

**IDENTIFYING SUICIDE RISKS THROUGH
TWITTER (X) IN MALAYSIA**

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IDENTIFYING SUICIDE RISKS THROUGH TWITTER (X) IN MALAYSIA

by

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TABLE OF CONTENTS

ACKNOWLEDGEMENT	ii
TABLE OF CONTENTS.....	iii
LIST OF TABLES	vii
LIST OF FIGURES	viii
LIST OF APPENDICES.....	ix
ABSTRAK	x
ABSTRACT	xii
CHAPTER 1 INTRODUCTION.....	1
1.1 Introduction	1
1.2 Problem Statement	1
1.3 Research Questions	3
1.4 Research Objectives	3
1.5 Significance of Study	3
1.6 Research Scope	4
1.7 Conceptual and Operational Definitions	5
1.7.1 Suicide risk, suicidal ideation and suicidal behaviour	6
1.7.2 Suicide risk monitoring	6
1.7.3 Sentiment Analysis.....	6
1.8 Study Rationale	7
1.9 Conclusion.....	8
CHAPTER 2 LITERATURE REVIEW.....	10
2.1 Introduction to Suicide	10
2.1.1 Defining and Describing Suicide	10
2.1.2 Epidemiology of Suicide and Suicide Attempts in Varying Countries	11

2.1.3	Prevalence of Suicide in Younger Population.....	12
2.2	Factors Influencing Suicide: Risk & Protective Factors	14
2.2.1	Individual Level Risk Factors	15
2.2.2	Relationship Level Risk Factors	17
2.2.3	Environmental Level Risk Factors	18
2.2.4	Protective Factors	19
2.3	Patterns in Expressions of Suicide Risk	22
2.4	Suicide in Malaysia	23
2.4.1	Suicide Prevalence and Patterns in Malaysia.....	24
2.4.2	Impact of COVID-19 Pandemic on Suicide Rates in Malaysia	27
2.4.3	Sociocultural and Religious Factors in Suicide Behaviour	28
2.4.4	Suicide Prevalence Among Younger Malaysians	30
2.5	Limitations of Existing Method of Data Collection in Malaysia	31
2.5.1	Early Efforts in Documenting Suicide in Malaysia	31
	2.5.1(a) National Suicide Registry of Malaysia	32
2.6	Leveraging Social Media to Understand Real World Events and Behaviours	35
2.6.1	Utilising Twitter as a Source of Data Collection Tool	38
2.6.2	The Relevance of Twitter in Collecting Suicide Data.....	39
2.6.3	Sentiment Analysis as a Tool to Automate Labelling of Tweets	43
2.7	Theoretical Framework	48
2.7.1	Speech Act Theory	49
2.7.2	Appraisal Theory of Emotion.....	51
2.8	Conceptual Framework	53
2.9	Research Hypotheses.....	54
2.10	Research Gaps	54

CHAPTER 3	METHODOLOGY.....	56
3.1	Research Design	56
3.2	Sampling Technique, Study Area and Study Population	57
3.3	Keywords: Suicide-related and Positive Keywords	58
3.4	Study Criteria	59
3.5	Sample Size	61
3.6	Ethical Considerations.....	62
3.7	Study Procedure	63
3.7.1	Twitter’s API.....	63
3.7.2	Collecting and Storing Twitter Data	65
3.7.3	Manual Categorization of the Datasets by a Human Coder	65
3.7.3(a)	Manual Categorization of Suicide Expression Tweets (Tweets derived from Suicide-related keywords)	66
3.7.3(b)	Manual Valence Categorization for both Suicide Expression Tweets and Positive-related Tweets (control dataset)	67
3.8	Generating Sentiment Scores using VADER Sentiment Analysis.....	71
3.9	Data Analysis Strategy	76
3.9.1	Evaluating the Performance of Sentiment Analysis via Confusion Matrix	77
CHAPTER 4	RESULTS.....	79
4.1	Introduction	79
4.2	Keyword Analysis	79
4.3	Performance of Sentiment Analysis on Suicide-related Tweets	81
4.3.1	Performance of Sentiment Analysis on Suicide-Related Tweets	86
4.4	Overall Performance of Sentiment Analysis and Positive-related tweets.....	89
CHAPTER 5	DISCUSSION	94
5.1	Introduction	94

5.2	Relevance of Keywords used in identifying suicide-related tweets in Malaysia	94
5.3	Performance of Sentiment Analysis in Identifying Suicide Expressions Tweets in Malaysia	97
5.3.1	Performance of Sentiment Analysis when Compared Against a Control Dataset of Positive-related Tweets.....	99
5.4	Overall Performance of Sentiment Analysis	101
5.5	The Implications for Suicide-Risk Monitoring in Malaysia	103
5.5.1	Theoretical Implications.....	105
5.6	Limitations of the Present Study	106
5.7	Recommendations for Future Research	108
5.8	Conclusion.....	109
REFERENCES.....		111
APPENDICES		

LIST OF TABLES

		Page
Table 3.1	Suicide-related keywords	60
Table 3.2	Positive keywords	61
Table 3.3	Examples of suicide expression tweets categorized by type and valence.....	69
Table 4.1	Suicide-related keywords with highest frequency of ‘suicide-related’ tweets	80
Table 4.2	Suicide-related keywords that yielded no tweets in the final dataset	80
Table 4.3	Count comparison between human coder and sentiment analysis for 1858 suicide expression tweets	81
Table 4.4	Confusion matrix findings for 1858 suicide expression tweets	84
Table 4.5	Count comparison between human coder and sentiment analysis of 948 suicide-related tweets	86
Table 4.6	Confusion matrix findings for 948 suicide-related tweets	87
Table 4.7	Count comparison between human coded and sentiment analysis for 736 positive-related tweets	89
Table 4.8	Confusion matrix findings for 736 positive-related tweets.....	90

