Adeleke University Journal of Engineering and Technology

[AUJET] Vol. 2, No 3, 49-60 (2019)

aujet.adelekeuniversity.edu.ng

ISSN: 2714-2450

Development and Evaluation of Land Use Planning Framework Based on Major Accident Hazard Facility

Qaeem M.[1] , Rashid Z.A.[1], Babamale H.F.[3,4], Busari Y.O.[5], Alizada A.M.[2]

[1]Faculty of Chemical Engineering
[2]Faculty of Civil Engineering
Universiti Teknologi MARA, 40450 Shah Alam Selangor
[3] Industrial Chemistry Department,
[5]Materials & Metallurgical Engineering Department,
University of Ilorin, Ilorin, Nigeria
[4]School of Chemical Sciences, Universiti Sains Malaysia. 11800, Gelugor Pulau Pinang.
Corresponding Author: *yusuff_busari@yahoo.com*

ARTICLE INFO

Received: October / 2019
Revised: October / 2019
Accepted: November / 2019
Published: December / 2019

Keywords: *Major Hazard Facility(MHF),Framework, Environment , Risk management , Checklist.*

ABSTRACT

The identification of more hazard facilities with respect to land use planning (LUP) to solve the adverse consequences that threatens nature and human life. There is an urgent need for better understanding of the current regulations and frameworks of major hazard facility (MHF) siting in order to adapt a strategic approach for LUP and preventing major accident hazards. This research aims to develop a checklist/framework to study LUP- MHF and validate its effectiveness with practical use in LPG's site planning. The results of applying this checklist in five LPG siting facilities in Malaysia which stored more than 50 tons in their premises and comparison with various standard of consequence-based method (CBM) applied from several countries show that most of the receptor below 100 m will be exposed to high lethality. However, degree of lethality is reduced when the distance of the receptor is increased. Based on results, French method is more stringent compared to Italy and Malaysia. According to findings from library – based research and practical use of developed checklist/framework in MHF-LUP, the Malaysia method is similar to UK standards that should be revised because there is increasing of 6.67% of the people around the LPG vicinity that could be mentioned as unsafe. The research suggested that to impose additional criteria in between 4 - 12.5 kW/m^2 as practiced currently in Malaysia. The iterative cycles of evaluation and assessing the consequences of a number of scenarios, which then serve as a reference for the determination of protection zones around the installation is also suggested to avoid Domino-Effect.

1. INTRODUCTION

Different approaches were developed for land use planning (LUP) by the member states of the directive 96/82/EC (the so-called, Seveso II Directive). However, this study found the urgent need for developing new framework for LUP, because there is no standard for LUP and each country has special method.

The risk of major accident hazards (MAH) is eminent and such has resulted into putting "personnel, production, capital investment and corporate reputations at risk" and leads to a dangerous threat to the environment (Dalzell, 2003). MAH as "a major emission, fire or explosion, leading to serious danger to human health and/or the environment, immediate or delayed, inside or outside an establishment, involving one or more dangerous substances". In another segment where the MAH has been viewed like in the oil, gas and chemicals industries as substances with high consequences and these includes major fires, explosions and toxic releases (Anderson, 2005). The issue of MAH comes as a result of the risk and danger it portends to the health of the public as well as the land itself. It then becomes obvious that the community/government through the respective department and agencies have to protect the societies from the hazardous substances within the industries. The development of the society cannot progress without putting the necessary measures meant to protect the community safety and from the industrial risk (Venart, 2004). In every developed society, the interest and safety of the public is considered, particularly on hazardous environment. The health factors become imminent and such could not be compromised (Stuart & Dexter, 2006) .

However, the causes of major accident happen to be an issue of an industrial safety connected occurrences, this is because the measures put to prevent the occurrences of such incidents are unsuccessful. This can be seen as the incidences associated with the work, the risk and the absence of the usage of the protective measures by the users and therefore affects not only the work place but all the environment. (Dalzell, 2003). The designs must be in line with policy so as to provide affordability and environmental sensitivity that support the use of information and communication technology, particularly in the area of geographical information system which has provided guidance in developing the physical features and presentation of the outcomes of the LUP integrating system (El-Harbawi, et al., 2010).

It is crucial at this point to highlight that planning belong to places and people which differs. There are plans that are already for the old, new and the future developed cities. This is connected with the realities of the need of the people. To ensure the conservation of the places, such as neighborhood, business area and parks. Though, the plans as highlighted varies because of the differences in people, culture, age and plus ethnicity and urban renewal of environment (khudbiddin, et al., 2018).

In Europe, looking at the vast environment, which further identify the use of large amounts of dangerous chemicals in the continent which are unavoidable in most of the industries and particularly those that are vital for a modern industrialized society. Then, it becomes essentials for the Seveso to ensure the minimization of the related risks. Therefore, the need to measures necessary to prevent major accidents becomes crucial and to also ensure appropriate preparedness and response should such accidents nevertheless happen (Burlando, 2012).

