



An Assessment of Current Practices on Landslides Risk Management: A Case of Kuala Lumpur Territory

Anas Alnaimat¹, Lam Kuok Choy², Mokhtar Jaafar²

¹Environmental Management Programme, Faculty of Social Sciences and Humanities, Universiti Kebangsaan Malaysia, Bangi, 43600 Selangor, Malaysia

²Social, Environmental and Developmental Sustainability Research Centre, Faculty of Social Sciences and Humanities, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

Correspondence: Anas Alnaimat (anas2as@gmail.com)

Abstract

In Kuala Lumpur to date, there is little evidence to support landslide causes and very little research into the nature of landslide vulnerability. This article takes an interdisciplinary method and empirical approaches to examine, in addition where necessary, challenge a series of assumptions made regarding Landslide Risk Management (LRM) with a view to developing better understanding of social vulnerability on landslide hazard and its underlying causes alongside combine expert judgment on triggering factors. Moreover, the contribution of Malaysia Public Works Department (PWD/JKR) via the implication of National Slope Master Plan (NSMP 2009-2023) operational capabilities and its effectiveness on landslide risk mitigation measures is reviewed. The finding on the influence of landslide causative and triggering factors have shown steepness of slope was greatly functioned as a landslide primary causative factor on mass movement whereas, in Kuala Lumpur rainfall and human activities plays significant role in triggering landslide on a slope vulnerable to failure. The result suggests occupants of landslide prone areas have decent perceptions of landslide and its associated risk. Contrary wise, a loss of confidence by local residents on government authorities on implementing appropriate hazard mitigation measures, lack of voluntary data sharing and insufficiency public awareness campaigns conducted by Malaysian local authorities.

Keywords: Kuala Lumpur, Landslide Risk Management (LRM), landslide vulnerability, National Slope Master Plan (NSMP), mitigation measures.

Abstrak

Di Kuala Lumpur sehingga kini, terdapat sedikit bukti kajian yang menyokong punca kejadian tanah runtuh dan kekurangan penyelidikan yang mengkaji sifat kerentanan tanah runtuh. Kajian ini mengambil pendekatan antara disiplin dan kaedah empirikal untuk memeriksa dan, sekiranya perlu, mencabar andaian-andaian yang dibuat dalam Pengurusan Risiko Tanah Runtuh (LRM) dengan tujuan untuk membentuk pemahaman yang lebih baik terhadap kerentanan sosial kepada bahaya tanah runtuh dan faktor penyebab asas, di samping menggabungkan pendapat pakar terhadap faktor pencetus. Selain itu, sumbangan Jabatan Kerja Raya Malaysia (JKR) menerusi Pelan Induk Cerun Negara (NSMP 2009-2023) serta implikasi ke atas keupayaan operasi dan keberkesanannya kepada langkah-langkah pengurangan risiko tanah runtuh turut disemak. Hasil kajian ke atas pengaruh faktor tanah runtuh dan faktor pencetus mendapati faktor kecuraman cerun merupakan faktor penyebab utama tanah runtuh, manakala di Kuala Lumpur hujan dan aktiviti manusia memainkan peranan penting dalam mencetuskan runtuhan di cerun berisiko. Hasil kajian turut menunjukkan penghuni di kawasan cenderung berlaku tanah runtuh mempunyai kesedaran dan persepsi risiko yang baik terhadap tanah runtuh dan risiko yang berkaitan. Sebaliknya, penduduk tempatan kehilangan keyakinan terhadap pihak berkuasa kerajaan untuk melaksanakan langkah-langkah mitigasi pengurangan bahaya ekoran kekurangan perkongsian data secara sukarela dan kekurangan kempen kesedaran awam yang dianjurkan oleh pihak berkuasa tempatan di Malaysia.

Katakunci: Kuala Lumpur, Pengurusan Risiko Tanah Runtuh (LRM), kerentanan tanah runtuh, Pelan Induk Cerun Negara (NSMP), langkah mitigasi

Introduction

Landslide is one of the natural hazards disasters, and it is one of the many natural processes that shape the surface of the earth (Matebie et al., 2015; Reichenbach et al., 2014). Landslides phenomenon is treated as just a natural process disturbing the environment, however when it occurs in populated regions it will become a serious matter to investigate (Toshiyuki et al., 2008). Recently there have been many occurrences of landslides in Malaysia, some of them are fatal or with serious consequences. Most of these landslides have occurred on cut slopes or on embankments alongside roads and highways in mountainous areas (Low and Faisal, 2012), as well as a vast number of these landslides occurred near high-rise apartments and in residential areas. In Malaysia landslides and floods are two major natural disasters that have impacted the country in terms of injuries, deaths, property damage, disruption and destruction of services, public inconvenience and economic as well as financial losses (Ibrahim et al., 2011).

