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Perpustakaan Univeristas Multimedia Nusantara

PART II

LITERATURE STUDY

2.1. Interactive Design

Norman (2013) states about two important aspects in interactive design, which is discoverability and usability/understanding. Discoverability means that users are able to seek a design's many features, and able to determine when and where to access the features with ease. Usability means that users understand the main feature of the product, how the product is supposed to be used, and how to use it according to user's needs. A design that is well-executed could fulfill users' need without abandoning manufacturing, system design, and ergonomic principles (p. 3).

Norman (2003) further states that there are three aspects that needs to be held accountable when producing a design, which are the overall user experience, aesthetic form, and quality of interaction (p. 4). Designers should always keep these aspects in mind because a badly executed design could trigger negative emotion from users such as distrust, boredom, and exasperation.

2.1.1. Human-Centered-Design-Based Interaction Quality

According to Norman (2013), Human Centered Design (HCD) is an interaction design approach which put emphasis on needs, ability, and basic human behavior. In a Human Centered Design, clear communication between human and machine is required in order to execute a clear performance by human to machine or vice-versa. Clear communication is also mandatory to determine what action is

happening and what result is to be expected from the action. In a Human Centered Design, the designers need to anticipate possible mistakes from users while using their design (p. 8).

Understanding of HCD is acquired through observation. This is due to people's inability to analyze individual needs effortlessly, or to make personal introspection related to their own setbacks. Two of the main principles in HCD is to avoid making assumption of a problem, and to always make design iterations when there's a rising problem so that the end product could function optimally. The iteration process is performed with many trials of ideas repeatedly. Each trial would inevitably alter the product according to the highlighted problem.

2.1.2. User Experience

According to Soegaard (2018), User Experience Design (UXD) is a design process in which its main objective is to achieve an ideal experience while using a certain service or product. UX in itself refers to user's impression while using some service or product. Each form of human interaction with an object can be categorized as UX, but specifically, the UX discipline refers to Human – Computer Interaction (HCI) or a relationship between users and computer-related products such as websites, applications, and computer system (p. 7).

Norman (2013) states that experiences emerging from cognition and emotion makes user recall an interaction positively. Cognition and emotion are entangled and necessary in an interactive design. When interacting with a design,

user should have a personal understanding about how the design is supposed to work (p. 10)

2.1.2.1. Affordance

Norman (2013) explains that affordance is a correlation between different features of a product and user's ability to use said product. Affordance refers to a relationship between user and design, not just the design's attribute or user's ability being taken into account individually. Correlation plays an important role in affordance, as affordance would appear on a strict condition when the product's feature and user's ability align. In other words, affordance would vary individually according to the right condition (p. 11-13).

2.1.2.2. Signifiers

Norman (2013) explains that signifiers work as indicator to the questions what, where, and when that describe some features of a design. What information are needed by users and what answers could the designer offer are categorized as signifier. Signifier could be direct like "push" sign in a door, or indirect like an observation of people pushing a door which indicates how to operate said door. (p. 13-19).

2.1.2.3. Constraints

Normam (2013) explains that constraints is an indicator which limit a certain action when user is interacting with a design. Constrains have a function to guide and ease user while they interpret an action within the design. The

concept of constraints is also applicable to help users learn about a certain design's many functions. (p. 123).

2.1.2.4. Mapping

Norman (2013) explains that mapping within interaction design means a correlation between elements possessed by two different objects. Mapping has an important role within layout and display design process. While implementing mapping on a design, there ought to be a clear concept model so that users could intuitively see the cause and effect between a controlling subject and a controlled subject. One of the examples of this correlation is the relationship between wheel and steering wheel rotation in a car (p. 20-23).

2.1.2.5. Feedback

Norman (2013) explains that feedback is an effort to communicate some reactions caused by a certain action. Human could perceive a diverse range of feedback according to the body's possessed senses. A good feedback design could give users a response no longer than 10 seconds after a certain action is executed. A delayed feedback has a risk of stunting communication between users and design. A good feedback trait is also being informative and has a clear context. An ambiguous feedback, caused by a lack of information or too much information, has a high potential of causing confusion, which could be followed by triggering negative emotion from users. A badly designed feedback causes more harm to a designed product than having no feedback at all (p. 23-25).

2.1.2.6. Usability

Hussain, Abbas, Abdulwaheed, Mohammed, & Abdulhussein, (2015) explainst usability as a design's ability to be understood, learned, operated, and attract user's attention in order to complete a certain goal effectively and efficiently (p. 549). The measure of usability is demonstrated through a design's interface. A few usability aspects applicable for mobile games are as the following:

1. Learnability: Indicates how much ease a certain user completes a task at the first attempt, or how much growth user could improve his or her performance.
2. Efficiency : Indicates how long it takes to complete a task. Before measuring efficiency, user should be verified to possess a past experience of using the design
3. Memorability: Indicates how much ease user trace back steps taken within a design after a period of time not using it. Another point of memorability is how effortlessly user could re-operate a design with no stints.
4. Error: Indicates how many mistakes user makes when using a design. Error should also be analysed regarding how each mistake affects the interaction with said design. Designer should also analyse how user could get through or avoid the mistakes.

5. User Satisfaction: indicates a measured response of how users react to design. User satisfaction also indicates users' contentment and fulfilment while using the design.
6. Simplicity: indicates a degree of comfort users experience while completing a task. Simplicity could be used as a measure of quality in a structured menu or navigation system within a design.
7. Comprehensibility: Indicates and are synonymous with readability. Comprehensibility measures users' understanding of a certain design's content. Comprehensibility dissects how some information are presented to users.

2.1.3. User-Based Design Methods

Soegaard (2018) states that the main methodology applied for any type of interaction design must be user-centric, as the design is targeted to be used by users. The design should focus on the targeted users, which includes design efforts focusing on user behavior and expectations. (p.7)

The most commonly used design method process is Design Thinking. The goal of applying Design Thinking is to systematically design a product with the targeted users in mind. By implementing Design Thinking, designers could better understand the mind of the targeted user and their interaction with the designed product, designers may minimize assumptions when deeming what is best for the users, and explore different perspectives of a design problems along with different solutions. There are a wide variety of design methods which could be applied within

the Design Thinking process such as conducting user researches, creating user personas, and developing prototypes.

Design thinking, as defined by Stanford d. school consists of 5 different stages (Soegaard, 2018, p. 11). Each stage may be repeated non-linearly for the sake of optimizing the designed product. The first phase is Empathize which is a phase of making efforts in understand and building empathy towards the targeted users. The second phase is Define which is a process of making statements regarding user's needs that the designers must fulfill. The third phase is Ideate, which is a phase of exploring ideas and innovations which suit the user's needs the best. The fourth phase is Prototyping, the phase of implementing ideas into tangible product. The Fifth and final phase is Test, which is defined as a phase of verifying the product's ability to meet users' needs and expectations.

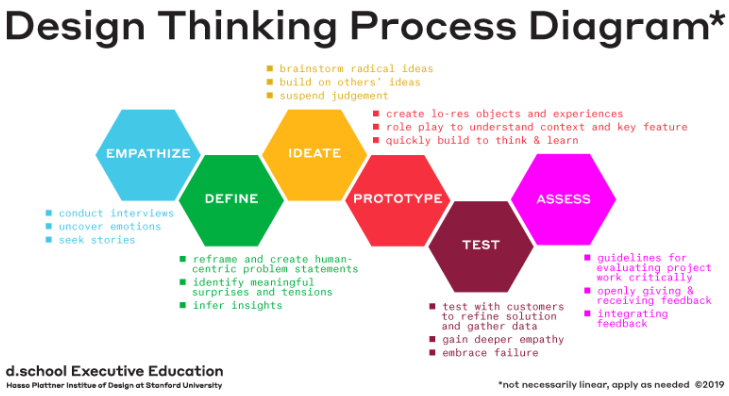

Figure 2.1. The Inverted Pyramid Model
(https://dschool.stanford.edu/executive-education/dbootcamp)

2.1.4. User-Based Research Methods

Acccording to Unger & Chandler (2009), before implementing design, there is an urgency to define user's needs and frustrations (p. 86). These basic user datas could

be archieved through conducting research. While researching, designers should always base their research on the required datas as irrelevant datas wastes money, time, and effort. Designers must focus the research activities on collecting datas which plays crucial role on the design proces. There are 5 steps to help designers focus on their research:

1. Defining the main user group

   Defining the main user group means generalizing the targeted user for the designed product. This step is implemented in order to pin-point group of users to be researched.

2. Planning user involvement

   In this step, designers determine which techniques to use for collecting data in order to have better scopes toward user's insights.

3. Executing Research

   Researches are executed by implementing research methods such as conducting surveys and doing field observations.

4. Validating choice of user group

   This step’s purpose is to determine wheter the targeted user group is valid or needs adjustment, The judgement is made after analizing datas collected during research.

5. Generating user requirements

   In this step, designers list down user’s needs which would be implemented on the designed product.

