

Safety Devices Compliances Study: Liquid Fuel Dispenser Area of Petrol Stations in Terengganu

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ABSTRACT : *There were several cases of industrial accidents recorded at petrol stations recently. The need for a standard guideline for Occupational Safety and Health (OSH) compliance has become vital to petrol station operators. Among the aspects of OSH to be considered are installing safety devices on every hardware or equipment associated with fuel loading, storage, and distribution systems at petrol stations. Therefore, a study was conducted on petrol station operators in Kuala Terengganu to assess compliance with installing safety devices using the Department of Occupational Safety and Health Malaysia (DOSH) checklist. In addition, the factors behind the non-compliance were also reviewed and used as the basis for the establishment of a standard guideline for petrol station operators throughout the country. The study's outcome found that the safety device installation compliance is good at fuel loading. In contrast, some important safety devices were not installed and maintained well in the storage and distribution section. The current procedures for the construction of petrol stations should be reviewed to ensure that all required safety devices are installed before the station begins to operate.*

Keywords - *Fuel Dispenser, Occupational Safety and Health (OSH), Petrol Station, Safety Devices*

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1.0 INTRODUCTION

In the United States, petrol stations are known as gas stations, and there is a total of 121,446 stations throughout the country as in 2012 (Pierce, 2014). Meanwhile, in 2014 China had some petrol stations of 99,000 operating in the country (Research in China, 2015). Based on a report by the Ministry of Domestic Trade, Co-operatives and Consumerism Malaysia (MDTCC), there were a total number of 2,883 petrol stations as of December 2017. Fig. 1 shows the number of petrol stations in Malaysia as of December 2017. The increasing number of vehicles every year reflects the high demand for petrol stations.

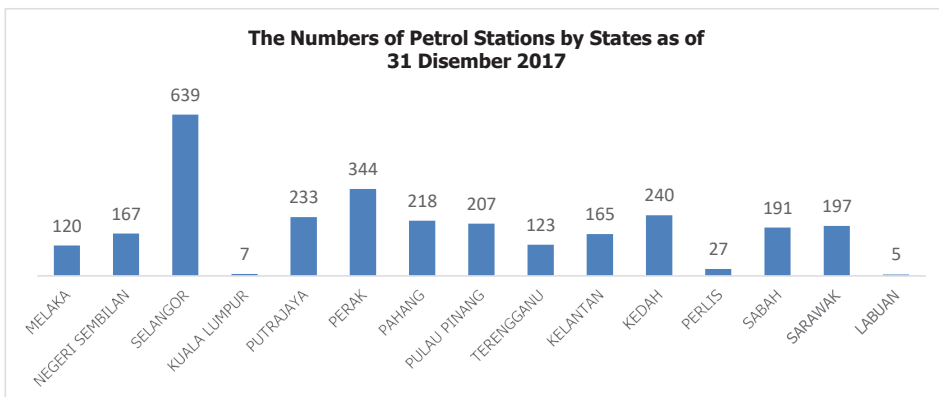


Figure 1 The Number of Petrol Stations in Malaysia by States in 2017 (MDTCC, 2017)

Petrol stations are considered hazardous and high-risk areas, whether aboveground or underground. Most research focused on chemical exposure, such as Volatile Organic Compound (VOC), Toluene, and Xylene (Zhang, 2014). Shamsuri et al. (2017) elaborated on the workers’ perception of the fire risk and there is a need among workers to understand the fire risk perception towards petrol stations. An experimental study was conducted by Frobese et al. (1995) on the underground tanks during the unloading process at the petrol station. The experiment found that the air entering the tank during fuel delivery diluted the gas atmosphere in the tank, and the upper explosion limit is not reached in explosive partial volumes. The explosive characteristics of the partial volumes were influenced by the impulse created by the incoming airflow. Therefore, the maximum permissible rate of 200 L/min is required to ensure a smaller explosive material partial volume created during fuel transfer to the underground tank (Frobese, 1995).

