyikin Mahat²

^{1,2} Centre of Studies of Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, 40450, Shah Alam, Selangor.

Email: afiq7195@gmail.com¹, nooraisyahasyikin@yahoo.com²

Abstract:

Accident causation is a complex issue, as there are usually several contributing factors that are the root causes of accidents on sites. There are many available theories on the accident causation, and the most influential theories are the Dominos Theories which has been applied and adapted worldwide until today. Although some causes of accidents are known, the underlying factors that bring about accidents are not yet well understood. This research aims to create proactive measure for accident prevention in Malaysian construction industry. Henceforth, the objectives of the research are to investigate the root cause of accidents and to relate the key elements from the Domino theories that influence the accident causation. This research adopted quantitative approach of research methodology. Fifty (50) sets of questionnaires survey are distributed among the Grade G7 CIDB Registered building contractors. The findings highlight the key factors contributing to accident and the crucial attributes from Dominos Theories that relate to safety precaution in construction environment. Critical contribution factor of accident are identified such as human element, unsafe equipment and the job site condition. Factors preventing from accident also has been identified such as enforcement, training & education, involvement of management and safety awareness and promotion. Strategies on hazard prevention and the awareness of safety in construction could actually spur economy in construction as well as to make construction more productive. Ultimately, it will result in the formulation of preventive health and safety policies that can assist industry to reduce accident occurrence on construction sites.

Keywords: Accident; Construction Accident; Domino Theory; Safety

1.0 INTRODUCTION

Construction industry is the most hazardous sector in both developed and developing countries. Despite the contributions to economic growth, construction industry has always been blamed for the high rates of accidents and fatalities. The statistics reported by the Department of Occupational Safety and Health (DOSH), Social Security Organization (SOC SO) as well as the Construction Industry Development Board (CIDB), show the increase in the number of accident fatalities in recent years. This issue has placed the construction industry among the industries with unreasonable rates of accidents, permanent and non-permanent disabilities and even fatalities (Abdul Hamid et al. 2003). Safety at work is a complex phenomenon, and the subject of safety performance in the construction industry is even more so. Although several studies have been conducted to investigate the causes of accident in the construction sites, there is a fact that construction accident causation stop at a premature level to identify the root causes of accidents. Improving safety in construction remains a priority in almost every country around the world because the construction industry stands out among all other industries as the principal contributor to severe and fatal accidents (Ahmed et al. 2000).

Accident causation is a complex issue, as there are usually several contributing factors that are the root causes of accidents on sites (Powell R. et al. 2009). To minimise the number of accidents in the construction industries, it is essential to identify the root causes of accidents by analysing theories of accident causation before proceeding to strategise manuals to implement it. There are various theories of

accident causation that can help people to understand the occurrence of an accident, analyse the causes and later adapt the theories into reality. Accident causation models present factors and processes involved in accidents in order to develop strategies for accident prevention. Major theories of accident causation which are commonly used include Heinrich Domino Theory, Management-Based Theories, Human Error Model, The Swiss 'Cheese' Model and Accident Root Cause Tracing Model (ARCTM) (Sayyed et. Al. 2012). Hence, this research aims to create proactive measure for accident prevention in Malaysian construction industry. Meanwhile, the objectives of the research are to investigate the root causes of accidents and to relate the key elements in the Domino theories that influence the accident causation.

2.0 LITERATURE REVIEW

It is important to know the causes of the accident before the accident prevention takes place. Accident prevention has been defined by Heinrich et al. (1980) as "An integrated program, a series of coordinated activities, directed to the control of unsafe personal performance and unsafe mechanical conditions, and based on certain knowledge, attitudes, and abilities" (Abdul Hamid et al. 2003). Theories and models of construction accidents are evolved based on the enlightenment of how construction accidents occur. According to Mitropoulos T. P (2012), the different models are based on the different perception of the accident process. The adaptive accident prevention theories will be created to prevent an accident from occurring in the construction site. There are many methods and models for examining safety and health occurrence, however, this research only focuses on Domino Theories. There are several domino theories of accident causation such as Heinrich's Domino Theory (1930's), Bird and Loftus's Domino Theory (1976) and Marcum's Domino Theory (1978). Although each Domino theory presents a different explanation for the cause of accidents, they all share one thing in common. Domino theories represent accidents as predictable chronological sequence of events or causal factors. Each causal factor builds on the effects of the others. If allowed to exist without any form of intervention, these hazards will interact to produce the accident (Mark A. Friend et al. 2010). These well-known models are highlighted in this paper because of the recognition and application to the construction industry.