2.2. Game Design

Related to how vast the game design discipline has spread, as it has been intersecting with sociology, interaction design disciplines, and Human-Computer-Interaction, game has evolved into an entity which is hard to categorize and identify. According to Fullerton (2008), game is defined as a formal and enclosed system, and involves players within a synthetic conflict (p. 42-43). This conflict is presented as a wholesome structure and has many potentials of reactions related to problem solving. Schell (2008) defines a game based on ten distinct attributes (p. 34). The mentioned attributes are as the following:

1. Game is entered with a free will
2. Game has an objective which the players must achieve
3. Game possesses conflict
4. Game includes rules
5. Game can be won or can cause defeat.
6. Game has interactive traits
7. Game contains challenges
8. Game have a build-in value measurement
9. Game engages users
10. Game is a formal closed-system

2.2.1. Immersion

According to Lidwell, Holden, & Butler (2003), immersion is a state of mental focus so high it lowers players' consciousness of their physical environment (p. 112). When the senses and consciousness are not stimulated well, apathy and sense

of boredom could be triggered. On the other hand, when there is too much stimulation, a sense of stress and frustration will surface. Immersion itself appears when players are in between a balanced sense of control when executing a task. This also refers to the proposed theory of flow by Csikszentmihalyi (1990) in which a state of enjoyment towards a certain task would emerge when an individual's ability and a presented challenge reach an equilibrium.

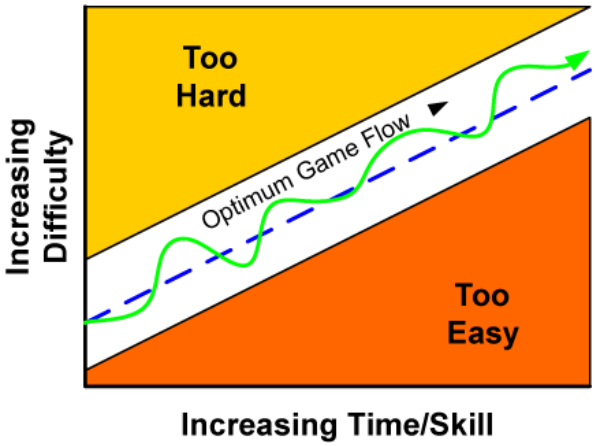

Figure 2.2. Game Flow Adapted from Csikszentmihalyi's Flow Theory
(https://www.jesperjuul.net/text/fearoffailing/)

2.2.2. Player Involvement Model

According to player involvement model, a game's attributes such as narration, visual, or interaction could influence other dimensions when there is an interaction happening between player and a game. Player involvement model are categorized into two groups according to its form, which is micro involvement and macro involvement.

Poels in Calleja (2011) explains that there are many factors that could influence player's opinion and involvement during gameplay (p. 38). Macro Involvement comes from the player's mind, planning, emotion, and expectation

before and after play. A sense of involvement outside the game also includes a sense of belonging in a community, a sense of challenge for exploring strategies, an interest in understanding the narration from the start to the end, a desire to explore the in-game world, motivation to best another player within the game, or a longing of being surrounded by the allure of virtual game world. In conclusion, Macro Involvement consists of all things related to long term game involvement.

Macro Involvement could be explained further as something that influences post-playing experience. The experience includes a sense of fulfillment after completing a game (ludic involvement), a sense of pride after surpassing hurdles within a game (kinesthetic involvement), and a sense of peace after the game being played is finally over (spatial & affective involvement)

Micro Involvement is explained as an involvement of moments between gameplay. Every form of representative media needs a cognitive attention to be interpreted coherently. Without attention, there would be no involvement during gameplay. Pay in mind that player's mental concentration to the game's stimulus involves many aptitudes, process, and cognitive conditioning which interacts with one another within the mind (Fan et al., 2002). When the brain is undergoing many activities at once, the coordination involved needs a higher attention. To conclude, the attention given by player's mind is the main key to player's involvement model.

2.2.3. Features

According to Hight & Novak (2007), game features describe many forms of players' interaction with a game. Feature doesn't have to be unique but should be

able to give selling value (p. 35). Examples of what can be considered as features are:

1. *Point of view*
2. *Online/multiplayer*
3. Number of missons / levels
4. Weapon / items / transportation / other unique assets
5. Voice recognition system
6. *High definition image/*1080p
7. *Seamless world*
8. Other unique features as the game's defining identity.

In order to determine the main feature of game, each feature must be evaluated, whether it has unique selling points (USP) or not. If it has no USP, the feature shouldn't be included within a designed game. A game with strong cohesion between feature and USP tends to fulfill players' expectancy, as well as giving the players a sense of being polished and immersive.

2.2.4. Genres

Salen & Zimmerman (2003) States that game genre are drawn from different kind of medias such as literature, motion picture, popular culture, and classical art. There are no defined boundary when designing a game genre / narrative. With many genres circulating within the global game market, genre in general is quite difficult to define. Moreover, game genres are usually assimilated and/or converged from two or more different genres. The end product of such assimilation/convergence is a brand new genre entity. Some games have a repetitive genres such as sports,

racing, fighting. This is due to the game's marketing influence, and due to the game's effort to satiate the targeted user's demand.

Attempts of categorizing game can be done by analyzing the game mechanic (not the game's theme contrary to popular belief). To analyze a game's theme means to look beyond it's visual and setting. it is possible to design an RPG set in a sci-fi world, or a racing game set in medieval/fantasy setting. One of the core analyzing point for defining game genre is its Game mechanic. The game mechanic includes the game's challenges and objectives. When defining a game genre, it is imporant to analize it's features, components, and challenges. Furthermore, it is important to analize the player's response toward said features and challenges. Comparing a game's genre with another's genre is an excelent strategy to have a better understanding about genres and it's application to the game design process.

2.2.4.1. Platformer

Figure 2.3. Platform Game Example: Ori and the Blind Forest (https://www.telegraph.co.uk/technology/video-games/video-game-reviews/11491589/Ori-and-the-Blind-Forest-review.html)

According to Hight & Novak (2007), within a platformer game, players must control a character that jumps and climbs form one platform to another

platform, as well as passing enemies and collect power-ups. Platformer game is generally more popular with younger audiences (p.36).

2.2.4.2. Adventure

Figure 2.4. Adventure Game Example: Samorost
(https://amanita-design.net/games/samorost3.html)

According to Hight & Novak (2007), the main objective of adventure game is to solve a problem usually shrouded in a form of mystery. In a classic adventure game, players are taking the role of "detective" who collect clues in the form of puzzles and riddles by exploring the game environment. The story narrative within an adventure genre usually plays a more significant role than the game's main character (p. 38).

2.2.4.3. Puzzle/Maze

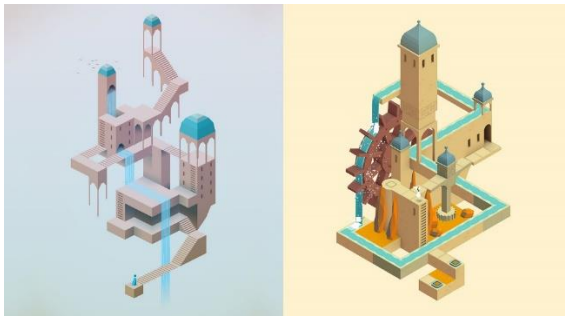

Figure 2.5 Puzzle Game Example: Monument Valley
(https://www.ustwogames.co.uk/games/monument-valley/)

According to Hight & Novak (2007), In a puzzle/maze game genre, players must solve a visual or mental puzzle in order to continue playing. This genre is usually a derivative from arcade games. Some puzzle games need a fast response during problem solving, like as seen on a Tetris game (p.39).

2.2.5. Story-Telling Medium

According to Hight & Novak (2008), Every games possesses a story aspects, which includes a premise, main character, or an opponent to fight. A game's story is usually developed through outlines or plot points. An outline for a game should be no longer than two full pages. Plot points are defined as particular moments within a storyline that produces a sense of interest or focus towards the game's narration. The plot points aids players in understanding motivations of game characters. (p. 70)

Rouse III (2005) explains that storytelling in a game should be kept to a minimum. Players should have a sense of control towards the game's story development (p. 202). Even though a game does not need to incorporate storytelling, but the game’s story could enrich the playing experience. Agame's story is predetermined and can't be changed by players, the storytelling is communicated in between gameplay, usually through cut-scenes. One important point about an interactive storytelling experience is that the story's detail should be flexible to be intepreted by users, just like parents telling a bed time story to their child; the storyline is predetermined but the detail of the story can be intepreted according to the child's preferences.

Storytelling can be integrated within a game through different system locations or media. Some ways to communicate stories can be integrated within gameplay through these methods:

1. Out-of-Game

The story unfolds when players are not actively playing. An example of implementing out-of-game narrative is through cut-scenes, mission briefings before players enter a gameplay. Out-of-game narration are uncontrollable by the players.

2. In-Game

The story unfolds when players are actively playing the game. In-Game narrative encompass the game stage's setting, behavior of the game avatar and the NPCs, and player's choice of taking a certain mission.

3. External Materials

The storytelling is communicated externally through a different media, such as game merchandise in the form of comic books, story map, and collectible cards.

2.2.6. Graphical Styles

Keo (2017) states that a game's visual style influences a player's gaming experience significantly. There are a common graphic styles and visualization that are possible to be classified in a certain groups. Varying visual designs are referred as graphical styles. Jarvinen, Smith & Brown, and Smith & Tosca cited in Keo (2017) categorizes graphical styles into three distinct groupings, which are abstract, stylized, and realistic.

