PHONETIC AND PHONOLOGY STUDY: A SOUND AND SPELLING OUTLOOK ON WAYPOINTS IN MAKASSAR AIR TRAFFIC SERVICE CENTER

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F022191017

A THESIS

ENGLISH LANGUAGE STUDIES

FACULTY OF CULTURAL SCIENCES

HASANUDDIN UNIVERSITY

2020

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THESIS

As a Partial Fulfillment to Achieve Master Degree

Program

English Language Studies

Arranged and Proposed by

Didik Agus Suryono

To

ENGLISH LANGUAGE STUDIES

FACULTY OF CULTURAL SCIENCES

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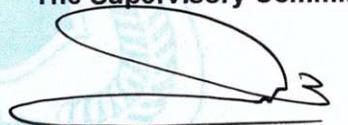
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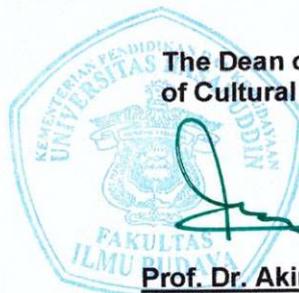
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Makassar, 11 September 2020

Yang menyatakan

DIDIK AGUS SURYONO

ACKNOWLEDGMENT

Alhamdulillah, all praise is due to Allah God Almighty, because of God's gracious guidance this research has reached its goal and come to and end. Researcher hope that God will always give light to all of us to continue learning and producing meaningful knowledge for the sake of human life.

The Researcher is fully aware that this research can be finished by the assistance of many parties, thus he wants to extend his sincere gratitude to all supporting parties, especially to board of supervisors: Prof. Dr. Hamzah A. Machmoed, M.A. and Prof. Drs. Burhanuddin Arafah, M.Hum., Ph.D. who have tirelessly supporting researcher, and board of examiners: Dr. Harlinah Sahib, M.Hum., Dra Herawaty, M.Hum., M.A., Ph.D., and Dr. Sukmawaty, M.Hum. who have provided the with useful critical thinking and suggestions. The researcher's sincere thanks also goes to Prof. DR. H. Fathu Rahman, M.Hum for his ongoing support and facilitation to researcher's class so that the learning process has run so smoothly.

Researcher also wants to extend his gratitude to General Manager of Air Navigation Indonesia Branch Office Makassar Air Traffic Service Center for supporting the learning process and provide his facilitation to conduct classroom learning and research, all classmates who have been supporting each other, all students of reguler class of English Language Program who _____ ovided a significant contribution in supporting the research _____ tion, administration staffs of both University of Hasanuddin and Air

Navigation Indonesia for their meaningful paper works and all anonymous parties in these two institutions which cannot be mentioned one by one, researcher wishes for their health and wealth.

Special thanks goes to pilot informant, Capt. Ardy M. Almatsir and ATC informant, Akhmad Abdillah who have provided information and shared their precious time to support the research. Special thanks also goes to researcher's parents, Suyanto Hari Saputra and Sunarti, for their spiritual support, researcher's wife, Nila Sophia and children, Annisa Aozora Suryono, Firman Rizky Nagata Suryono and Helene Aiko Damara Asa Suryono for their spiritual support and understanding so that this research has come to an end. Researcher always pray for their forever well-being.

This thesis is dedicated to all of them mentioned above. Researcher hopes that this research will be useful for both theoretical and practice area. Although the research has been completed, yet for the sake of knowledge, researcher will be still expecting critical comment and suggestions.

Makassar, 11 September 2020

Didik Agus Suryono

ABSTRACT

DIDIK AGUS SURYONO. Phonetic and Phonology Study: A Sound and Spelling Outlook on Waypoints in Makassar Air Traffic Service Center. (Supervised by Hamzah A. Machmoed and Burhanuddin Arafah).

This research was aimed to understand the consideration of phonetic and phonology in aviation industry especially in air-ground communication. This research was also aimed to provide any possible solutions to solve air-ground communication problem in terms of sound and spelling. Air-ground communication is so important that miscommunication should be anticipated. Miscommunication in air-ground communication may result a serious incident or accident. A smooth air-ground communication will automatically promote the safe and efficient conduct of flight.

The method used in this research was a combination of quantitative and qualitative. Data were collected from MATSC's voice recording facility and interviews with pilot informant, ATC informant and twenty active air traffic controllers.

The research had found that there was a lack of awareness in English sound and spelling within air traffic controllers in Makassar Air Traffic Service Center. There are some factors which have resulted the condition such as the absence of sound and spelling subject in the syllabus of the initial ATC training. Another factor is the absence of labio-dental fricative sounds in Indonesian local language. The research had provided some suggestions to some parties who have big concern on the air-ground communication like providing a guidance to name a waypoint, conduct a training on English sounds and spelling and to consider local phonemes limitation in assigning a waypoint name. The research encouraged other researchers to do another research in aviation and linguistic for the sake of knowledge.

Keywords: Phonetic, Phonology, Air Ground Communication, ICAO, Aviation Language, Aviation English.

ABSTRAK

DIDIK AGUS SURYONO. Studi Fonetik dan Fonologi: Pandangan Suara dan Ejaan *Waypoint* di Makassar Air Traffic Service Center. (Disupervisi oleh Hamzah A. Machmoed dan Burhanuddin Arafah).

Penelitian ini bertujuan untuk memahami pertimbangan ilmu fonetik dan fonologi dalam industri penerbangan terutama pada komunikasi *air-ground*. Penelitian ini juga bertujuan untuk memberikan beberapa solusi yang mungkin dapat diterapkan untuk menghindari terjadinya miskomunikasi dalam komunikasi *air-ground*. Komunikasi air-ground sangat penting sehingga miskomunikasi harus benar-benar dihindari. Miskomunikasi dalam komunikasi *air-ground* dapat mengakibatkan insiden maupun kecelakaan yang fatal. Terjaminnya kelancaran komunikasi air-ground secara otomatis akan meningkatkan tingkat keselamatan dan efisien penerbangan.

Metode yang digunakan dalam penelitian ini adalah kombinasi dari kuantitatif dan kualitatif. Data diperoleh dari fasilitas perekaman suara komunikasi yang ada di MATSC dan hasil dari interview dengan informan pilot, informan ATC dan dua puluh pemandu lalu lintas udara yang aktif.

Penelitian ini telah menemukan adanya ketidaktahuan dari petugas pemandu lalu lintas udara yang ada di MATSC pada ilmu suara dan ejaan Bahasa Inggris. Beberapa faktor yang menyebabkan kondisi ini adalah karena tidak adanya mata pelajaran khusus tentang ilmu suara dan ejaan di pendidikan awal. Selain hal tersebut, bahasa daerah dari para ATC ini tidak mengandung suara *labio-dental fricative*. Penelitian ini telah memberikan beberapa saran bagi para pemerhati komunikasi *air-ground* seperti pemberian panduan untuk menamakan waypoint, mengadakan pelatihan khusus di bidang suara dan ejaan Bahasa Inggris, dan mempertimbangkan keterbatasan fonem lokal terhadap pemberian nama *waypoint*. Penelitian ini memberikan dorongan kepada para peneliti lain untuk mengadakan penelitian-penelitian dalam dunia penerbangan dan linguistik untuk kebaikan ilmu pengetahuan.