LIST OF FIGURES

	Page
Figure 2.1 Conceptual Framework	53
Figure 3.1 Classification of suicide expression tweets.....	57
Figure 3.2 Classification of positive-related tweets	57
Figure 3.3 An API based communication flow	65
Figure 4.1 Confusion matrix heatmap illustrating the distribution of human coded and sentiment analysis categories for 1858 suicide expression tweets	85
Figure 4.2 Confusion matrix heatmap illustrating the distribution of human coded and sentiment analysis categories for 948 suicide-related tweets.....	88
Figure 4.3 Confusion matrix heatmap illustrating the distribution of human coded and sentiment analysis categories for 736 positive-related tweets.....	92

LIST OF APPENDICES

Appendix A	Ethics Approval by Human Research Ethics Committee of Universiti Sains Malaysia (USM), under protocol code USM/JEPeM/22040252
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MENGENAL PASTI RISIKO BUNUH DIRI MELALUI TWITTER (X) DI MALAYSIA

ABSTRAK

Peningkatan kadar bunuh diri di peringkat global menekankan keperluan mendesak untuk kaedah yang lebih berkesan dalam mengenal pasti dan memahami risiko bunuh diri, terutamanya di kawasan yang mempunyai sistem pengumpulan data yang terhad. Tesis ini memberi tumpuan kepada cabaran dalam memperoleh data berkaitan bunuh diri di Malaysia, di mana stigma sosial dan kekangan struktur seperti kebergantungan terhadap laporan perubatan serta sejarah pengkategorian cubaan bunuh diri sebagai jenayah yang hanya dinyahjenayahkan pada tahun 2023 menghalang pelaporan yang menyeluruh. Bagi menangani jurang ini, kajian ini meneroka potensi platform Twitter sebagai sumber data tambahan dalam mengesan ekspresi berkaitan bunuh diri melalui analisis sentimen. Objektif utama kajian ini adalah untuk menilai keberkesanan penggunaan alat analisis sentimen (VADER) di platform seperti Twitter dalam mengesan individu yang menunjukkan tanda-tanda risiko bunuh diri melalui analisis kandungan ciapan. Menggunakan API Twitter, ciapan daripada pengguna Malaysia berumur 18 tahun ke atas yang ditulis dalam bahasa Inggeris telah dikumpulkan melalui penapisan kata kunci tertentu. Dua senarai kata kunci telah digunakan: satu yang menyasarkan ekspresi berkaitan bunuh diri dan satu lagi yang memfokuskan kepada pernyataan positif. Ciapan yang diperoleh kemudiannya dibahagikan kepada dua set data: set berkaitan bunuh diri dan set kawalan (positif), serta dikod secara manual berdasarkan kandungan dan valens emosi. Analisis sentimen kemudian dijalankan ke atas kedua-dua set data, dan prestasinya dibandingkan dengan pengekodan manusia untuk menilai ketepatannya. Analisis

sentimen menunjukkan tahap keselarasan yang tinggi dengan pengkodan manusia dalam mengenal pasti ciapan negatif dalam set data berkaitan bunuh diri (ketepatan 80%, kepekaan 81%, skor F1 0.81) dan ciapan positif dalam set kawalan (ketepatan 83%, kepekaan 88%, skor F1 0.85). Namun begitu, ia menghadapi kesukaran dalam mengenal pasti ciapan neutral dalam kedua-dua set data, sekali gus menonjolkan kelemahan dalam mentafsir kekaburan, konteks, dan nuansa ekspresi manusia. Dapatan ini mencadangkan bahawa alat digital boleh melengkapi kaedah tradisional pengumpulan data berkaitan bunuh diri dengan menyediakan cerapan masa nyata yang berskala untuk menyokong strategi intervensi awal. Dengan membuktikan kebolegunaan data media sosial dalam pemantauan risiko bunuh diri, kajian ini mengesyorkan integrasi alat digital dalam sistem pengawasan kesihatan nasional.

IDENTIFYING SUICIDE RISKS THROUGH TWITTER (X) IN MALAYSIA

ABSTRACT

The rise of suicide rates globally highlights the urgent need for improved methods of identifying and understanding suicidal risk, particularly in regions with limited data collection systems. This thesis focuses on the challenges of suicide-related data acquisition in Malaysia where stigma and structural limitations such as reliance on medically reported information and the historical criminalization of suicide attempts, which was only decriminalized in 2023 impedes comprehensive reporting. To address this gap, this study explores the potential of Twitter as a supplementary data source for detecting suicide expressions through sentiment analysis. The primary objective of this research is to evaluate the potential of utilizing sentiment analysis tool (VADER) on platforms such as Twitter to detect individuals exhibiting signs of suicide risk through the analysis of tweet content. Utilizing Twitter's API, tweets from Malaysian users aged 18 and above, written in English, were collected by filtering for specific keywords. Two keyword lists were used: one targeting suicide expressions and the other focusing on positive statements. The resulting tweets were divided into suicide expression and positive-related (control) datasets and manually coded by a human coder based on content and emotional valence. Sentiment analysis was then applied to both datasets, with its performance benchmarked against human coding to assess accuracy. Sentiment analysis demonstrated strong alignment with human coding in identifying negative tweets in the suicide expression dataset (precision 80%, recall 81%, F1-score 0.81) and positive tweets in the positive-related dataset (precision 83%, recall 88%, F1-score 0.85). However, it struggled to identify neutral tweets in

both datasets, highlighting limitations in its ability to interpret ambiguity, context, and nuanced human expression. These findings suggest that automated tools can complement traditional methods of suicide data collection by offering scalable, real-time insights to support early intervention strategies. By demonstrating the viability of social media data in suicide risk monitoring, the study advocates for the integration of digital tools into national health surveillance systems.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Suicide remains a critical global public health concern, claiming approximately 740,000 lives annually, averaging one death every 43 seconds (Institute for Health Metrics and Evaluation [IHME], 2024). In the United States alone, over 49,000 individuals died by suicide in 2022, with an additional 13.2 million seriously considering suicide, 3.8 million formulating a suicide plan, and 1.6 million attempting suicide (Centers for Disease Control and Prevention [CDC], 2024). The European Union (EU) reported 47,346 suicides in 2021, accounting for 0.9% of all recorded deaths and an average suicide rate of 10.2 per 100,000 people. Among EU nations, Slovenia recorded the highest suicide rate (19.8 per 100,000), followed by Lithuania (19.5) and Hungary (15.7) (Eurostat, 2024).