1. Abstract

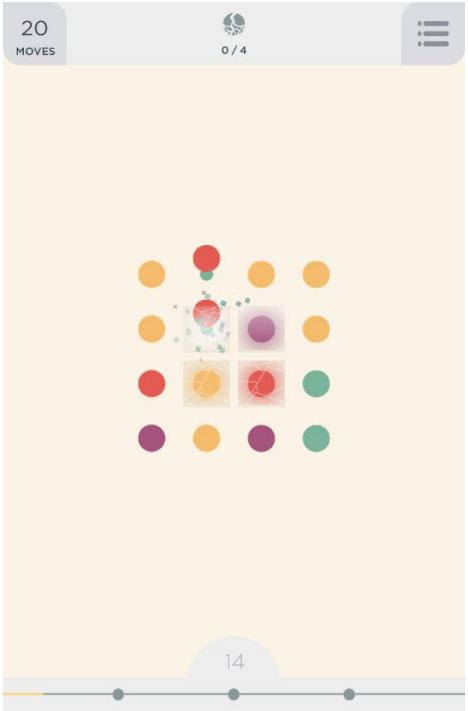

Figure 2.6. Abstract Game Example – Two Dots
(https://www.mobygames.com/game/android/twodots/screenshots/gameShotId,746964/)

Abstract graphic style adopts geometric shapes and forms to represent a game's visual. Abstractionism has no representative form towards any material thing found on daily occurance.

Järvinen in Keo (2017) states that video games seldom adopts a purely abstract graphical style as most game simuates a distinct environment. Even puzzle games occasionally adopts a stylized graphical style instead of pure abstracitonism.The implementation of abstract graphic style can be found wihtin the game Tetris. The popularity of abstract graphic style has dwindled due to the rising populairity of of storytelling aspect within game which requires a defined visual instead of abstract.

Egenfeldt-Nielsen et. al in Keo (2017) counters that abstract style's implementation has risen in popularity with the introduction of mobile gaming (p. 6). Since the. Due to the emphasis of simplicity within the presentaion of mobile games, abstarct graphical style is commonly favored to be adopted. Abstaract graphical style is compatible with casual gamers as the graphical style helps players to focus on the gameplay instead of the visuals. On the production perspective, the development of abstract-styled games are also not as demanding as their stylized counterparts.

2. Stylized graphics

Figure 2.7. Stylized Game Example – Undertale
(https://www.eurogamer.net/articles/2018-09-22-undertale-endings-hard-mode-4873)

Stylized graphics put emphasis on exagerating specific features possessed by visualized subjects. There are a wide range of stylized graphic variations due to the flexibility of being implemented. Järvinen in Keo (2017) compares stylized graphics to caricature which is a simlified representaion of an object which has been

produced through simplification. Stylized graphics took inspiraion form painting, drawings, and cartoons.

Stylized graphics are implemented to attract a certain group of players as the style enables artists to focus on color palette and atmospheric moods. Another aspect possessed by stylized graphics are its expresiveness and flexibility outside the law of real-life physics. Thus, stylized graphics are usually implemented for the sake of immersing players towars the game world and/or environments. Some example of stylized graphic are World of Warcraft.

Pixel art is one of many popular stylized graphics represented within video games. The use of pixel art originated from a limited color palette (256 hues) use at the rise of video game graphics during 1970 to 19990 which results in a "pixelated" graphics. In contemporary gae pgraphics, pixel art is usually adopted by indie-developed games. Some examples of pixel art games are Super Mario Bros (1985) and Sonic the Hedgehog (1991)

3. Realistic Graphical Style

Figure 2.8. Realistic Game Example –Rise of Tomb Raider
(https://www.t3.com/news/e3-2012-tomb-raider-gameplay-trailer-unveils-characters-plot)

Realistic graphical style mimics reality and instills it on the designed visuals. Although resulting in splendid visuals, realistic graphical syle possesses limitations within game hardware and gameplay. For example, realistic graphical style could only be implemented on a certain game genres such as adventure, first-person shooter, or survival horrors. The creation of realistic graphical style requires focus on modeling, texturing, lighting, animation with motion capture, and other detailed video game production processes, which results in seldom implementation on mobile or other hand-held game media.detail of the story can be intepreted according to the child's preferences.

2.3. Information Design

Meirelles (2013) States that the main purpose of informational design is to communicate information, whether the media is digital or non-digital. Additionally, information design is part of the communication discipline which main purpose is to purely communicate information (no persuation, etc). Information design output includes infographics, information system, data / statistic visualization, and wayfinding system among many others.

Tufte in Baer (2008) defines clutter as a failure of design, not an attribute of information. It could be concluded that clarity and ease of access is crucial when presenting information. In order to pursuit the best result, information design combines different fields of expertise such as typography, graphics, communication discipline, ergonomic principles, human psychology and sociology, linguistic study, and computer science. Information design is also closely related to the field

of information architecture, which is defined as the act of organizing and categorizing information.

Furthermore, a visualized information has a correlation with the human cognition system which include tasks such as:

1. Archieving information
2. Communicating meaning
3. Boosting memorability
4. Enabling search function
5. Enhancing discovery
6. Supporting perception
7. Boosting recognition and detection
8. Illustrating theories and facts
9. Framing data perception

2.3.1. Cognitive Principles

Accodding to O'Grady & O'Grady (2008), Information design is related to cognitive principles, therefore it must relay specific message towards audience in a clear, accessible, and comprehensive way. There are a few learning methods related to the cognitive processing of informations. People have different process and motivation for learning as proven by theories form the educational and cognitive science field. Most individual prefer a specific sensory stimulus or stimuli to perceiving and retaining information. According to a study by Dunn and Dunn in

O’Grady & O’Grady (2008), the three most common learning methods are as the following:

1. Visual

   visual learners thinks in images and retains information better when they are being presented in still image, motion picture, charts, and such. Visual learners are also more sensitive towards space and aesthetics.

2. Auditory/Verbal

   These type of learners projects their thinking in words. They absorb information better when they are presented with lectures, discussion, and written words. They methods of choice for studying are usually taking notes, listening, talking, and reading.

3. Kinesthetic/Tactile

   Kinesthetic learners prefer learning information through action. They need physical stimuli to activate muscle groups in their body for experiencing a feeling of completion when learning. These type of learners prefer learning through plays, demonstrations, experimentation. This group's sense of brain-muscle coordination is usually heightened.

Aside from learning styles, cognitive principles is also related to human memory. Memory works by enabling human to store, retrieve, and apply knowledge. Within the study of human memory, there are a few theories and models of how memory operates which will be described on the following sub-sections.

2.3.2. Confirmation Techniques

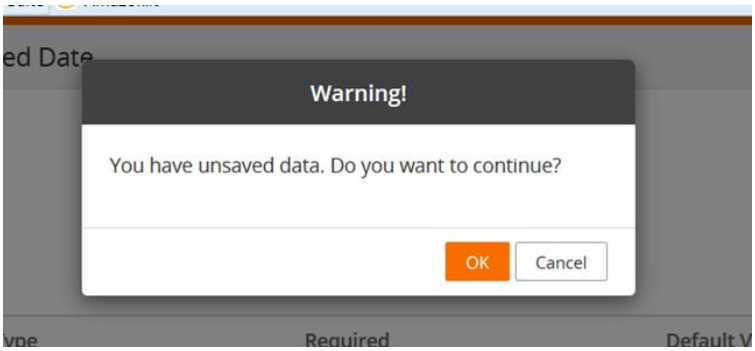

Figure 2.9. Confirmation Technique Applied in Pop Ups
(https://communities.bmc.com/thread/171752?start=0&tstart=0)

Lidwell, Holden, & Butler (2003) explain that confirmation is a technique of giving affirmation before continuing a certain action (p. 45). The purpose of confirmation is to assist users in avoiding interaction mistakes. Confirmation is synonymous with verification principles and force-function.

Confirmation technique is usually applied (and most of the time exclusive) for important actions. This technique's main purpose is to ensure that an action is meant to be done and not just a human error. Confirmation technique is most effective when being applied to an irreversible action within a system, as applying confirmation technique in a mundane task would only slow down users' performance.

There are two methods for applying confirmation in a design; the dialogue method and two-step-operation method. The dialogue method requires a verbal communication between users and the designed system, as in dialogue boxes and pop up screens. Within a dialogue box, users are asked to confirm their action. An overused dialogue method causes users to ignore the confirmation process, therefore the whole process will be a moot point. Messages directed to users in

dialogue method should be short, precise, and clear in order to avoid misunderstanding. Confirmation is usually answerable with a simple yes or no question, or in some cases an action verb such as proceed, go, and exit. Confirmation dialogues tend to work as notifications and reminders, therefore designers must provide an option to turn of this confirmation feature for the sake of users' comfort.

The two-step-operation method tends to use a "terms and conditions" phase before a system action or command can be executed. The two-step-operation method is normally found in hardware systems, as in a pull-able lever that moves large machineries. The two-step-operation method could also be applied to interactive designs, as the purpose of this operation is to prevent accidental actions.

2.3.3. Layering

Figure 2.10. Example of 2D Layering
(https://venngage.com/blog/what-is-an-infographic/)

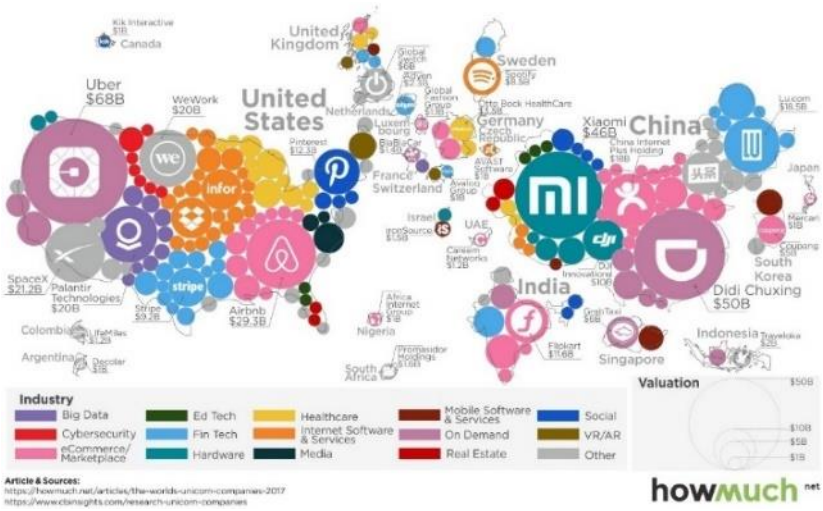

Figure 2.11. Example of 3D Layering
(https://www.visualcapitalist.com/worlds-200-unicorns-map/)

According to Lidwell, Holden, & Butler (2003), Layering is an information organizing process by grouping in order to avoid presenting complex information as well as showing relations between presented information (p.123). Layering is being done by grouping and presenting the grouped information one at a time. Layering is differentiated into two types; two dimensional and three dimensional layering.