Keywords: Fonetik, Fonologi, Komunikasi Air Ground, ICAO, Bahasa Penerbangan, Bahasa Inggris Penerbangan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AIP	Aeronautical Information Publication
ANSP	Air Navigation Service Provider
ATC	Air Traffic Controller
ATS	Air Traffic Service
DGCA	Directorate General of Civil Aviation
FAA	Federal Aviation Authority
FIR	Flight Information Region
GVS	Great Vowel Shift
ICAO	International Civil Aviation Organization
IPA	International Phonetic Alphabet
L1	First Language or Mother Tongue
MATSC	Makassar Air Traffic Service Center
NOTAM	Notice To Airman
OJT	On the Job Training
PTT	Push to Talk
UPR	User Preferred Route

CHAPTER I

INTRODUCTION

This chapter consists of several subchapters which are going to be explained. Those subchapters are as follows: (1) Background of the Research, (2) Research focus, (3) Research questions, (4) Objectives of the research, and (5) Significance of the Research.

A. Background of The Research

When people speak, they produce a continuous stream of sounds. Scholars divide this stream into small pieces that are called as segments and people can find great variety in the way these segments are made.

Moreover, Bett (2002) said that there is an abstract set of units as the basis of one speech. These units are known as phonemes and the complete set of these units is called the phonemic system of the language. The phonemes are abstract but there are many slightly different way in which people make the sounds that represent these phonemes . There are many ways in which people may make a mark on a piece of paper to represent a particular (abstract) letter of the alphabet.

The perception of spoken words is considered as an extremely difficult task. The reason is that speech is distributed in time, a fleeting signal that has a few reliable cues to the boundaries between segments and words. The way the listener perceives spoken words may sometimes lead to __pretation and even misunderstanding as experienced by most pilots __raffic controllers.

Air-ground communication is a term used to define two way communication between pilot and air traffic controller in doing their respective professional activities. A successful air-ground communication will contribute on the safe and efficient conduct of flight. In successfully conducting air-ground communication, pilot and air traffic controller are required to establish a mutual understanding of the nature of events relevant to the operational procedures.

In air ground communication, pilot and air traffic controller must be aware of the absence of visual clues. Communication will only rely on the quality of sounds, including phonological clues. When one of the parties loss to produce or to interpret the other party's utterance, the consequences maybe fatal. One example of this is the case of flight accident at Kuala Lumpur back in 1989. It was the Flying Tigers Boeing 747 crashed just 8 miles before the runway. This accident was investigated and found a problematic pronunciation between "to" and "two". At the first transmit air traffic controller instructed the aircraft "Descend to two seven zero zero" (two thousand seven hundred feet) which then replied by pilot "Roger, cleared to two thousand seven hundred, we're out of forty five". Minutes later, air traffic controller instructed "Descend two four zero zero" which then replied by pilot "OK, four zero zero". At this point the crew was assuming that "two" as "to" as the first instruction. Four crews of this Flying Tiger were killed after executing the descend and crashed to the ground. This accident ʜot have happened, had the air traffic controller not dropped the ". The air traffic controller should have said the instruction using

preposition "to" in order to complete it by saying "Descend to two four zero zero".

Compared to the other kind of communications, air-ground communication is a unique and challenging interaction. Air traffic controller, as the air traffic service provider, act as the host in an area which usually called a sector, using a radio equipment which is set to a specific radio frequency. Within the frequency pilots are only served by a single air traffic controller. The topics of the communication, though may be varied, are very limited to the concern of the safe and efficient conduct of flight. Pilots and controller are not permitted to communicate any irrelevant issues.

Transmission of a message in air-ground communication is fully controlled by push-to-talk system (PTT) in both side, which means, a speaker needs to push a button every time he/she wants to deliver a message. Finishing the message, a speaker should release the button, otherwise other speaker will not be able to send a message into the channel. This condition depicts that there is only a single transmission will be successfully sent over the channel at a period of time. Every pilot has to make sure that a communication has been completed before starting his/her own communication to air traffic controller. Overlapping transmission may cause a failure to speaker to deliver a complete message, thus the communication will require repetition or prolonged time to be accomplished.

In a high-density period, air-ground communication may be too busy. he workload of an air traffic controller will be significantly increased occasions, namely, in bad weather condition. Many pilots will rush

into the frequency for various inquiries, such as level change request, course change request, information request or just a routine position report. On the other hand, air traffic controller needs to provide instructions, clearances or information to pilot to keep the safe and efficient flow of air traffics under his/her responsibility. Furthermore, all of those messages involved in the communication should be read-back and heard-back to ensure the correctness of receiver's perception. A failure to safe guard this communication may result a serious incident or accident.

In the context of air-ground communication, International Civil Aviation Organization (ICAO) provides a standard guidance to conduct a safe and efficient air-ground communication. The standard guidance includes the provision of a limited set of phrases, known as phraseology, which will always be used for pilots and air traffic controllers to communicate and exchange information. Only when these phraseologies are unable to accommodate the transaction, then, pilots and controllers are allowed to use plain English language.

In many air traffic controller's instructions or clearances, and pilot's reports as well, involve the pronunciation of a waypoint. A waypoint is an imaginary point in the air which represents a specific geographical position, consists of latitude and longitude, used to refer a position of an aircraft projected to earth's surface. Sometime a waypoint is generated based on one or more navigational aids. ICAO frees states to name waypoints inside pective airspace. In a conventional navigation, waypoint is always of route/routes. Today, as the introduction of performance based

navigation technology, waypoint may stand alone without being engaged to a specific route.

According to ICAO document, Annex 11-Air Traffic Services (2018), every waypoint should be given a unique five letter name code. The five letter name code must be pronounceable as it is for the purpose of voice communication. Procedure designers shall assign the waypoint name so as pilots and air traffic controller will not find any difficulties in pronouncing it. Such waypoint's names (five letter name code), along with the airways can be seen on table 1.

Furthermore, once pilots and/or air traffic controllers face a difficulty to understand each other on communicating a waypoint, ICAO require both of them to spell the name using aviation alphabets. Aviation alphabets is a set of spelling guidance to aviation community to anticipate ambiguity which may occur on the use of a sensitive air-ground communication. The full A to Z of aviation alphabets can be seen on table 2.