Despite the extensive study of suicide and self-harm in Western contexts, research in Asia remains scarce due to inconsistent reporting practices. Current estimates indicate that 60% of global suicides occur in Asia (Beautrais, 2006; Chen et al., 2011; Wu et al., 2012), with Southeast Asia alone accounting for 39% of all suicides worldwide (Vijayakumar et al., 2020). However, the accuracy of these estimates is uncertain due to inconsistencies in study populations, research methodologies, and incomplete data registration systems (WHO, 2019; Wu et al., 2012).

1.2 Problem Statement

Malaysia exemplifies the challenges associated with systematic suicide reporting. The estimated national suicide rate in 2019 was 5.8 per 100,000 people,

translating to approximately 1,841 suicide deaths annually (Norhayati et al., 2021). The country ranked second among selected Muslim-majority nations and mid-range among ASEAN members. During the COVID-19 pandemic, the Royal Malaysia Police (RMP) reported 468 suicides between January and May 2021, a significant increase compared to the 631 and 609 cases recorded in 2020 and 2019, respectively (Free Malaysia Today, 2021). However, these figures do not represent comprehensive national statistics, further underscoring Malaysia's data collection limitations.

Malaysia's attempts at suicide surveillance have been hindered by systemic shortcomings. The National Suicide Registry, established in 2007, was discontinued after only two report publications due to its inability to capture unverified cases of suicide or self-harm significant predictors of suicide (Ministry of Health Malaysia, 2007; Hayati et al., 2008). Stigma and legal constraints, such as the now-repealed Section 309 of the Penal Code criminalizing suicide attempts, further discouraged accurate reporting and help-seeking behaviors (Utyasheva, 2023).

Given these limitations, there is an urgent need for alternative methods to gather suicide-related data. Social media platforms, particularly Twitter, offer an avenue for monitoring public discourse on suicide. Previous studies have demonstrated the utility of social media in tracking public health trends (Fung et al., 2015; Luo et al., 2019) and suicide-related discussions (Luo et al., 2019; Nesbitt et al., 2025; Ding et al., 2024). However, research on social media-based suicide detection remains limited in Malaysia. This study seeks to address this gap by evaluating Twitter as a tool for identifying suicide-related discourse and assessing the effectiveness of sentiment analysis in this context.

1.3 Research Questions

1. To what extent are suicide-related keywords effective in identifying relevant suicide expressions in Malaysian Twitter data?
2. How accurately does sentiment analysis (i.e. VADER) classify the emotional valence of suicide expression tweets compared to human coders?

1.4 Research Objectives

The primary aim of this research is to evaluate the potential of Twitter as an effective platform for detecting individuals exhibiting signs of suicide risk through the analysis of their tweet content. This aim is achieved by assessing the performance of a sentiment analysis tool and the effectiveness of pre-defined keywords used in extracting a relevant dataset for this research:

1. To evaluate the effectiveness of suicide-related keywords in filtering Malaysian tweets relevant to suicide discourse.
2. To assess the accuracy and precision of sentiment analysis tools in detecting emotional valence within suicide expression tweets, using human-coded categorization as the reference point.

1.5 Significance of Study

This study carries considerable significance for both academic research and mental health professionals, particularly in the Malaysian context. By examining the potential of Twitter as a tool for identifying individuals who may be at risk of suicide through the analysis of their tweet content, this research seeks to address a pressing gap in Malaysia's current suicide prevention framework. The findings offer new insights into how automated technologies can be leveraged to systematically gather

and analyze suicide-related data, thereby contributing to improved monitoring and early intervention efforts. Additionally, this study evaluates the effectiveness of sentiment analysis in detecting suicide-related sentiment, offering a critical assessment of its accuracy and applicability within the field of mental health surveillance.

Furthermore, by investigating the relevance and efficacy of predefined suicide-related keywords in identifying pertinent discussions on Twitter, this research enhances the understanding of linguistic patterns and cultural nuances associated with mental health expressions in Malaysia. The findings hold the potential to inform the development of more refined detection methodologies that account for local variations in language and sentiment. Moreover, this study provides valuable evidence to support the design of targeted intervention strategies, including proactive mental health outreach and crisis response mechanisms aimed at reducing suicide risks and fostering psychological well-being within Malaysian communities.

Beyond its academic contributions, this research carries meaningful implications for public health policy and clinical practice. By exploring the feasibility of social media-based suicide detection, the study supports the potential role of digital platforms in strengthening Malaysia's mental health infrastructure. The insights derived from this research can guide policymakers and healthcare practitioners in formulating data-driven approaches to suicide prevention, ultimately contributing to more effective national mental health strategies.

1.6 Research Scope

This study investigated the viability of Twitter and sentiment analysis as tools for gathering data related to mental health and suicide risk among Malaysians.

The research scope was delimited to the recruitment of public Twitter accounts belonging to Malaysians aged 18 years and above who tweet in English within Malaysia. The sample comprised of individuals who maintained public Twitter accounts. Tweets were obtained using an API function that filters tweets based on predefined parameters such as language and location, as well as predefined keywords for suicide expressions and positive-related. Tweets that were made within the period of January 2021 to December 30th, 2021, were collected.

