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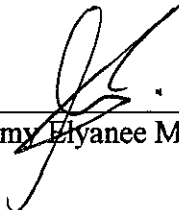
**Colors Effect on Perception from Screen Layout With The View of
Human Computer Interaction**

by

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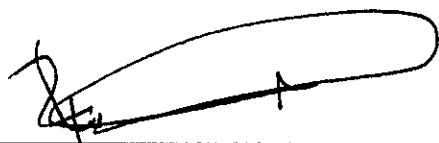
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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



ISA AL-HUSAM BIN SHUHAIMI

ABSTRACT

This project is a research conducted on Human Computer Interaction (HCI) area. Color is one of the elements in HCI subject which will be discussed in the project research specifically. Color has become one of the important subjects in many fields, perhaps one of the important attributes in the study of HCI. When it comes to the designing a system or a web page, HCI also had presented some guidelines to propose color selection, perhaps there is a “why” factor on the subject to question why such color must be use or avoid. In other hand, traditionally designers tend to reflect personnel favoritism on color preferences, normally preferably choice of color or even local customs and believe over designing a system.

This project will blend between color science and perception through the view of Human Computer Interaction. There are two objectives of the study which is to test and prove that does color effects the users and productivity. Usability testing will be performed and trough the result, this research is targeting to propose a standard of good practice color preferences on page display over a specific system.

In this research, the main element to be studied is human factor and the human perception. Two areas of studies relates which is the color science and its fundamental as well as the human perception where the usability testing will be perform to structure and generate findings of the experiment. The scope of research is specifically targeted on ‘sensitive system’ such as banking system, aircraft, etc. The project consists of five phases of methodology which needs to be simple, and reported in sufficient detail as to be easily replicable. There are three experiments conducted for usability testing which are the video recording session with the ‘think aloud method’ practice, questionnaires and interview session.

The data of the experiment will be analyzed and referred back to the fundamental of color science. At the end of the research, a standard of recommended ‘Good Practice Color’ will be proposed.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This project is a study about human factor, color science, perception and psychology and how the relationship does influenced the users. The relationship can be studied by conducting usability testing. Before hand, it is important to understand the principle of color science and its fundamentals. It is also important to understand the system of human visual transmission, human perception and psychology. Understanding of the principles will help to plan on how to conduct the usability testing, which area must be focus on as well as to understand why such an output can be resulted from the experiment.

When we discuss the term color, study of color science is a very wide subject. There are few scholars who had discussed deeply into the color discipline such as Ewald Hering and Peter Gouras on how color transmitted and determined by a human. Discussion on color in this project is not all about color which is most favorable or color which is most suitable, but the study will look at from the view of science of color where it will be focus on the basic color which could produce least tension to the user of a system which will leads to the highest productivity and quality. This research will specifically focus on the fundamental of colors which are red, blue and green as well as the two basic combination of color which is white and black. Through these colors we can propose range of other colors which will fall into a group of colors which likely to be presented as recommended color to use.

Beside other than conducting the study from the perspective of science of color, there is other factor that is closely related to this research that is known as human factor. 'Human factor' is terms associated with human factor which include human characteristics, human factors engineering, ergonomics, human engineering and the human element. The

phrase 'human factor' itself is often used to derive the meaning as 'human characteristic'. Various human factors in this sense generally fall into one of three group of human characteristic: (1) physical characteristic, (2) physiological characteristic, (3) psychological or behavioral characteristic. These groups of human factors are not necessarily mutually exclusive. Here human factor define the nature of our humanness that is the characteristic of being a human. Physical human factors include physical attributes of the human body which specifically refers to the visual structure which is from the eye sight to the brain. Physiological human factors include such things that relate the attributes of the visual structure from physiology sight such as retina, cord and visual cortex. Psychological or behavioral human factors include things such as mental reaction time to various stimuli, various acquired meanings associated with certain colors (red often means 'danger'), the capabilities and limitations of short term memory, 'expectancy' as an element of perception.

In a typical environment of understanding human factors, usually a study will be conducted that is known as Usability Testing, where a group of hired or volunteer test subjects that represent future end users is given tasks to do so. Typically a test subject is observed while doing a task, asked to react verbally as any direct respond from the event or as observation are made and interviewed after each test. Usually the test is videotaped for later study. In some cases, successive correction to the product is made during the course of testing. Human factors study can focus on general human behavior in relation to the technology (such as studies of how people react to various type of styles and sizes), on a generic type of a product (such as wearable computers), on specific environment or product. Depending on objectives, the result of human factors study can include suggestions on how to redesign the object of study or a general guideline for designing such object.

1.2 BACKGROUND OF STUDY

Information technology has a tremendous development and growth. In order to adapt with the rapid growth of information technology, there are many other factors beside the technical factors that should be put into consideration in order to ensure that the information era growth is aligned with other related important factors. Information technology itself is a huge field that the studies are not only focus on technical factors but as well as other factors such as business, management and human factor. Human factor in Information Technology is known as Human Computer Interaction (HCI) and this study has become famous from late 1980's by the influence of rapid development of computer usage in our daily life. Human Computer Interaction has been defined as a discipline that studies the relationship between human and computer. The role of Human Computer Interaction is to provide people with a design that allows the user to "carry out their activities productively and safely".

The discipline is concerned with the capturing of information on such factors such as ease of use, safety, usability by the end user, efficiency of use by human elements, the ability to understand without great detail of the interface design and the actual design of the interfaces. Additionally, many other actors are measured after the fact to capture effects such as the implementation of new designs and to measure productivity changes due to design changes. Two key principles identified by Donald Norman, well known author of Human Computer Interaction, is Visibility and Affordability. Visibility defines being visible as capable of being seen or perceptible, while affordability means in a more abstract sense which is that of knowing how to act or how to response towards certain situation. However HCI is a very broad category of studies and can not take a simple specific approach for providing answers because each and every situation is different and calls for differing solutions. In this study the HCI scope is narrowed to only to the Usability Testing with the scope of color effect on "sensitive system".

In this research usability testing needed to be done in order to understand the problem, to test the result and propose a solution with by holding on the principle of science of color.

Usability testing will be conducted into three stages which are observation through recording session with the method of “think a loud”, questionnaires sampling and interview session. The testing methodology needs to be simple, and reported in a sufficient detail so as to be easily replicable. The usability problems identified along with the result and design recommendation need to be written. Another possibility is to quantify each usability test by different type of principle of colors with a severity rating, allowing having same gauge of their potential contribution by solving their problem. The result of the usability testing will be analyzed to define that factor by referring to principle of color a science which will promotes the best range of colors to be practiced. It is important to choose the right color when designing a system especially for defined “sensitive system”. The mission is to develop a system that is harmless to the user either physically or mentally. System with the right color of visual display will contribute user focus and least tension in order to give the best comfort, increase efficiency, productivity growth and zero error.