2.1 Heinrich Domino Theory

H.W. Heinrich developed the original domino theory of accident causation in 1930's. Although written decades ago, his works in accident causation still remains the basis for several contemporary theories. Heinrich came out with five dominoes in his model: ancestry and social environment, fault of a person, unsafe act and/or mechanical or physical hazard, accidents, and injury.

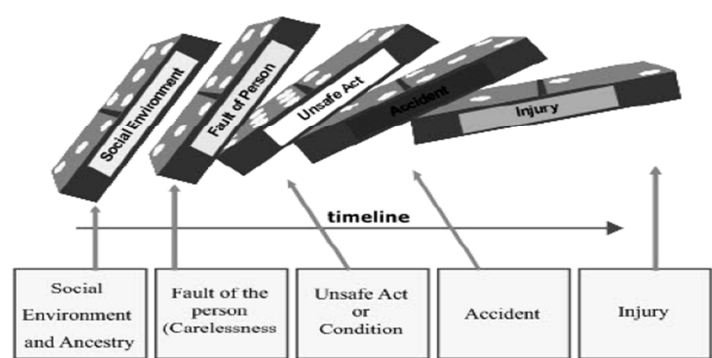


Figure 1: Domino theory of accident causation

Figure 1 shows the illustration of Heinrich Dominos Theory. This five-domino model suggested that through inherited or acquired undesirable traits, people may commit unsafe acts or cause the existence of mechanical or physical hazards, which in turn cause injurious accidents. The two key points in Heinrich's Domino Theory are that (1) injuries are by the action of preceding factors, and (2) removal of the events leading up to the incident, special employee unsafe acts or hazardous workplaces conditions, prevention

of accidents and injuries. Heinrich believed that the unsafe act caused more accidents than unsafe conditions. Therefore, his philosophy of accident prevention focused on elimination unsafe acts and people-related factor that lead to injuries (Sabet et al 2013).

2.2 Bird and Loftus's Domino Theory (1976)

Bird and Loftus (1976) rationalised the "Domino theory" in order to replicate the role of management system or management relationship in the sequence of the accident causes defined by Heinrich (Domino-based model). The main point in this theory is that management is responsible for the safety and health of the employees. The theory also emphasises the contact incidents can be if unsafe act and condition are prevented. The updated and modified sequence of events are, i) Lack of control/management, ii) Basic causes/origins (personal or job factors), iii) Immediate causes/Symptoms, iv) Incident (contact with energy and substance), and v) Loss (property, people, process).

2.3 Marcum's Domino Theory

Figure 2 show the Marcum's Domino Theory of Accident. Marcum's theory focuses on management responsibility for protecting employee's safety as well as preventing the downgrading of an organisation. The theory attempts to examine the management accidents response protocols to ensure that sustained losses and the subsequently incurred cost were minimised. Marcus theory focuses on the human element of misact. The term of misactsidents in Marcus theory emphasizes the fundamental aspect of his accident causation theory. Misactsidents is an identifiable sequence of misacts associated with inadequate task preparation which could lead to substandard performance and miscompensated risks. Marcum also includes the cost aspect of a loss.

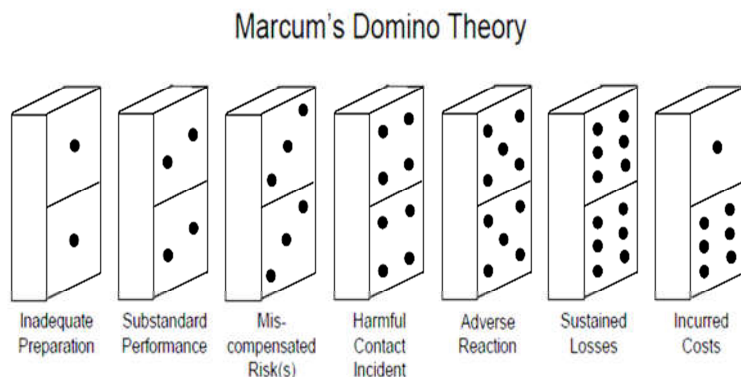


Figure 2 : Marcum's Domino theory of accident causation

According to the revised model of Domino theory that signifies the role of management, the process of incidents begins by the lack of control by management. Planning, controlling, organising, and leading by management are the factors that can prevent incidents from happening (Katsakiori,et al 2009).

3.0 METHODOLOGY

This research adopted quantitative approach of research methodology. Sakaran (2003) states that research methodology as an organised, systematic, critical, scientific enquiry or investigation into a specific problem, undertaken with the objective of finding answers or solutions. The use of qualitative method for data collection may be difficult to get the answer but the data captured are rich. Fifty (50) sets of questionnaires were distributed among the Grade G7 CIDB Registered, building contractor organisations, within the Klang Valley area. The survey covered various aspects of the accident preventions such as the root cause of accidents and the relation of the key elements from the Domino theories that influence the accident causation. From a total of 50 respondents approached, only 35 questionnaires were returned for

analysis. The data gathered was analysed quantitatively. A Software called Statistical Packages for Social Sciences (SPSS) was used to analyse the data. This software enables the data to be transferred automatically from spreadsheet to graphic in order to present the data in more attractive manner. The averaging statistical analysis was also used to calculate straightforward totals, percentages and averages. Qualitative technique was applied to make sense of meanings. Contextualising strategy was used to connect statements, opinion and comments to provide a coherent picture.