The final sample consisted of Twitter users with tweets that met the filter keywords and sample criteria. The collected tweets were analysed by a human coder who categorized them into four main categories: 'Joke/Sarcastic,' 'Neutral (Uncertain),' 'Not Suicide-related,' and 'Suicide-related.' 'Suicide-related' tweets were further categorized into subcategories of 'At-risk,' 'Potential risk,' and 'Not-at-risk.' Additionally, these tweets were manually categorized based on their valence (positive, negative, or neutral) by the human coder.

A control dataset was formed from tweets filtered based on positive keywords. These positive-related tweets were similarly categorized based on their valence. Sentiment analysis was conducted on both the dataset containing tweets that fulfil suicide-related keywords and the positive-related keywords. The performance of sentiment analysis in categorizing the dataset's valence was compared against the human coder's categorisation.

1.7 Conceptual and Operational Definitions

All terminologies used in this study is conceptualized and operationalized as follows.

1.7.1 Suicide risk, suicidal ideation and suicidal behaviour

Suicide risk is defined as the possibility that an individual may attempt or die by suicide, shaped by a complex interaction of biological, psychological, clinical, social, and environmental influences (Turecki & Brent, 2016). Suicidal ideation refers to a range of thoughts concerning ending one's life, spanning from brief, passing ideas to more elaborate plans (Klonsky et al., 2016). Suicidal behavior includes any actions undertaken with the intent to end one's life, such as suicide attempts, regardless of whether they result in death (Nock et al., 2008). In this study, users who publicly Tweeted expressions of suicidal ideation, self-harm behaviors, or other indications of suicide risk are identified through a keyword-based filter (using 63 suicide-related keywords from Colombo et al., 2016) and manually categorized as "suicide risk" by a human coder.

1.7.2 Suicide risk monitoring

Suicide risk monitoring refers to the continuous evaluation and management of an individual's suicide risk, particularly within clinical and research contexts. It involves the implementation of protocols designed to detect and respond to shifts in risk levels (Schatten et al., 2020). In this study, sentiment analysis and Twitter data are explored as supplementary tools for monitoring suicide risk among the Malaysian public. Sentiment analysis using VADER is employed as an automated method to manage and flag large volumes of data, taking advantage of Twitter's accessible APIs to compile extensive datasets reflecting expressions of suicide risk.

1.7.3 Sentiment Analysis

Sentiment Analysis refers to the computational technique of detecting and classifying opinions within text, particularly to assess whether the expressed attitude is positive, negative, or neutral (Sudhanshu et al., 2023). In this study, VADER-based

sentiment analysis is utilized to automatically assign a valence (positive, negative, or neutral) to each tweet. These automated valence classifications are then compared with human-coded categorizations of the same tweets to evaluate the accuracy of sentiment analysis within the context of this research. This comparison enables researchers to evaluate the applicability of sentiment analysis to Malaysian Twitter data.

1.8 Study Rationale

Malaysia faces persistent challenges in the systematic collection and reporting of suicide-related data. Despite efforts to establish surveillance mechanisms, such as the now-defunct National Suicide Registry, the country continues to struggle with incomplete data capture, influenced by stigma, legal constraints, and methodological limitations (Ministry of Health Malaysia, 2007; Hayati et al., 2008; Utyasheva, 2023). These gaps have hindered the development of evidence-based suicide prevention strategies, particularly in a context where suicide remains significantly underreported.

Given that Southeast Asia accounts for 39% of global suicides (Vijayakumar et al., 2020), and Malaysia ranks notably within the region, addressing the limitations of traditional data sources has become increasingly urgent. The COVID-19 pandemic further highlighted the inadequacies of existing surveillance systems, with the Royal Malaysia Police (RMP) reporting a sharp increase in suicides during 2021 (Free Malaysia Today, 2021), yet without comprehensive national figures to guide interventions.

Social media platforms such as Twitter have emerged as potential alternative sources of mental health data, given their widespread use for self-expression and public discourse. In Malaysia, where approximately two million active users engage with Twitter, the platform offers a promising avenue for capturing real-time

expressions of psychological distress and suicide risk. Previous research has demonstrated the feasibility of using social media data for public health monitoring and suicide-related studies (Fung et al., 2015; Luo et al., 2019; Nesbitt et al., 2025; Ding et al., 2024), yet local studies examining its utility remain limited.

This study is grounded in the need to explore innovative and culturally sensitive methods for suicide risk detection in Malaysia. By leveraging sentiment analysis techniques, specifically VADER, to evaluate expressions of suicide risk within Malaysian Twitter discourse, this research seeks to assess both the performance of automated sentiment detection and the effectiveness of pre-defined suicide-related keywords in identifying relevant content.

The findings of this study are expected to contribute toward strengthening Malaysia's suicide surveillance infrastructure by providing insights into the applicability of digital monitoring tools. Furthermore, by comparing the outputs of sentiment analysis with human-coded categorisations, the study critically examines the reliability of automated approaches in a Malaysian cultural and linguistic context, supporting future advancements in mental health monitoring and public health policy development.

1.9 Conclusion

Reliable suicide data is essential for accurately assessing the prevalence of suicide and formulating effective intervention strategies. In Malaysia, the absence of a comprehensive national suicide surveillance system, coupled with the pervasive stigma surrounding suicide, has resulted in significant data gaps. These limitations hinder the development of evidence-based policies and targeted prevention efforts. As

a middle-income country where suicide remains underreported, there is an urgent need to explore alternative methods for collecting and analyzing suicide-related data.

With the widespread adoption of social media and an estimated two million active Twitter users in Malaysia who use the platform to express personal thoughts and emotions, digital platforms present a novel avenue for suicide risk detection. This study highlights the potential of sentiment analysis as a tool for systematically identifying suicide-related discourse on Twitter, offering an alternative approach to monitoring mental health concerns at a population level. By assessing the effectiveness of automated sentiment analysis in comparison to human coding, this research contributes to the ongoing discourse on the reliability and applicability of machine learning and automation approaches in suicide prevention.

