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# Decision Making in Mobile Business Intelligence

## An Individual Cognitive Fit Perspective

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# Decision Making in Mobile Business Intelligence: An Individual Cognitive Fit Perspective

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Abstract:
One of the central features of a successful decision support system is the interface. What to provide and how to provide information that later will support the users to make a decision is crucial. With the emergence of mobile business intelligence, the concern about how this technology could increase its user performance in the decision making context and how to deliver these capability to the workforce application as close as possible to the consumer-level application in the organizational arises. Visual representation and user experience take place as two main features that will be the focal point during the study. Using cognitive fit as the theoretical framework, we developed a research model to investigate on how the cognitive fit theory will be affected by both visual representation and user experience and whether it will indirectly influence the decision making process from an individual users' perspective. Four hypotheses were proposed based on our literature review and questionnaire-based survey was used to collect empirical data. The result of this study indicates that while the value of visual representation is important as it is positively influenced the decision making process through cognitive fit, user experience does not have the same result. Hence, if one wants to enhance their mobile BI application in context of the decision making process, visual representation features of the mobile BI must be prioritized as it will eventually increase the cognitive fit that leads to enhance the decision making process performance.

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# 1 Introduction

## 1.1 Background

The complex interconnectivity between the value chain, market and business has created a greater need for systems that can be the basis for the decision-making (Gangadharan & Swami, 2004). Organizations have the opportunity to monitor and evaluate key information using today's advanced Business Intelligence (BI) systems, which, in turn provides a basis for the decision-making. Experts argue that the market for BI systems will continue to increase exponentially with regard to its high demand and its promising outcome (Sallam, Tapadinhas, Parenteau, Yuen, & Hostmann, 2014).

Along with the enhancement of the technology, trends illustrate that business decision-makers often utilize such technology outside the offices (Middleton, Scheepers, & Tuunainen, 2014; Tona & Carlsson, 2013). The increased flexibility has created a need for business-critical data in real-time. Emergence of mobile devices since early 2010 has created a higher demand for organizations to change their perception of the work environment. This phenomenon changes the way people work into more fluid as they can work from anywhere and anytime while on the move (Cowie & Burstein, 2007). By combining the capability of mobile devices and the ability of BI, mobile BI as a recent technology of BI system, creates new demands in the BI system as it provides users with critical data for making decisions in form of application in a device that provide high mobility functionality (Stipić & Bronzin, 2011). With support of the mobile BI system that provides information in real-time, it allows the decision-makers to handle critical business decisions under pressure on better grounds (Buchana & Naicker, 2014). Having seen that massive usage of mobile BI could take place within organizations due to the fact that mobile platforms have increased their popularity by offering constant connectivity and uninterrupted information, mobile BI could, sooner or later replace conventional BI existence in organizations (Bitterer, 2011; Deepak & Pradeep, 2012).

Mobile BI, as another form of decision support system, has become a new tool for organizations to support their decision-making process. It is commonly used by executive level in organizations for various purposes (O'Donnell, Sipsma, & Watt, 2012). These phenomena could directly influence the utilization of Mobile BI for the rest of the organization due to the fact that with an innovation, an individual could influence others within an organization (Schein, 1968). According to Yuen (2013) during the year of 2016, over 50 percent of mobile users will rely exclusively on mobile devices for insight delivery and the number of mobile BI users will grow by 20 percent. However, since there are technological limitations on mobile devices as opposed to desktop devices, most of the organization will use this technology as a mean of notifications, alerts and access to systems (Gebauer & Shaw, 2004). Nevertheless, despite the limitations, mobile BI can provide with rapid and flexible decisions which, consequently, can lead to reduction of the decision cost (Holsapple & Sena, 2005).

Considered as an application within the area of mobile computing, mobile BI has brought a new phase to determine the aspects to fulfil the demands of its users (Buchana & Naicker, 2014). Visual representation which uses the unique of human ability to recognize and see the patterns of meaningful data (Kolata, 1982), arises as one of the potential aspect to carried out as it stands behind the phenomena of increasing growth of the BI market and its dazzling capabilities (Basole, 2014; Frolick & Smith, 2015; Lira, Alves, Costa, Pessin, Galvao, Cardoso, & de Souza, 2014). By having visual representation, users of this technology will have the ability to lower the cognitive load and enables the decision makers to process more data without overloading their sense (Lohse, 1997; Tegarden, 1999; Zhang, 1995). Other than the visual representation, opulence of user experience in mobile application also taking place as a promising aspect to satisfy the demands in mobile BI. This notion has become a more relevant subject for mean of mobile application distribution despite its enigmatic concept within researchers (Buchana & Naicker, 2014; Charland & Leroux, 2011; Law, Pelgrum, & Plomp, 2008). (Kim and Han (2011); Löwgren and Stolterman (2004); Udsen and Jørgensen (2005)) argued that arising of user experience caused by digital transformation which created a challenge to accommodate aspects that exceed the usability and functionality for a mobile application. Hedonic value like enjoyable, fun, entertaining, and satisfying concept became an essential feature to be pursued in the shifting paradigm of mobile application and has changed the method of approaching user-centred design to support more on user experience.