In one of the published standards, the US-based National Fire Protection Association (NFPA), (NFPA 30 Section 21.3.4) stated that the tank designed aboveground should not be used as an underground tank (NFPA, 2018). Petrol station incidents can be disastrous if there is a lack of safety measures during construction planning and operation. From 2004 to 2008, the United States Fire Department responded to an average of 5000 fire cases in petrol stations. These fires caused an annual average of two civilian deaths, 48 injuries, and 20 million dollars in indirect property damage (Evarts, 2011). The gas station explosion in Ghana killed around 100 people (The Guardian, 2015). The accident at a petrol station in Gua Musang, Kelantan, in April 2016 claimed one fatality and injured several others. The failure of the level indicator in an underground storage tank during the fuel unloading process from the road tanker caused the oil spillage to flow to the adjacent food stall, and it suddenly caught fire. The flame burnt the customers eating at the kiosk, causing one death and injuring several others (The Star Online, 2014). Currently, in Malaysia, there is no study conducted on the compliances and the fitting (please check factual context) of the safety devices at the fuel filling station. In addition, there is no standardization regarding the installation of safety devices at a petrol station. Therefore, this study was undertaken to evaluate the noncompliance factor by petrol station operators.

2.0 METHOD

Data collection involved all petrol station operators in Kuala Terengganu as of December 2017 through a survey using the inspection checklist on the installation of safety devices. A total of 32 petrol stations operators in the district of Kuala Terengganu, represented by five oil companies; PETRONAS, SHELL, PETRON, Caltex, and BHP Petrol, were involved in this study.

The proportion of operating petrol stations in Kuala Terengganu is shown in Fig. 2, which clarified that 31.3% or ten operators chose SHELL as their brand, 28% or nine picked PETRONAS, 22% or seven chose Caltex, and 3% or one operator chose BHP Petrol. SHELL, PETRONAS, and Caltex have been involved in Malaysia's petroleum retail market for decades, and this is proven by the number of petrol stations carrying their brand.

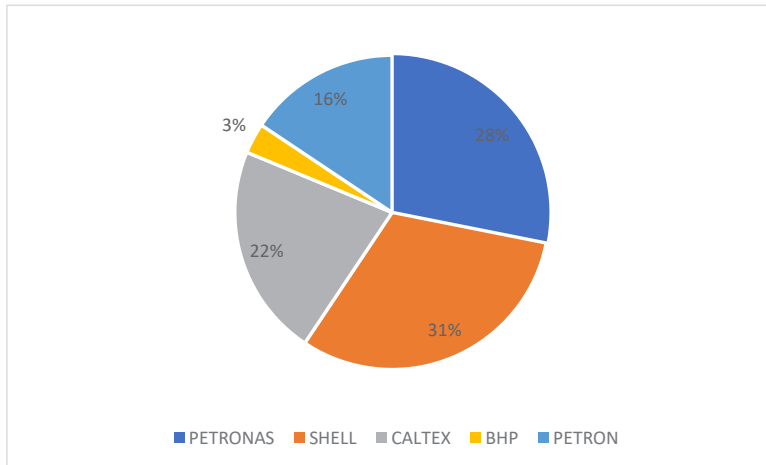


Figure 2 Brand of Petrol Stations in Kuala Terengganu

2.1 DOSH Inspection Checklist

This study emphasized the use of DOSH's inspection checklist as one of the tools for data collection. The data extracted from the same checklist was used as a stand-in for the site visit for data collection. The inspection checklist was issued by the Petroleum Safety Division (PSD) of the Department of Occupational Safety and Health (DOSHS) Malaysia. The output of each element in the checklist was divided into 'Yes' or 'No'. If the petrol station complies with the element, the output will be marked as 'Yes', and if it contradicts, the output is 'No'.

2.2 Checklist for Data Collection

The checklist used for data collection is the simplified version compared to the inspection checklist used by DOSHS. The data collected for the compliances of safety devices was divided into five sections: Part A: Demographic Profile, Part B: Unloading from Tanker, Part C: Underground Storage System, Part D: Fuel Dispensing Area, and Part E: NGV Dispensing Area.