1.3 PROBLEM STATEMENT AND THE SIGNIFICANT OF THE PROJECT

Color has become one of the important subjects in the study of Human Computer Interaction. Color has its own play role and has been discussed and practiced widely in other fields such as product marketing, industries, color-therapy, color-psychology, and even as corporate branding and so on. When we discuss color in the scope of digital design such as developing a system there are few points that will be highlighted. As for this study the scope will be downscale into sensitive system.

Why factor

There few problems and “why?” factors arise when we discuss on color subject. Human Computer Interaction itself has proposes to use certain color such as to use conservative colors on web design. But the subject is not discussed widely when it comes to the effect or consequences of using certain color over designing a web especially on the HCI educational course. The other question might arise is does really color has an impact and

will effect the human factor over performance and productivity from using certain system.

Wrong choose of color

When we discuss color in the scope of digital design such as system and web design, designers tend to reflect the other field on color practice as guidance. Perhaps traditionally, designers tend to reflect personnel favoritism on color preferences, normally preferably choice of color or even local customs and believe over designing a system. As an example, a designer who is designing a system for Ambank (M) Berhad might use red color as base color for the system since that 'red' is their corporate color and has been used overall from their logo, interior design of their branches and offices, staff uniform as well as their leaflets and pamphlets.

1.4 OBJECTIVE AND SCOPE OF STUDY

1.4.1 Objectives

The general objective is to contribute to IT body of knowledge. It is to portray the immersive ness of IT into almost knowledge area. Human Computer Interaction is the fundamental area of scope that this project will contribute. As the objective of Human Computer Interaction to provide a better relation between system and user, this project is aligned in order to project for a better solution of system design which will increase focus, enhance productivity and reduce error. The objectives of this project are:

Research, test and prove.

To study, research, test and prove that does color has impact and affect the users of a system. There are many scholars that has been discussing on color and perception subject such as Ewald Hering, Peter Gouras, Stephen Luecking (2001) and this research will be another chapter of continuation of study which specifically will focus on color effect of the visual display for "sensitive system" as defined.

Standard recommendation

From the result of the research, this project is aim to propose a recommendation of standard practice of color use on visual display when designing a system from a sensitive system.

1.4.2 Scope of Study

The scope of this study involves the researcher and a group of people from students, officers and academic group as main target to study the human behavior. These groups of people are the people that relate with using of systems as well as digital visual display. It is important to understand their behaviors and to get to know their feedback and response in order to carry out this research. This project is more on research finding and conclusion from the material gathered; hence it is important to identify the correct materials in order to ensure the research is conducted properly and to come out with a suitable recommended design. Other material that can support this research is journal, published book and related information about science of color, color physic, Psychology and Perception, Human Computer Interaction, HCI and Visual Communication, Human Factor and Physiology Sight. The result from this research little or big will contribute to the study of HCI and color, perhaps will be a guide for system developers in designing good system from sensitive system that harmonies with users; a system that de-facto of productivity, highly focus and the least error producer. The activities done can help to understand the relevancy of the project and clarify the project scope and relevant factors:

- To understand on human factor, physiology sight, perception and science of color
It is an interesting subject to understand all those factors relates with each other and how to analyze human science (human behavior) which is more subjective over color science which as the fundamental, objective subject. It is beneficial to research on those subjects and how does it able to influence human behavior for the better on future.

- To conduct survey on users behavior

It is important to conduct a survey from current users such as officers from bank companies whose using banking system (the sensitive system); and perform usability study based on selected targeted group during the lab session of usability testing. The recording has to be undercover and without the test objects' concern in order to get the real behavior during the lab session. "Think A Loud" method will be practiced where the test subject will allowed to say out their impromptu thought during the testing and through that we will know their direct psychology behavior. From the recording and observation can be made to identify the factor and to analyze the result based on the fundamental of color science.

- To get the feedback from the survey and understand the human factor and science
After conducting the survey, it is crucial to get feedback from targeted users since that recording material is not enough. Hence, questionnaires sampling are distributed to get feedback on close ended questions and interview also needed to be conducted in order to get spontaneous response from the users regarding the issues.

- To identify relevant factors that can lead to good design

Human factor plays the main role as the important subject for the research. From this point of subject, the research flow is guided by the principle of color science and physiology sight. Through all these three elements a conclusion can be made on how to perform the testing for the research. The study depends and stresses a lot on reading method from journals and related material before testing stage. Literature review is important to lead the research beforehand.

- To propose a recommended standard design on color preference

Last but not least, by blending all the information, materials from finding and observation to come out with a conclusion of the research by proposing a recommended standard of good color preference for visual display on designing sensitive system and develop a proposed design of good practice. The system is least

stress to deal by its user, higher focus which will influence to avoid error and direct to productivity increase.

CHAPTER 2

LITERATURE REVIEW

Colors Effect on Perception from Screen Layout With The View of Human Computer Interaction By Isa Al-Husam Shuhaimi

2.1 INTRODUCTION

The discipline of Human Computer Interaction has become part of the fundamental subject and it is of very important in the computer design. This subject has touches a lot of areas in the designing principle with the relation of human behaviors which deliver the subject and form the study of Human Computer Interaction. Human Computer Interaction (HCI) is the subject that links the theories of Human Behavior with the principle of computer system design. From the computer science perspective, the focus of the study is on the interaction between one or more humans and one or more computational machines. Study of Human Computer Interaction (HCI) is as simple as to improve the interaction between user and computer.

2.2 HUMAN COMPUTER INTERACTION

Human Computer Interaction (HCI) concerns the design of interactive computing systems for human use and the study of the contexts in which those systems are used. (ACM SIGCHI, 1992, p.6). The role of HCI is to enhance the interaction between humans and computer systems. The term of Human Computer Interaction was early adopted during the mid 1980s as a new field of study. The study focus is not only relates with the design of a system but in a broader way of better interaction between the system itself as well as the users or in another word between the computers and the users. Baecker and Buxton define as 'a set of process, dialogues, and actions through which a human user employs and interacts with a computer'. A more recent and broader characterization is provided by the following definition: 'human computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them' (ACM SIGCHI, 1992, p.6).

There are two key principles to ensure a good design of HCI which is visibility and affordance (Donald Norman, 1988, 1992). Human Computer Interaction has consists of three parts which are the users, the computer itself and the ways they work together.

2.2.1 The user

When we talk about HCI, we do not necessarily imagine a single user with a desktop computer. 'User' can be define as an individual user, a group of users working together, or maybe even a series of users in an organization, each involved with some part of the job or development. The user is whoever is trying to get the job done using the technology. An appreciation of the way people's sensory systems (sight, hearing, touch) relay information is vital to designing a first-class product. For example, display layouts should accommodate the fact that people can be sidetracked by the smallest movement in the outer (peripheral) part of their visual fields, so only important areas should be specified by moving or blinking visuals. And of course, people like designs that grab their attention. Designers must decide how to make products attractive without distracting users from their tasks.