However the aptitude of the geotechnical profession to formulate reliable predictions for slope failures/stability remains deprived (Gue and Wong, 2012). This is principally due to the copious sources of uncertainty faced by geotechnical engineering. Intrinsic natural unpredictability of soil properties, lack of data, restrictions of models and above all human uncertainties are some of the challenges that geotechnical engineers have to deal with (Qasim et al., 2013). Despite all of the advance methods and techniques in spatial prediction of landslides, it is extremely difficult to predict landslide hazards in absolute terms (Oven, 2009).

Sufficient understanding of landslide processes does exist to enable researchers to make an estimation of landslide hazard potential, whereby experts can use this estimation to make certain decisions regarding site suitability, causal and triggering factors of landslides, type of development, and appropriate mitigation measures. According to Pauline (2012), evaluation research is necessary to establish the effectiveness of public affairs programs and their contribution to organizational effectiveness. It provides the vital information necessary to plan public relation actions.

Significance of the Research

Recent advances methods and techniques such as GIS & Remote Sensing in risk analysis and risk assessment are beginning to provide systematic processes to formalize slope-engineering practice and enhance slope management (Dai et al., 2002). In recent years, risk analysis and management has become an important tool in addressing uncertainty inherent in landslide hazards. The advanced multivariate techniques proved to be effective in spatial prediction of landslides with high degree of accuracy. Physical process based models also perform well in hazards mapping even in the areas with poor database. Multi-criteria decision making approach also play significant role in determining relative importance of landslide causative factors in slope instability study (Pardeshi et al., 2013).

As often is the case in landslide management, planning studies, nevertheless, are often linked between scientific information and the general development planning process (Jasmi, 1996; Farisham, 2007). Failure to consider all of the natural hazards in the development planning process will result eventually in the loss of lives, bodily injuries, property damage, critical facility failures, and disruption of important economic activities (Tareq et al., 2012; Jamilah et al., 2014). The objectives of this study are: i) to explore the perception of scientists, experts and Geo-technical engineers at various government agencies on landslide triggering factors, implementation and risk management as well as the effectiveness of Malaysia National Slope Master Plan (NSMP 2009-2023). Secondly, to investigate local residents' understanding of hazard impact and the catastrophic consequences of landslide occurrences as well as to further inspect on socio-economic activities on the effects of landslide occurrences in the Federal Territory of Kuala Lumpur and its surrounding suburbs.

Materials and Methods

Study Area

The study area, the Federal Territory of Kuala Lumpur, is located within the Klang valley in the state of Selangor bordered by the Titiwangsa Mountains in the east (Figure 1). The study area covers approximately 243.6 sq km with a population of 1.7 million as of 2015. According to World-weather (2012) the temperature in Kuala Lumpur remains at a fairly constant 28-32 °C all year round, as is normal for a tropical country close to the equator and the average annual precipitation in Malaysia is around 2000 mm to 2500 mm.