2.3 Statistical Analysis

Statistical analysis is used to analyze the collected data from the study. Generally, two types of research can be conducted in descriptive and inferential statistics (Saunders & Brown, 2008). Descriptive statistical analysis is preferred to analyze the collected data since the data is captured in binary types of output, which are 'Yes' or 'No'. The frequency analysis, which is part of a descriptive statistic, will be conducted using the collected data to see the pattern of the safety devices compliances by comparing it with the demographic profile of the study. Data analysis will be conducted using the IBM SPSS Software version 21.0.

3.0 RESULTS AND DISCUSSION

The study found that most petrol stations in Kuala Terengganu have been in operation for more than ten years. For example, Fig. 3 shows that 69% or 22 petrol stations were in operation for more than ten years, 25% or eight have operated between 6 to 10 years, and only 6.3% or two petrol stations started their operation in the last five years.

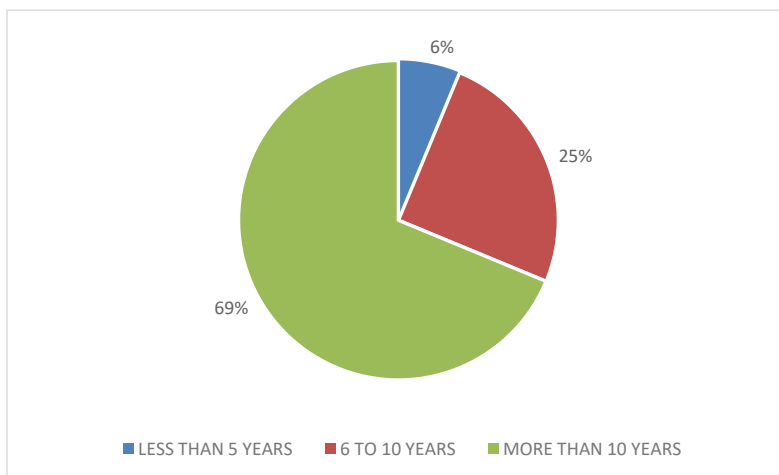


Figure 3 Years of Operation of Petrol Stations in Kuala Terengganu

Some of the owners of the petrol stations, which have operated for more than ten years, inherited the ownership from their parents as most of the petrol stations in Kuala Terengganu are set up as a family business.

Fig. 4 portrays the overall type of petrol station ownership in Kuala Terengganu arranged by the brand. In Malaysia, there are three types of petrol station ownership available: Company Owned Company Operated (COCO), Company Owned Dealer Operated (CODO). The DODO and CODO ownership type shared an equal portion in the total numbers of petrol stations 16 to 16. In addition to that, there are no COCO ownership type petrol stations in Kuala Terengganu. PETRONAS has the highest CODO ownership, and BHP Petrol and Caltex only have DODO-type petrol stations.