The LUP in Canada is rapidly developing, particularly in the States, recently, the community of Ontario proposed an amendment on the latest Bill introduced by the government for regulation conservation. The purposes of the Bill were to brings significant changes creating a better community and conservation in the land use planning system. Canada has never experienced the MAH, this may perhaps because of the efficient policies in the country. (Queen’s Team Project , 2009)

The regulation on major accident hazards in Singapore is new. It was recently enacted the new regulation under the workplace safety and health Act (Chapter 354 A). The comparison of the practices of LUP indicates a centralized system of regulation that aims at compliance by the respective countries and stakeholders. The LUP provides specific guidelines for the land planning which is meant to provide safety to the public and environment. The operation of MAH under the LUP based on the policy of a respective jurisdictions. Although, there are regulations which are internationally adopted by countries, still the objective is similar in regulation LUP and MAH. Priority is given to jurisdiction, though compliance counts, but the concern is the strengthen efforts by the countries in regulation and applicability of LUP in MAH. (Occasional Safety and Health Act 1994, 1996).

2. METHODOLOGY

The research design is based on four research objectives and has four phases. The combination of two methodologies based on characteristic of each phase of the study, the first phase was the investigation of MAH and provisions of LUP under the Seveso II Directive; the library research method for review of literature was considered. Then, a proper checklist and framework based on findings of library research was developed and its effectiveness with the practical use of this framework in identifying the real hazard accident was measured. Finally, based on the findings of reviews and identification of MAH scenarios, the suggestions for improving MAH-LUP process and hazard risk reduction was provided in this research process.

2.1 **Library Research Method**

The investigation about the guidelines, regulations and other characteristics of this study can be achieved through library-based research (Liamputtong, 2005).

This study will use the framework for identification of MAH with respect to LUP as part of a risk management policy. The principle behind LUP is that incompatible activities, such as handling of dangerous substances and residential areas, should be separated by sufficient distances.

These distances should be proportional to the level of risk confronted by the receptors. For that reason, and according to Article 12 of the Seveso II Directive, it is necessary to assess the level of risk remaining after the safety measures have been applied in the installation (residual risk). Although it is agreed that risk is the likelihood of occurrence of unwanted consequences from an accident (Seveso II Directive), the methods for addressing this risk vary among the different countries, due to different cultural and historical background and administrative frameworks. From the methodological point of view, a few countries have adopted simplified criteria based on “safety distances” between residential areas and industrial sites (khudbiddin, *et al*., 2018).

2.2 Review LUP Policy, Guidelines and Regulations Local and International

The main part of library research in this study is related to review of LUP policy, guidelines, local and International regulations. This review will help to develop MHF –LUP checklist and framework (Tugnolai *et. al*. 2012). To apply the Seveso II directive requirements and to develop a system on the control of major-accident hazards involving dangerous substances, the Member States have built a risk management policy combining several tools. This study conducted detailed investigation of these policies with comparison of their framework. This process helped the study to understand the control of major accident hazard and suggest solutions for improvement of LUP- MAH process.

2.3 Checklist and Framework for MHF Sitting

The six key criteria, according to the guidelines on MAH-LUP issued by France LUP-MAH policy (Oliver, 2012), were adopted in order to consider a framework for "facility sitting” that provides an assessment of occupied buildings given potential exposure to explosion, fire and toxic hazards.

2.4 Validity of Developed Framework and Checklist

In order to validate the developed framework, it will be applied on LPG stockiest facilities operated in Malaysia. Based on this framework, detailed information on the MHF are needed for calculation on the consequences of LPG accident at the locations as shown in Table 1 Their impacts and the thermal consequences analysis were carried out. There are several models applied to determine the heat intensity value (kW/m^2) from the LPG accident such as BLEVE fireball model (CCPS,1999 and TNO,2015).

Adeleke University Journal of Engineering and Technology
[AUJET] Vol. 2, No 3, 49-60 (2019)
aujet.adelekeuniversity.edu.ng
ISSN: 2714-2450

Table 1: Checklist of Major Hazard Facilities CBM Analysis

No	Address	Surrounding Area	Consequences Analysis			Vulnerability Analysis			Consequence based method CBM)				
			Human TLV, PEL, etc. Building structure or asset										
1-n	i. Name of company ii. Longitude and Latitude iii. Detailed location	i. Object located surrounding the MHF (north, south, west, east)	Thermal radiation effect (kW/m^2)	Heat load	Over pressure (kPa)	First degree burn	Second Degree burn	Lethality	(i)	(ii)	(iii)	(iv)	(v)
			BLEVE Fireball, etc.		TNT Equivalent TNO	Probity	Probity	Probity	Refer to Step 1				

Since the degree of LPG hazard depends on several factors, therefore information such as the quantity of substances released, the rate of gas release, physicochemical properties of LPG release, flammability and toxicity must be obtained. In order to get this data, detailed safety data sheet in developed checklist is used to identify the LPG characteristics. Based on the Malaysia's market, the domestic LPG is a non-toxic, colourless and clean burning gas. Commercial LPG marketed in Malaysia consists of 70% Butane and 30% propane. They are in vapour form at ambient temperature and they are condensed to liquid state by application of moderate pressure and simultaneous reduction in temperature. Detail on physical and chemical properties are shown in Table 2.