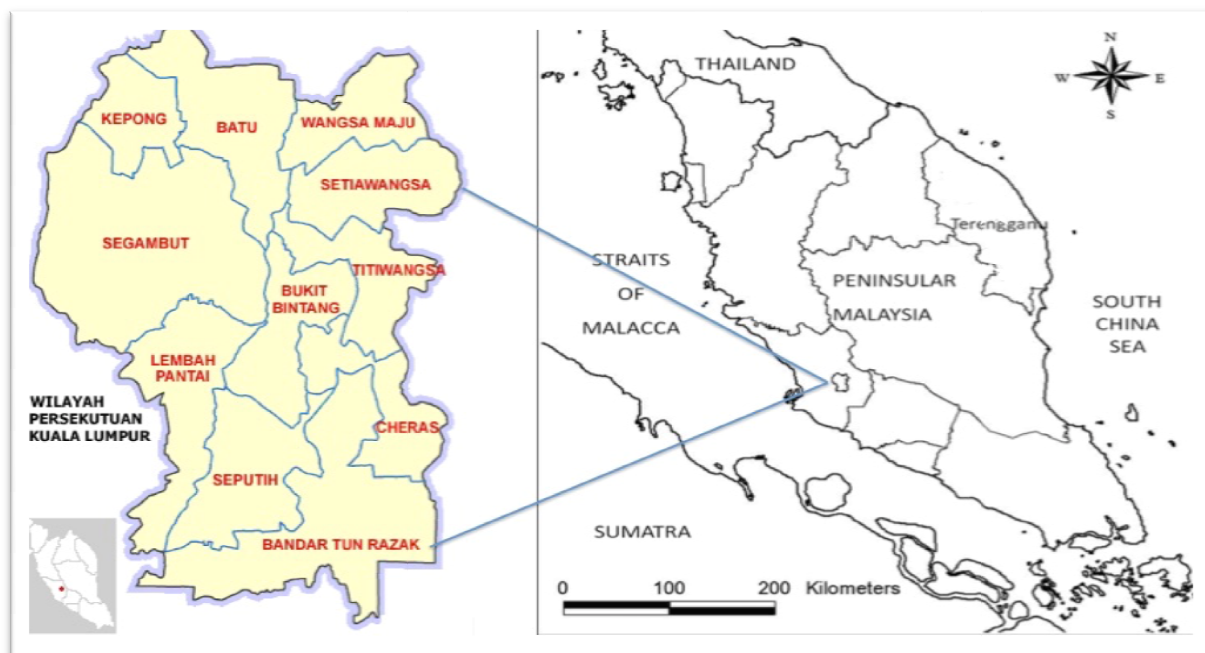


Figure 1. Geographical sketch and location of Kuala Lumpur

Sociological Survey

Research data is collected on the variables by using quantitative data collection techniques, which was prepared to measure the variables of this study. Two set of questionnaire were prepared and administered to the local population and expert community respectively. The questionnaire set for the local population is targeted at the respondent's perception on their understanding of landslide, risk concerns and landslide risk effect on property values, via prepared Likert scale Quintet with a series of questions as well as ranking test, close-ended and open-ended questions.

Whereas for the expert group, a distributed questionnaire together with close-ended, open-ended and personal experts comments are conducted to obtain data for the variables on NSMP 2009-2023 as well as Public Works Department (PWD) operational capabilities, causative/triggering factors (slope, rainfall, soil water saturation and human activities) were examined via the relevant authorities and government bodies that were involved with risk reduction and slope management in Malaysia and Kuala Lumpur Territory.

The study utilized simple random sampling technique and applied effectively to the population of the study. The selected districts of study area are located in the northern part of the Federal Territory of Kuala Lumpur, namely Titiwangsa, Setiawangsa, Wangsa Maju and Batu. The selection of districts were determined according to a number of studies (Alaraqdeh, 2011; NST, 2008; Satoshi et al., 2014) which have reported that these designated districts are located in landslide prone areas and situated within a hazardous zoning (Figure 2). The chosen districts covers approximately

one third of total size of the Federal Territory of Kuala Lumpur and the estimated population is approximately 0.5 million resident. National Statistic Department and Dewan Bandaraya Kuala Lumpur (DBKL) have estimated this figure from the total population of Federal Territory of Kuala Lumpur due to a lack of precise break down of population according to each district.

Based on the estimated population of the study area, the required sample size is determined at 384 participants for the public resident as suggested by Uma (2003) and Xu (1999). However, for the landslide expert respondents, there had been no precise figure and therefore according to statistics study conducted by Jamilah et al., (2014) the sample size of experts vary between 10-20 participants. This study managed to recruit 16 experts in close relevance with landslide and slope management within the Kuala Lumpur Territory as respondents.