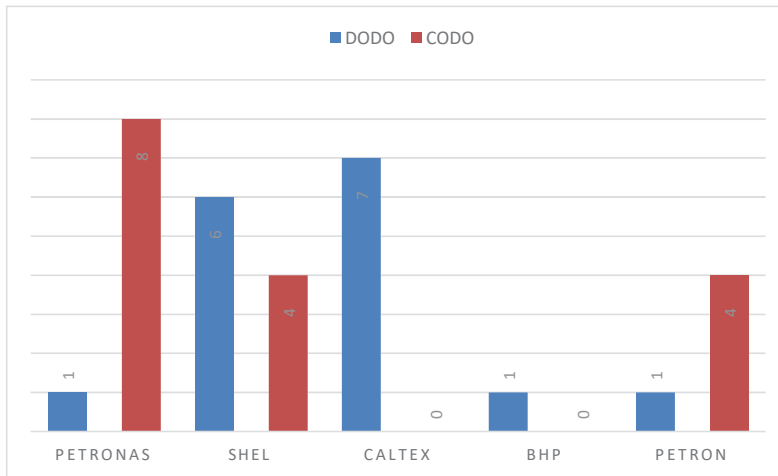


Figure 4 Types of Ownership for Petrol Stations in Kuala Terengganu

PETRONAS does not offer DODO ownership in Malaysia (Kiat, 2014), but the data collected shows that one PETRONAS petrol station has DODO in Kuala Terengganu. The petrol station has been in operation since 1990. Further research found that it was an initiative by the government of Malaysia through PETRONAS to adopt independent (no brand) local bumiputra petrol station operators that serve the rural community. However, the program was not available anymore since companies are focusing on small outlets in rural areas, such as Buraqoil (IPTB Sdn. Bhd.) and Smart Stream Resources Sdn. Bhd. There is no COCO-type ownership in Kuala Terengganu. This is in line with the study conducted by T. Kiat in 2014, which indicated no COCO typed petrol stations in Malaysia (Kiat, 2014).

Part D of the checklist evaluates the safety devices at the liquid fuel dispensing area. The fuel dispensing area is the point of fuel distribution to the public from the underground storage tank. The frequency analysis of data is listed in Table 3.

Table 3 Frequency Analysis Results of Elements in Part D

		Part D: Fuel Dispenser Area	
No.	Inspection Element	Compliance (%)	
		Yes	No
D1	Dispenser / Pump Anchoring Grounding to Earth	100	0
D2	Dispenser / Pump Anchoring Free from corrosion damage	97	3
D3	Dispenser Sump Containment Integrity (free from cracks, bulges, holes)	100	0
D4	Emergency Stop Button at each dispenser availability	63	37
D5	Emergency Stop Button clearly labelled	59	41

D6	Emergency Stop Button at each dispenser functionality	31	69
D7	Nozzle sensor functioning properly.	100	0
D8	Nozzle Splash Guard availability	81	19
D9	Valid breakaway (expired date) Manufacturer: (OPW / etc.)	69	31
D10	Bollards are in place to protect against vehicle impact	59	41
D11	Oil floor trap available at each dispenser and flow is not interrupted to oil interceptor.	47	53
D12	Oil floor trap is available, and flow from oil floor trap is not interrupted	81	19

All of the petrol station operators in Kuala Terengganu complied with items D1, D3, and D7, while more than 80% complied with items D8 and D12. Item D4 stated that 37% or 12 petrol station operators did not install the emergency stop button at each dispenser unit. Most of the emergency buttons were only located at the cashier counter inside the sales building. The latest model of fuel dispensers is equipped with the emergency stop button both at the counter inside the sales building and the dispensers' point.

Item D5 indicated that 41% or 13 of the petrol stations did not clearly label the emergency stop button at their premises. Most of the petrol stations which did not label the emergency button were equipped with the old model of the fuel dispensers, where the emergency buttons were located inside the sales building at the cashier's section.

The functionality of the emergency stop button must frequently be tested to ensure readability when it is needed. However, based on the collected data in item D6, 69% or 22 of the petrol stations failed to ensure the functionality of the emergency button for the fuel dispensing system. It will become a catastrophic event if the emergency stop button is not working when an accident occurs.

Item D9 evaluates the breakaway hose integrity at the dispenser point. There were 31% of non-compliance recorded for item D9. Evaluation on item D10 indicated that 41% or 13 petrol stations did not have a bollard at their premises. A bollard is the passive safeguarding to protect against vehicle impact to the dispenser's pump unit. The bollard can be made of concrete or steel structure. In Malaysia, no requirement or regulation emphasizes bollard installation during the construction of a petrol station building. There were several cases reported involving vehicles ramming into dispenser pumps which led to injury and property damage. The most recent case was reported in Melaka, where a car accidentally rammed into a petrol pump and caused fuel spillage, but no injury was reported (Nur Saliawati Salberi, 2018).