Table 1. Airways and Waypoints

AIRWAY	WAYPOINTS
W13	SIPUT, CUCUT, MADIN, KIDET, KIMON
W15	LEPAS, ALAMO, TAVIP, LAMUD, HAMOL, DIDIN, LADOP, TOSTY
W16	LASEM, CUCUT, MADIN, KIDET
W18	SPADA, ABILO, SPIKO, SUMDI, DUNIA, REBOL, BISOM, LOLOT, MADON

W41	PEDET, LIPOT, MILAT, LAMIN, LABAT, ALOBA, APASI, IBAMA, JODRA, KUBIA
A339	VARLA, POKOS, NIKOM, GUNAM, IDOTO, IKUMA, ELBIS, PINIR, OSUVI, SADEP, DOTIR, BOLUG, POXEL, SHREE, WRNNR, TILLY, KEITH, SABGU, MAKDA, TAXON, YOSHI
A461	BUBDA, IDUMA, BEKOL, NOMAN, MUMOT, AVMUP, TAALA, VERDE, TAPAP, PUSIT, OCORO, TINDO, TANAL, MOLLY, BONDA, BUTPA, ADKUL, OCTOB, AGUST, MONIC, BOYDI, DIGLA, ELLOW, IDANU, AGAGO
G326	NYOMA, ONOXA, GUNAM, BOYDI, BIKER, VINAX, TAVEV MIMMI, MORRO, WOODY
M768	ALGET, GODAV, OBDAL, UDIVO, GUTOX, SELSU, ISBIX, ODIRU, OBMAT, PAGAI, TOLIT, TULIP, KIDET, MADIN, CUCUT, LASEM, GABIT, SOTRA, SATNA, IDOTO, LARAB, JACKI
M522	GALKO, KEVOK, ELANG, NUGRO, MAMOK, ELPOX, ENBAX, NODIN, VINIK

Table 2. Aviation Phonetic Alphabets

CHARACTER	SPELLING	CHARACTER	SPELLING
A	ALPHA	B	BRAVO
C	CHARLIE	D	DELTA

E	ECHO	F	FOXTROT
G	GOLF	H	HOTEL
I	INDIA	J	JULIET
K	KILO	L	LIMA
M	MIKE	N	NOVEMBER
O	OSCAR	P	PAPA
Q	QUEBEC	R	ROMEO
S	SIERA	T	TANGO
U	UNIFORM	V	VICTOR
W	WHISKEY	X	X-RAY
Y	YANKIE	Z	ZOOLOO
1	ONE	2	TWO
3	THREE	4	FOWER
5	FIVE	6	SIX
7	SEVEN	8	EIGHT
9	NINER	0	ZERO

Although aviation phonetic alphabet is provided to avoid ambiguity in communication, in most of daily transaction, it seems that spelling names with aviation phonetic alphabets is seen as a more time consuming activity and considered as the last means to do. Moreover, most of the spelling are initiated with the process of "CONFIRM" and "SAY AGAIN". It is stated in doc 9835 (2004) that in daily life, miscommunication occurs but rarely in anything other than minor inconvenience, minor embarrassment,

or loss of time. Unfortunately, in the context of air-ground communication, the stakes are dramatically higher.

Furthermore, Katerinakis (2014) said, a special quote regarding the "SAY AGAIN", in his doctorate thesis that asking a repetition is considered as communication problem. Although infrequent when considered as a percentage of daily transactions, nevertheless, the increased workloads are considerably dangerous. It may end in a serious incident or accident.

Below is a transcript of a dialogue between pilots and air traffic controller which took place in Makassar Air Traffic Service Center, one of two air traffic control center facilities in Indonesia. From the conversation, it can be seen that how pronunciation of a waypoint may increase the workload of an air traffic controller.

UAE399 : Radar, good evening, Emirates 399 proceeding RABOL done an SID, approaching flight level 240

Ujung ACC : Emirates 399 identified, fly direct CUCUT /tʃutʃut/ and climb flight level 320

UAE399 : Climb flight level 320 and proceed direct to which point? Emirates 399?

Ujung ACC : Fly direct CUCUT /tʃutʃut/ Sir !

IDX555 : Red phoenix 555 request descend (and) request cancel altitude constraint

UAE399 : Emirates 399 please confirm that eeh..waypoint, can you please spell it for us?

Ujung ACC   : Emirates 399 standby please, break, Red phoenix 555

descend flight level 250

IDX555   : Descend flight level 250 and request cancel altitude

constraint

Ujung ACC   : Cancel constraint approved Sir

IDX555   : Red phoenix 555

Ujung ACC   : Emirates 399 fly direct CUCUT /kukut/ Sir !

UAE399   : Can you please spell the position? Emirates 399

Ujung ACC   : Emirates 399 fly direct charlie uniform charlie uniform

tango

UAE 399   : Roger Emirates 399, sorry about that it's CUCUT

/kukut/ direct, thank you!

It is widely understood that reading and writing convention are different in many countries. Thus, the way of pronouncing waypoint names is very much dependent on the reader's reading convention. This is not to say that one's pronunciation is better than the other, nor judging one's pronunciation is correct or wrong. But this condition is leading to a mismatch between speaker's utterance and listener's expectation. This mismatch, in the end, may generate another serious problem. Voiceless [tʃ] and its voiced pair [dʒ] are the only two affricate phonemes in English. [tʃ] as our focus here is slightly aspirated in the positions where p, t, k are aspirated. Since Ujung Pandang ACC did not pronounce it with an accurate aspiration, the UAE399 ___preted the sound.

ICAO has not provided any standard in reading or writing waypoint, thus, states are arbitrarily create a name of waypoints according to their own convention. In most cases, waypoint name is taken from a meaningful word so that, for domestic speaker, an exact clue of pronunciation already exist. CUCUT, for instance, is derived from the name of a specific kind of fish in Bahasa. This word may means nothing in other language.

There are many cases of problematic waypoint pronunciation occurred on the field. The differing sound and spelling knowledge within communication participants has create this situation. There are some possible variations of pronunciation for a single waypoint and these variations are not well understood by some ATCs or pilots.

Regarding the phenomenon of mismatch pronunciation above and the risk it may exposed, Reason (2016) has warned everyone involved in the industrial activity. His theory on Swiss cheese model will be well understood by looking at figure 5 on page 37. A systematic presence of failures or weaknesses will allow hazards to penetrate all possible defenses and in the end will result losses. In an individual accident the victim will be very limited but, as opposed to individual accident/incident, an organizational accident losses will be unpredictable.

Aside from the linguistic problem above, ICAO has committed to optimize airspace capacity around the globe. This is one of its efforts to anticipate the continuing traffic growth. One of its issues, which is stated in ocument 9750 (2016), is the implementation of User Preferred Route JPR is a flying method which will free operators to assign their own

routes from departure point to their destination. Traditionally, flight will be planned by operator to use a designated airways, but in UPR operators are allowed to fly over some assigned points without fully using an airway.

From the illustration above, there are some issues to be underlined, namely:

1. The mismatch of waypoint pronunciation (speaker) and waypoint expectation (hearer) is time consuming.

2. The workload of air traffic controller is constantly growing as the result of air traffic growth.

3. The implementation of UPR will potentially increase waypoint pronunciation in air-ground communication.

Thus, if waypoint pronunciation is not regulated properly then it will result a serious consequences.

Another reason which has made this research more interesting was the fact that English pronunciation has changed over the centuries while the spelling has remained basically the same, so phonemic transcriptions of English are different from written texts (Ladefoged, 2006:35). By having this fact, it was expected that this research would have an outcome which would be useful for the sake of aviation communication.

B. Research Focus

This research studied air-ground communication between air traffic controller and pilots. Waypoints pronunciation in air-ground communication occurs in Makassar Air Traffic Service Center had been the focus of research.

C. Research Questions

Based on the phenomena which have been illustrated above including the focus of the research, this study was aimed to answer the questions as follows:

a. What is the current condition of air-ground communication in MATSC?

b. How does waypoints pronunciation contribute to the safe and efficient conduct of flight?

c. What does the research promote to anticipate the problem of waypoint pronunciation?