2.2.2 The Computer

When we talk about the computer, we're referring to any technology ranging from desktop computers, to large scale computer systems – even a process control system or an embedded system could be classed as the computer. For example, if we were discussing the design of a Website, then the Website itself would be referred to as "the computer". Computer is not limited to traditionally known computer but computer is also referred to systems which consist of technology use such as machineries system, power plant and an airplane system.

2.2.3 The Interaction

There are obvious differences between humans and machines. In spite of these, HCI attempts to ensure that they both get on with each other and interact successfully. The objective of the subject is to enhance the interaction in order to gain the result output which will increase the productivity, quality and efficiency.

2.3 HUMAN FACTOR

Ergonomic and human factor is two subjects who are related each other. Ergonomics is defined as study of the problems of people in adjusting to their environment; especially the science that seeks to adapt work or working conditions to suit the worker. Classic ergonomic is of course mainly concern with the manual worker on the factory floor and not to many great extent with the office worker, who with their air-conditioned environment upholstered furniture and electronic equipment should be the most comfortable and most efficient (Barron, Janet J., 1991). In a modern era, ergonomics is focused more on the study of the design and arrangement of equipment so that people will interact with the equipment in healthy, comfortable, and efficient manner. Color is part that the writer considered as an ergonomic factor.

Human factor is closely related to the ergonomic subject. Sometimes ergonomics is also defined as human factor but actually there is a difference between those two terms (Meister, David, 1971). In industry, a human factor is a study of how humans behave physically and psychologically in relation to particular environments, products, or services. Many large manufacturing companies have a Human Factors department or hire a consulting firm to study how any major new product will be accepted by the users that it is designed for. According to Kantowitz, Barry H., 1983 human factors specialist typically has an advanced academic degree in Psychology or has special training and the term usability is now sometimes used as an alternative to human factors, although human factors is really a larger area of study, including responses that are unrelated to usability, such as reactions and preferences in relation to visual and other sensory stimuli.

Human factors study can focus on general human behavior in relation to technology, on a generic type of product, on specific environment or product design as a whole, or on some specific design aspects of a particular environment or product. Depending on objectives, the result of human factors study can include some suggestions on how to redesign the object of study or by proposing a general guideline for designing such an object. In addition for relatively formal human factors study is that human factors can be said to be underway anytime a designer thinks about the effects of the design on the end user, and in fact much corrective design work goes on without formal testing.

In this research, the scope is narrowed down to the relation of human factor with the perception on color effect towards the user from the screen display. Color is commonly referred to as a property of things, the sky is blue, the blood is red, bananas yellow. Color, though, exist only in brain. It is a neural process, triggered by retinal responses to wavelength of light (Stephen Luecking, 2001). Color has played an important role in every aspect of our life. Color can effect and stick to our memory. Survivors of the Kobe earthquake in Japan described themselves losing color memory during the most stressful parts of the quake. They remembered the events occurring there in black and white (Willard, 2002). It is widely spoken that color has an effect towards human psychology and this research is specifically will focus on the colors effect of screen display from sensitive system towards the user.

2.4 USABILITY TESTING

Usability testing is conducted to perform as an experiment to structure the problems and to generate findings as an output to the solutions. The testing methodology needs to be simple, and reported in sufficient details so as to be easily replicable. The usability problems identified along with the design recommendations need to be written. Another possibility is to quantify each usability problem with a severity rating, allowing some gauge of their potential contribution by solving the problem. Below the issue is discussed and the efforts to adapt the usability test.

(a) **Generating norms:** Quantitative measures of a user's interaction such as total time, for any given task can serve as norms for user's interaction with the screen layout. Such norms can serve as baseline for future usability tests, allowing one to track progress in usability of the arrangement.

(b) **Detailed usability testing report:** In this part it is important to include full details of testing methodology, associated questionnaires, and methods of interviews. The goal was that the information should be detailed enough so that the human factor can be understood to replicate the test with the provided information.

(c) **Quantifying usability problems in terms of severity ratings:** All usability problems were indexed in terms of severity ratings. Usability problems can range from minor irritants to major hurdles that can make it impossible for a user to complete a task successfully. The scale measures are three main attributes of a usability problem: frequency, impact and persistence. Frequency refers to percentage of the participants affected by a given problem. Impact refers to the ease with which a participant can overcome a given problem. Persistence refers to how able participants are to overcome a given problem once they know about it. Each usability problem received a rating for each attribute. By providing these severity ratings, it is possible to find contribution factor to a particular problem. Quantitative severity ratings might help to get clear idea about their potential contribution by solving the usability problem (J.R. Schrier, 1992).

2.5 DEBATING ISSUES

Color has become one of the important subjects in the study of Human Computer Interaction. Color has its own play role and has been discussed and practiced widely in other fields such as product marketing, industries, color-therapy, color-psychology, and even as corporate branding and so on. When we discuss color in the scope of digital design such as system and web design, designers tend to reflect the other field on color practice as guidance. Perhaps traditionally, designers tend to reflect personnel favoritism on color preferences, normally preferably choice of color or even local customs and believe over designing a system.

The focus on this research is to study the role of color within the scope of 'sensitive systems'. The writer defines sensitive system as a system which deals with large and important databases and/or a system that is vital to the other attributes which relate with security and safety. Any mistake or error can encounter big disaster to the part or the whole system and its attributes. An example of a system that handles with large and important database is such as banking system; system that is vital such as aircraft system and power plant system which any small error could affect the safety or even endanger the users and the surrounding attributes.

When it comes to the relation between color and the sensitive system, there are few areas and subjects that will be discuss as well as some of the 'Why' factor on the subject area. These subjects are discussed as follow:

2.5.1 Why factor

There few problems and "why?" factors arise when we discuss on color subject. Human Computer Interaction itself has proposes to use certain color such as to use conservative colors on web design (Jenny Preece, 1994). But the subject is not discussed widely when it comes to the effect or consequences of using certain color over designing a web especially on the HCI educational course. The other question might arise is does really

color has an impact and will effect the human factor over performance and productivity from using certain system.

2.5.2 Wrong choose of color

When we discuss color in the scope of digital design such as system and web design, designers tend to reflect the other field on color practice as guidance. Perhaps traditionally, designers tend to reflect personnel favoritism on color preferences, normally preferably choice of color or even local customs and believe over designing a system.