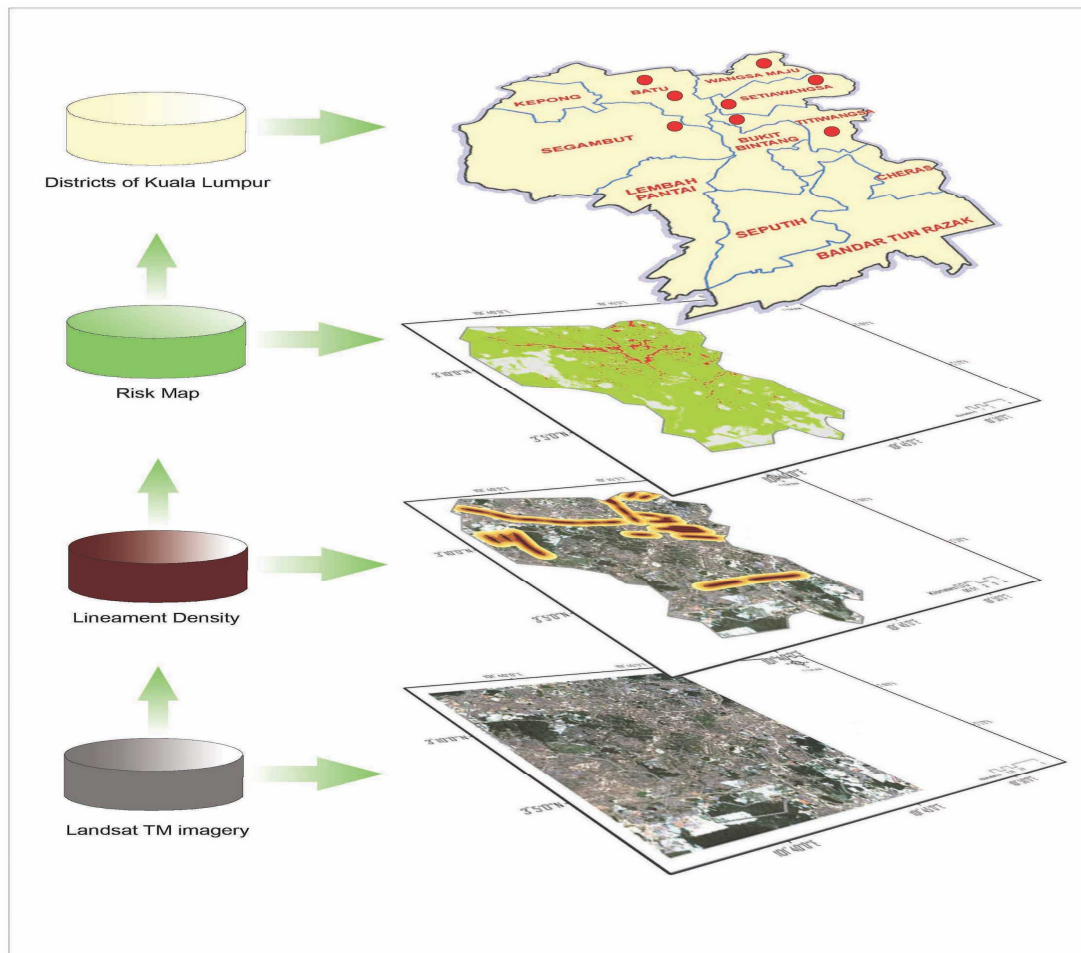


Figure 2. Districts of Kuala Lumpur situated within a hazardous zoning to landslide Source: Research primary data & Alaraqdeh 2011

Results and Discussion

The results for the local population and expert's perceptions are presented respectively as below.

Local Resident Profile

A total of 384 respondents from the local resident were sampled in this study. The respondents were made up of 51.65% female and 48.44% of male gender. Out of the total respondent, about 41.93% of the respondent lives in the area of study for 10-20 years, followed by 36.20% living there for more than 20 years and the remaining percentage of residents have been living there for less than 10 years. The respondents' education level among the female respondent was slightly higher in the diploma and

bachelor category at 32.55%, compared to the male’s achievement of 22.66% in the same category. The percentages of male respondents who obtained post graduated education is 17.19% compared with 14.58% for the females. The female respondents who gained upper secondary school certificate is 4.43% compared to 7.55% for males. Finally, 1.04% of male respondents obtained lower secondary school level. In terms of spatial distribution of respondents, the majority percentages of respondent lives in districts somewhere else near Kuala Lumpur (36.20%), Setiawangsa (18.49%), Titiwangsa (17.45%), Batu (14.32%), and Wangsa Maju (13.54%).

Correlation Analysis

Table 2 illustrates a significant and positive relationship obtained between the independent variable (understanding and risk concerns) and dependent variable of landslides risk management (LRM) $R=0.537$ and positive relationship was obtained between independent variable (property values) and dependent variable LRM $R=0.310$ for all independent variable correlation is significant at the 0.01 level (2-tailed). The results therefore implied whenever local understanding, risk concern and property values are highly presented the LRM increasing trend impact towards LRM positive impact.

Table 2. Correlation of understanding, risk concerns and property values on LRM

		Understanding and risk concerns	Property values	LRM
Understanding and risk concerns	Pearson Correlation	1	.300**	.537**
	Sig. (2-tailed)		.000	.000
	N	384	384	384
Property values	Pearson Correlation	.300**	1	.310**
	Sig. (2-tailed)	.000		.000
	N	384	384	384
LRM	Pearson Correlation	.537**	.310**	1
	Sig. (2-tailed)	.000	.000	
	N	384	384	384

* Correlation is significant at the 0.01 level (2-tailed).

Regression Analysis

Regression test between local understandings and risk concern on LRM shows analyzed results indicated adjusted $R^2=0.287$ between understanding and risk concern on LRM within local resident. The results therefore implies that understanding and risk concern predicted at 28.7% in the variance of LRM while other factor which were not considered in this study predicted 71.3%. The results also shows The (Sig=.000) implies that understanding and risk concern was a significant predictor in the variance of LRM, on the other hand ($F=155.052$, Sig=.000) the regression test concludes a significant statistical effect upon local understanding and risk concern towards landslide hazard reduction within the designated districts of Kuala Lumpur and its surrounding.

Landslide Influential Factors

The findings of the descriptive approach on the influence of landslide causative and triggering factors have shown local respondents categorized human activities to be first on the list in terms of its effectiveness in contributing to landslide occurrences in Kuala Lumpur Territory and its surrounding areas. The human activities obtained highest percentage ranking (69.53%), followed respectively by rainfall (68.75%) and slope (54.95%).

Conversely, the result shows soil water saturation factor plays a weak function and have low impact on slope failure. As a consequence of this reference it is important to emphasize on this noteworthy research finding point for the risk perception matching throughout Kuala Lumpur

inhabitants and experts of landslide. In contrary, the analysis determines a difference on the scale in influencing ratio (Figure 3) led by human activities accompanied with rainfall and slope.