A two dimensional layering divides information into many layers which could be viewed one by one. Two dimensional layering can be arranged either linearly or non-linearly. The linear layer is usually applied to information with a beginning, middle, and ending content (as in pages of a book). A non-linear layer is usually applied to put emphasis on information's with no hierarchy (like parallels and networks).

A three dimensional layer separates information into many layers which can be viewed together spontaneously. A three dimensional layer is designed in either

an opaque or translucent surface, which are stacked together and creates a three dimensional illusion. An opaque front layer is used when there is a new information which needs to be communicated without changing the context of the first information (for example pop up screens in a computer). A translucent front layer is used when a few information is communicated at the same time to illustrate a specific correlation (as in the layout of a weather map).

2.3.4. Wayfinding

Lidwell, Holden, & Butler (2003) explains wayfinding as a process of accessing spatial information and information obtained from surroundings to navigate a destination (p.209). The process of wayfinding is divided into four phases; orientation, route decision, route monitoring, and destination recognition.

Orientation is a phase of pinpointing a certain subject's / object's location in between another object and the destination point. In order to improvise orientation, there needs to be a way to divide the location's area into tinier parts. A location checkpoint will also give stronger orientation and makes a certain location easier to remember.

Route decision is a process of choosing a route that leads to a destination. In order to optimize route-decision-making, choices for navigating directions should be minimalized. Pathfinders should also be given a landmark or recommendation while searching for the most ideal route. People tend to choose a route which they consider shorter even though said route are harder to access compared to a longer route alternative. A simpler and easier to follow route would be more sufficient if there are a clear guide to follow the route. Maps could be used

to give a wholesome mental representation, therefore being the most successful wayfinding strategy when navigating a vast, complex, and sometimes poorly planned areas.

Route Monitoring is an act of observing a chosen route in order to ensure the route would lead to the expected destination. Route Monitoring could be optimized by connecting a location with a path they consist of a beginning, a middle part, and a clear ending. The path taken should be designed to give information about the distance already taken and needed to reach the destination. When a path is too long and full of hurdles, it is advised to use bread crumbing method. Bread crumbing is a way of giving visual cues that highlights a path to a destination. Bread crumbing is also usable to keep tract of a route, especially when a wrong path has been taken and the pathfinder needs to trace back his or her steps to the starting point.

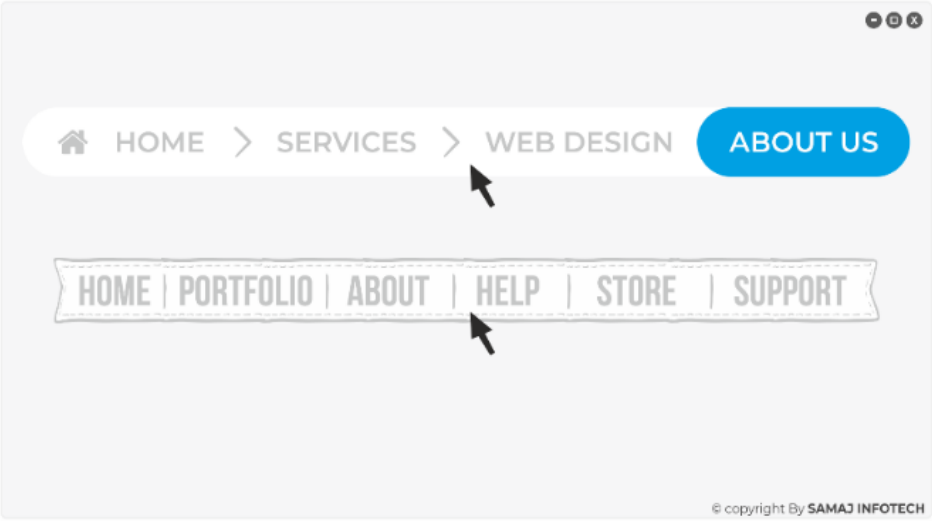

Figure 2.12. Breadcrumbing Example in User Interface
(https://www.samajinfotech.com/blog/importance-of-breadcrumbs-in-web-design/)

Figure 2.13. Breadcrumbing Example in Gameplay
(https://forum.cookierun.com/thread/73068#/page-1)

2.3.5. Fallibility / Errors

Allanwood & Beare (2014) explains that errors often results from a design that misleads, confuse, distract user's focus, or encourage wrong action (p. 66). There are 4 known types of errors:

1. Slip

   User plans to act correctly, but mistakenly perform an incorrect action. Slip may be detected when users are given a feedback after taking an action. A slip's consequence may be reduced or reversed by providing an "undo" feature.

2. Lapses

   Users plan a corect action but forget to execute. May happen when there are too many stimuli that demands attention or memory capacity. Lapses may be countered by providing a simple and consistent design, such as by adding

hierarchy and emphasis on the interface design (adding progress indicators, adding action validating stystem).

3. Mistake

   Incorrect action is planned, then executed. May be caused by expectation gap (a deviation from a conditioned action and a requirement to break the pre-condinctioned action) For example, the procedure of registration within an app used to be taken in only 5 steps, but the system is updated into 8 steps.

4. Violation

   Users intentionally deviate from the intended action within a system. Can be countered by implementing behavioral control.

2.3.6. Communication Principles

O'Grady & O'Grady (2008) states that communication discipline studies how people share knowledge, explain concepts, and process information with the help of language. Communication can be categorized into two groups based on who they are intended for, which are interpersonal communication and mass communication. Interpersonal communication is focused towards interaction between pair/group of individuals. This communication style takes consideration on the sender and receiver of messages and feedbacks. On the other hand, mass communication focuses in communication with a broad audience, and how media could affect the message being relayed. In order for an attempt of communication being well-received, designer or communicator must organize the information in such a way by implementing specific communication principles.

When developing and analyzing content of information that needs to be communicated, designers might need to consider these following points:

1. Are the design goal clear and well though out?
2. What achievement is pursued (for users, for stakeholders, for designers)?
3. Create parameter of success.
4. List down assumptions about users, the urgency of project, and possible deliverables.
5. Are the information complete and written organizedly?
6. Is the informational message written specifically for the users (need to reference personas, audience analysis, research).
7. Has the content been finalized and approved by involved stakeholders?

2.3.7. Direct Response Design

Allanwood & Beare (2014) states that the basic practice of Information Design put particular emphasis on precise communication of a certain information sets and how the users perceive said information. In order to pursue precise communication, Direct Response Design for relaying information directly and efficienly may be applied. The techniques and tips of applying direct response design are as the following:

1. Emphasis neatness, organization, and direct to the point.
2. Use picture and caption for quick view of content.
3. Use callouts for quicker information processing.
4. Creativity are not always the answer if there's no engagement from users.

5. The fewer design elements, the more credible it will look.
6. Communicated urgency shouldn't be exagerated and falsified.
7. The color red and black signifies urgency and action
8. Use variation to avoid list fatigue.
9. Use copywriting to build credibility and engagement towards content

2.3.8. Plain Language

The Plain Language theory states that written information must be clear, concise, and has meaning. Lutz in Baer (2008) defines plain language as the use of economical words so that user could better understand information. Plain language is distinguished by compact sentence structure, with direct (but may be welcoming) tone.

Furthermore, Lutz advised that Information in a page must be designed so that users know where they are within the written text. Information designer may also implement type hierarchy to boost information clarity. Tangible implementation may be practiced by using table of contents, headers, as well as sub headers.

2.4. User Interface Design

According to the discipline of HCI, User Interface is an interactive medium between human and a designed product, or specifically within digital media context, an interaction between human and digital system. Tidwell (2011) claims User Interface (UI) is not exclusively focused to visual aspects. The essence of UI is understanding users, knowing what are the users' preferences, what feature the

users use, and how the users interact. Similar to UX, UI in general can be spotted within human-interaction-related products. Specifically, UI has a strong affiliation with digital products and their interaction with users either directly or indirectly. UI design begins with an understanding of users' needs and wants, as well as understanding what task users are trying to complete.

2.4.1. User Interface in Mobile Game

According to Hight & Novak (2007), User Interface in mobile games includes on-screen and peripheral buttons, as well as device control (p. 98). These elements are used by mobile game users for these following tasks:

1. Navigation (for example walking, jumping, flying)
2. Controlling playable characters (for example skill activation, accessing inventory)
3. Virtual world orientation (for example accessing map, zoom in / zoom out)
4. Inventory management (for example equip weapons, wear armor, use item)
5. Interacting with NPC (for example engaging in combat, start conversation)
6. Playable character status monitoring (for example health, money, experience points)
7. Using special items (for example using keys, opening doors, opening chests)
8. Accessing setting option (for example adjusting visual, language, buttons)
9. Saving / loading game data
10. Joining / starting multi-player sessions
11. Communicating with device
12. Finding help / information
13. Stopping / quitting from game

Some User Interfaces have a direct relationship with player interaction towards a specific feature within a game. One example is the UI presented in an inventory menu such as compass, telescope, probe, and many more.