CHAPTER 3

METHODOLOGY

3.1 PROCEDURE IDENTIFICATION

In order to conduct the research of the project, the activities have been well planned as with the right flow of for the research system. The activities have been well identified as the steps of every single method are divided into sections so that the research study will be smooth and orderly. The methodology or the procedure on conducting the research is a combination of waterfall looping model and System Development Life Cycle (SDLC) phases. Every phase is well determined and each phase will continue one another. The phases cannot be overlapping and cannot be performed at one time where one phase can be started after previous has been completed; if there is a mistake or missing and the phase needed to be reviewed then the research system will refer back to the previous phase and continue the research step. Each phases conducted one by one based on priority and the relevancy of the task to the project. Phase one is the preliminary research where at this phase research has been done as mass info gathering. From the first phase then the second phase can take over where the planning part will be determined as the guidance for the rest of the phases. Research and Analysis is the third phase which is a continuation from the first and second phase. At this phase research is done in a specific narrowed scope base on the subject of research. From the third phase then Analysis Testing is performed in order to get the output from the whole research study. Result and Recommendation is part of the output of the fourth phase and last but not least a recommended sample system is developed on the fifth phase which is the Development.

Each phase can be reviewed back as a looping structure when there is necessary extra input is needed to be add on. The process and procedures of each phases is discussed in detailed as below.

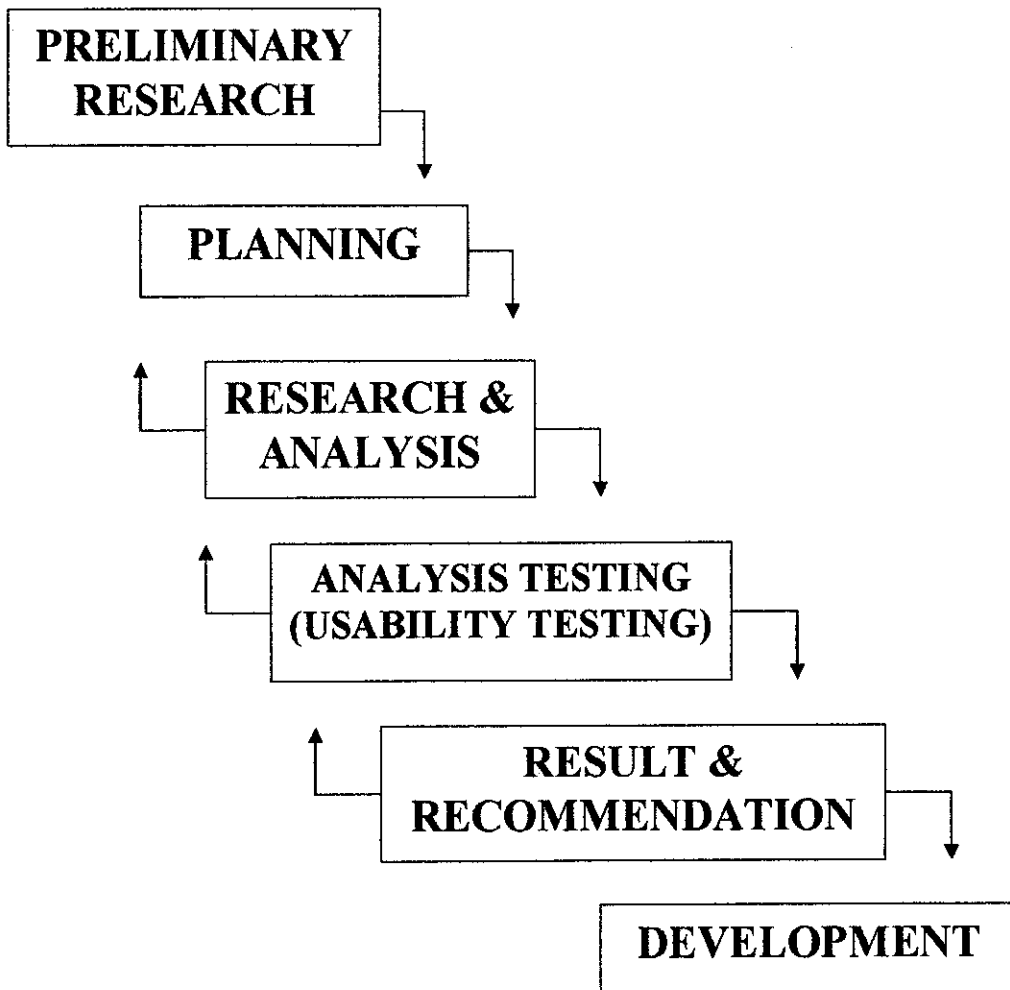


Figure 3.1 Design Methodology

3.1.1 Preliminary Research

The first phase is the initial stage of the project. It is the stage where identifying problems, opportunities and objectives is determined. The main concern of this stage is to focus more on making research on the project title, its attributes and the scope of study. The project title is studied thoroughly to define the scope and objective of the project. The method that is been implemented during this stage is the 'mass research' technique where research is done by gathering any input and information from any resources which is from books and journal, web pages, interviews and discussion. From the mass research technique, the scope and the objective of the project is defined. In this phase there are three stages involved as described below:

- **Problem identification**

Problem statement and the significant of the project is part of the important element needed to be outlined before conducting the research of the project. Human Computer Interaction is the subject that is selected to be as the study and from the mass research phase, color is the subject scope and the research is been narrowed down.

- **Problem analysis**

As the subject has been narrowed down, the scope is studied and there are few related subject been identified and from the study, the problem and the issues can be discussed. At this stage once the scope has been determined the rest of related factors is easier to be highlighted.

- **Information gathering**

Search and collect any relevant information from books, journals and articles that are related to the scope of the study as the reference to support the ideas. At this stage any related information is gathered even though some of the topic is slightly away from the scope subject, hence as supporting ideas to enrich the study input.

3.1.2 Planning

This phase focus on the arrangement and the management for the following step on how to conduct the research in a manageable way. From the first phase where the technique of 'mass research' has been used, planning is to narrow down the scope to plan on what to research and to analysis specifically and arranged planning. There are two parts of planning which described as below.

- Plan for information research.

After performed the mass research now it is much easier to decide on which is the best way to perform the research scope specifically. The research is planned on which subject to touch and needed to be taken into account which are the HCI, Human Factor, perception, color science and the visual receive system. Then this is the phase to plan too for where to refer for the right personnel in order to perform the interview as well as what is the information is needed. All of this information can be gathered and planned from the sequel planning of the mass research at the first hand.

- Plan for usability test.

Before conducting the usability testing, the test structure and the concept needed to be determined. Usability need to be planned by referring to the problem based on the scenario of the problem. The structure of the testing is based by referring to the color science. For this project, through the information research gathering, it is understood that there are few fundamental color which is the best to perform for the usability test. Beside that, the way and the structure o how to perform the testing is based on the supervision of the psychology expert on human perception. For this project, the usability test's experiment specimen are the staffs of few organizations whose dealing with systems in their working environment. The test is planned to interact with them by using questionnaires, interview session as well as 'think aloud' method where the specimen has been monitored fro their behavior and thought when they had presented the test samples.