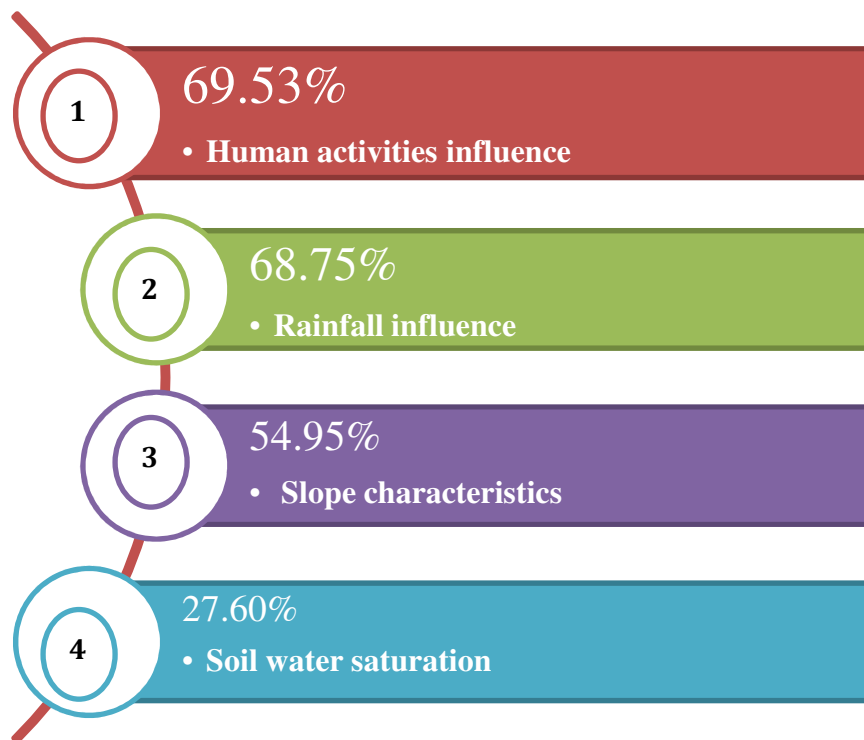


Figure 3. *Local resident perception on landslide influence factors*

Over the past decades landslide experts and scientific researchers have developed and created very detailed landslide hazard mapping for many different parts in Malaysia and all its metropolitan areas (Alaraqdeh, 2011) in addition to formulated a tremendous spatial database in accordance to slope instability causative and triggering factors however it has been always scarcely when it comes to perception of local resident within urban areas to be considered as an effective formula on the analysis and evaluation of landslide causative, triggering factors or over risk practices and their impact power upon its associated landslide occurrences. As a consequence of this, research paper has taken social risk perception and preparedness into account that due several important considerations such as decision makers need to understand how people think about and responds to risks.

The result shows Kuala Lumpur inhabitants assessed human activities as substantial causative factor on slope failure this understanding helps improve risk assessment measures among many parties. The finding is supported by recent studies and according to (Reichenbach et al., 2014; Blahut et al., 2014) the influence of human-induced land use changes on slope stability have shown that in populated areas or metropolitan cities such as Kuala Lumpur federal territory and its surroundings, the impact of humans on the environment contributes significantly to the initiation and reactivation of landslides vulnerability. However, as mentioned earlier not only engineering and scientific aspects and technological approaches of hazards have to be considered and implemented. Therefore, result of the present research comply with the concept of availability heuristic in order to extract a suggested outcomes for local behave on risk practices and hazard understanding.

Experts Profile

The gender breakdown of the respondent in the expert group were equal for the male and female at 50%. In term of living period in Kuala Lumpur, majority percentage have been living there for more than 20 years (37.5%), followed by between 10-20 years (25%) and 37.5% been living there for less than 10 years. Vast majority of the respondents had working experience between 5-10 years (43.75%). The educational level achieved by the respondents showed that 25% of the female obtained

bachelor degree and post-graduate degree respectively. Conversely, the male respondents having a bachelor degree were 31.25% and post-graduate degree at 12.50%.

Multi-influence Factors on LRM

The landslide triggering and causative factors have been key research focus that is important in landslide hazard and risk management study. Thus investigating the triggering and causative factors is a critical task in landslide assessment and management process, despite landslides is being influenced by several preparatory and triggering elements, which vary significantly from region to region. It is therefore difficult to determine weights for given parameters or which factor had triggered the event upon the slope failure. However, this study would concentrate on slope, rainfall, human activities and soil water saturation factors and that's due to regional conditions for being located at a tropical climate. The findings of landslide hazard triggering / causative factors shown human dumping of waste and construction development works had ranked first and highest in agreement in regards with causative and triggering factors of landslide hazard occurrence in Kuala Lumpur Territory (Mean=4.43). The results implies the crucial influence of slope overloading by human dumping of waste and construction development works specially when it occurs at urban and most populated city in Malaysia, thus in Kuala Lumpur the scenario of risk in slope instability occurrence is catastrophic and resulting in more complex consequences. Furthermore, the results indicate significant importance for studying the underlying elements for causing and triggering landslide occurrences.