2.4.2. Form Aesthetics in UI/UX Design

According to Lenz, Diefenbach, & Hassenzahl (2014), interaction aesthetic is used for rating beauty, precision, and interaction elegance. The value system of interaction aesthetic is categorized into two groups. The first category is form aesthetics' evaluation based on interaction's sensor-motoric and action-reaction quality. The evaluation system in this category is influenced by other branch of disciplines which are based on gesture forms, such as sports and dance. The other aesthetical categorization is through user experience's quality. In this category, the subject being evaluated is the value of stimulating experience when interacting with a design.

In User Experience and interactive design context, the value of aesthetic is considered crucial, as it could conjure attractiveness bias. Attractiveness bias is a condition where a beautiful object lures attention to itself. When a design is being used for the first time, the design's aesthetics is responsible of creating user's first impression. An aesthetic design is also capable of enhancing user's performance and tolerance when using the design.

It should be kept in mind that the concept of beauty in a design is subjective as it is influenced by cultural, education, and social backgrounds of each individual. When aiming for an aesthetic design, there have to be a thorough research regarding user's preference within the design's market area as well as the market's trend.

2.4.2.1. Aesthetic Usability Effect

Lidwell, Holden, & Butler (2003) state that an aesthetic design is considered more usable by the users compared to a design that has no aesthetic value (p. 19). Due to this perception, user tend to prefer the more aesthetic choice. A design with no aesthetic value, despite being usable, tends to be rejected by users. This perceptional bias influences a design's usage in a long term. For example, if a design is deemed unfavorable at the first impression, then said design will keep on being perceived as unfavorable in the long run.

An aesthetic design influences how the design would be used by its targeted users. An aesthetic design invites positive responses, such as loyalty, patience, or even love. Positive reactions encourage users to think with creativity and an open mind, as well as creating a higher success of problem solving. This positive response is crucial to reduce stress when user is interacting with the designed product. With stress being reduced, user's performance when using the design tends to be optimized.

2.4.2.2. Form Follows Function

According to Lidwell, Holden, & Butler (2003), a design's beauty is determined by the purity of its function (p. 91). Form follows function could be interpreted descriptively as a design's beauty that is created from its function. While another way to define it prescriptively is all aesthetical considerations within a design should be prioritized after a design's function.

The descriptive definition of form follows function is based on a common belief that form always follows function in nature. But the reality is that function is the one who usually follows form as a law of nature. Keep in mind that a design's function aspect is tends to be viewed as more objective compared to its form and aesthetical aspects. Because of this objectivity, the design's form is considered more reliable for evaluating its quality.

The prescriptive of form follows function should be applied with a grain of salt. When exchanging an aesthetic aspect and functional aspect in a design, designers should consider the success rate of their design neutrally. Designers shouldn't sacrifice the aesthetic aspect as an effort to maximize the function aspect, and vice-versa.

In conclusion, form follows function is used as a guide for designing aesthetically, it is not a fixed rule that needs to be implemented strictly. After considering the two types of interpretation, designers should compromise when designing something based on form-follows-function principles. When design is taking place, there should be a right balance as a design that has a function following its form may end with less-optimized User Experience, while a design that have a form that purely follows its function might get abandoned by users as it has no significant hook.

2.4.2.3. Four Fulfilment Aspects in Aesthetical Design Principles

Nikolov (2017) claims there are four fulfillment aspects within a person that needs to be executed in an interactive design as a rule for the design to be

categorized into an aesthetic design. These fulfillment aspects are as the following:

1. Physical Fulfillment

   A sense of fulfillment originating from touch, sight, hearing, or the act of doing something concrete. Physical fulfillment is related to the implementation of ergonomic principles; users' comfort should be prioritized, and a design shouldn't bombard user's senses with too much stimulus. There needs to be a balance of sensitivity towards user's senses as well as an optimized moderation.

2. Social Fulfillment

   A fulfillment which originates from interacting with other individual or with machine. The design should support one of the most basic human needs which is having a social interaction. This fulfillment would only suffice when the interaction has enough quality.

3. Psychological Fulfillment

   A fulfillment that emerges from solving a problem in an activity. This fulfillment can be seen as a sense of security and being in control. Psychological fulfillment has a strong tie with usability. In order to create psychological fulfillment, the elements in a design should be created simply and consistently so that users could navigate the design with comfort and a right amount of control.

4. Ideological Fulfillment

A fulfillment appearing from the designed product itself. For example, an environmental friendly product could create a certain satisfaction within the buyers' mind when the product is used. There need to be an attempt of communicating ideas behind the design towards the targeted users so that they could find a deeper meaning while using the designed product.

2.4.3. Five Principles of User Interface Design

Batagoda (2017) states about five UI principles that could be functioned as a design guide. These principles adopt the basic principles of interactive design, based on user's experience as cited by Norman (2013). These five principles are as follows:

1. Affordance

   Affordance is a UI's designed property that indicates how the design could be functioned. The interface design should be able to communicate its function and how said functions could be accessed. The example of affordance is button elements that could be tapped and are distinguished by different colors, moreover the buttons give different reactions after being pushed.

2. Consistency

   Consistency means that a design possessed similar operation methods towards different element parts. Adding similar elements to accomplish some task would help users reach their goals faster and more conveniently. Limiting element styles help users in understanding and categorize each

elements' different functions, so that users' mental model would expand while using the design.

3. Mapping

Mapping means the existence of relationship between action and reaction within a design, either inside the design in a digital form or outside in the user's reality. For example, sliders inside a design requires an indicator that marks the increase or decrease of value when the slider is being manipulated.

4. Constrains

Constrains indicates limitation of interaction within a design and how far is the possibility of said design to be operated. When possibilities of a design are too vast, users may feel confused and forget about the task at hand.

5. Visibility

Visibility means making elements inside a design easier to view so that users could better understand the elements' function. Unorganized elements may not be viewed optimally by users even if they are arranged in plain sight.

2.4.4. Visual Hierarchy of User Interface

According to Batagoda (2017), visual hierarchies determines which elements would attract users' sight and attention within a design. It needs to be understood that there are no concrete hierarchies within any design process.

2.4.4.1. Colors

Baer (2008) states that color communicates differentiation, helps wayfinding process, and makes quick isolation and separation of design elements. Moreover, according to Batagoda (2017), colors are useful for arranging and grouping design elements, communicating meanings, and boost a design's aesthetical value. Similarly, according to Samara (2007), colors have unique attributes to distinguish visual hierarchies, but colors tend to be perceived subjectively. Color's subjectivity results from the eye's interpretation of light and the brain's interpretation of information. Furthermore, color influences the psychology of a design. For example, a bold and "hard" colors such as red and black attracts more attention, while soft colors like white and yellow has lower attracting value. Colors could also be used the separate elements.

Figure 2.14. Basic Color Psychology for Design
(https://www.allfloridapaper.com/5-things-to-know-about-color-coding/)

There are four main color attributes known and used in the design field. The first is Hue. Hue is defined as different values of color separated by its wavelengths. Some examples of hues are blue, red and yellow. The second attribute is Saturation. Saturation is a color's degree of being muted or vivid.

Some examples of saturation are murky red, vermilion red, and brick red. The third attribute is Temperature. Temperature is the perceived coolness or warmth of a color. Some examples of color temperature are blue which is categorized as cold, and red which is perceived as warm. The last attribute is color value. Value is a color's perceived lightness or darkness. Some examples of different color value are baby blue (tinted blue) and navy blue (shaded blue).

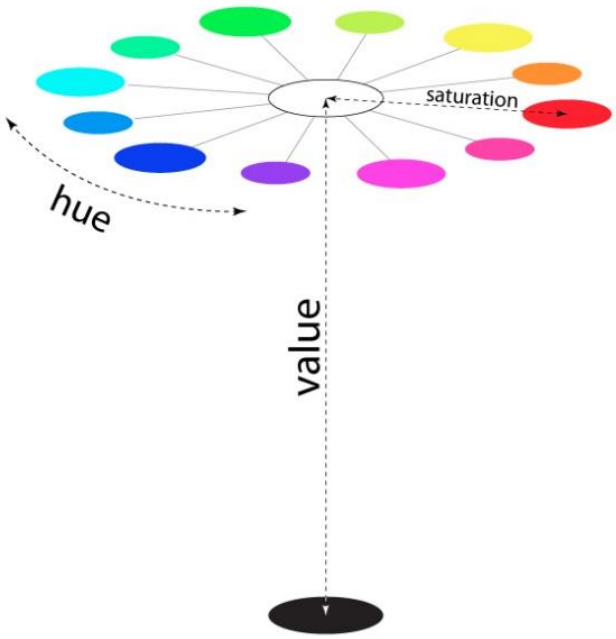

Figure 2.15. Color Attributes Diagram
(http://learn.leighcotnoir.com/artspeak/elements-color/hue-value-saturation/)

When colors are not used optimally, they could distort the design's shapes and function so that the design may fail to be communicated towards the targeted users. Keep in mind that each individuals perceives color differently so that colors should be limited efficiently for communicating information's. The most effective way of using colors is by using it

conservatively rather than expressively. The number of color palettes should be limited as human eyes could only perceive five different colors at a time. As an exception to the rule, the number of colors may be increased depending on the complexity of design.