3.1.3 Research and Analysis

Collect relevant information and input from books, journals, articles and web pages that are related to the scope of the study; to make reference and to support the ideas. At this stage, Literature Review Report is produced as journal for this project. From the readings and information gathered, it is then determined the output on how to conduct the usability study and which area is important.

3.1.4 Analysis Testing

This is the stage where the usability testing is performed. The usability testing is conducted in order to get the users behavior and to get the feedback from them. The usability testing is conducted in three processes:

1. Monitoring session, where user has been given few types of color from screen layout which is the black base and white base. From the session ‘think aloud’ method has been used where users is allowed to say anything and react in order to get their real thought over the test medium.
2. Questionnaires, a set of questionnaires is prepared and given to a group of targets in order to get their feedback on the close ended question by giving rating. Through that, the total answer is examined and an output is delivered.
3. Interview, few simple questions is asked to targeted personnel who are the users of a system from different part of organizations. From the interviews various feedbacks can help the total session of analysis testing.

3.1.5 Result and Recommendation

The data is analyzed will be organized properly and studied to identify the result and to produce findings of the research. This stage is very important and to ensure the success of this project. From the result itself, it is then referred back to the objectives of the project which is to proof that does color affects the user or it is vice versa. The result is documented properly in a simple presentation and recommendation is made through the output of the total findings. Chapter 4: Conclusion and Recommendation Report is prepared as the final documentation of this project. In this stage the result and findings will be summarize to conclude this project. Some recommendation also will be proposed in this chapter to support the findings and the outcome.

3.1.6 Development

After considering the result and the finding, a sample of proposed recommended screen layout is developed. The design is proposed after making conclusion from the data analyzed from the test and after considering the human factor, color science as well as the perception area. The sample will be simple but the objective is to produce and present the idea of total research findings of the project.

3.2 THE USABILITY TESTING

To conduct experiment, usability testing needs to be done to understand the problem and to identify the solution. The testing methodology needs to be simple, and reported in sufficient detail so as to be easily replicable. The usability problems identified along with the design recommendation need to be written. Another possibility is to quantify each usability problem with a severity rating, allowing some gauge of their potential contribution by solving the problem. Below the issue is discussed and the efforts to adapt the usability test.

3.2.1 The Elements of Usability Testing

(a) **Generating norms:** Quantitative measures of a user's interaction such as total time, for any given task can serve as norms for user's interaction with the screen layout. Such norms can serve as baseline for future usability tests, allowing one to track progress in usability of the arrangement.

(b) **Detailed usability testing report:** In this part it is important to include full details of testing methodology, associated questionnaires, and methods of interviews. The goal was that the information should be detailed enough so that the human factor can be understood to replicate the test with the provided information.

(c) **Quantifying usability problems in terms of severity ratings:** All usability problems were indexed in terms of severity ratings. Usability problems can range from minor irritants to major hurdles that can make it impossible for a user to complete a task successfully. The scale measures are three main attributes of a usability problem: frequency, impact and persistence. Frequency refers to percentage of the participants affected by a given problem. Impact refers to the ease with which a participant can overcome a given problem. Persistence refers to how able participants are to

overcome a given problem once they know about it. Each usability problem received a rating for each attribute. By providing these severity ratings, it is possible to find contribution factor to a particular problem. Quantitative severity ratings might help to get clear idea about their potential contribution by solving the usability problem. Result evaluation and usability testing can be tailored to ensure that new design layout meet the end user's needs. Measurements are going to be made from the existing system screen layout. By applying human factor principles about human capability and limitation to the design of equipment of a product with the principle of color science results in:

- Reduced human error and tension.
- Ease of use and understanding
- Increased productivity

3.2.2 The Procedure of Usability Testing

In this research the main test subject is system user from various departments and organization such as Maybank, Bumiputra Commerce, Tenaga Nasional Berhad, KOMAG USA, and Malaysia Airport Berhad. The usability testing conducted for this research is divided to three phases which are the questionnaires sampling, interview session and 'think aloud' method from monitoring session.

- Questionnaires sampling

Questionnaires sampling are targeted to the actual system users from various departments and organizations. They are actually the users of systems that fall under the category of sensitive system and most of them spend their most daily task at the desk in front of a screen layout. Overall there are about 40 questionnaires distributed that contain eight questions where they have to answer. There are five questions been given in a format of objective where they only have specific choice of answer and three questions on subjective format. The objective question is designed to be so, so that the scope of study and the output can be controlled base on the scope subject. While the subjective questions is to give the freedom of the participants to explain their answers. The last question from question eight is the art where various answers and feedback can gain in order to look at the variety of human factor. The rest of the questionnaires are also distributed among students in order to get the different perspective from non system users and incoming system users.

(Refer appendix A)

- Interview session.

Interview session is conducted to different personnel in two manners of situation: arranged interview session and impromptu interview session. The interview questions are not specific and more into conversational manners but it is planned so that the main objective targeted will achieved. For the arranged session, interviewers are

given the same structure of questions from the questionnaires sampling but they are given a freedom to answer the questions rather than options where the questions is open ended and they can answer the questions based on their own opinion. The interview session is recorded using voice recorder. For the impromptu session structure of question has been plan earlier but the time and atmosphere is not stringent where the session can be any time and anywhere when the chance is available.

(Refer Appendix B)

- Monitoring session.

This experiment is conducted by providing a sample of various type of screen layout. There are two parts of testing which is the text base and numerical base. From the two parts, the screen layout is designed into two types of basic color which is the black background with white fonts and white background with the black fonts. The group that is targeted is students from various of study. The significant of using student is because that they are one of the sampling group whose dealing with screen layout daily from numerical and text base during their study. The testing screen layout is planned to be simple and specific in order to narrow the scope of the research study. The page of the screen layout must be clear and there must not be any other unrelated image such as pictures or other color rather than black and white. The testing is planned to be that so because of to drag the participant directly to the subject study and to avoid their intention swayed as well as to minimize their concentration over unnecessary subject.

The color white and black is chosen because from the view of color science color has the seven spectrums of lightings; both black and white is a combination of all colors that has the biggest and the least lightings. For an example, a surface of red color is seen to be red because when the seven spectrums of lightings hit the surface the red light will be reflected back so that we will see the surface red. For white color, when seven spectrum of lightings hit the surface, all the lights will reflected back which means that white has the most reflected lightings while black color when a surface hit

by the seven spectrum of lights, none of light is reflected which carries that black is the least color of light reflection.

CHAPTER 4

RESULT AND DISCUSSION

4.1 DATA GATHERING AND ANALYSIS

All the data from the usability testing is analyzed in detailed. Data from the usability testing conducted are processed phase by phase. The first part is the compilation of data in category of observation. The complied data will be presented in tables and graphs, and explained. The second part is based on the answers given from the objectives part and from the answer a rating can be given from the questionnaires sampling. The other part of subjective was earlier predicted to have few sets of answers and the answer will also been given rating as the result of the session. And last but not least is the session of discussion on spontaneous verbal feedback from the interview session conducted.