D. Objectives of The Research

By doing this research, it was expected that this research would be able to :

a. Describe the conditions of air-ground communication between air traffic controller and pilots in Makassar Air Traffic Service Center.

b. To find out and elaborate whether waypoints pronunciation contribute to the safe and efficient conduct of flight.

c. Provide a solution to air-ground communication problem especially on waypoint pronunciation.

E. Significance of the Research

Both practically and theoretically speaking the research is very significant to:

Pilots, as they may encounter abundant of waypoints along their international route. The research gives them more understanding

on how different countries may read and pronounce waypoint differently.

b. Air traffic controllers, as they have to interact with many international pilots whose linguistic background are different from one another. As well as to pilots, air traffic controllers gain knowledge on how different countries may read and pronounce waypoint differently.

c. Air Navigation Service Provider (ANSP) and ICAO are very advantaged by this research as this research has identified hazard on the operational segment of aviation. This research may be the reference to create or modify their policy.

d. Theoretically, other researchers, as this research may be of their reference to do further research on aviation or linguistic, and

e. Another theoretical benefit will be for aviation training institutions, as this research may be of their reference to construct the syllabus.

CHAPTER II

REVIEW OF LITERATURE

This chapter consists of several subchapters which are going to be explained. Those subchapters are as follows: (1) Previous study, (2) Theory of Linguistic, (3) Air Traffic Services, (4) Swiss Cheese Model.

A. Previous Study

The number of research on aviation linguistic is still limited that it may be difficult for someone to find a suitable article for his/her research literature review. But this also brings a good news that there are still a lot of topics available for aviation linguistic researcher. Provided below are previous studies which have been conducted by David McMillan, Ana-Marija Pliso, Haryani Hamzah, and Andre Gurtov and his team. Their works has given researcher to have a better perspective and make a good judgement upon studying air traffic communication.

1. David McMillan

Miscommunications in air traffic controller was the title of McMillan work for his research in 1998. This research was studying matters which may cause miscommunication within the communication air traffic controller environment. The research is important for the development of aviation English.

In this research, it is found that there are many aspects, including ⬚nent and controller's psychological condition, identified as ⬚tors in miscommunications. This finding is very helpful for the

controllers as they can understand the types of miscommunication and how miscommunication occurs. The controllers may be aware of this types and try not to commit to any of these miscommunications.

Waypoint pronunciation was not discussed in this research. Although, as today's phenomena, waypoint pronunciation sometime contributes in miscommunication. seemingly, as the increasing number of traffics accidents around the world become potential problem caused by this miscommunication, it will raise as well as the volume of traffic increases. It is significant to discuss and to find out the way to anticipate miscommunication affected by wrongly pronounced waypoint.

2. Ana-Marija Pliso

Non-standard phraseology in aviation English was the title of Ana-Marija Pliso work for her research in 2014. Departed from the awareness that the usage of standard phraseology in air-ground communication is so important to minimize miscommunication. She began the research in Switzerland air traffic control facility . The research was trying to find out which group of pilot tend to use non-standard phraseology.

In the sense of differing codes which have occurred in air-ground communication, this research tries to bring the idea to a special case of waypoint pronunciation. The research which has been done by Pliso did not discuss waypoint pronunciation within multicultural background of speakers. The research was conducted under qualitative method and conversation techniques. By comparing a standard guidance document and field tion, Pliso tried to find the anomalies and made conclusion.

This research finds out that the most factor triggering the usage of non-standard phraseology is English speaker. Native English speakers, because they have many variations to say a thing, they tend to use what is so called plain English language. Similar to previous research, this research does not concern the importance of waypoint pronunciation. It is good to have a research which is focusing on native English speaker as today's issue on pronunciation is getting bigger.

3. Haryani Hamzah

Miscommunication in pilot-controller interaction was the title of Haryani Hamzah work on her research in 2018. Hamzah proposed the definition of miscommunication here is defined as any indication of a misunderstanding in a conversation due to a misinterpretation or non-understanding of the message. Miscommunication or misunderstanding in air-ground communication can lead to loss of human lives. Parties must be aware of the nature of language and the ways it is interpreted by individual could lead to misunderstanding, even when both pilot and air traffic controller speak English very well.

The research was conducted in Malaysia air traffic control facility in some sectors or some phases of flight which involved different corpus of each phase of flight. This research utilize a conversation analysis techniques. The finding of the research was the failure, both controller and pilot, to adhere the use of standardized phraseology is the main reason for munication to occur. Standardized phraseology consist of highly zed words, jargons and phrases specially created for the use of air-

ground communication. It is proposed by Hamzah that the use of standard phraseology is highly recommended to minimize the miscommunication to occur. This research did not discuss any issue regarding waypoint pronunciation, in fact, in some cases waypoint pronunciation trigger miscommunication.

This research is very useful guidance to both air traffic controller and pilots to always employ the standard phraseology and avoid code-switching in the communication between air traffic controller and pilot. This research also suggest to all parties involved in the communication to maintain a proper radio discipline.

Phonetic and phonology are not considered in this research. This research only considers the proper radio techniques and the usage of phraseologies in aviation communication. Yet, as the introduction of new technologies of User Preferred Route (UPR) in aviation start creating a new challenge in a communication between air traffic controller and pilot, it is therefore significant to do a research which discusses and finds the way out of this challenge.

4. Andrei Gurtov, Tatiana Polishchuk and Max Wemberg

Controller-Pilot Data Link Communication (CPDLC) Security was the title of Andre Gurtov's work on his research in 2018. This work mostly talked about the other mean of air-ground communication. This research was located in Sweden and trying to prove its hypothesis on the weaknesses of employing CPDLC for the mean of air to ground (air traffic controller and pilot) communication. Although this research is having a little bit sense to

the scope of technology, but it can be classified as linguistic problem because this research is also focusing on the communication.

The finding of the research has proven that CPDLC, which is employed as the primary means of communication in most oceanic area, is prone to unlawful interferences. These interferences, namely jamming, flooding, injection, alteration and masquerading can have direct impact to flight safety. The research recommends engineers who have great concern with this technology to be able to close the security as a whole.

The finding of the research has revealed that radio transmission is still the most reliable and safe media for the use of air-ground communication. This finding is also encourage researcher who has passion in aviation communication to discover a new way to improve the quality of air-ground communication.

Again, similar to the previous researches, this research does not concern over the exchange of waypoint pronunciation in the communication system. it is understood that in some point the usage of CPDLC may effectively eliminate miscommunication problem caused by waypoint pronunciation, yet this kind of communication is not reliable to be the main communication in aviation.

Regarding to all of the previous researches mentioned above, all of them were focused on the miscommunication in various manner including the usage of standard phraseology and the opportunity of failure to ___rding CPDLC communication between pilot and air traffic controller. ___earch, other than previous researches, are trying to have a deeper

focus on the effect of phonetic and phonology in pronunciation which, in the end, will also influence the successful conduct of air-ground communication. This research, academically, is expected to fill the gap which is exist among researches in aviation language subject.