Table 2: Physical and Chemical Properties of Malaysia Domestic LPG

Physical properties	**Physical properties of the major components of LPG**		**Commercial (substance)**
	Propane	**n -butane**	**LPG composition: (Propane butane)**
Chemical formula	C_3H_8	C_4H_{10}	
Molecular weight	44.097	58.124	> 44
Boiling point at 101.3kPa (°C)	-42.1	-0.5	>-40
Liquid density at 15°C (kg/m^3)	506	583	547
Vapour pressure at 40°C (kPa)	1510	375	380-830
Flash point (°C)	-104	-60	
Upper explosive limit (per cent vol)	9.5	8.5	
Lower explosive limit (per cent vol)	2.3	1.9	
Auto ignition temperature (°C)	450	405	
Vapour volume produced by 1l liquid at 15°C, and 101.3kPa (litres)	269	235	
Vapour density (air = 1)	1.551	2.07	
Specific heat of the gas (at 15.6°C) and 1atm	1.625	1.671	
C_p(kJ/kg°C)	1.436	1.528	

C_v(kJ/kg°C)	1.131	1.094	
Ratio of specific heats, (C_p/C_v)	0.94	1.39	1.13
Heat combustion (kJ/kg)	46,350	45,750	46,013

Note: - Commercial LPG in the market normally consists of propane and butane with 30 percent and 70 percent in composition respectively.

For 30 kg of 1 cylinder that store LPG, the mass of LPG in the cylinder is in the range of 14 kg. in this study, the range of quantity applied in calculation are between 14 kg to 50 000 kg (50 tonnes) as total limit value under CIMAH Regulation 1996. For consequences analysis, there are two threshold limit value used in calculation. First for thermal radiation effects, (kW/m^2), the model calculations are as below: -

2.4.1 Height and Duration of fireball

The height and duration of the fireball was obtained using equation 1:

$$D = b_1 M^{b2} (1)$$

Where:
D is the diameter of fireball (m)
M is the mass of fireball (kg) and b1, b2 are parameters

$$t = c_1 M^{c2} \quad (2)$$

Where:
t: Duration of fireball (sec)
M: Mass of fireball (kg)
C_1, C_2: parameter

Meanwhile, height of the fireball is calculated when the fireball reached ¾ of the maximum diameter by using as follows:

$$H=0.75Dmax(3).$$

Table 3: List of Models for BLEVE Geometric Parameter

Model	Maximum Diameter (m)	Duration (s)	Bottom Height (m)
Brassie	$3.8m^{0.333}$	$0.30m^{0.333}$	-
Marshall	$5.5m^{0.333}$	$0.38m^{0.333}$	-
Gayle I	$3.68m^{0.326}$	$0.245m^{0.356}$	-
Gayle II	$6.14m^{0.325}$	$0.41m^{0.340}$	-
Roberts	$5.8m^{0.333}$	$0.45m^{0.333}$	$0.5D_{max}$
Moor house	$5.33m^{0.327}$	$0.923m^{0.303}$	$0.5D_{max}$
TNO	$6.48m^{0.325}$	$0.852m^{0.260}$	$0.5D_{max}$

2.4.2 *Static model method is applied to determine heat radiation from BLEVE events as following,*

i. Calculate the heat flux by:

$$E = F_{rad} M \Delta H_c / \pi (D_{max})^2 tBLEVE \quad (4)$$

where R or F_{rad} or F_{21}, (dimensionless) is the radiation fraction and H_c (kJ/kg) is the heat combustion for fuel being used.

ii. Assume R or F_{rad} or F_{21} = 0.3 or calculate using the following equation as follows: -

$$F_{21} = \frac{D_{max}^2}{4r^2} \quad (5),$$

$$\text{or,} F_{rad} = 0.00325 . P^{0.32} \quad (6)$$

where P is the pressure in the vessel just before the explosion, in N-m $^{-2}$or

$$F_{21} = L\frac{D^2}{2} L2 + HBLEVE23/2 \qquad (7)$$

iii. Determine the thermal heat flux received by the receptor by using Eq.8 as shown below; -

$$Er = \tau EF_{21} \qquad (8)$$

where τ, is the atmospheric transmissivity accounts for the absorption of the thermal radiation by the atmosphere content like carbon dioxide and water vapour. However, the carbon dioxide content in the atmosphere is essentially constant, whilst the water vapour content depends on the temperature and the atmospheric humidity. Thus, τ, value wil be estimated from the following equations: -

$$\tau = 1.53(P_w l)^{-0.06}, \text{ for } P_w l<10^4 \text{ Nm}^{-} \qquad (9)$$

$$\tau = 2.02(P_w l)^{-0.09}, \text{ for } 10^4 \le P_w l \le 10^5 \text{ Nm}^{-1} \qquad (10)$$

$$\tau = 2.85(P_w l)^{-0.12}, \text{ for } P_w l>10^5 \text{ Nm}^{-1} \qquad (11)$$

$$P_w = P_{wa}\frac{H_R}{100} \qquad (12)$$

$$\ln P_w = 23.18986 - \frac{3816.42}{(T-46.13)}$$ Eq. (13), where T is temperature (K)

iv. The radiation energy is also can be calculated by using Eq. 14 as follows

$$Er = \frac{2.2\,\tau\, RHcM^{\frac{2}{3}}}{4\pi Xc^2} \qquad (14)$$

where X_c, is the distance from the centre of the fireball to the receptor.

Meanwhile for explosion (r) consequences analysis, the threshold limit value is measured maximum overpressure unit, (kPA), the model's calculations are as below: -

In order to estimate the consequences of an accident on people and the damage caused by the accident, the best method is probity analysis.

Eq. 15 provides a relationship between the probability P_r and the probity variable *Y*. For spreadsheet computations, more useful expressions for performing the conversion from probity to percentage is given by Crowl and Louver (2002).

$$P_r = 50\left[1+\frac{Y-5}{|Y-5|}erf\left(\frac{|Y-5|}{\sqrt{2}}\right)\right] \qquad (15)$$

where *erf* is the error function.