4.1.1 Analysis from questionnaires sampling.

Overall there are 40 questionnaires that are distributed to be answered. The question has two type of format where five are from objective and three in subjective where the totals are eight questions. The reason to have the objective question is to make sure that the test subject is controlled base on the subject scope and for the subjective is to make sure that they have the freedom to answer the question base on their environment. From the subjective answer itself we can gather some information for the analysis. The analysis of the answers is in the appendix segment.

(Refer Appendix C)

4.1.2 Analysis from interview session

Interview session is conducted to different personnel in two type of situation: arranged interview session and impromptu interview session. The interview questions are not specific and more into conversational manners but it is planned so that the main objective targeted will achieved. For the arranged session, interviewers are given the same structure of questions from the questionnaires sampling but they are given a freedom to answer the questions rather than options where the questions is open ended and they can answer the questions based on their own opinion. The interview session is recorded using voice recorder. For the impromptu session structure of question has been plan earlier but the time and atmosphere is not stringent where the session can be any time and anywhere when the chance is available.

- Feedback from the interview session

70% feedback from the interviewees responded that they are aware of the color of their screen layout and they believe that color has its own effect while 22% do not think that color has effect and 8% thought nothing. When it is come to the question of what type of their screen layout color 85% of them has responded that their screen layout are from white or light color such as blue; but for the banking system those light colors are only from the main page screen layout while the rest of the pages are black color. Surprisingly that interviewees who are dealing with machine from KOMAG USA and two of them are pilots from the Malaysia Airport Berhad, they had responded that all the screen layout are from black background.

When it comes to the question of which color do you feel more comfortable it is surprisingly that 99% prefers black color as their back ground and only 1% prefers white. The interviewees has responded that black color gives less eye stress and the sight is more comfortable to look at the screen while the respondent of white color says that white color makes the screen sees clearly.

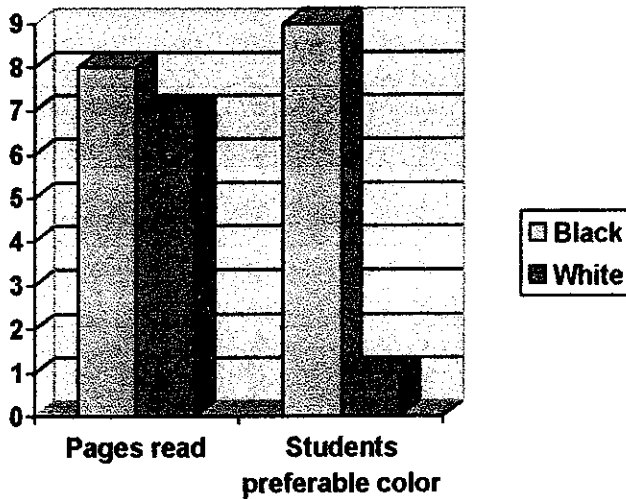
4.1.3 Analysis from monitoring session

This experiment is conducted by providing a sample of various type of screen layout. There are two parts of testing which is the text base and numerical base. From the two parts, the screen layout is designed into two types of basic color which is the black background with white fonts and white background with the black fonts. The group that is targeted is students from various of study. The significant of using student is because that they are one of the sampling group whose dealing with screen layout daily from numerical and text base during their study. The testing screen layout is planned to be simple and specific in order to narrow the scope of the research study. The page of the screen layout must be clear and there must not be any other unrelated image such as pictures or other color rather than black and white. The testing is planned to be that so because of to drag the participant directly to the subject study and to avoid their intention swayed as well as to minimize their concentration over unnecessary subject.

There are 10 students that are given about 10 minutes to participate on the session. From the observation, it reveals the findings as discussed below:

- **Text base**

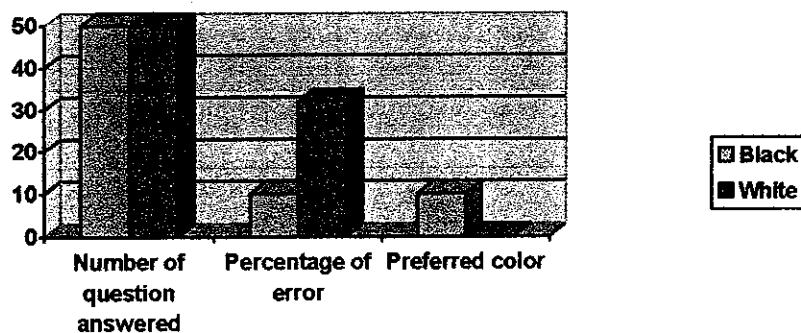
From the observation it is seems to be everyone is comfortable to read the text page by page and through the participants behavior it is difficult to capture what they are thinking. They are about ten pages of the text and almost all of them can exceed to the fifth pages. At this stage not many of action can be captured. It is concluded that for the text base analysis it is seems to be not effective enough to determine through monitoring behavior. Another step of action has been taken where students are asked each of them on which page they prefer most and 9 over 10 has chosen the black and their respond is that the black color is much pleasant to the eyes. The result is presented in following graph:



Graph 4.1.3 (a) Percentage on color preference from the text base

- Numerical base

From this part, the study is assessed through the rate of error performed by the students. Simple mathematical calculation is given and the question has been substitutes by the numbers arrangement where it is actually the same question for both pages the black page and the white page. As referred to the scenario from the first task, participants are asked after the session on which color they prefer most as the background. The result is presented in the following graph:



Graph 4.1.3 (b) Percentage on color preference from the numerical base

Overall from both analysis observation, little reaction or behavior is countable such as their hand movement, conversation and so on. Students are given the white base color at the first hand and followed by the black base color. One part that has been observed and putted into account was two of the participant has said 'wow' when the page turned into black. From the result it is concluded that student prefer most on black color as the background of the screen layout.

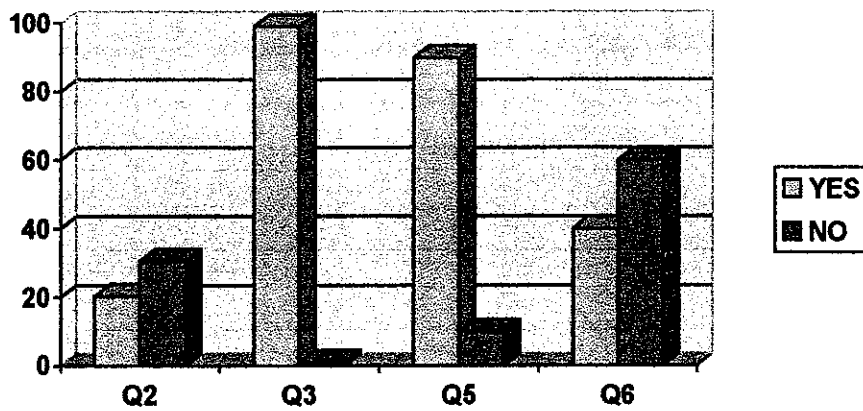
4.2 DISCUSSIONS

From the three process of data gathering and analysis of the usability testing conducted, it is indicated that the ergonomics factor, human factor and psychology is very important in reducing human error, ease of use and understanding and increasing productivity level. It is discussed one by one below.