4.0 ANALYSIS AND FINDINGS

4.1 Analysis of the Causes of Construction Accident

Table 1: Causes Of Construction Accident

Factors Of Construction Accidents	Mean Deviation	Rank
1. Unsafe equipment	3.61	2nd
2. Job site condition	3.36	3rd
3. Unique nature of industry	2.41	6th
4. Unsafe method	3.23	4th
5. Human element	3.71	1st
6. Management involvement	2.82	5th

Table 1 signifies the overall mean scores of the causes of construction accident. The mean scores indicate the degree of frequency of factors that contribute to the cause of accidents. According to Table 1, human element was rated as the most frequent factors that lead to the construction accident. Human element is related to unsafe act conducted by construction personnel due to inappropriate operative actions such as inadequate of PPE, improper handling object and material, etc.

4.2 The relation of Domino's Theories and accident prevention

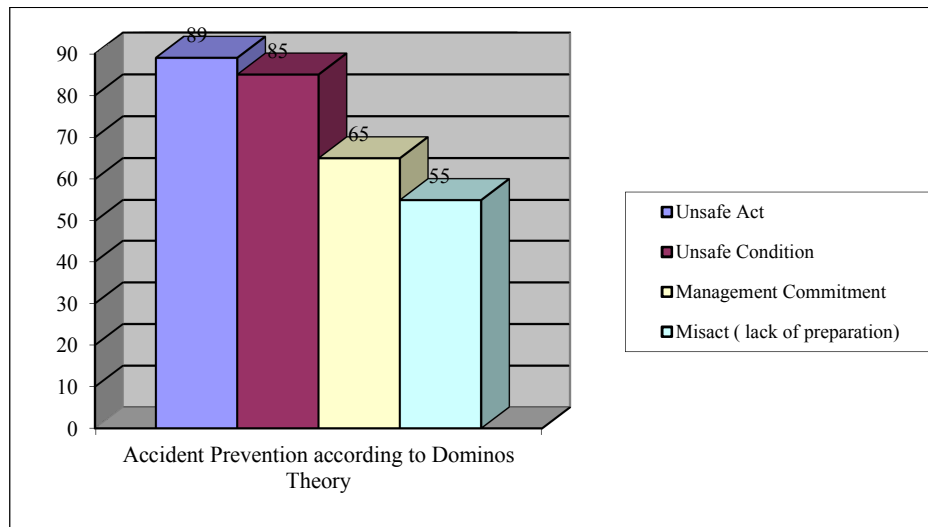


Figure 3 : The relation of Domino's Theories and accident prevention

Figure 3 shows the respondents answer due to their understanding on the relationship of Domino's Theories and accident prevention. From the figure, it is shown that most respondents have cited that the unsafe act (89%) and unsafe condition (85%) are the major influence factors to the accident, while , the management commitment and misact have lower influence factor to the accidents.

4.3 Analysis of the Dominos Theory : Contributing Factors

Table 2 signifies the overall mean scores of the contributing factor to construction accident, in relation to Dominos Theory. The means scores indicate the degree of frequency of factors which contribute to the cause of accidents.

Table 2 : The contributing factors to construction accident, in relation to Dominos Theory.

	Contributing Factors	Mean Deviation	Rank
UNSAFE ACT	Personnel Protective equipment (PPE) are not used accordingly	4.21	1
	Hazardous method of handling equipments	3.65	6
	Improper tools or equipment are used	3.33	8
	Hazardous movement (running climbing over, throwing, etc.)	4.00	3
	Operating without clear instruction or operation.	4.00	3
	Unsafe position / posture	3.15	9
UNSAFE CONDITION	Ineffective safety devices	3.88	4
	Safety devices is not provided	4.12	2
	Hazardous housekeeping	3.70	5
	Equipment, tool and machine are defective	3.88	4
	Improper dress for jobs	3.50	7
	Improper illumination and ventilation	3.50	7

According to Table 2, the unsafe act, contributed by the human element factors such as PPE are not used accordingly, also due to operating without clear instruction and hazardous movement (running climbing over, throwing , etc. or operation. the safety devices is not provided. Besides, workers should familiarise themselves with all potential factors that can lead them to the accident and follow all the rules provided. On the other hand, the highest mean score (4.12) due to unsafe condition which exposes the workers to the incidents most is when the safety devices are not provided to the workers. Defective machine and equipment is also cited as the second highest score (3.88), which later can cause the accident to happen. A safe work environment is important, as it allows a worker to concentrate on the job thus increases the probability that the job will be done correctly.