Abramowitz and Seguin have given a rational approximation for digital computation (Christou, 1999):

$$erf(x) \approx 1-(a_1\phi + a_2\phi^2 + a_3\phi^3)\exp(-x^2)+\varepsilon \qquad (16)$$

where:

$$\phi = \frac{1}{(1+\alpha x)}; \quad \alpha = 0.47047; \quad a_1 = 0.34802;$$

$$a_2 = -0.09587; \quad a_3 = 0.74785 \text{ and } \varepsilon \le 2.5\times 10^{-5}$$

2.4.3 *Effects of Overpressure on Humans and Structures*

The probity equation for eardrum rupture is given as [37].

$$Y = -15.6 + 1.93\ln p_0 \qquad (17)$$

where Y is the probity variable. Direct blast effects, particularly lung haemorrhage has been studied Eisenberg *et. al.*(1975).

$$Y = -77.1 + 6.91\ln p_0 \qquad (18)$$

Adeleke University Journal of Engineering and Technology

[AUJET] Vol. 2, No 3, 49-60 (2019)

aujet.adelekeuniversity.edu.ng

ISSN: 2714-2450

Fugelso *et. al.*, (1972) gives estimation of the glass breakage (Fugelso, 1972).

$$Y = -18.1 + 2.79 \ln p_0 \quad (19)$$

Eisenberg *et. al.(*1975), have derived a probity equation relating lethality for body translation to impulse.

$$Y = -46.1 + 4.82 \ln i_p \quad (20)$$

For very large buildings and structures, differential loading may cause damage ranging up to complete destruction. The following probity equation has been suggested by Fugelso *et. al*.(1972).

$$Y = -23.8 + 2.92 \ln p_0 \quad (21)$$

2.4.4 *Effects of Thermal Radiation on Humans and Constructions*

A simplified formula has been suggested by Buettner, to predict the time required for pain with reasonable accuracy (Buettner, 1951):

$$t_p = [35/Q]^{1.33} \quad (22)$$

where t_p is the time required for pain (sec), and Q is head flow.

Eisenberg developed a probity model which can be used to predict probability of fatality due to incident of thermal radiation.

$$Y = -14.9 + 2.56 \ln (Q^{4/3} t) \quad (23)$$

While the probity equations for non-fatal injury are Christou (1999) and CCPS (1999):

1st degree burns: $Y = -39.83 + 3.02 \ln (Q^{4/3} t)$ (24)

2nd degree burns: $Y = -43.14 + 3.02 \ln (Q^{4/3} t)$ (25)

Finally results of thermal radiation and maximum overpressure effects are compared with TLV value standard practiced from various countries as in step 1. Based on results comparison analysis, proposed LUP for MHF safe sitting procedure or framework was then developed.

Based on adapted France risk assessment and LUP with special focused on the comparison of the specific approaches in different countries and has developed a proper check list and framework for MHF siting and LUP. This checklist could be used for identification of MAH-LUP and comparison of countries' different approaches. Validation of developed checklist/framework was done by using in assessing risks and MHF siting.

Therefore, this research looked into several current practices on LUP methodology, from other countries such as France, UK, Malaysia, Italy, etc. and suggest the best LUP decision framework to be used for Major hazard facilities in COMAH.

3. RESULTS AND DISCUSSION

3.1 Hazard Identification Using Developed Checklist/Framework

The developed checklist and framework were used for identification of MAH-LUP for LPG stock list siting in Malaysia and results from the LPG siting analysis for facility that store more than 50 tons in the premises was compared with various standard of consequence-based method (CBM) applied from other said countries and the following results was observed.

Five LPG facilities have been selected as a case study, the impact on human vulnerability is determined for various distances from 50m to 500m, and these distances are based on the current actual siting of LPG facility in Malaysia. A particular company is located almost less than 50m from residential building and neighboring industries. Secondly, these distances are chosen due to regulation practice in Malaysia according to guidelines for siting and zoning of industry and environment in Malaysia revision of October, 2012 which provides guidance when selecting a site to locate manufacturing or industrial facilities. Based on existing LPG siting in the study it was found that most of the facilities are located light type industry which have indicative primary buffer distance for sensitive receptor minimum 50m or more; however, there are several facilities which are located under category of medium type industries which requires primary indicative buffer minimum distance of 100m or more. The distance of 500m is used in this study after considering the impact from LPG facilities could give major severity up to 500m distance

Adeleke University Journal of Engineering and Technology

[AUJET] Vol. 2, No 3, 49-60 (2019)

aujet.adelekeuniversity.edu.ng

ISSN: 2714-2450

if 1000 cylinders of LPG which are equal to 14 tons is involved in BLEVE incidents, therefore, the LPG impact from 50m to 500m were very significant to show how severe the BLEVE fire ball is to human. For the correlations among results, when the receptor is far away from LPG BLEVE fire ball incident it was shown that the thermal head dosage received by the receptor is reduced. If we consider a light industry buffer zone which is 50m from neighbouring building, it was shown that with only ten cylinders, which are equal to 140kg, can easily cause fatality to human as shown in figure 1 below.