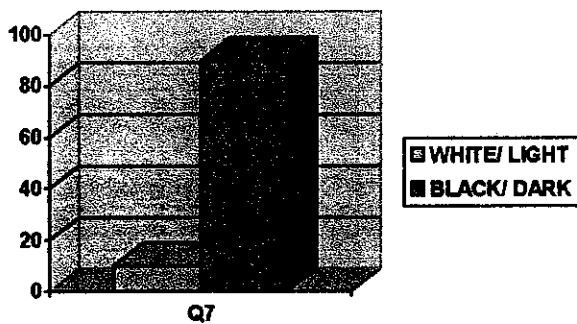
4.2.1 Discussion of analysis from questionnaires sampling.

For analysis on the questionnaires sampling, as the objective questions are designed to be simple and direct, it is easy to analyze the subject objectively. It can be seen from the result that most of the participant are aware of what system they are dealing with and important of zero error. It is clearly stated that the participants believe that color has impact on their productivity but they seem to be unsure why does color has an effect and which color is the best. The seventh question on which color most preferred is purposely design only two choice of colors in order to direct the result according to the scope. If the answer is given as subjective option, the result might be varies and the output tend to reflect on personnel color favoritism rather than the principle of color science and perception. For the final question on the eighth question which asked why they choose the color, 70 to 75% answered the question according to what is the project study predicted earlier where black color has less tension and pleased to the eye sight. This is compatible with the principle of color science where black has the least light reflection over other colors. There are also participants who are unsure about their choice of

answer, why they did choose the color but it is clearly stated that they feel comfortable with black. Overall of the result from the questionnaires objective answers are as follow:



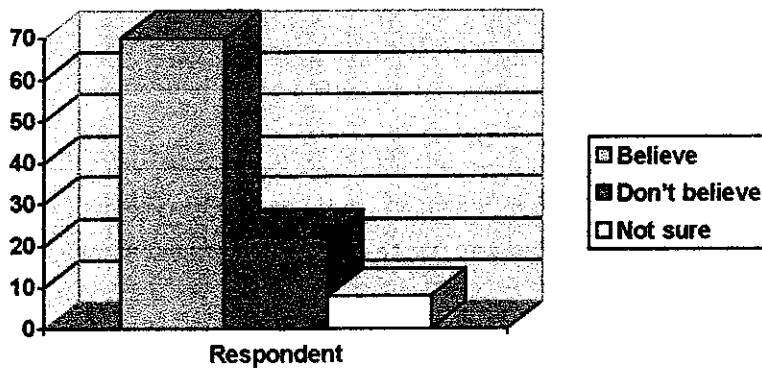
Graph 4.2.1 (a) Overall percentage on objective questions



Graph 4.2.1 (b) Percentage on preferred color for the background screen layout

4.2.2 Discussion of analysis from interview session

From the interview session conducted, there are few types of groups which deal with varies of system format. The question points are based from the questionnaires sampling. From this interview session interviewees are given a freedom to answer the question where the choices of the answer are more subjective so that the output from the research will be more critical. The summarize result of the finding in a percentage presentation is described as below.



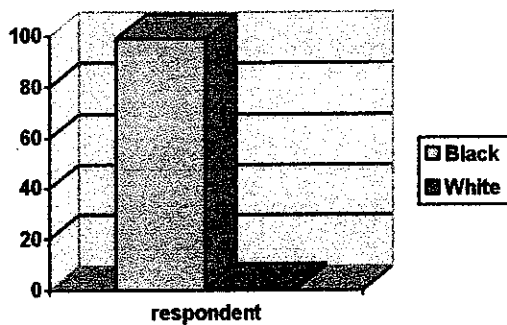
Graph 4.2.2 (a) Users believe on color effects on system screen layout.

From the graph presented above is clearly stated that most of the respondent from the interview believe that color has an effect where some of the interviewees relates the idea into other background of study such as children's psychology. But when it comes to the group some of them believe but they are not sure how the subject of color works does and what makes the color affect the productivity.

When it comes to the specific question on color there is a contradictory on their current color of their system over their choice of color. 85% of the respondents informed that their current system are white base as well as other colors such as light blue by the respondent from Bumiputra Commerce Berhad on Banking System. But when it comes to the data tracing of the banking system, the background of the screen layout are in black or dark grey. Perhaps respondent from plant machineries as well as cockpit or air traffic monitoring system, their background of the screen layout is in

black. It is also realized by the writer that when it comes to vehicle such as a motorcar, most of the meters in the car are indicated with black screen layout.

For the choice of color, the study has narrowed down the research into two basic principles of colors. Interviewees are given the choice to choose either one and they are asked to explain the reason of their preferred choice. The findings indicated as below.



Graph 4.2.2 (b) Respondents choice of most preferable color on screen layout.

It is surprisingly that 99% which is almost the entire respondent preferred to have black or dark color as the background of their screen layout. That feedback is that black color is less stress to the eye sight and more comfortable to look at the screen layout for a longer time. White screen layout is preferred as the screen visible clearly to the eye sight. But when it is asked that does white color acquires longer time of concentration, the feedback indicated that usually users tend to give a pause period during work rather than concentrating on the screen layout for a very long time.

4.2.3 Discussion of analysis from monitoring session.

After analysis from the monitoring session and identifying the factors that influence the students behavior, it is identified that the students interaction as the system user with the environment does and other small attributes which is the color does really influence and effect towards the subject. As an example when from white base screen layout is changed into black color, there is an immediate reaction been said as ‘wow’

which is actually part of the 'think a loud' method. It is clearly mentioned that good choice of color gives longer time to maintain their eye sight which is black while white color has the vice versa effect. In order to overcome the situation users has to pause their eye sight over screen to give a break to the eye sight. From the result error since that students only been given 10 minutes to answer simple 50 questions, the timeline is purposely designed with the total number of questions in order to make sure that participants will not have a break pause during the session. It is clearly stated from the result a different output of the error from both screens where white has the higher rate. Overall when it comes to the question session after the monitoring on which color is preferred most black color has dominated the area.

CHAPTER 5

CONCLUSION AND RECOMMEDATIONS

5.1 CONCLUSION

The analysis has been done and data has been collected. It is proved that color really has the effect on the user and it is important to have the right choice of color in system development. The usability testing that has been performed direct and indirect way has given some guidelines and proved that color choice is crucial to the system user. Perhaps if the monitoring session can be improved by providing a tenses situation the result might be more obvious.