Findings from this study hold important implications for national health data collection and mental health interventions. The integration of social media analytics into existing suicide surveillance frameworks could provide real-time insights into emerging trends, enabling timely and targeted intervention strategies. By demonstrating the feasibility of leveraging social media data for suicide detection, this research emphasizes the need for interdisciplinary approaches that combine computational methods with mental health expertise. Ultimately, strengthening Malaysia's suicide surveillance infrastructure through innovative data collection strategies can inform more effective public health policies and contribute to reducing suicide-related harm.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Suicide

The following chapter starts with defining and describing suicide through global rates for suicide and suicide attempts, risk and protective factors and prevalence of suicide globally. This chapter then provides an overview of existing data on the prevalence of suicide within Malaysia. Through reviewing existing research, the chapter proceeds into understanding limitations of existing method of data collection for suicide behaviour in Malaysia. Lastly, the chapter introduces the potential utility of social media as a form of data collection tool in studying suicide behaviour.

2.1.1 Defining and Describing Suicide

The term ‘suicide’ originates from Latin, with *sui* (of oneself) and *caedere* (kill) (Mitra et al., 2021). While suicide does not have one universally agreed upon definition, it is usually termed as intentional self-inflicted death with evidence (either explicit or implicit) that the person intended to die (Silva et al., 2024 & Jacobs et al., 2010).

Suicide risk refers to the likelihood that an individual will attempt or die by suicide, encompassing a wide range of factors including psychiatric disorders, substance abuse, previous suicide attempts, and environmental stressors (Turecki & Brent, 2016). Suicidal ideation describes a spectrum of thoughts about wanting to end one's life, ranging from fleeting considerations to detailed planning (Klonsky et al., 2016). Meanwhile, suicidal behaviour encompasses actions taken towards ending one's own life, including suicide attempts, which may or may not result in death (Nock et al., 2008).

Understanding suicide risk is crucial to identifying the factors that may influence an individual's likelihood of self-harm, suicidal ideation, or suicidal behaviour. The

following sections will examine the prevalence of suicide attempts, a key form of suicidal behaviour as well as explore various risk factors, including those related to age, individual characteristics, relationships, and environmental contexts.

2.1.2 Epidemiology of Suicide and Suicide Attempts in Varying Countries

According to the World Health Organisation (WHO, 2019), approximately 727,000 people die by suicide each year, with many more attempting suicide. The Global Burden of Disease Study 2021 reports a slight increase, with approximately 746,000 suicide deaths in 2021, including 519,000 among males and 227,000 among females. This reflects a global age-standardized suicide mortality rate of 9.0 per 100,000, down from 14.9 per 100,000 in 1990 (Weaver et al., 2025).

While many European countries have seen a decline in suicide rates over recent decades (Lochmannová, Majdan, & Šafr, 2025), regional disparities persist. In 2021, Eastern Europe had the highest suicide mortality rate at 19.2 per 100,000, followed by Southern Sub-Saharan Africa at 16.1 per 100,000, and Central Sub-Saharan Africa at 14.4 per 100,000 (Weaver et al., 2025).

In contrast, certain Asian countries such as South Korea continue to face significant challenges. South Korea consistently reports one of the highest suicide mortality rates globally, with 24.1 per 100,000 people in 2021 (Park, 2025). In India, the total number of suicide deaths reached 230,314 in 2016, surpassing the combined total of AIDS-related (62,000) and maternal (33,800) deaths in the same year (Varghese et al., 2025). However, India's suicide rate stood at 12 per 100,000 in 2021, which, while concerning, is closer to the global average. This highlights the importance of viewing suicide data both in terms of absolute numbers and per capita rates, particularly in densely populated countries like India and China, where large populations can obscure per capita comparisons if not contextualized properly.

Low- and middle-income countries, particularly in Southeast Asia, are crucial regions for studying suicide behavior. The WHO estimates that the 26 percent of the global population living in the 11 countries of the WHO South-East Asia Region accounts for 39 percent of global suicides (Ahmed et al., 2017). Additionally, 77 percent of suicide deaths occur in low- and middle-income countries (World Health Organisation, 2021).

Suicidal behavior is multifactorial, arising from the complex interaction of various contributing elements. No single factor determines suicide risk (Itua et al., 2025). Given the considerable cultural, economic, and healthcare differences between regions, findings from one area may not be directly applicable to another. The following sections examine additional factors that influence suicide risk.

2.1.3 Prevalence of Suicide in Younger Population

Research on age-related factors in suicide indicates that although older adults (70 years and above) have high suicide rates, adolescents and young adults are more likely to engage in suicide attempts and exhibit suicidal behaviors (Conejero et al., 2018). To gain a clearer understanding of suicide trends in younger populations, the next section examines patterns across adolescents (ages 10 to 19), young adults (ages 15 to 24), and adults (25 years and above), as defined by the World Health Organization and United Nations Department of Economic and Social Affairs (WHO, 2014; UNDESA, 2013).

Globally, suicide ranks as the second leading cause of death among individuals aged 15 to 29, according to the World Health Organization (2014). This is particularly concerning given the complex and often elusive nature of the factors that contribute to suicide in young people (Hawton et al., 2012; Cha et al., 2018). Country-level data also point to a rising trend in adolescent suicide rates (OECD, 2017b; Glenn et al., 2020).

In the United States, for example, the age-adjusted suicide rate increased by 24 percent between 1999 and 2014. Age adjustment is a statistical method used to allow comparisons between populations with different age structures by eliminating the effect of age. It ensures that observed differences in suicide rates are not due to one population being older or younger on average than another. This makes age-adjusted rates useful for tracking suicide trends over time or comparing across regions.

During the same period in the US, the most significant rise in female suicide rates occurred among those aged 10 to 14, while males in this age group experienced the second-largest percentage increase among males overall (Curtin et al., 2017). Between 2007 and 2015, suicide rates among 15- to 19-year-olds of both sexes also increased. In 2015, the rate for females in this age group reached its highest level in 40 years (Curtin et al., 2017). A review of global suicide mortality among youth aged 10 to 19 found an estimated suicide rate of 3.77 per 100,000 people, which is consistent with previous findings for this age group (Glenn et al., 2020).