B. Linguistic Theories

Discussing air-ground communication will lead us to refer to some linguistic theories. There are broad theories exist which are related to this kind of communication, but for the concern of waypoint pronunciation, below are some theories which are seen to be good grounds for us to discuss further on this topic.

1. Phonetic and Phonology

There are two main aspects of language, anything which is related to sound and anything which is related to meaning. Semantic is a special subject which studies meaning while phonetic is a special subject which studies sound. According to A Dictionary of Theoretical Linguistic, Phonetics is a branch of linguistics that studies the sounds of human speech, the changes and the production of sounds.

There are some different interest among phoneticians. Some of them are only interested in sounds difference between languages, some other are interested in in pathological speech, while some other more are interested in helping people understanding sounds in specific language. nguists divide phonetic into three main concentration, they are phonetic, auditory phonetic and articulatory phonetic.

Acoustic phonetic concerns on how sounds are produced by human sound system, and how sounds travel through the air and reach the receiver. Usually this phonetic need an electronic instrument to study its object. Auditory phonetic concerns on how the sounds are received by the hearer. And lastly, articulatory phonetic concerns on how sounds are produced by specific human organ such as lips, tongue, teeth and so on.

Philosophers divide the subject which study sound into two, phonetic and phonology. But the boundary between those two are ambiguous and sometime overlap. Principally phonetic concerns on how sounds are produced by human sounds system, how it travels through the air, without having concern on the function of sound in the language. Contrary to phonetic, phonology studies sound according to its function within language.

P, t, k are three characters in English which are always aspirated when the position is in front of a word. It will not be aspirated when the position of p, t, k is in the middle of a word. For example "pot", the pronunciation of this word should be [pʰɔt], while in the word "spit" the pronunciation should be [spɪt]. In this analysis, the different position of "p" is a kind of phonetic, not phonology. It will be classified as phonological problem when the difference influence the meaning. For example, in English "l" and "r" are phonologically different as the word "right" and "light" have different meaning. Unlike those in English, Japanese language consider "l"

_re phoneme. Ladefoged (2006:33) said that when two sounds can

_ to differentiate words then they are can be said to belong to

different phonemes. This means that in Japanese language [l] and [r] will not change meaning.

Another example of phonetic and phonological difference can be found in difference of "c" character and "k" character. The word "key" and "car" both has /k/ sound, only slight difference between them. While "key" is pronounced [kʰi:], car is pronounced [kʌr]. so, in this example the letter "k" and the letter "c" are considered as members of the same phoneme, in other word, "c" and "k" in this example are phonetically different but phonologically the same.

Phonetics is concerned with describing speech. When people speak they produce a continuous stream of sounds. Scholars divide this stream into small pieces that are called as segments and people can find great variety in the way these segments are made. Moreover, there is an abstract set of units are known as phoneme and the complete set of these units is called the phonemic system of the language.

The perception of spoken words is considered as an extremely difficult task. The reason is that speech is distributed in time. When people say a phoneme, it will help the listeners to access the whole word and avoid them from misinterpretation. A phonological representation is created, spelling out the words as phonemes. Phonological rules then apply to produce a final string of phonological elements. The phonological awareness will specify the way the word is to be uttered. The final ntation incorporates all the phonetics detail necessary for the actual on of the word. The awareness is then translated into instruction to

the vocal apparatus from the motor control area of the brain and then neural signals are sent out to the muscles of the lips, tongue, larynx, mandible and respiratory system to produce the actual speech signal. When the speech is clears it means that there is no disturbance and unused noise in communication.

2. International Phonetic Alphabet

In Linguistic study, there are features which are called phonetic and phonology. Phonetics and phonology are closely related, dependent fields for studying aspects of language. Phonetics is the study of sound in speech; phonology is the study of sound patterns to create meaning. Phonetics focuses on how speech is physically created and received, including study of the human vocal and auditory tracts, acoustics, and neurology. Phonology relies on phonetic information for its practice, but focuses on how patterns in both speech and non-verbal communication create meaning, and how such patterns are interpreted. Phonology includes comparative linguistic studies of how cognates, sounds, and meaning are transmitted among and between human communities and languages

The history of phonetic started in the early nineteenth century when European successfully conquered and colonized much of the world. The colony include North America, Africa, Asia and the South Pacific. In the process of interaction and its expansion, European discovered many hundreds of groups of people who spoke different languages. To keep the s run, European needed to learn and understand all of the

languages. This was necessary for the purpose of trading, living side by side in peace, conversion of Christianity, exploitation, etc.

For the needs of subsequent travellers in the regions, written records for languages had been published. But the different convention on reading created a new challenge in transferring the language knowledges. Therefore, in the early of nineteenth century, a group of phoneticians in France, led by Paul Passy (1854-1940) and others agreed to create and promote the international phonetic association in 1886. In 1889 it published the International Phonetic Alphabet which, in modified and expanded form, is today the most widely used system for transcribing the sounds of language. This international phonetic association was also triggered by the awareness of the need of the standard reading system for the study of philology (word and language history).

The initial goal of IPA was intended for use in transcribing the sounds of any language that had been discovered or will be discovered. This would allow anyone familiar with the system of the sounds transcribing, no matter what his/her native language and reading convention might be, to have a very clear idea of how to pronounce words correctly.

The idea of creating International Phonetic Alphabet is to guide anyone in pronouncing words of newly known language. Anyone who has the knowledge of International Phonetic Alphabet will be capable in pronouncing new words precisely as long as he/she follow the guidance. So rnational Phonetic Alphabet has proven itself for always being to provide guidance to language learners.

International phonetic alphabets system is almost similar to our daily alphabetical writing system. The difference is on how a sign represents a phoneme. A single sign is designated only for one phoneme. In our daily alphabetical writing, a sign may represent more than one phoneme. The letter "e" for example, in Bahasa Indonesia represents three phonemes, they are /æ/ like in "apel" means roll call, /ə/ like in "kelas" means class and /e/ in "enak" means delicious.

a. Vowels

Although it is not purely adopted, English language has been established as international aviation language. Therefore this study will give more focus on English though the application of International Phonetic Alphabet is widely open to any language in the world.

English language has seven short vowels, five long vowels, eight diphthongs and five triphthongs. How each vowel is being represented are enlisted with the samples as follows:

1) Short vowels

ɪ = bit, silly   æ = cat, dad

ʌ = cut, nut   ʊ = put

ə = about, clever   ɛ = dress

ɒ = dog, rotten

2) Long vowels

i: = cream   ɜ: = burn, firm

a: = hard   ɔ: = corn, faun

u: = shoot, glue

3) Diphthongs

Diphthong is a movement or glide from one vowel to another without interruption. Diphthong involve only two vowels which meet the following requirement:

- The vowels must belong to the same syllable, and

- The stronger stress fall on the first vowel.

The Indonesian [au] as in "engkau" is classified as diphthong but can be monophthongized into [kɔ]. But [au] as in "kaum" is not a diphthong because the two vowels [a] and [u] belong to the different syllables. The /a/ to /ka/ and the /u/ to /um/. One can say [kau] become [kɔ] but not [kaum] becomes [kɔm]. in similar fashion, the vowels [ai] in "ramai" and "santai" can be monophthongized into [ramɛ] and [santɛ], but "kain" and "main" do not.