2.4.4.2. Size (Weight and Scale)

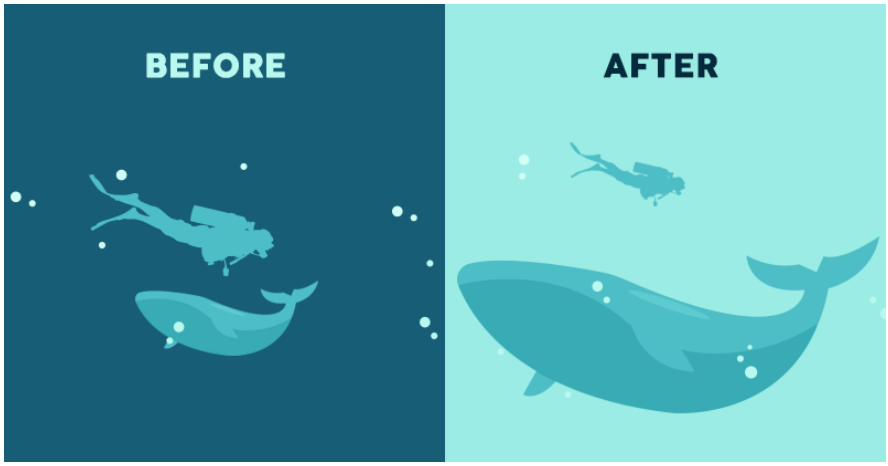

Figure 2.16. Design Scaling in Practice
(https://visme.co/blog/visual-hierarchy/)

According to Baer (2008), people in general are sensitive to size patterns and differences. When designer want to prioritize an information, he or she may change the design element's weight and scale to give emphasis. The larger an element’s size is, the bigger and faster attention it would get form users. But increasing element size may cause complication during the design process such as making details more difficult to add. When designing large elements, harmony and stability should be prioritized for the sake of better design impression.

2.4.4.3. Positioning / Grouping

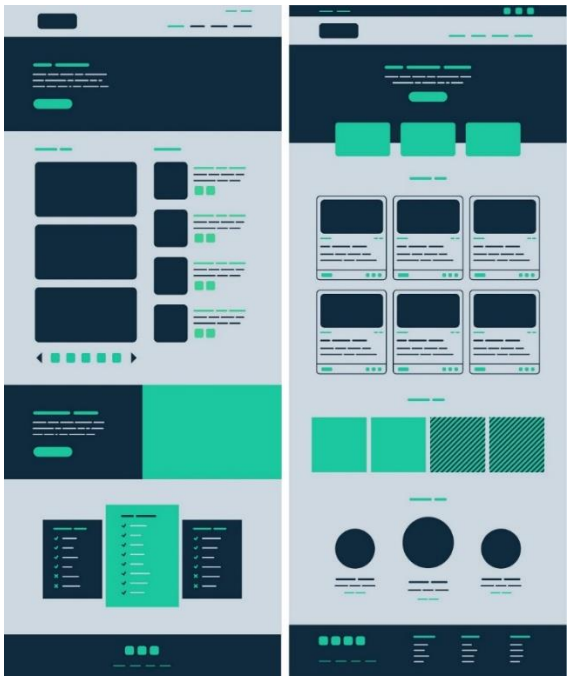

Figure 2.17. Example of Grouping in UI Wireframe
(https://medium.muz.li/gestalt-principles-in-ui-design-6b75a41e9965)

According to Batagoda (2017), visual hierarchies in a design heavily depend on their positioning. A thoughtful element positioning encourages positive response from users. Similar functions in a design should be clustered together in close proximity or in an equal level. This rule is to assist users in distinguishing different functions and pin-point a desired function with more ease. Aside from design elements, for easier information locating, related information contents can also be clustered together.

2.4.4.4. Figure-Ground Relationship / Structure

Figure 2.18. Figure vs Ground
(https://visscom.wordpress.com/2013/04/08/the-principle-of-figure-ground/)

Baer (2008) states that element spacings and white space must be carefully taken into consideration. The structure of a product's layout (including pacing and organization effort) can convey different message towards audience. The human brain tends to categorize elements as figures (a focused object) and ground (other objects blurred into backgrounds). This principle has strong ties with gestalt theory relating to human perceptions.

The relationship between figure and ground could be applied in different medias such as audios and visuals. The optimized correlation of figure and ground is composed boldly and with optimum clarity. Figure elements should be highlighted to increase users' attention and be easier to remember.

2.4.4.5. Alignment

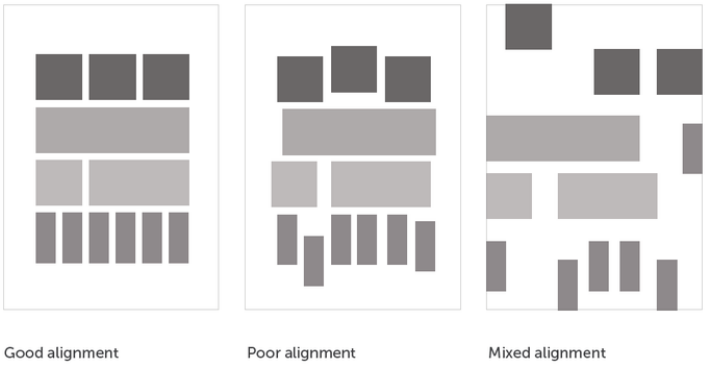

Figure 2.19. Example of Alignment
(https://bbagraphicdesign2.jimdo.com/unit-3-1/)

According to Baer (2008), alignments encourages the eye to move on a predetermined order. Movement of eye may affect the duration of viewing content.The positioning of elements could be observed with the help of placing lines on imaginary rows and collumns, as well as the placement of elements from the same center. Elements in a design should be aligned towards other elements in order to create a sense of unity and influence the aesthetical property positively and with stability.

Rows and columns in a grid or table is a resource to align different design elements, or even to communicate relationships between one and the other elements. Rows and columns aid users' eyes to see design element sequentially from left to right or from above to below. The edge of design mediums (for example edges of a page or a screen), and the natural positioning of design medium (for example the center line), could be implemented as a mark to align a design.

In a textual paragraph, a left or right aligned paragraph creates a stronger sense of alignment compared to a center-aligned one. The reason of the tendency is because an imaginary column created by the left/right aligned paragraphs offer a visual mark that aligns the text cluster with other design element. A center-aligned text creates a more ambiguous alignment with other elements. It is better to create a justified text alignment rather than a center one if necessary.

In a design process, there exists more complex alignments that doesn't involve grids and column. For example, the alignment of elements may be aligned diagonally. In the case of diagonal alignment, the relative imaginary angle created by the elements should be at least 30 degrees wide as a narrower angle is harder to perceive by the human eyes.

2.4.4.6. Proximity

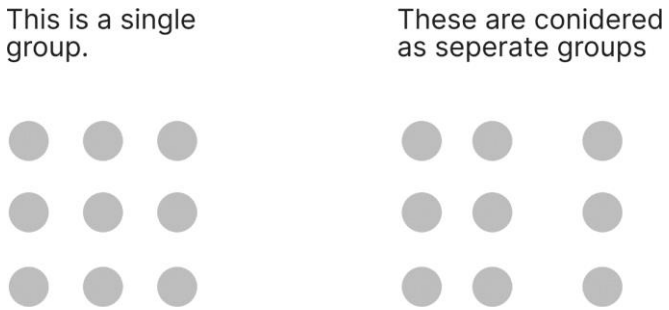

Figure 2.20. Example of Proximity
(https://uxdesign.cc/using-gestalt-principles-in-ux-design-3fc64614d3ef)

According to Batagoda (2017), Proximity in a design assists users in distinguishing different functions and information. Distance can be categorized based on proximity and the area of negative space. Proximity is used to group element based on different value of distance. Negative space

area created by proximity is used to focus users' attention toward certain elements.

2.4.4.7. Closure

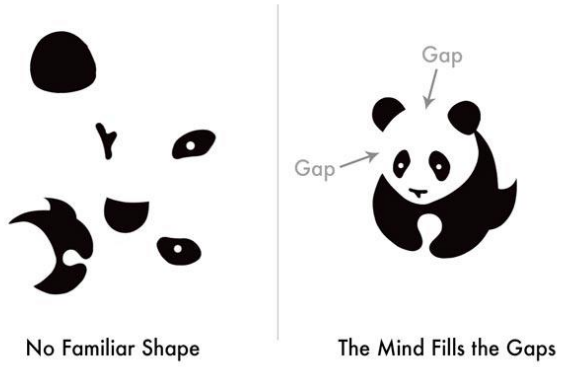

Figure 2.21. Closure Explained
(https://ipoxstudios.com/law-of-closure-video-gestalt-psychology-for-artists/)

According to Batagoda (2017), Closure is users' tendency to see a group of individual element as a single comprehensible entity. The force of this tendency may cause a person to fill out a cluster of elements that he or she find incomplete in order to create a perceived whole information. The tendency of closure reveals a person's desire to perceive something in a simple way rather than abstractly or complexly.

Closure effect is easiest to observe when different design elements are arranged in a familiar pattern such as in a geometric way, or event put closely together. When closure is difficult to conjure, designers could create a transitive element (an element for visual marking that helps the eyes to focus on a pattern. When users' effort in finding a pattern is easier than

perceiving different elements one by one, closure effect would surface naturally.