The analysis revealed the importance of descriptive statistics that carried out by deductive statistics approach, ie. through univariate analysis, which involves describing the distribution of a single variable, including its central tendency on landslide causative and triggering factors. Thus finding shows slope features and steepness to be most relevant causative factors influencing the mass movements on slope failure occurrences in the study area. Therefore slope characteristics have been classified as an essential parameter that causing landslide tragedies at Kuala Lumpur's hillsides developing districts. However, human activities and rainfall have been ranked as much important as slope but within different approach by being primary triggering factors that made the slope vulnerable to failure. It was clear that rainfall, human activities and slope instability influence distribution and result shows the study area should include engineering consideration to reduce these factors influence of landslide hazards (Figure 4).

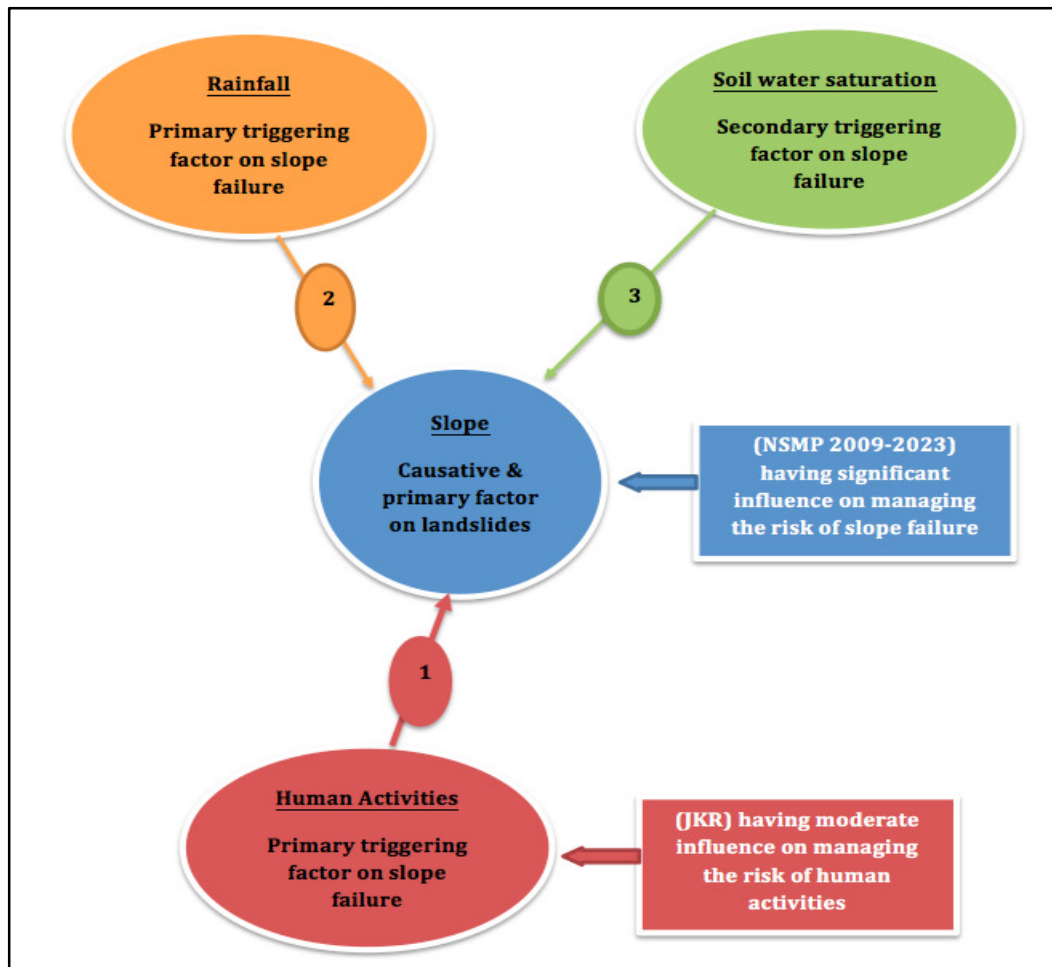


Figure 4. Experts standpoint on multi-influence factors on LRM

Undoubtedly field studies, experts and government authorities' opinion are playing great key factors on identification of the effective factors and its ratio of influence on the landslides occurrence (Capitani, 2014). However, this technique usually puts a large number of factors ahead of researcher and by using all of those factors in the research process would impose certain constraints such as precision in quality, time, efforts and high cost. Alternatively, the implementation of statistical analysis and descriptive approach of landslides hazard occurrences on assessing their ratio and how they are related to the specified primary factors is an appropriate method for an accurate identification of the factors with the greatest impact on LRM.