When examining gender patterns among adolescents, suicide deaths are significantly more common among males, occurring two to four times more frequently than among females (Bridge et al., 2006; Cha et al., 2018; Kølves & DeLeo, 2014). This gender disparity aligns with trends observed in adult suicide rates (Bachmann, 2018; Canetto & Sakinofsky, 1998; WHO, 2016b).

Research shows that suicidal thoughts and behaviors are rare in childhood but increase substantially during adolescence (Dervic, Brent, & Oquendo, 2008; Nock, 2012). Most youths who move from suicidal ideation to behavior do so within one to two years of the onset of suicidal thoughts (Glenn et al., 2017; Nock, 2012). This highlights the importance of early detection and intervention at the ideation stage in order to reduce the risk of suicide attempts in adolescents.

Cross-national studies of suicide mortality among 15- to 19-year-olds report a rate of 7.4 per 100,000 people, with the highest rates found in countries such as New Zealand, Finland, Ireland, Guyana, Sri Lanka, and several former Soviet Union states (Bridge et al., 2006; Cha et al., 2018; Kølves & DeLeo, 2016; Roh, Jung, & Hong, 2018). Multiple studies confirm that suicide attempts peak during mid-adolescence and gradually decline into adulthood, reflecting a similar trend in suicidal ideation (Rueter & Kwon, 2005; Kerr et al., 2008; Nkansah-Amankra, 2013; Nock, Borges, Bromet, Alonso, et al., 2008).

A prospective study of 180 adolescents aged 12 to 19 at the time of hospitalization found that suicide attempts increased through mid-adolescence for both males and females and stabilized by the mid-20s (Goldston et al., 2015). Similarly, Boeninger et al. (2010) found that the highest levels of suicidal ideation and planning within the past year occurred during mid-adolescence for females, while for males, these rates increased more gradually and extended into late adolescence.

Several studies have emphasized the need for further research into adolescent suicidal behavior (Gould, Greenberg, Velting, & Shaffer, 2003; Whitlock et al., 2014). This study also supports that need, as it enables healthcare providers to identify critical developmental periods for intervention and provide early support to individuals at higher risk for suicide (Boeninger et al., 2010).

2.2 Factors Influencing Suicide: Risk & Protective Factors

With the increasing prevalence of suicidal behaviour globally, there has been growing interest in understanding the underlying causes and risk factors associated with it. These include variables such as gender, age, socioeconomic status, relationship dynamics, and existing mental or physical health conditions. To provide a structured

understanding of these contributing factors, this section adopts the social ecological model, which categorizes risk factors into (1) individual-level, (2) relationship-level, and (3) environmental-level domains (Garbarino, 1980; Thompson & Light, 2011). The section ends with a discussion on protective factors, offering a comprehensive view of what may increase or mitigate suicide risk.

2.2.1 Individual Level Risk Factors

Individual-level risk factors for suicide encompass mental disorders, mental health factors, and psychological risk factors. Among these, mental disorders, especially mood disorders, substance use disorders, and antisocial behaviors, are significant mediators of suicidal behavior (Beautrais, 2005). Psychological autopsy studies involving both youth and adults across genders have demonstrated high rates of mental disorders among those who die by suicide or attempt suicide (Cavanagh et al., 2003; Pitkälä et al., 2000).

Even in approximately 10% of individuals who die by suicide without an Axis I diagnosis (e.g., mood disorders, dissociative disorders, psychotic disorders), it has been reported that these individuals often exhibit sub-threshold psychopathology, making them more similar to those with an Axis I diagnosis who die by suicide than to a control group (Ernst et al., 2004). Controlled studies have found that the prevalence of mental disorders among those who die by suicide or make suicide attempts ranges from 63% to 98% (Appleby, Cooper, et al., 1999; Phillips et al., 2002; Vijayakumar & Rajkumar, 1999).

Beyond mental disorders, other mental health factors, such as comorbidity and previous suicidal behavior, can also elevate an individual's risk of suicidal behavior. Comorbidity, defined as the presence of two or more mental disorders simultaneously, has been reported in more than half of those who die by suicide or make suicide attempts

(Beautrais et al., 1996). Depression and anxiety are two particularly significant factors that can influence an individual's suicide risk. Although depression and anxiety are categorized as distinct mood disorders, they often coexist as comorbid conditions. For instance, an individual diagnosed with major depressive disorder may frequently exhibit symptoms related to anxiety disorders (Department of Health Australia, 2009).

While research shows a strong link between depression and both suicidal ideation and attempts, there is limited knowledge about the specific characteristics that increase suicide risk among people with depression, making it a less specific predictor for suicide. In a study examining suicidal thoughts and behaviors in rural Australians with depression, Handley et al. (2018) found that the severity of depression was a significant correlate of suicidality in both men and women, with suicide attempts being more common among younger females with an earlier onset of depression and a higher number of psychiatric comorbidities. Similarly, in a study of Han Chinese outpatients, Li (2017) identified that comorbid anxiety disorders, self-reported anxiety, insomnia, and suicidal ideations were significant factors associated with Major Depressive Disorder (MDD) and suicidality. Furthermore, patients with panic disorder who had a history of depression exhibited a higher rate of suicide attempts compared to those with only panic disorder (70.6% versus 29.4%) (Lepine et al., 1991).

Finally, psychological risk factors, such as suicidal ideation, are crucial precursors to suicide attempts. For example, in a study involving 3,701 psychiatric outpatients who were assessed using scales for current suicide ideation (SSI-C), the most severe suicide ideation in their life (SSI-W), and hopelessness (BHS), it was found that 30 patients died by suicide within an average of four years after the initial assessment. The study determined that measuring the most severe suicide ideation had

an odds ratio of 13.84 for identifying individuals at high risk of suicide (Beck et al., 1999).