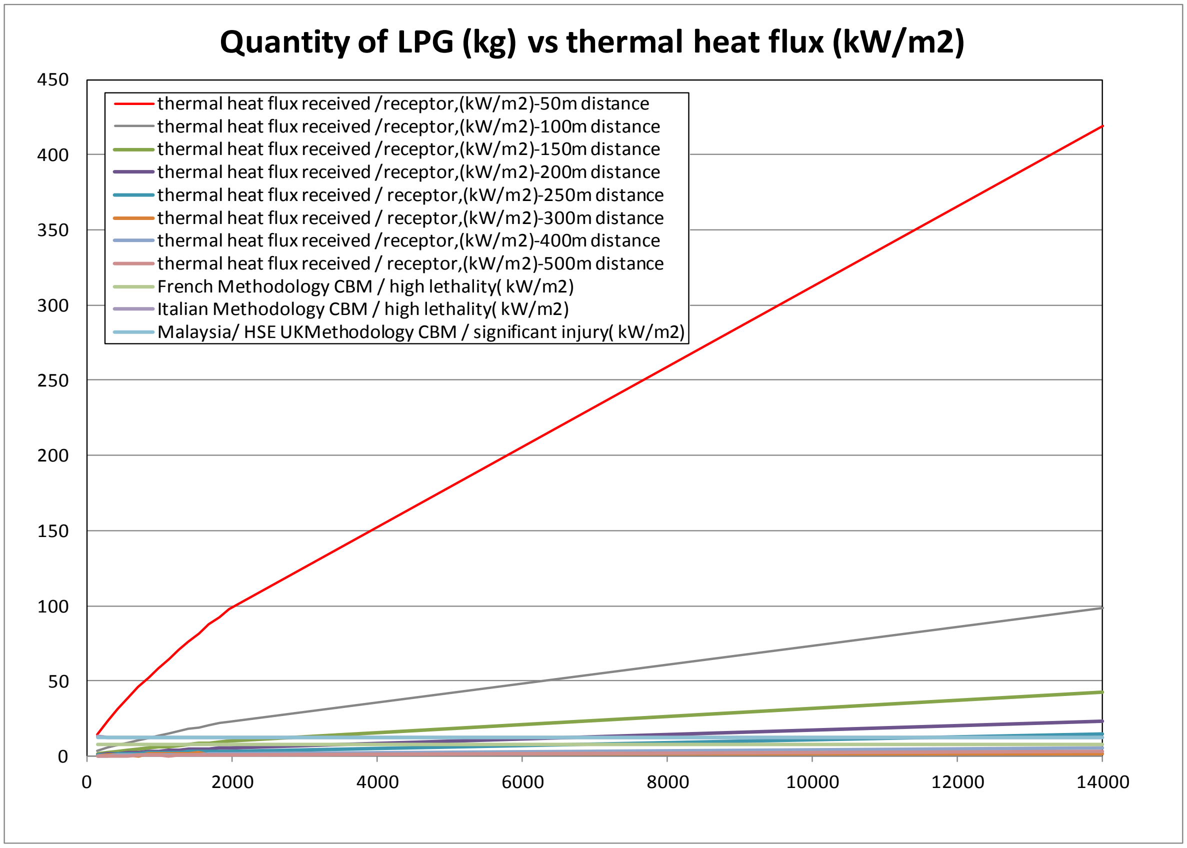

Figure 1: Results for thermal heat flux received by the receptor (kW/m^2) at varies LPG quantity (10-1000 cylinders) and varies distance (50 m till 500 m)

Consequently, when the distance is increased to 100 m any impact from 140 kg LPG can only cause pain after an exposure of 20 sec, however, the condition of the victims will be worse if expose to heat flux is longer than 30 sec. Most probably the victims receive second degree burn injury. Based on medium industry buffer zone with 150 m distance of LPG impact it will only cause minimum feel pain to victims if 140 kg LPG is involved in BLEVE fire ball incident and the chance of human's survival is increased. However, at 150 m distance it could harm human or receptor if 40 cylinders of LPG is involved in BLEVE fire ball. For example, the possibility of exposure to BLEVE fire ball to be absorbed by receptor is more than 7.35 kw/sec for 500 m distance, it was shown that 140 kg will give an impact of 3.4 kw/sec to human. We can conclude that the minimum requirement to be proposed for non-major hazard installation should be suggested 500 m or more.

Based on Figure 1, it shows that most of the receptor that are standing within below 100 m will be exposed to high lethality based on French, HSE UK, Malaysia CIMAH and Italy LUP standard. This result is based on 60 cylinders involved in BLEVE incident. However, degree of lethality is reduced when the distance of the receptor is increased for the 60 cylinders of LPG BLEVE incident. At 1000 cylinders of LPG, receptor that are standing within 300 m and

Adeleke University Journal of Engineering and Technology

[AUJET] Vol. 2, No 3, 49-60 (2019)

aujet.adelekeuniversity.edu.ng

ISSN: 2714-2450

above will only experience irreversible impacts according to Malaysia and HSE UK. However according to French, receptors will be exposed to high lethality, meanwhile based on Italy LUP method, a person will only experience irreversible effect at the beginning of lethality. The above results are simplified as in Figure 2.