The significant findings obtained in this study is the impairment influence of soil water saturation ratio on landslide hazard occurrences in comparison with the great effective role played by the rest of variables; slope, rainfall and human activities in landslide occurrences and its associated risk management measures. The outcome of expert judgment reveals steepness of slope functioned as a landslide main causative factor on mass movement in Kuala Lumpur Territory and across Malaysia. Whereas rainfall and human activities plays significant impact on triggering of landslides occurrences however soil water saturation remains as inactive factor and demonstrates low effectiveness on slope failure. Hence, the study suggested in accordance to the findings, further social perception and geospatial data analysis on the contribution factor of soil water saturation on landslide hazard and its correlation on LRM to be undertaken.

NSMP Operational Capabilities

The Malaysia Public Works Department (PWD) operating performance and the National Slope Master Plan (NSMP 2009-2023) were examined based on current status, needs and constraints, mitigation strategies, workshops attendance, frameworks and operational capabilities, risk map

creation and future enforcement of planning obligations. Figure 5 illustrates a summary and restatement of main points for NSMP’s operational capabilities & effectiveness.

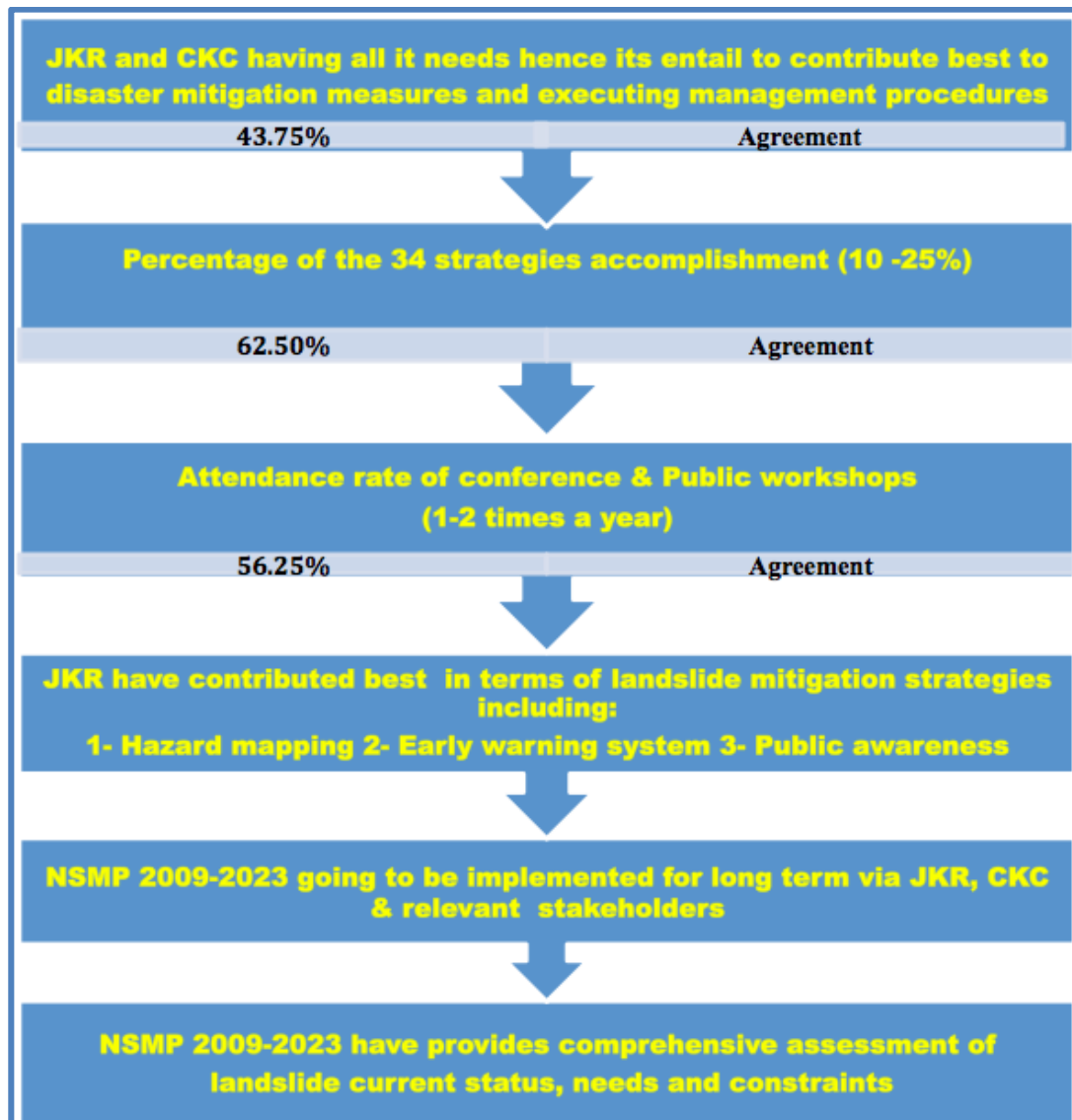


Figure 5. Operational capabilities & effectiveness of NSMP

The research indicates significant role play by the Malaysian PWD and other stakeholders on both variables of risk management and the implementation of NSMP 2009-2023 for an effective operation and mitigation measures on landslide hazard management and its associated environmental risk impacts in Malaysia and particularly for Kuala Lumpur Territory.