In English language diphthongs are as follows:

ɪə like in the word "peer" /pɪə/

eə like in the word "pear" /peə/

ʊə like in the word "poor" /pʊə/

eɪ like in the word "bay" /beɪ/

aɪ like in the word "buy" /baɪ/

ɔɪ like in the word "boy" /bɔɪ/

əʊ like in the word "go" /gəʊ/

aʊ like in the word "cow" /kaʊ/

4) Triphtongs

Triphtong is a glide from one vowel to another and then to a third, all produced rapidly and without interruption. Triphtong involve three vowels in its operation. In English language triphtongs are as follows:

eɪə like in the word "player" /pleɪə/

aɪə like in the word "fire" /faɪə/

ɔɪə like in the word "royal" /rɔɪəl/

əʊə like in the word 'lower" /ləʊə/

aʊə like in the word "power" /paʊə/

b. Consonants

Consonants are categorized into two class according to the involvement of the vocal chords. They are voiced consonants and voiceless consonants. Voiced consonants is one in which the vocal chords vibrate when the consonant is being pronounced, and the other wise is voiceless consonants.

The list of English consonants and how it is represented on international phonetic alphabets are as follows:

1) Voiced consonants

b like in the word b̲at   d like in the word d̲og

g like in the word g̲old   v like in the word v̲oice

ð like in the word th̲is   z like in the word z̲ebra

ʒ like in the word leis̲ure   l like in the word l̲ips

r like in the word r̲un   j like in the word y̲et

w like in the word wait   dʒ like in the word lodge

m like in the word mummy   n like in the word pan

ŋ like in the word sing

2) Voiceless consonants

p like in the word pip   t like in the word tell

k like in the word cat   f like in the word fish

θ like in the word thick   s like in the word sit

ʃ like in the word ship   h like in the word hut

tʃ like in the word chip

3. English Phonic Rules

It has been discussed earlier that English pronunciation has changed over centuries while spelling has remained basically the same. This is resulting the difference between phonemic transcriptions of English and the texts. The present spelling of English language reflecting the pronunciation of English some centuries ago when vowel sounds have the same values to the corresponding letters. Historical study shows the change of the English transcription occurred during 1400 – 1700 which is known as Great Vowel Shift. It is the major change in English that resulted in new phonemic representation of words and morpheme. For example middle English [i:] becomes modern English [ai] that makes middle English [mi:s] becomes modern English [mais] for the word mice. Middle English [u:] becomes modern English [au] that makes middle English [mu:s] becomes modern [maus] for the word mouse. Middle English [e:] becomes modern [i:] that makes middle English [ge:s] becomes modern English [gi:s]

for the word geese. The diagram in figure 1 below shows this shift. As it is shown, the Great Vowel Shift is a primary source of many spelling inconsistencies of English, as mentioned above, because English spelling system still reflects the way words were pronounced before the Great Vowel Shift.
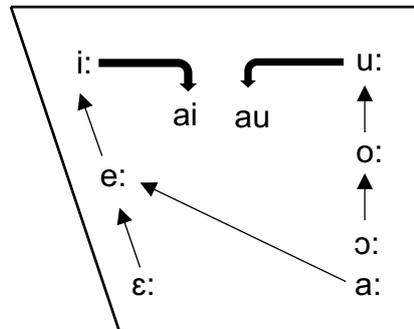
Figure 1. Vowel Transformation Diagram Caused by GVS

As the development of English pronunciation, there are some clues that can be used as guidance to pronounce English words based on its text. Some rules, but not much, are not working in all situation. These anomalies are called "broken rules". Those popular English pronunciation rules are as follows:

a. Short and Long Vowel

All vowel letters are representing two sounds, namely short vowel and long vowel. Their long vowels is indicated by the name of each vowel letter, i represents /ai/, e represents /i:/, a represents /ei/, u represents /ju/ and o represents /əu/. While their short vowels should be properly memorized, i represents /ɪ/, e represents /e/, a represents /æ/ or /ɒ/, u represents /ʌ/ or o represents /ɒ/.

A vowel will have its short sound when it is followed by a consonant in a syllable. Consonant digraph following a vowel is a strong indication that a vowel will produce its short sound. Some examples following this rule are it /ɪt/, will /wɪl/, accept /əksep/ and the like. But this rule is not applicable for the letter /r/ to follow a vowel. When a vowel followed by r it is subject to r-controlled rule. Some examples following this rule are burn /bɜ:rn/, firm /fɜ:rm/, girl /gɜ:rl/ and the like.

A vowel will have its long sound when its position is in the first of a vowel digraph. As a consequence of this digraph, the second vowel will be silent. Some examples of this event are seat /si:t/, hoax /həuks/, gauge /geidʒ/, lie /lai/ and the like. Unfortunately, successful generalization for this rule is only as much as 45% of all cases.

Another rule which will make a vowel have its long sound is when its position is at the last vowel in a word which is ended with the letter e (final e). There are some word couples which will be easy to recognize the switching of short sound to long sound of a vowel. Some examples for this case are lit /lɪt/ switches to lite /lait/, hat /hæt/ switches to hate /heit/, cut /kʌt/ switches to cute /kjut/ and the like.

A vowel which is followed by a ght digraph is also a signal for the vowel to produce its long sound. In this case gh digraph will be silent. Some examples on this rule are light /lait/, knight /nait/, bright /brait/ and the like.

b. Soft C, Hard C, Soft G and Hard G

ese two consonant are unique compared to the other consonant. ch represents more than one phonemes and how they switch are

almost following the same signal. The same spelling can represent different sounds. C has three phonemes, namely /s/ known as soft C, /k/ known as hard C and /tʃ/. The letter G has two phonemes, namely /dʒ/ known as soft G and /g/ known as hard G.

The letter C will produce its soft sound when it is followed by letter i, e, and y. It will produce its hard sound when it is followed by the other letter rather than those have been mentioned, but not letter h. The letter C will produce its special sound /tʃ/ when it is followed by letter H. Some examples following this rule are center /sentər/, city /siti/, cylinder /si:lindər/, cat /kæt/, cup /kʌp/, cry /krai/, chat /tʃæt/, cheat /tʃi:t/ and the like.

Letter G will produce its soft sound when it is followed by letter i, e, y. When the letter G is followed by the other letter rather than those have been mentioned, it will produce its hard sound. Some examples following this rule are general /dʒenərəl/, giant /dʒaiənt/, gymnastic /dʒɪmnæstɪk/, globe /gləub/, gun /gʌn/ and the like. The word get is considered as a broken rule in this particular rule.

c. Silent 'e'

When a single letter e takes place at the end of a word, it will not produce any sound or silent. Some examples following this rule are cake /keik/, line /lain/, dice /dais/ and the like. It has been discussed before that this rule is a signal for the preceding vowel to produce long sound.

d. The schwa

e most common unstressed vowel is [ə], the one people note at the

ome of the diphthongs in British English. It is often called by its

German word, schwa. It occurs at the ends of words such as soda [səudə] and sofa [səufə). It also occurs at the middle of a words such as company [kʰʌmpəni] and emphasis [ɛmfəsis]. Schwa may also occurs at the beginning of a word such as in arise [əraiz], about [əbaut].