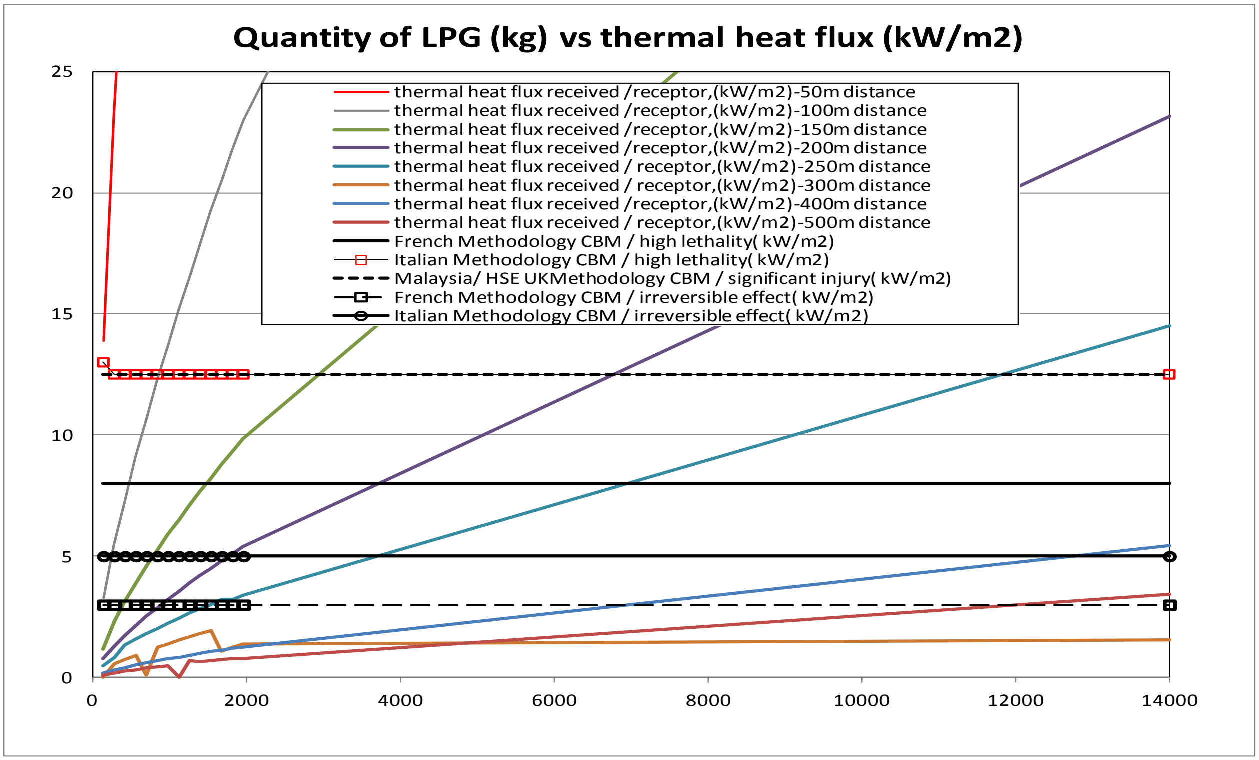

Figure 2: Results for thermal heat flux received by the receptor (kW/m^2) at varies distance (50 m till 500 m) reflect to several LUP standards (French, Italy, Malaysia/HSE UK)

3.2 Analysis of the LPG Land Use Facilities Due to BLEVE Incident (up to 100 Cylinders of LPG)

Results show that almost all of LPG facilities can affect the surrounding environment more than 45% impact. Location such as at Choo and Son in Kuala Lumpur Puchong, Rusba, Sitiawan Perak have shown that 97.5 -100% of the surrounding within the LPG vicinity will be affected with BLEVE incident, according to all references LUP CBM methods (French, Italy, UK and Malaysia). According to French LUP method for Choo and Son, and Rusba Sitiawan facility, it was shown that percentage for the lethality of human affected within the vicinity is 90-100%. However, the percentage of lethality is less than 78%, if LUP CBM benchmark, is based from Italy, HSE UK, Malaysia method. The different in percentage between French and the other three methods applied in this study shows that, the French method is the most stringent CBM LUP method. The 22% different of lethality is considered high and this condition would increase the issues of uncertainties during process of MHF sitting decision. However, results for lethality percentage for Heng Seng company and Rompin enterprise shows not much different (4% only) between all of LUP CBM methods applied which is the range of 22.5% -26%.

Based on the analysis to other affected of thermal radiation impact to human, such as reversible impact, irreversible impact, the beginning of lethality, it was found that the French and Italy show their methods have used more rational ways of define severity by putting additional impact to human compared to Malaysia LUP method, which only used 4 - 12.5 kW/m for reversible and high lethality. Therefore, through the results of this work, it is recommended to suggest and impose additional criteria in between 4 -12.5 kW/m^2 as practiced currently in Malaysia.

Based on simplification of our assessment, impact to surrounding environment toward Askolani and Rusba activity can be plotted as in Figure 3.