It is proven that color is part of the ergonomic factor which ergonomic and human factor does influence the user interaction with the system. The risks of Repetitive Stress and Eye Sight Stress problem is not the only hazard posed by a poorly choose of color for a system. The greatest risk is that the unnecessary disaster that could happen due to the error or mistake that leads because of less concentration or stress. An example is that a person who is dealing with a plant machineries tend to loose concentration because of the Eye Sight Stress may perform an error which leads to huge mistake over the system. It is not only could incur the financial cost but even could harm the life of other related system users.

There is only one goal in Human Computer Interaction subject, to develop a good system for both the system and user to interact the best in order to enhance and increase the productivity. Good choice of color for the system screen layout is part of the study which needed to be taken into account.

5.2 RECOMMENDATION

The principle of color science has been understood at the earlier stage before the research and analysis testing from the usability testing. Colors are transmitted as lights which receive to the eye sight as wavelength and detected by the three cones of the eye sight. The color is determined from retina and to the visual cortex of the human brain. It is proven that the least amount of light received has the best performance and most preferred by the user testing. Purposely black and white was been chosen and at this situation black has the winning power over white and when we relate the output with the science of color, black does fit with the idea of the amount of least lights and wavelength.

For a system use, it is not only recommended that black is the only best color practice. The base color that has been used is only as the measured platform to perform the analysis. The idea is to look at from different range of lightings which carries the highest and the lowest. It is proven that lower wavelength of lightings is a good practice which leads to less stress for the eye sight. Through this, black is most recommended but other colors are also relevant as colors have various type of wavelength. Below is an example of colors wavelength from the three basic color which is the Red, Blue and Green.

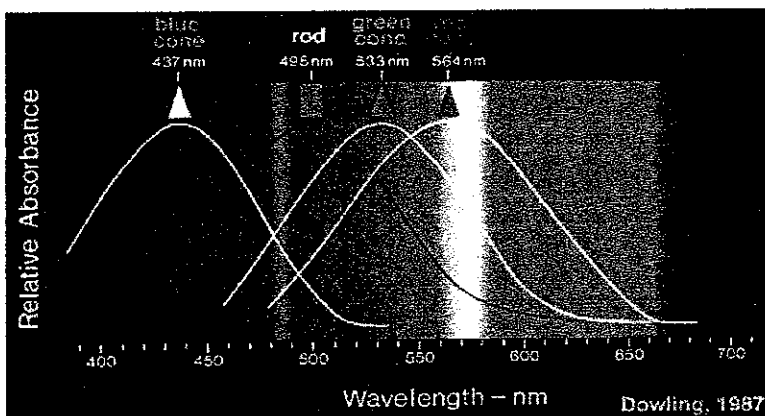


Fig. 14. The peak spectral sensitivities of the the 3 cone types and the the rods in the primate retina (Brown and Wald, 1963). From Dowling's book (1987).

Overall as the conclusion it is recommended to develop a sensitive system by using the right choice of color. The choice of color must be pleasant to the eye sight and less stress for a longer period of timeline to look at. Those factors are determined by referring to the science of color where color that has lower amount of lights reflection to the sight and lowest wavelength is the best.

Black color is the best choice and its other range of black color in a different saturation and brightness. Besides black blue is another color that has the lowest wavelength and recommended to use. At this stage it is proven that why there are a lot of sensitive systems such as machineries are designed with black screen layout. Another example is by an airplane cockpit and motorcar driving meters.

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APPENDICES

APPENDIX A

**COLOR EFFECTS ON PERCEPTION OF SCREEN LAYOUT FROM THE VIEW OF
HUMAN COMPUTER INTERACTION (HCI)**

Research Study Questionnaires

Name: _____

Company: _____

Position: _____

System use: _____

1. Please tell us what kind of system that you are dealing with.

.....
.....

2. What is your system format base.

Numerical Base Text Base Both

3. Does your system is a sensitive system which need your fully attention; any small error could incur problem to the whole system.

YES NO

4. What is the background color of your system screen layout.

.....

5. Do you think that the color of your system screen layout does effect your productivity.

YES NO

6. Do you satisfy with the color

YES NO

7. If you have been given an option, which color do you prefer most as your system screen layout

WHITE / LIGHT BLACK / DARK

8. Why?

.....

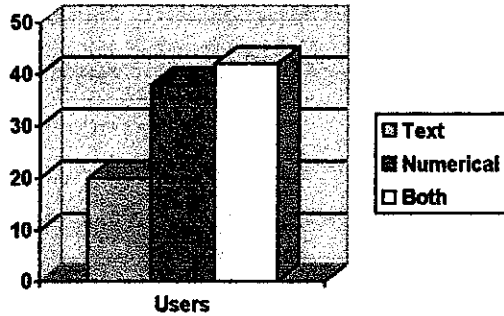
APPENDIX B

Below are some of the simple questions that have been asked for the interview session.

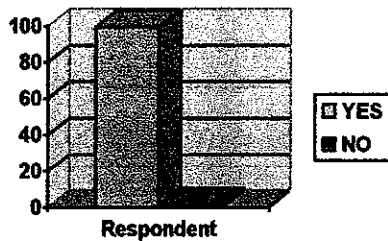
1. Which company are you working at right now?
2. Are you dealing with any system?
3. Does your system needs your full attention.
4. If any error that you make does it affects the system and gives trouble to your work?
5. What kind of problems that you might encounter if you have made a mistake.
6. Do you realize that what is the color of your system screen layout background
7. What is the color background of your system screen layout.
8. Do you think that color may affect human behavior?
9. Do you believe that color from the screen layout does affect user's productivity?
10. Do you feel that your current system has the right color for you?
11. If you have been given two choice of color, which one do you feel more comfortable as your screen layout, black or white?
12. Why do you say so?
13. Do you agree that good choice of color can affect the user's productivity and attention?

APPENDIX C

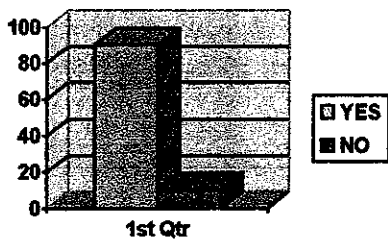
Q2. What is your system format base.



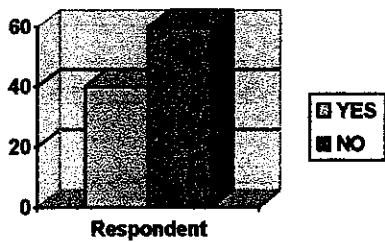
Q3. Does your system is a sensitive system which need your fully attention; any small error could incur problem to the whole system.



Q5. Do you think that the color of your system screen layout does effect your productivity.



Q6. Do you satisfy with the color



Q7. If you have been given an option, which color do you prefer most as your system screen layout