In a more recent study, Law, Jin, and Anestis (2018) explored whether the severity of suicidal ideation at its worst point could distinguish between those who only think about suicide (ideators) and those who attempt it (attempters). Analyzing responses from self-report questionnaires completed by 229 adults with a history of suicidal thoughts, they found that individuals who reported more intense suicidal ideation at the worst point were more likely to have made previous suicide attempts. This relationship was further intensified by significant painful and provocative events, which increased their capability for suicide. The study concluded that managing the intensity of suicidal ideation could be crucial in preventing fatal suicide attempts and emphasized that suicidal ideation is a key predictor of such attempts (Law et al., 2018).

2.2.2 Relationship Level Risk Factors

Key relationship-level factors contributing to suicide risk include parental relationships and childhood adversity. Research has shown that young people from disadvantaged and dysfunctional family backgrounds are more likely to engage in suicidal behavior (Beautrais et al., 2005). This dysfunction may manifest as parental separation, parental psychopathology, a history of sexual, physical, or emotional abuse or neglect, impaired parent-child relationships, parental discord, or parental violent behavior (Fergusson et al., 2000; Beautrais et al., 2005).

Supporting this observation, studies have identified an increased risk of suicidal behavior among young people exposed to dysfunctional or adverse family environments (Beautrais, 1996). For instance, a study in New Zealand found that the risk of suicide attempts was higher among children from disadvantaged family backgrounds characterized by a composite score of childhood adversity, including socioeconomic

disadvantage, parental substance abuse, marital discord, compromised child-rearing practices, and frequent residential mobility (Fergusson et al., 2000; Beautrais et al., 2005). Moreover, the risk of suicide attempts within these families increased in correlation with the level of adversity experienced (Fergusson et al., 2000; Beautrais et al., 2005).

The range of childhood adversity factors associated with suicidal behavior significantly overlaps with known risk factors for juvenile crime, substance abuse, mental health issues, and other adverse outcomes in youth and adolescents (Smith & Rutter, 1995). This overlap suggests that the major life processes and pathways leading to suicidal behavior are similar to those that contribute to mental health problems and other negative outcomes for young people (Beautrais et al., 2005).

2.2.3 Environmental Level Risk Factors

In examining the relationship between sociodemographic factors and suicide risk, both aggregate-level and individual-level studies across various countries have indicated that lower social class and socioeconomic disadvantage are associated with increased risks of suicide and suicide attempts (Fergusson et al., 2000; Johansson et al., 1997). For instance, research utilizing Danish longitudinal registers revealed that low household income is linked to higher suicide risk, although this risk diminishes significantly when mental illness is taken into account. The impact of low income appears to be more pronounced for males than for females, suggesting that men may be more vulnerable to the adverse effects of poor economic conditions (Goldney, 2004). This study highlights the importance of adjusting for potential confounding factors, particularly mental illness, when evaluating the association between social class and suicide risk, as failing to do so may lead to overestimations.

The relationship between suicide rates and urbanicity or rurality is complex and often confounded by factors such as age, race, and gender, which are frequently not accounted for in urban-rural analyses of suicide data (Qin et al., 2003; Frances, 1986; Singh, 2002). Generally, suicide rates in Western societies tend to be higher in rural areas compared to more densely populated regions. When other factors are considered, living in rural areas is associated with a decreased suicide risk for females but an increased risk for males. Possible explanations for the higher suicide rates in rural areas include greater access to pesticides and other poisonous substances, limited access to mental health and emergency medical services, higher rates of mental and physical illness, stressful life situations such as the impacts of rural economic downturns, greater stigmatization of mental health issues, and reluctance to seek help (Beautrais et al., 2005).

2.2.4 Protective Factors

Risky health behaviors can be influenced by a wide range of factors, from individual characteristics to environmental conditions. However, it's crucial to recognize that not everyone exposed to these negative influences will develop suicidal thoughts or attempt suicide. The following section explores the current understanding of protective factors that may help mitigate suicide risk. Protective factors are conditions or variables that positively influence individuals, enhancing the likelihood of favorable health outcomes (Hawkins, Cummins, & Marlatt, 2004; Jessor, Turbin, & Costa, 1998).

Similar to risk factors, protective factors can be categorized into individual attributes, relationship attributes, and environmental attributes (Masten & Powell, 2003). Individual attributes include cognitive abilities (such as IQ scores and executive

functioning skills), self-perceptions of competence (e.g., self-esteem, self-efficacy), temperament and personality traits (e.g., adaptability, sociability), self-regulation skills (such as impulse control), and a positive outlook on life (e.g., hopefulness).

Relationship attributes encompass the quality of parenting, close relationships with competent adults (such as parents, relatives, or mentors), and connections to pro-social peers. Environmental attributes include external resources and opportunities such as access to quality education, connections to pro-social organizations (e.g., religious groups), neighborhood quality, and the availability of social and health care services (Masten & Powell, 2003), as well as religiosity (Beautrais et al., 2005). These protective factors can serve as valuable resources that counterbalance adversity or moderate the impact of risk factors on specific outcomes.

For example, in examining the role of a positive self-image as a protective factor, "believing in one's value and potential" was identified as a safeguard against alcohol use and abuse (Allen et al., 2006). Multiple studies confirm that self-efficacy fosters positive health outcomes, such as reducing alcohol consumption (Allen et al., 2006; Henson et al., 2017; Hawkins et al., 2004). Self-efficacy, defined as the perceived ability to avoid violence, has also been shown to protect against violent behavior (Pu et al., 2013) and to serve as a protective factor against suicide attempts (Mackin et al., 2012).

In terms of relationship attributes, both non-familial connectedness and family connectedness are significant protective factors. Caring non-familial adults, including school officials, religious leaders, and tribal leaders, have been found to protect against hopelessness in female adolescents and against suicidal ideation in male and female adolescents who reported past sexual abuse (Pharris et al., 1997). Similarly, adolescents

who felt cared for by non-familial adults, such as school staff, church leaders, and tribal leaders, were found to be protected against depression (Barney, 2001).