Similar to English, the schwa sound is never stressed in Bahasa Indonesia for those who speak languages of mother tongue that have no schwa [ə], they tend to replace it with either [ɛ] or [ɔ] and therefore the unstressed schwa [ə] becomes stressed [ɛ or ɔ]. In this case the word "pergi" [pərgɪ] becomes [pɛrgɪ] or [pɔrgɪ].

e. Consonant Digraphs and Blends

Consonant digraph is the production of new sounds as a result of two consonants working together. These newly produced sounds are not the same with any sound produced by single consonant. Some examples following this rule are chip /tʃɪp/, ship /ʃɪp/, this /ðɪs/, thick /θɪk/, photo /fəutəu/ and the like.

Unlike consonant digraph, consonant blend is a group of two or three consonants whose individual sound of these consonants are still can be heard. Some examples following this rule are clam /klæm/, scrub /skrʌb/, grasp /græsp/ and the like.

There are many more rules on English phonic. English phonic rules is very useful for systematically learn the pronunciation of English words. These rules are different from phonic rules for other language. To support earch, this literature review is purposed to raise awareness that native speaker will read differently from speakers of other language.

C. Air Traffic Services

Air traffic control services is such service provided by air traffic control unit in safe guarding the operation of flights. There are some purposes of air traffic control services, namely to prevent collision between aircrafts in the air, to prevent collision between aircrafts on the maneuvering area and obstructions on that area, to expedite and maintain an orderly flow of air traffics. ICAO, 2018:I-3.

Air traffic controller is always required to follow the guidance of ICAO in delivering the service. The guidance consist of standard practice and procedures. The ICAO guidance usually come in the form of documents and annexes to the aviation convention. All of these documents and annexes are well distributed to contracting states. Contracting states are required to adopt or ratify or make adjustments to the procedures considering the condition of every states.

Air traffic controller always plays a pivotal role in an information exchange system. Along with this role, controller is responsible for the provision of separating aircrafts by providing clearances and instructions to ensure the safe and efficient conduct of flights. In doing his/her role, controller is equipped and surrounded with high technology environment. Radio communication, radar screen which is now popular as air display situation, air traffic flow management system, ATS system, direct speech circuit, and many more modern technologies have to be familiar with by

er. Figure 2 will provide more understanding of controller's pivotal

In terms of communication, controller is required to have a direct controller pilot communication (DCPC) with pilots under his/her jurisdiction. There are two medias which are considered as DCPC, namely radio communication and controller pilot data link communication. Radio communication rely on voice communication while CPDLC rely on text communication.

Air Traffic Management

Other Sectors/Units Domestic/Inter-national   **Air Traffic Controller**   **Other Controllers**

Aircraft Crew
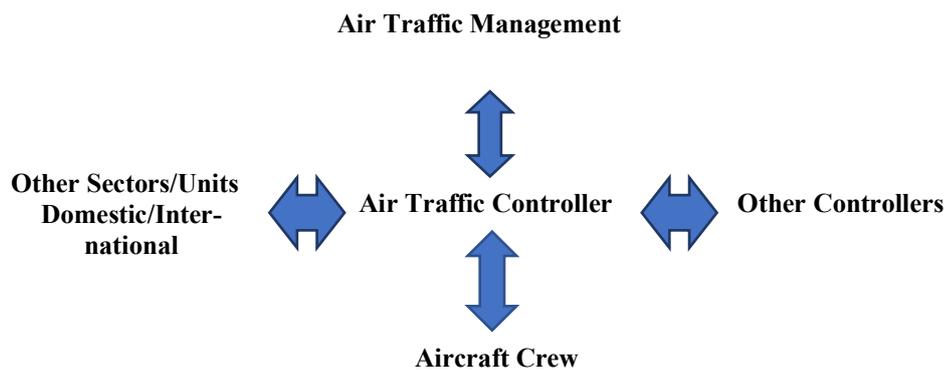
Figure 2. The pivotal role of air traffic controller

The advantage of using radio communication is that the exchange of information and the delivery of clearance or instruction can be rapidly conducted. Along with this advantage, of course, there are some disadvantages. Radio communication is very much dependent on the quality of radio transmission. Based on the study of McMillan, which has been discussed earlier, miscommunication is likely to happen in this kind of communication. Noise, linguistic problem, radio coverage which will influence the quality of transmission and so on.

In terms of accuracy, the use of CPDLC is likely to have more reliability
ed to radio communication. CPDLC is a text base communication.
d controller exchange information in text rather than voice, and this

data will be sent over satellite network. Unfortunately, the use of CPDLC is not so efficient as radio communication. It consumes more time to prepare the text, to send it via satellite network, to be read by counterpart and to reply with another text.

In a busy airspace, communication via CPDLC is not recommended as the media to exchange information, clearances and instructions are required to be done timely. A failure to perform a timely action, especially in a high capacity airspace, will result an accident. In this situation radio communication is still highly preferable.

As the increasing demand of air transportation, the number of flights which have to be handled by controller is increasing as well. This means that the workload of an air traffic controller is always increasing over time. Global air traffic management is challenged to always be able to solve this problem.

ICAO as the main organization in regulating aviation in the world has create some policies to anticipate the increasing demand of air transportation. Environmental issue has also driven the process of procedures review. Increasing airspace capacity is now becoming the most visible effort to overcome traffic management issues.

Implementation of new kind of procedures such as required navigation performance (RNP) and user preferred route (UPR) which employ high technology have been introduced. It has been enlisted in long term program the road map ICAO, aviation system block upgrades (ASBU). RNP ntation will allow controller to apply closer spacing between

aircrafts in the air, while UPR implementation will allow pilots to fly as efficient and economic as possible.

UPR is a method of navigation which will allow pilot to file flight plan on his/her preferred route. When UPR is implemented then there will be no requirement for pilot to fly via a designated airway. Pilot will freely designated any point during his/her flight within the area of free route. Pilot will only be required to selects any waypoints from aerodrome of departure to aerodrome of arrival. It is seems that by applying UPR, the communication involving waypoint pronunciation will increase.

D. Swiss Cheese Model

Swiss cheese model is a theory which was introduced by James Reason (1997) and is a famous model explaining the accident causation theory. This theory is focusing on the risk analysis and risk management. Reason promotes three elements to become part of organizational accident study, they are hazards, defences and losses. Their relationship is shown by figure 3 below.

Hazard is a situation that poses a level of threat to life, health, property, or environment. Hazard can be dormant or potential. Once a hazard active and breakthrough defence layers, then it can cause an incident/accident which may be followed by some losses.