Having seen this technology conform the organization needs, challenge on how the mobile BI could fit the individual usability occurs. Pearlson and Saunders (2013) argue that, aligning aspects of business goals, information system and organization strategy which considered as information system triangle is needed to have a successful impact of information system. While the business goals are the targets of the organization and the information system is a supporting tool to achieve those goals, the organizational strategy is the design of organization. The organizational strategy was formed based on the structure of the organization which constitutes an individual entity that creates and finds a way on how to achieve the business goals from the abovementioned triangle. Since massive usage of mobile BI as a form of information system, that also supports the decision-making process, has a promising growth (Information-Builders, 2014). Hatch and Buytendijk (2010) and O'Donnell et al. (2012) argued that mobile BI must match the needs and could be used properly by those individual entities to gather and later use the information to facilitate their decision-making process. seeing the demands of mobile BI to fit the needs of its users, cognitive fit theory that was developed by Vessey (1991) is appropriate as the fundamental that can be employed in mobile BI mean to address the abovementioned challenges. It deals with problem-solving performance and suggests that problem-solving tools (e.g. Mobile BI) should consider with the problem representation and problem-solving task that take place for decision-makers.

The abovementioned facts and review in regards to mobile BI, visual representation, user experience as well as cognitive fit theory in an individual perspective, serve as our motivation and the main objects of the study which will be presented throughout this paper.

## 1.2 Problem Area

Today's research on computer-based BI has developed models and frameworks to measure the benefits of BI in an organization (Elbashir, Collier, & Davern, 2008). There are also researches presenting how BI affects the organization and the type of organizations that benefit from the use of BI (Chen, Chiang, & Storey, 2012). At the same time, interest in mobile devices has increased, both in business and in research (Chu, Hwang, Huang, & Wu, 2008; Lee & Park, 2008). Continuously, the authors believe that the functionality of a mobile device includes all activities and processes, and is a well-documented area that has the ability to positively affect an organization. However, since researches regarding mobile devices come distinctly in terms of BI, it generates a flawed outcome when it comes to the research of mobile platform of BI and its impact on business (Chu et al., 2008; Lee & Park, 2008). Align with the state of mobile BI research, mobile devices that is being utilized by BI, widely face difficulties for individual users to efficiently interpret and interact with the data due to the small screen (Abolfazli, Sanaei, Gani, Xia, & Yang, 2014; Airinei & Homocianu, 2010; Saylor, 2013; Sharma, 2015) and also the users adaption to the environment where the handling of the mobile device will occur (Airinei & Homocianu, 2010; Saylor, 2013). These circumstances could lead to a negative influence on the user's decision-making process and cause further loss of time efficiency, increase in cost of failures, and decrease the efficiency process (Abolfazli et al., 2014; Saylor, 2013).

The shifting trend toward mobile BI has been predicted since 2011. Around 60 percent of the large-sized organizations are likely to possess some form of mobile reporting and analytics (BARC, 2011). MicroStrategy (2012) in their press release stated that an aggressive implementation plan of mobile BI has been performed during the year of 2015 with expectations of 41% deployment rate and nearly 33 percent of organization plan, are in the process of planning to deploy mobile BI (Gartner, 2012). Despite, having seen the massive trend on the usage of mobile BI and the problems and limitations of mobile devices, to the best of our knowledge there is no study that has been carried out about the difficulties when combining those technologies could affect the output of the decision-making, generated from mobile BI application. Furthermore, neither has there been a study on understanding failures to achieve how the visual representation in mobile BI could lead to decrease of the quality in data representation and decrease the quality of the decision-making (Power, 2013; Stipić & Bronzin, 2011).