The results also revealed high agreement (81.25%), which implies strong satisfaction from expert’s respondents towards NSMP 2009-2013 comprehensive plans and effectiveness. Thus such strategic directions, action plans and key performance indicator measures, the NSMP 2009-2023 would indeed help planners and decision makers for setting priorities on what needs to be done to stem the increasing tide of landslides hazardous events in Malaysia and Kuala Lumpur in particular.

Nevertheless, despite the promising outcomes of this evaluation on the effectiveness and implementation capabilities of NSMP 2009-2023, the study indicated landslides are contextualized in terms of the abundant threats and risks facing people and as a result, are seldom a priority concern due to lack of voluntary data sharing between government parties and public residents, insufficiency in public awareness campaigns and programs set and lead by the Malaysian PWD and its related private sectors. This is in line with the outcomes from the local perception which shows loss of confidence by the community when it comes to government bodies such PWD or Malaysia Slope-Engineering

Branch (CKC) on doing their tasks accordingly and effectively in terms of landslide hazard assessment, risk management and mitigation measures.

Significance of Specific Findings

This paper has examined local population's perception on landslide risk and evaluated the experts of government authorities' view on hazard practices, assessment and Landslide Risk Management (LRM) in the Territory of Kuala Lumpur. Research findings have challenged a number of assumptions made in the context of LRM. In particular, the study has highlighted the changing patterns of risk assessment and management associated with landslide events and the occupation of landslide prone areas in Kuala Lumpur and its surrounding suburbs. Research highlights the benefits of interdisciplinary approach, empirical evidence and descriptive analysis. Therefore, focusing on the physical hazard alone does not explain why people choose to reside within landslide prone areas or the factors giving rise to their vulnerability. In like manner, a social science based approach may mitigate the landslide risk altogether and thus fail to consider the potential for a future landslide fatal event.

The objectives for the assessment of landslide occurrences and its associated risk practices at different levels could be analyzed and discussed in more detail. Experts on disaster management, social and earth science scientists should be able to come up with better definition on what should be expected from the results on landslide hazard management. Besides, social sciences could virtually improve and present risk assessment methods, particularly by evaluating the tolerance and consent of the landslide risk measures via Public Works Department (PWD) and/or relevant stakeholders.

Kuala Lumpur residents' perceptions and risk concerns to landslide hazard are explored in detail. Research findings emphasize on community concerns with short-term standpoints over long-term risk mitigation measures. However, local resident react to landslides events as and when they occur. Sad to say participants noted the absence of relevant government authorities in landslides risk management activities. National institutions and expert's practices on landslide risk assessment and management in Kuala Lumpur and Malaysia actively engaged in development and, to some extent, disaster management activities through the establishment of CKC, JKR and via the implementation of NSMP 2009-2023. Conversely, for the local resident themselves, their priorities are large-scale education campaign, awareness raising programs, livelihoods and resources in social environmental contexts.

Conclusion

This study focused on the local populations' understandings, perception of risk concerns and the role-play of PWD by the means of the effectiveness on NSMP 2009-2023 on LRM. The findings strongly suggested that occupants of landslide prone areas having a decent perception of understanding on landslide hazard management and its associated risks. In accordance of the significant interaction between local understanding, risk perception and landslide risk management, the study shows that respondents situated with urban residential zones scored higher in risk perception and decent landslides hazards understanding compared to respondents who live in outskirts or provinces area. This could be the result of higher chance from gaining better educational level and other socioeconomic contributing factors.

For an outsider, it can be difficult to comprehend that Kuala Lumpur residents willingly settle in areas at risk from catastrophic landslide hazards. However landslide risk emerges not just from societal marginalization but also from situations of relative prosperity and social growth. People want to live by the road or as close as possible to amenities, in which the majority has been successful in doing so, despite the coincidence of these areas with high probability of slope instability. Hence, it requires a crucial role from the Ministry Of Works, PWD and Slope-Engineering Branch (CKC) for an ultimate early warning system, hazards mitigation measures, and immediate field implementation. It is because the study have shown strong indication and believes that social and economic losses

associated with landslide hazard occurrence can be monitored, controlled and mitigated by means of effective assessment, planning and management.

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