Defence is a protection against attacks or hazards, it may be physical or nonphysical. Typically defence is consist of some layers, layers of defence will ensure the hazard will not breach it. sical defence may be in the form of regulation which is created to

block an identified hazard, thus a good safety management system will be able to predict a hazard before this hazard is capable in breaching the defence layers.
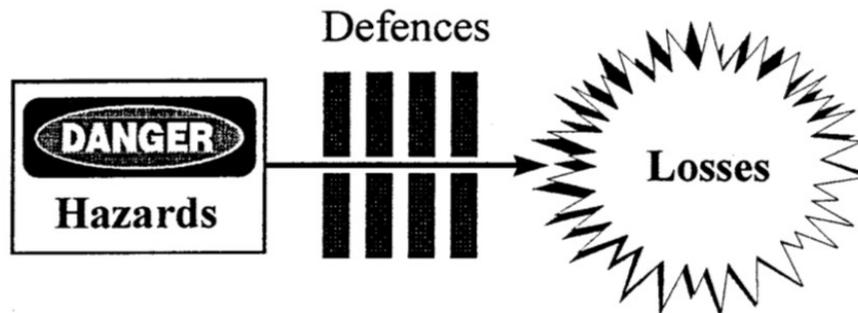
Figure 3. Relationship between Hazards, Defenses and Loses

The ideal shape of a defence layer should be solid and without holes. But unfortunately, human who create the defences has what is so called human nature. Doing an error is really human, and unfortunately doing errors repeatedly is also human. The comparation between ideal defence layers and defence layers in reality will look like figure 4. Safety manager should try to identify the existence of defence weaknesses, and try to fix it to avoid hazard penetration.
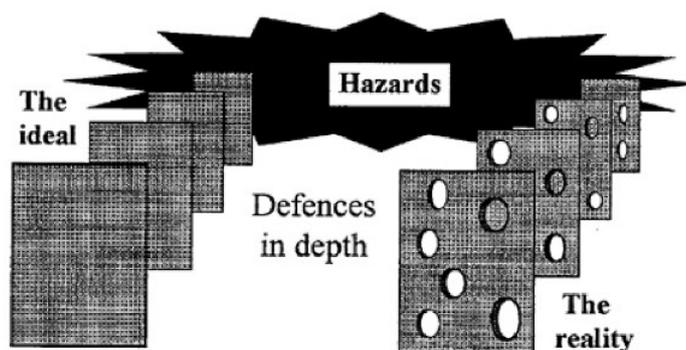
Figure 4. Defence Layers

Swiss cheese model is derived from the shape of the Swiss cheese which has holes here and there. A cheese layer represent a defence layer. A better understanding on how Swiss cheese layers study will be depicted by figure 5. A weakness to a defence layer will not make an active hazard to cause an incident if only when this weakness is not supported by the next defence layer. A hazard cause an accident and losses only when those defence layers has weaknesses which supports one another.
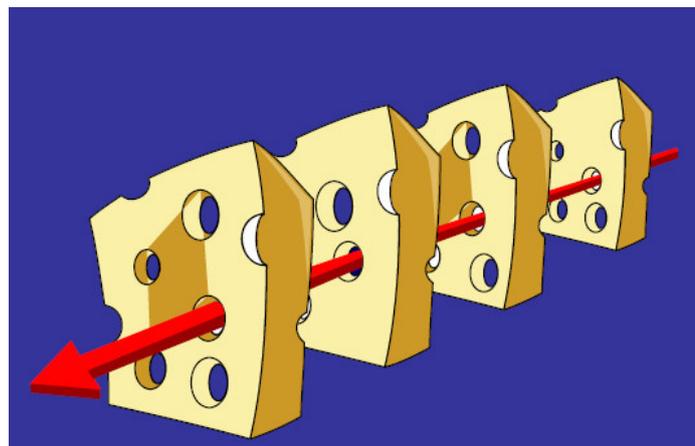
Figure 5. Swiss Cheese Model

Reason (1997) said that there are two kinds of accident, they are individual accident and organizational accident. Individual accident is an accident which is frequently occurs and the result is minor loss. Unlike individual accident, organizational accident rarely to occurs, but once it occurs it will be catastrophe. While individual accident may have a person to be the agent and the victim, organizational accident can have devastating effect on uninvolved populations, assets and environment.

an organization, an incident or accident cannot be seen only as erson's mistake. A wide range of investigation to analyse the

organization's defence weakness should be conducted. The cause of the accident or incident may be coming from the infrastructure such as regulations or procedures which is supported by the other layer's weakness.

E.   Conceptual Framework
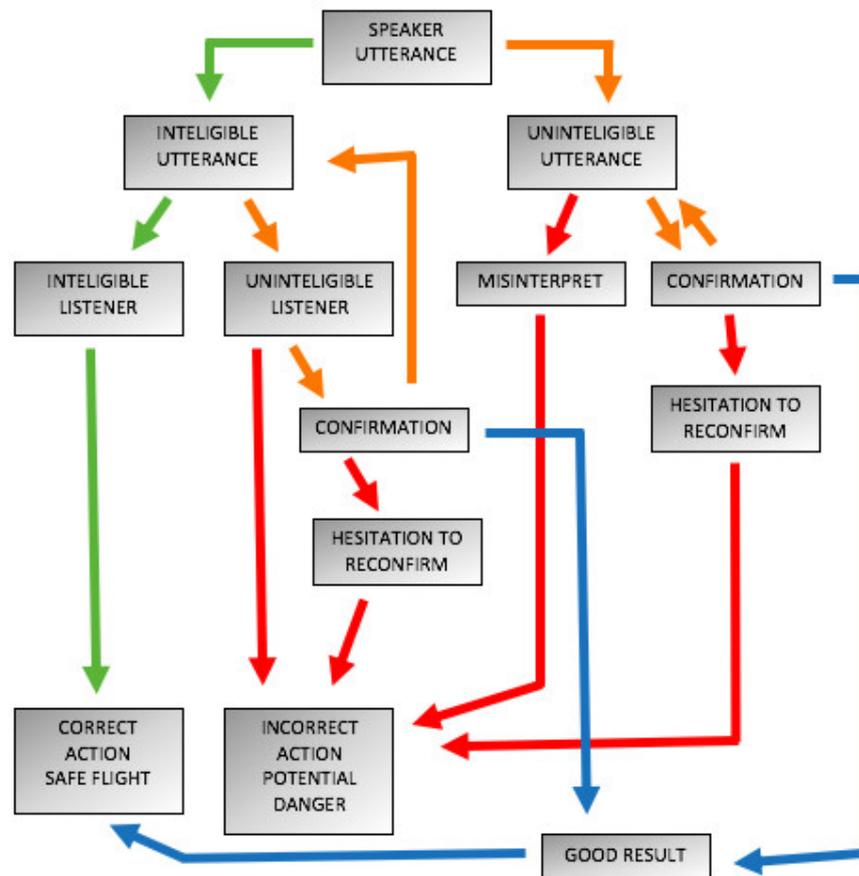
Figure 6. Conceptual Framework

Based on the theories above, researcher has created a model of conceptual framework in air-ground communication as seen on figure 6 above. This conceptual framework is used to understand the flow of the communication and to identify in which phase the air-ground communication problematic to provide safety to flight operation.

In this conceptual framework, it is used four different colors to represent the risk which may be affected in the communication. Green arrows represent the ideal processes of communication. When a communication is done by following the green arrows means that it will be done with the minimum time consuming and best result. Orange arrows represent an existence potential danger of flight caused by unpredictable time consumed in this phase. The process of orange arrows may be looped or repeated for some times. The successful orange arrows may result blue arrows which means, because of time has already been consumed, the result of the communication maybe still valid or invalid for the safe flight operation. Red arrows represent the existence of potential danger to the safe of flight as there is a positive indication of miscommunication.