Lastly, Item D11 assessed the availability of the oil floor trap at each dispenser. The flow from the oil floor trap to the oil interceptor must not be blocked to ensure the best functionality of the system. The data collected for Item D11 indicated that 53% of 17 petrol stations failed to ensure the oil floor trap system was in good condition. The function of the oil floor trap is to prevent any fuel spillage during the filling process is not directly discharge to the environment. Therefore, proper maintenance programs need to be established and supervised to ensure the system functions per designated purposes.

A cross-tabulation analysis was conducted for item D4 to see the significant relationship between the compliances and the population's demographic profile. Table 4 shows the Cross-tabulation Data of Item D4 and Demographic Profile for Item D4. The analysis result indicated only PETRONAS and SHELL brand operators have 100% compliance for emergency stop button availability at each dispenser point. While Caltex and BHP Petrol branded operators were 100%, PETRON branded operators stated 80% non-compliance for item D4.

Table 4 Cross-tabulation Data of Item D4 and Demographic Profile for Item D4: Emergency Stop Button at Each Dispenser Availability

	Brand of Petroleum Product					Total
	<u>PETRONAS</u>	<u>SHELL</u>	<u>CALTEX</u>	<u>BHP</u>	<u>PETRON</u>	
NO	0	0	7	1	4	12
YES	9	10	0	0	1	20
Total	9	10	7	1	5	32

	Years of Operation			Total
	<u>Less Than 5 Years</u>	<u>6 To 10 Years</u>	<u>More Than 10 Years</u>	
NO	0	1	11	12
YES	2	7	11	20
Total	2	8	22	32

	Types of Ownership		Total
	<u>DODO</u>	<u>CODO</u>	
NO	9	3	12
YES	7	13	20
Total	16	16	32

The cross-tabulation analysis was conducted for item D5 to see the significant relationship between the compliances and demographic profile of the population. Table 5 shows the Cross-tabulation Data of Item D5 and Demographic Profile for Item D5. The analysis result indicated only SHELL brand operators have 100% compliance for emergency stop button labeling. While Caltex and BHP Petrol branded operators were 100%, PETRON branded operators stated 60% non-compliance for item D5. The CODO petrol stations have a better non-compliance at 25% than DODO at 56% non-compliance for item D5.

Table 5 Cross-tabulation Data of Item D5 and Demographic Profile for Item D5: Emergency Stop Button Clearly Labeled

	Brand of Petroleum Product					Total
	<u>PETRONAS</u>	<u>SHELL</u>	<u>CALTEX</u>	<u>BHP</u>	<u>PETRON</u>	
NO	2	0	7	1	3	13
YES	7	10	0	0	2	19
Total	9	10	7	1	5	32

	Years of Operation			Total
	<u>Less Than 5 Years</u>	<u>6 To 10 Years</u>	<u>More Than 10 Years</u>	
NO	1	1	11	13
YES	1	7	11	19
Total	2	8	22	32

	Types of Ownership		Total
	<u>DODO</u>	<u>CODO</u>	
NO	9	4	13
YES	7	12	19
Total	16	16	32

Based on the cross-tabulation analysis, SHELL branded petrol station operators are better at 30 % non-compliance with the emergency stop button functionality. Table 6 indicates the Cross-tabulation Data of Item D6 and Demographic Profile for Item D6. While another operator; - PETRONAS 89%, CALTEX 100%, BHP Petrol 100% and PETRON 60% of non-compliances.

Table 6 Cross-tabulation Data of Item D6 and Demographic Profile for Item D6: Emergency Stop Button at Each Dispenser Functionality

	Brand of Petroleum Product					Total
	<u>PETRONAS</u>	<u>SHELL L</u>	<u>CALTEX</u>	<u>BHP</u>	<u>PETRON</u>	
NO	8	3	7	1	3	22
YES	1	7	0	0	2	10
<u>Total</u>	<u>9</u>	<u>10</u>	<u>7</u>	<u>1</u>	<u>5</u>	<u>32</u>

	Types of Ownership		Total
	<u>DODO</u>	<u>CODO</u>	
NO	10	12	22
YES	6	4	10
<u>Total</u>	<u>16</u>	<u>16</u>	<u>32</u>