2.4.4.8. Icon Representation

According to Lidwell, Holden, & Butler (2003), icon representation is a way of using images for identifying or memorizing a sign or a control's function (p. 111). Icons decrease performance load and limits use of space in the design medium. Commonly, all icons in a design should be labelled and should be given consistent visual motifs. Icon representation in a digital context is used conventionally in signage's, computer displays, and control panels. There are also four different icon representations as follows:

1. Similar

Figure 2.22. Similar Type Icon Example
(https://www.creativesafetysupply.com/caution-slippery-floor-with-icon-portrait-wall-sign/)

The usage of image that possesses correlation with a certain action, object, or concept. The similar representation is applicable to communicate simple information. The effectiveness of similar icon representation may decrease as the information presented gets more complex. Example of similar type icons can be observed in some road signs.

2. Example

Figure 2.23. Example Type Icon Example
(https://cognitiondesign14.weebly.com/iconic-representation.html)

The usage of images as examples can be associated with actions, objects, or concepts like similar icon representation. Example type icon is applicable for presenting complex information in a simple way. For example, a washroom for women is represented with a picure of female using skirts even thouth not all women entering the washroom may use skirts.

3. Symbolic

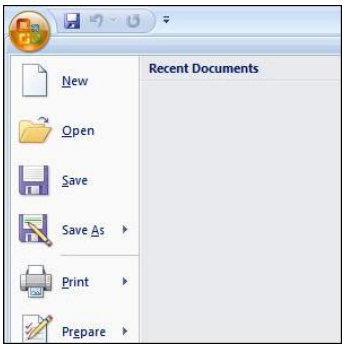

Figure 2.24. Symbolic Type Icon Examples
(http://chepa.net/all/2018/03/19/geek-trivia-the-floppy-disk-icon-as-a-save-button-on-modern-software-is-an-example-of-a-design-element-called-a/)

The usage of images that represents action, object, or concept abstractly. Symbolic icon representation is best applied for indicating familiar functions of the things being represented. For example, is the key icon in a

digital product indicates a locking function as in literal keys. Even though how lock system works in a digital environment and real environment is different, the idea behind the function is similar therefore it could be represented with the same image of a key.

4. Arbitrary

Figure 2.25. Arbitrary Type Icon Example
(https://nuclear-news.net/2018/10/22/hanford-given-more-time-to-empty-leak-prone-radioactive-waste-tank/)

The usage of images that possesses minimum relations with action, objects, or concepts so that the correlation between image and information should be learnt. Arbitrary icons are applicable for a global-scale standardization effort that requires the design to be neutral and free from cultural bias. For example, is the geometric icon for PlayStation brand that became the product's global identity.

2.4.4.9. Grid System Implementation

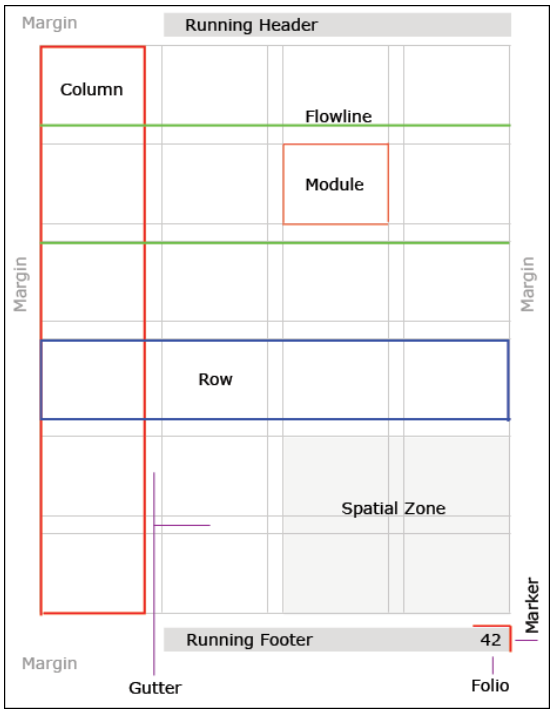

Figure 2.26. Grid Components
(http://www.graphic-design-institute.com/blogs/types-grid-system-useful-layout-making)

According to Samara (2003), grid system is implemented as problem solving towards content organization and visual arrangement (p. 22). Grid may take an organic or rigid form based on a design's requirements. The benefit of implementing grid is to increase the design content's clarity, efficiency, and continuity.

Lupton (2014) States that grids for digital mediums has multiple columns with the most common are 16 columns per-page. Vertical columns within a digital field is relatively manageable as the width within a site usually has a fixed size. On the other hand, horizontal fields often have varying lengths. Digital devices adopt a responsive design to implement its layout. There are two types of responsive layout, which are liquid layout and

adaptive layout. A liquid design adjusts and reflow a site's content to a device's width and position. The grid columns on liquid layout will get narrower or wider in accordance to the device. Adaptive layout has a set size for width based on a certain device's size and orientation. The grid columns it possesses will add or subtract in numbers to adjust the content's layout within the device (p. 56).

O'Grady & O'Grady (2008) states that a Grid's layout consists of ratios, collumns, gutter width, margins, and relationship between horizontal and vertical space. A correctly applied grid has positive impact on final look, feel, and usability of visual design.

Grid is used for differentiating information types, creating a layout design system, and assisting the design's users in navigating the product. The usage of grid enables a large sum of information to be added within the design's interface. Grid could also support the design collaboration process between many designers as it provides a standardized design arrangement.

Organization by grid can be viewed on micro and macro level. On Micro level, grid organized the content within a single visual layout. when used continuously, grid affects familiarity between visual contents. With grid system, design viewer may feel at ease when perceiving content due to familiarity and established system for viewing.

Grid system commonly possesses modular components consisting of these elements:

1. Margin

The negative space in between the design media's edges and a space that surround the area where texts and images are arranged. The positioning of margin should be taken into serious consideration as it could influence how the design contents are perceived. Margins are useful for focusing attention, acting as a rest area for the eyes, and as an additional area to put extra information.

2. Flowlines

Flowlines is a guiding line that separates an area into two or more horizontal parts. Flowlines acts as a guide for the eyes to perceive contents and can be used for aligning images and texts.

3. Spatial Zone

A modular group that creates a specific area. Each area can be filled with different contents as a display of information.

4. Marker

Marker is a positioning indicator for texts that are related with each other or for texts that appears consistently. For example, is the marker for a general design title, content title, or page number.

5. Modules

Modules are individual space unit that are separated at different intervals. Some repeated modules in a media's space creates rows and columns.

6. Rows & Columns

Columns are vertical areas that creates horizontal divisions between margins. Rows are columns opposites, which is horizontal areas that creates vertical divisions. The number of rows and columns is determined based on content necessity. Rows or columns naturally have a uniform size even though variations of size in a design space are possible.

2.4.4.10. Typography

Figure 2.27. Typeface vs Font
(http://www.annenbergdl.org/tutorials/typography-basics/)

Baer (2008) says that type styling establishes hierarchy. Designer may consider using palette of typefaces to distinguish different content types. It should be noted that typeface and font has a different meaning. Typeface refers to a set of fonts form a differeny family of classification. On the other hand, font refers to the same typeface with different family farioation such as type boldness, usage of italic letters, and different point size.

According to Samara (2007), there are a few main aspects within typography theory that need to be taken into consideration when designing a written content. One ot the main aspects are spacing. Spacing is applied between letters, words, sentences, and paragraphs. A too narrow spacing of letters creates an illusion of dark spots in the imaginary line of letters. Adjusting spacing between typography elements (letters, words, sentences, paragraphs) properly improves both aesthetic value and legibility. Letters set too far apart also erases unity and makes the meaning of word formed by said letters harder to comprehend. Digital typefaces are naturally programmed to balance spacing between letters by automating kernings between letters. Some combination of digitalized typeface is not spaced properly, so the unevenly spaced letter should be aligned manually.

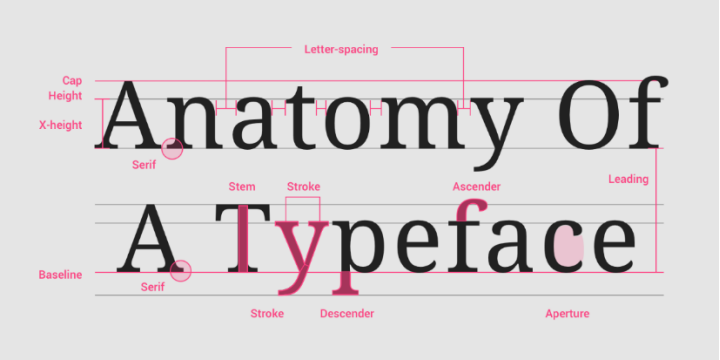

Figure 2.28. Spacing as Part of Typeface Anatomy
(https://material.io/design/typography/understanding-typography.html)

The second important aspect is point measuring. Point Measuring System is the standard to measure type size. Types with 14 or more measurement point are used as displays, such as in headlines and callouts. Types sized 9 to 14 are the basic size used in texts. Types smaller than 9 are

applied for captions. The smaller the type size, the more letter space it requires in order to increase clarity.

The third important aspect is stylistic communication. All type forms' variations are differentiated by its case, weight, contrast, width, posture, and style. A typeface style's neutrality is subjective by nature and easily influenced by the other typefaces surrounding it. when the surrounding typefaces have more flourish, the original typeface would appear neutral. The level of contrast between different typeface's style also influences a typeface's neutrality.