Adeleke University Journal of Engineering and Technology

[AUJET] Vol. 2, No 3, 49-60 (2019)

aujet.adelekeuniversity.edu.ng

ISSN: 2714-2450

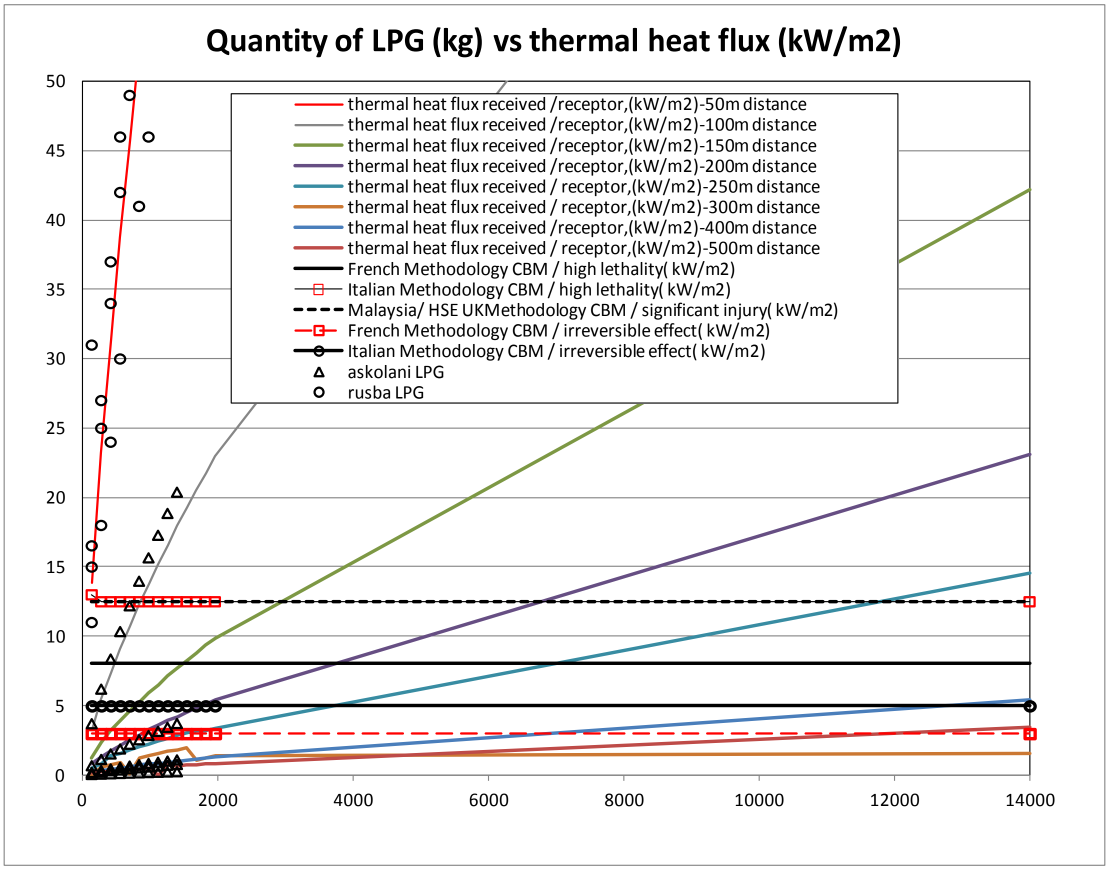

Figure 3: Result for Surrounding Impact Due to LPG Storage Incident Based to Several LUP Standard.

Based on the two (2) facilities from Askolani and Rusba, results show that most the existing receptors were in dangerous zone according to French and Italy LUP methodology. However, Malaysia claimed it just have significant injury below than 12.5 kw/m2. Thus, it is recommended that the existing LUP guidelines of buffer zone should be revised by considering all LPG exist in Malaysia.

4. CONCLUSION

Based on the MHF Siting of Five LPG Facilities in Malaysia, LPG BLEVE consequences are analyzed. TNO model is used to determine the fireball parameter and time duration for the fireball in order to complete its consumption on flammable substance of LPG on air before its dissipated. The findings show that almost all of LPG facilities can affect the surrounding environment more than 45% impact. According to French LUP method for Choo and Son, and Rusba Sitiawan facility, it was shown that percentage for the lethality of human affected within the vicinity is 90-100%, compared with Italy, UK and Malaysia with less than 78%. Therefore, the French method is the most stringent CBM LUP method.

5.0 RECOMMENDATION*: To Suggest Possible Solutions for Land Use Planning Guidelines*

Suggestion for land-use planning with respect to risk assessment system of French method includes:

1- assessing the hazard and estimate the danger zones in a homogeneous manner, following a common procedure

2- conducting iterative cycles of evaluation and assess the consequences of a number of scenarios, which then serve as a reference for the determination of protection zones around the installation;
3- developing and accessing alternatives that can be negotiated at the local level, according to criteria that should be made explicit

References

Anderson, M. (2005). Behavioural Safety and Major Accident hazards: magic Bullet or Shot in the Dark. *Process Safety and Environmental Protection , 83*(2), 109-116. doi:DOI: 10.1205/psep.04230

Buettner, K. (1951). Effects of extreme heat and cold on human skin. II. Surface temperature, pain and heat conductivity in experiments with radiant heat. *J. Applied Physiol.*, 703-713.

Burlando, C. (2012). *Land Use Planning Policy in the Far North Region of Ontario: Conservation targets, politics of scale, and the role of civil society organizations in Aboriginal-State relations.* Natural Resources Institute University of Manitoba, Winnipeg, Manitoba, Canada,, Faculty of Graduate Studies (Natural Resources and Environmental Management).

Callies, D. L. (2008). "Town and Country Planning in the United Kingdom", Environmental Laws And Their Enforcement. *Encyclopedia of Life Support Systems (EOLSS), 2*. Retrieved 11 5, 2017, from https://www.eolss.net/Sample-Chapters/C04/E4-21-08.pdf

CCPS. (1999). *Guidelines for Consequence Analysis of Chemical Releases.* new york: Centre for Chemical Process Safety, American Institute of Chemical Engineers.