Family concern has been identified as a protective factor against suicide attempts in male adolescents and against suicidal ideation in female adolescents with a history of sexual abuse (Pharris et al., 1997). Additionally, parental attention was found to protect against suicide attempts in female adolescents, suicidal ideation in both male and female adolescents, and feelings of hopelessness in female adolescents with a history of sexual abuse. Parental concern also served as a protective factor against suicide attempts and suicidal ideation in female adolescents who reported past sexual abuse, a finding further supported by Cummins et al. (1999), who identified perceived family concern as the most powerful protective factor associated with adolescent mental health.

Research on environmental protective factors reveals that positive opportunities can significantly mitigate negative health outcomes. A study by Moilanen et al. (2014) involving 5,701 adolescents found that participation in extracurricular activities acted as a protective factor against substance use. Whitbeck et al. (2001) found that involvement in sports teams and clubs contributed to academic success, while Osilla et al. (2007) identified participation in sports and music as protective against tobacco use. Allen et al. (2006) also noted that opportunities for adolescents to engage in community contributions were protective against alcohol use and abuse.

Religious affiliation and activity have also been shown to protect against suicide, with higher suicide rates observed among those without religious affiliation (Pescosolido & Georgianna, 1989; Lester, 2000). Religious involvement likely exerts a protective effect by prohibiting suicide and promoting social support through religious communities and networks. This network of support and the prohibition of suicide

within religious communities also reduce the risk of psychiatric disorders associated with suicide, such as depression, substance abuse, and antisocial behaviors (Beautrais et al., 2005).

Understanding the determinants of health and identifying modifiable factors that support positive health choices during adolescence can inform interventions aimed at reducing suicide risk. However, it is important to recognize that the interactions between risk and protective factors vary among individuals, making it challenging to accurately predict who will build resilience and who may be more vulnerable to suicide risk, despite extensive research on these factors.

The preceding sections on both risk and protective factors highlight the multi-layered influences that may contribute to suicidal expression. Understanding these factors provides essential context for how suicide risk may appear in online communication, particularly through expressions of ideation or distress on social media. The next section explores how such risk may be communicated.

2.3 Patterns in Expressions of Suicide Risk

Language serves as a crucial indicator of an individual's mental state, particularly in expressing suicidal ideation (Sierra et al., 2022). Analyzing verbal expressions provides insights into the psychological distress individuals may experience. This section examines linguistic markers associated with suicidal thoughts and behaviors, comparing findings from Western and Asian studies, and discusses their relevance in online contexts.

Research in Western contexts has identified distinct linguistic patterns associated with suicidal ideation. Owen et al. (2012), through an analysis of 14 completed suicide cases from coroners' files and interviews with close associates in

London, Southwest England, and South Wales, categorized verbal expressions of suicide into two forms: direct and indirect communication. Direct communications involve explicit statements of intent, threats, or plans, such as a man telling his aunt, “I am going to hang myself,” or another individual stating to his girlfriend, “If you’re not going to come away with me, I’m going to kill myself.”

In contrast, indirect communications imply suicidal ideation without explicit articulation, exemplified by statements like, “This year I am not going to be here anymore, don’t feel sad for me,” or a remark to a general practitioner: “Sometimes a sacrifice has to be made for things done wrong in the past.” These findings highlight the variability in how suicidal intent may be conveyed, ranging from overt declarations to more nuanced, ambiguous expressions.

2.4 Suicide in Malaysia

The previous sections attempted to address key concerns relating to the severity of suicide globally. This included the general epidemiology of suicide, the influencing factors that can contribute to an individual’s suicide risk as well as ways to assess an individual’s risk for suicide. The present section attempts to understand the same concerns however in the context of Malaysia, with the overall objective of understanding if there are similarities in the way suicide presents itself in this part of the world. The following section starts with looking at the prevalence of suicide in Malaysia before attempting to delve into other influencing variables that can increase the risk for suicide risk in Malaysian individuals and finally looking into Malaysia’s effort into suicide surveillance.

2.4.1 Suicide Prevalence and Patterns in Malaysia

Malaysia, classified as an upper-middle-income nation, has a diverse population composed of indigenous Malays (69.3%), Chinese (22.8%), Indians (6.9%), and other minority groups (1%). The country has a median age of 30.3 years and an average life expectancy of 73.2 years (Raaj et al., 2020). Rapid urbanization and globalization have brought about significant cultural and lifestyle transformations within the nation (Raaj et al., 2021; Hussain et al., 2016). According to the World Economic Forum, Malaysia ranked 35th in 2018 and 37th in 2017 on the Global Innovation Index (Duta et al., 2020), signaling its progress toward becoming a high-income country.

Studying suicide prevalence in Malaysia is crucial, especially given that 79% of global suicides occur in low- and middle-income countries (World Health Organization, 2019). However, estimating accurate national suicide rates has been difficult due to the absence of official national data (Cheah et al., 2018) and the fact that suicide was criminalized in Malaysia until June 2023. Although recent estimates suggest a suicide rate of approximately 5.50 per 100,000 population (WHO, 2018), the World Health Organization has expressed concern about the credibility of this data, attributing the issue to significant underreporting linked to Section 309 of the Penal Code (WHO, 2014; Mishara et al., 2016).

Suicide is a significant public health concern in Malaysia, with rates and risk factors varying across age, gender, ethnicity and region. Research highlights both the challenges of accurate data collection and urgent need for targeted prevention strategies (Lew et al. 2022; Armitage et al., 2015; Bakar et al., 2023).

Several academic studies have sought to estimate Malaysia's actual suicide rates. Armitage et al. (2015) conducted a systematic review of 39 studies and reported an estimated suicide rate of 6-8% per 100,000 population annually. Suicidal ideation was