The fourth important aspect is the combination of type styles. The conventional rule to combine different type style is by choosing types from different families. The combination should be limited between two or three different type styles. By limiting typestyles, a clear hierarchy of type will be perceived by readers. The chosen combination of types should bear contrast and familiarity with each other at the same time, for example a type combination could have a contrasting style, but it's weight should be familiar with each other, or vice versa.

Figure 2.29. Typeface Style Examples
(https://bestfontforward.wordpress.com/tag/type-styles/)

Lupton (2014) explains for any kinds of type in digital screen, text size should be relatively bigger than those found in printed medias. There are four different type measurement used for digital screens. Those are pixel and points (absolute), as well as percentages and ems (scalable). The standard type size for screens is 12 px. The larger the size, the more comfortable users get when reading, so designers tend to set the type in larger size around 14 px and up. As for type size in mobile devices, the size of type may be adjusted to the device size. For example, the smaller the size, the more affordable the type size is to be made smaller. This is because users could adjust the distance between their device and their eyes to maximise reading comfort (p. 58).

2.4.4.11. Graphic elements

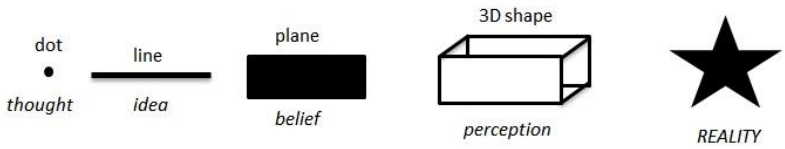

Figure 2.30. Basic Graphic Element Examples
(https://mymindsjournal.com/2012/06/14/thought-a-dot-2/)

Baer (2008) says that graphic elements helps users navigate content through strong visuals. The most basic elements to attract the eye include dots, lines, and shapes. Designers may also use imagery, or a combination of text and images to create a powerful tool to relay information.

2.5. Light Pollution

Figure 2.31. Java Island Night Map
(https://earth.google.com/)

Figure 2.32. Jakarta Aerial view
(https://earth.google.com/)

Heilig (2010) defines light pollution as over-use of artificial light and tends to produce blue lightwave. The officital Internation Dark Sky Association claims that light pollution is any form of negative effect caused by artificial light which includes sky glow (not to be mistaken with air glow), glare, light tresspass, light clutter, loss of visibility at night, and waste of energy. Light pollution is classified into two category based on it's effect. The first category is abundant artificial light, while the second category is intrusive artificial light. Heilig also claims that the main source of light pollution are (but not limited to) high-intensity LED's (or HI-LED), poorly placed and designed street lamps, billboard lights, decorative lights, garden lights, stadium lights, and outdoor stage lights.

Light pollution has many negative attributes such as damaging ecosystem and distrurbs human health. Light pollution also causes negative cultural impact (the declining appreciation of natural night environment), and dependency on unrenewable energy (as in depleting power plant energy supplies for unecessary electric lightings). Moreover, many astronomers has voiced their concerns regarding their difficulty of conductiong observations becaus of light pollution's impact to the environment. Natural lights that are observable to human eye at night time come from starlights, zodiac lights (a cluster of sunlight and space dusts scattered on the solora system), and airglow (glowing effect in the night sky that results form the upper atmosphere's natural radiation). These natural lights creates the right condition for aerial object observation from the earth's surface. But due to light pollution, natural lights are obstructed by artificial ones, which results in decreasing visibility of aerial objects at night.

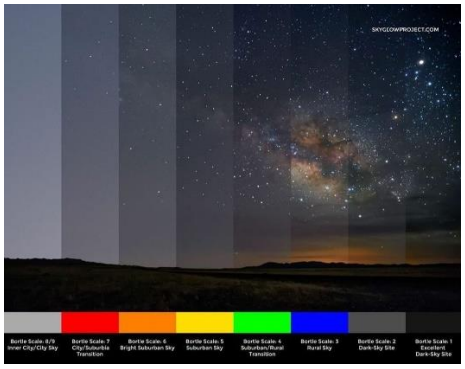

Figure 2.33. Bortle's Light Pollution Scale
(https://jgroub.wordpress.com/2018/09/28/september-28-2018-the-bortle-scale-or-why-gas-is-your-friend/)

2.5.1. Light Pollution Classification

Light pollution has different types of classifications. The many types of light pollution are caused by unthoughtful city planning and/or bad quality artificial lighting. Rajkhowa (2014) classifies light pollution into 5 categories based on their observable forms.

2.5.1.1 Light Trespass

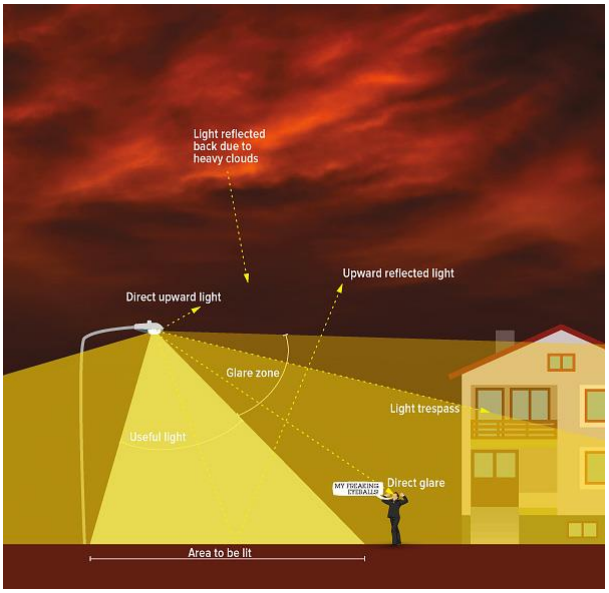

Figure 2.34. Light Trespass Diagram
(https://www.darksky.org/light-pollution/)

Light Trespass is a scattered light phenomenon that cause intrusion to a certain area which are not supposed to be brightened. An example of light trespass is the intrusion of street lamp's glow into a room inside a house. The problem is caused by a strong light glow.

2.5.1.2 Over-Illumination

Figure 2.35. Over-Illumination Example
(http://www.rocketroberts.com/astro/lpawards.html)

Over-illumination is caused by an abundance of light use. Too much use of artificial lights not only waste energy, but also un-renewable energy which has become electricity power plant's main source of energy. Over illumination could be prevented by implementing a timer switch, or occupancy sensors. A bad planning at areas overflowing with artificial lightings cause over-illumination, for example a wrong choice of lightbulb installments, a bad managerial training which wastes energy used on buildings, and a personal choice to use artificial lights abundantly for the sake of boosting a sense of security and attracting people's attention.

2.5.1.3. Glare

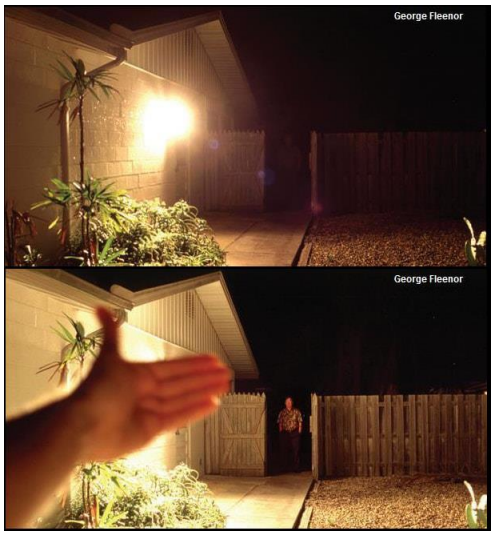

Figure 2.36. Light Glare Example
(https://www.darkskydefenders.org/light-pollution.html)

Glare is caused by contrasting effect between a dark and a bright area that causes a blinding effect. Glare effect happens when the eyes are exposed to bright light in a naturally dark environment. Glare influences road safety and could cause accidents. Glares that the eyes perceive disturbs night vision for at least an hour after exposure. Glare also dulls human eye's natural sensitivity to distinguish objects at night, it is the main cause of temporary disability called veiling glare.

There are three types of glare. The first one is blinding glare, which causes blindness and other temporary vision damage. The second one is disability glare, which disturbs vision temporarily. The last is discomfort glare, which don't cause damage but triggers discomfort and exhausting a person's vision and cognition ability in a long period of time.

2.5.1.4. Clutter

Figure 2.37. Light Clutter Example
(https://www.greaterkashmir.com/news/opinion/light-pollution-a-new-emerging-challenge/)

Clutter is caused by an excessive grouping of artificial light source and may cause confusion, distraction, as well as increasing risk of accidents. Clutters are observable in roads with poorly designed lighting. Clutter effect may be intentional or unintentional. Clutter is also harmful for aerial navigation; as for example it may distract pilots when attempting landing.

2.5.1.5. Sky Glow

Figure 2.38 Sky Glow Example
(https://www.flickr.com/photos/jonsiegel/15228328251)

Sky Glow is a dome of light that envelope an urban area. Sky glow is formed by accumulations of glare, stray light, and scatter effect which are mixed

with air pollutants such as smog, fine dusts, and aerosols. The radius of sky glow may reach hundreds of kilometers from its source. Sky glow is the main source of astronomical activities' disturbance.

2.5.2. Handling Light Pollution

Duriscoe (2011) states that light pollution could be handled with relative ease compared to other environmental issues such as air pollution. Light pollution is possible to handle even in a large and developed metropolitan area. It takes a review of regulation as well as a review of design and distribution of artificial light source put in outdoor areas.

An example of effort in handling light pollution is through socializing the usage of full-cutoff lamp which assist light's distribution efficiently and effectively. The use of spherical light bulb should be avoided or at least maneuvered by using light caps.