	Years of Operation			Total
	Less Than 5	6 To 10	More Than 10	
	<u>Years</u>	<u>Years</u>	<u>Years</u>	
NO	2	6	14	22
YES	0	2	8	10
<u>Total</u>	<u>2</u>	<u>8</u>	<u>22</u>	<u>32</u>

The cross-tabulation analysis stated that the petrol stations operators that did not comply with item D9 were PETRONAS 44%, SHELL 30%, and Caltex 43 %. Table 7 shows the result of cross-tabulation analysis for Item D9 and Demographic Profile. In addition to that, BHP Petrol and PETRON operators were all complied with item D9.

Table 7 Cross-tabulation Data of Item D9 and Demographic Profile for Item D9: Valid Breakaway

	Brand of Petroleum Product					Total
	PETRONAS	SHELL L	CALTEX	BHP	PETRON	
NO	4	3	3	0	0	10
YES	5	7	4	1	5	22
Total	9	10	7	1	5	32

	Years of Operation			Total
	Less Than 5 Years	6 To 10 Years	More Than 10 Years	
NO	0	4	6	10
YES	2	4	16	22
Total	2	8	22	32

	Types of Ownership		Total
	DODO	CODO	
NO	5	5	10
YES	11	11	22
Total	16	16	32

The cross-tabulation analysis was conducted for item D10 to see the significance of compliance and the demographic profile. Table 8 shows the Cross-tabulation Data of Item D10 and Demographic Profile for Item D10. PETRONAS and SHELL branded operators contributed to most of the non-compliance to the item at 67% and 50% operators, respectively. At the same time, nine CODO operators contributed to the non-compliance of bollard availability at dispensers' island.

Table 8 Cross-tabulation Data of Item D10 and Demographic Profile for Item D10: Bollards are in Place to Protect Against Vehicles Impact

	Brand of Petrol Station					Total
	PETRONAS	SHELL L	CALTEX	BHP	PETRON	
NO	6	5	1	1	0	13
YES	3	5	6	0	5	19
Total	9	10	7	1	5	32

	Years of Operation			Total
	Less Than 5 Years	6 To 10 Years	More Than 10 Years	
NO	2	4	7	13
YES	0	4	15	19
Total	2	8	22	32

	Type of Ownership		Total
	DODO	CODO	
NO	4	9	13
YES	12	7	19
Total	16	16	32

The cross-tabulation analysis was conducted to see the pattern of non-compliance of item D11. Table 9 shows the Cross-tabulation Data of Item D11 and Demographic profiles for Item D11: The oil floor trap available at each dispenser, and

flow is not interrupted to oil interceptor. Based on the data, 12 or 38% of total non-compliance was contributed by the petrol operation are in operation for more than ten years.

Table 9 Cross-tabulation Data of Item D11 and Demographic Profile for Item D11: Oil Floor Trap Available at Each Dispenser and Flow is Not Interrupted to Oil Interceptor.

	Brand of Petrol Station					Total
	PETRONAS	SHELL	L	CALTEX	BHP	
NO	7	5	2	1	2	17
YES	2	5	5	0	3	15
Total	9	10	7	1	5	32

	Types of Ownership		Total
	DODO	CODO	
NO	6	11	17
YES	10	5	15
Total	16	16	32

	Years of Operation			Total
	Less Than 5 Years	6 To 10 Years	More Than 10 Years	
NO	1	4	12	17
YES	1	4	10	15
Total	2	8	22	32

4.0 CONCLUSION

The need for a standardized guideline for installing a safety device is vital to ensure the level of compliances can be equally monitored and enforced by law enforcement agencies or the authorities. Besides that, it also helps the petrol station operators, oil companies, or independent retailers to have all required safety devices since currently, they are following the guidelines or requirements provided by the oil companies. Some critical elements such as overfill protection devices and emergency stop buttons at dispenser points indicated a low level of compliance. There was some significant pattern that can be outlined between the element's compliances and the population's demographic profile.

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