Christou, M. D. (1999). The control of major accident hazards: The land-use planning issue. *Journal of hazardous materials, 65*(1-2), 151-178.

Crowl, D., & Louver, J. (2002). *Chemical Process Safety: Fundamental with Applications* (2nd ed.). Prentice hall.

Dalzell, G. (2003). Understanding Major Accident Hazards – The Cutting Edge of Common Sense. *Symposium Series No. 149* (pp. 501-504). Icheme.

Eason, G., Noble, B., & Sneddon, I. (1955). On certain integrals of Lipschitz-Hankel type involving products of Bessel functions. *Phil. Trans. Roy. Soc., A247*, 529-551.

Eisenberg, N., Lynch, C., & Breeding , R. (1975). Vulnerability Model: A Simulation System for Assessing Damage Resulting from Marine Spills. *Environ Control Inc., Rockville, MD.*, , Rep. CG-D-136-75. Environ Control Inc., Rockville, MD.

El-Harbawi, M., Mustapha, S., Choong, T. S., Rashid, Z. A., Rashid, S. A., & Sherif, A. (2010). SCIA: GIS-Based Software for Assessing the Impacts from Chemical Industrial Accidents. *Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management, 14*(2), 104-114.

Fugelso, L. L. (1972). *Explosion Effects Computation Aids.* Fugelso, L.E., L.M. Wenner and T.H. Schiffman, 19Gen. Am. Res. Div., Gen. Am. Transportation Co., Niles, IL.

khudbiddin, M., Rashid, Z., Yeon, A., Alias, A., Fuad, F., Fuad , M., & Hayati, H. (2018). Prevention of Major Accident Hazards (MAHs) in major Hazard Installation (MHI) presmises via land use planing (LUP): A Review. , *IOP Conf. Ser.: Mater. Sci. Eng. 334 012033.*

Liamputtong, P. E. (2005). *Qualitative research methods* (Vol. 2). Melbourne: Oxford university press.

Maxwell, J. C. (1892). *A Treatise on Electricity and Magnetism* (3rd ed., Vol. 2). Oxford.

Occasional Safety and Health Act 1994. (1996). (Act 514), P. U (A) 39/1996, Control of Industrial Major Accident Hazards-COMAH) regulation. Retrieved 12 27, 2017, from http://www.utar.edu.my/osh/file/OSHA%201994%20-%20Control%20of%20Industrial%20Major%20Accident%20Hazards%20Regulations%201996.pdf

Olivier, S., Kirchsteige, C., Delvosalle, C., Duijm, N., & Casal, J. (2012, Feb). ARAMIS: Accidental Risk Assessment Methodology for Industries in the framework of SEVESO II directive. *Colloque" Urbanisation et Pr´evention des Accidents Majeurs".*

Queen's Team Project . (2009). *The Control of Major Accident Hazards in Canada.* Queens University,. Canadian Society for Chemical Engineering. Retrieved 11 8, 2017, from http://team.appsci.queensu.ca/documents/CSChE_ControlMajorAccidentHazardaCanada_Report.v4.pdf

Roorda, J., Van Stiphout, W. A., & & Huijsman-Rubingh, R. R. (2004). Post-disaster health effects: strategies for investigation and data collection. Experiences from the Enschede firework disaster. *Journal of Epidemiology & Community Health, 58(12)., 58*(12), 982-987.

Stuart, D., & Dexter, D. (2006). Understanding Major Accident Hazard Management. *Understanding Major Accident Symposium Series No. 151*, p. 4.

The Industrial Accidents Convention and the Seveso II (III) Directive. (2014). Retrieved 11 26, 2017, from https://www.unece.org/fileadmin/DAM/env/documents/2014/TEIA/Nikolay_docs/4._Montenegro_TEIA_Seveso

TNO. (1989). *Methods for the determination of the possible damage to humans and goods by the release of hazardous materials (Green Book).* Dutch Ministry of Housing, Physical Planning and Environment. The Hague.

TNO. (2015). Methods for the calculation of the physical effects due to the releases of hazardous materials (liquids and gases). *The Hague*. Dutch Ministry of Housing, Physical Planning and Environment. .

Tugnolia, A., Wijk, L. V., Christou, M., Gyenes, Z., & Spadoni, G. (2012). Scenario Selection for Land Use Planning Purposes around "Seveso" Establishments. *Chemical Engineering Transactions, 26*, 417-422.

UN Habitat. (2017). *Land Use Planning "Islamic Republic of Afghanistan Kabul Municipality Housing Profile".* Department of Urban Planning. Retrieved 11 5, 2017, from http://pdf.usaid.gov/pdf_docs/PA00JMBJ.pdf

United Nations Economic Commission for Europe. (n.d.). *The Industrial Accidents Convention and the Seveso II (III) Directive*. (N. Savov, Producer) Retrieved from https://www.unece.org/fileadmin/DAM/env/documents/2014/TEIA/Nikolay_docs/4._Montenegro_TEIA_Seveso.pdf

Venart, J. (2004). Flixborough: the Explosion and its Aftermath. *Process Safety and Environmental Protection, 82*(2), 105-127. doi:10.1205/095758204322972753