4.3 Success Factor in Preventing Accident

Referring to Figure 4, the critical success factors in reducing accident in construction site can be opted in four (4) approaches. In order to prevent such hazard, most of the respondents agreed that training and educating workers about safety awareness can be the best approach in reducing accidents. Through training and education, it is believed that it can change the work culture significantly at construction site. Enforcement and management involved were also pointed out in solving hazardous issues in construction. This means that the management plays vital roles in determining successful strategies. Other elements such as promotion and ...awareness also give significant contribution to the strategy itself.

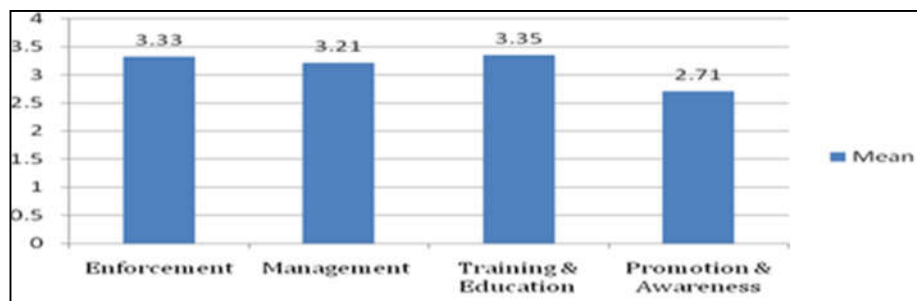


Figure 4: Success Factor in Preventing Accident

5.0 CONCLUSION

Models and theories of construction accidents causation are the basis of explanation how construction accidents occur. There is a variety of theory of accident causations that can help us to understand the occurrence of an accident, analyse the causes and adapt the theories to the reality. Accident causation models present factors and processes involved in accidents in order to develop strategies for accident prevention. Theories and models provide an explanation of why incident and accident occur. These theories and models have considerably increased the understanding of accidents and how they happen. Dominos Theories provides the foundation for accident prevention measures aimed at preventing unsafe acts or unsafe conditions. A worker might perform unsafe acts regardless of the condition of the work (Safe or unsafe condition). Unsafe condition is a condition where workplace and its environment are not safe according to safety and health standards. Unsafe conditions include wrong scaffolding, openings, protruding reinforcement bar and etc. At present, theories of accident causation are conceptual in nature and, as such, are of limited use in preventing and controlling accidents. As much as the management tries to avoid them, they still occur because there are always some lingering risks. The task of the safety professionals is to identify the risk, advise management to reduce or eliminate as much as possible, and continue to monitor and help to ensure that the assets of the company, especially its employees, are free from those hazards.

REFERENCES

- Abdel Hamid, A.R., Yusuf, W. Z. W. and Singh, B., (2003) "Hazards at construction sites." Proceedings of the 5th Asia-Pacific Structural Engineering and Construction Conference (APSEC 2003). 26-28 August 2003 Johor Bahru, Malaysia
- Ahmed, S. M., Kwan, J. C., Ming, F. Y. W., and Ho, D. C. P. (2000). Site Safety Management in Hong Kong. *Journal of Management in Engineering*, (November), pp. 34-42.
- Katsakiori, P., G. Sakellariopoulos, and E. Manatakis, Towards an evaluation of accident investigation methods in terms of their alignment with accident causation models. *Safety Science*, 47(7), pp. 1007-1015
- Mark A. Friend, James P. Khon (2010), *Fundamentals of Occupational safety and Health – 5th edition*, Government Institute: The Scarecrow Press.
- Mitropoulos T. P., Howell A.G, Tariq S. A., (2012), "Accident Prevention Strategies," *J. of Constr. Engrg. & Mgt.*, 135 (5), pp. 407-415
- Powell R., (2009), "The Measurement of Safety Performance," Government of Western Australia Department of Commerce.
- Sabet, P., G., P., et al., (2013) Application of Domino Theory to Justify and Prevent Accident Occurrence in Construction Site", *IOSR Journal of Mechanical and Civil Engineering*, 6(2), pp. 72-76.
- Sekaran, U. (2003). *Research Methods for Business: A Skill Building Approach* (4th edition). New Jersey: John Wiley and Sons
- Seyyed S.H, Zahra J. T, (2012) "Major Theories of Construction Accident Models : Literature Review", *International Journal of Advances in Engineering & Technology*, 4(2), pp. 53-66