In the research, various evaluation methods have been focused on different aspects of the user experience in interactive artefacts such as emotions, affection, pleasure and aesthetics (Bargas-Avila & Hornbæk, 2011). There is a consensus among scientists that better methods and more studies are needed to evaluate the user experience of interactive artefacts. On the occasion of the recent mobile development, we see the user experience to be particularly relevant to study how its evaluation methods can also be applied in the context of mobile applications. Bargas-Avila and Hornbæk (2011) argued that it is necessary to evaluate the user experience in order to improve the interactive artefact such as mobile applications. Without conducting these relevant studies, problem will arise in the usage of mobile application as the inefficient user experience could lead to negative outcomes which include wasted time and money due to the adjustment or development of a user experience to enhance its attributes (Kraft, 2012; Kuusinen & Väänänen-Vainio-Mattila, 2012; Unger & Chandler, 2012; von Saucken, Lachner, & Lindemann, 2014). The lost opportunities and productivity is the repercussions to this outcome. Additionally, one of the factors to productivity is how well users understand the application and its functionality that are adapted to the users. von Saucken et al. (2014) and Philipson (2004) stated that the organizational care of the employees is needed to preserve and develop the organization, instead of losing employees that are highly valued.

Having seen the setbacks that would occur when an organization fails to provide an understandable application to its users, concerns whether the application could support decision making process start to commence within the individual on the organization. This problem is also amplified along with the routines of people that are more likely have a closer and personal relationship with their mobile technology as stated by Jarvenpaa and Lang (2005). Workers within the organizations have a tendency to expect their workplace applications (e.g. Mobile BI) to have the same quality of performance as consumer-oriented applications (Bock, 2014). These expectations are challenging and oblige the provider of the application (e.g. Organization) to provide functionality of the workplace applications that is similar to the functionality of the daily applications. However, despite the importance of this matter, researches that use the mindsets and experience from a daily consumer-oriented mobile application for workforce area are limited.

Seeing the problem that taken place within the aspect of visual representation and user experience in mobile BI and how its users perceived with the problems in the decision making context encourage us to have a more detailed examination within this problem area.

## 1.3 Purpose

The purpose of the study is to examine the influence of visual representation and user experience to the decision-making process within the area of mobile business intelligence from an individual user's perspective.

The result of the study aims to target the organizations that are already or wanted to adopt mobile BI in the future. They will have insights in regards to how does individual users of consumer level mobile application which has a similar capability with mobile BI perceive visual representation and user experience that is provided by the application for their decision-making process. Moreover, organization could consider the result of this study as an outlook from academic perspective. In addition to that, for IS research area, the extension model from this study could be further used and adopted to different mobile-based decision support system tools or other mobile computing functionality in different research subject.

## 1.4 Research Question

*How does visual representation and user experience in a mobile business intelligence application influence the decision-making process from an individual user's perspective?*

## 1.5 Delimitation

Although there are many aspects that could be considered as an important terms of mobile BI, this study will only examine factors that may affect problem representation of cognitive fit theory by Vessey (1991) namely, visual representation and user experience. Additionally, the constructs within the cognitive fit theory will not be further investigated in this study as there are many studies that have confirmed this theory (Agarwal, Sinha, & Tanniru, 1996; Dunn & Grabski, 2001; Hubona, Everett, Marsh, & Wauchope, 1998; Khatri, Vessey, Ram, & Ramesh, 2006a).

Seeing the purpose of this study which to explain how mobile BI application could support users in terms of the decision-making process from the individual user's perspective and having the tendency of mobile BI application users wanted to have a similar functionality towards consumer-level application, subsequently to have an unbiased result, this study is limited to users of consumer-level mobile application. Betting application was chosen as a research subject as we believe it has a similar functionality and capability with general mobile BI application. Moreover, a betting application should be installed in a modern mobile device that fulfils the characteristic suggested by (Chatterjee, Chakraborty, Sarker, Sarker, & Lau, 2009; Junglas, Abraham, & Watson, 2008; Liang, Huang, Yeh, & Lin, 2007) that argues the mobile device should be small, lightweight and portable. Moreover, other aspects that it should contain is wireless Internet coverage, input and output devices and certain communication standard which involves that data has to be readable and transferable by another mobile device using a standard protocol and vice versa.

# 2 Literature Review

This study will transpire under the context of mobile BI and the upcoming chapters as decision making process, cognitive fit theory, visual representation and user experience will be used as constructs to measure the causational relationship in our proposed model. The chapter (2.6) will further elucidate the association between the constructs.

## 2.1 Mobile Business Intelligence

Explosive growth in the number of products and services offered in the adoption of business intelligence (BI) has occurred in the last two decades (Chaudhuri, Dayal, & Narasayya, 2011). Chen et al. (2012) stated that this technology has evolved during the last ten years, from DBMS-based with structured content which they called as Business Intelligence & Analytics (BI&A) 1.0 until the emerging evolution of BI&A 3.0 which focus more on the analysis of mobile and sensor-based content. Along with the evolution, shifting paradigm to access BI system into mobile device was also taking place. Verkooij and Spruit (2013) argued that it is a procedure that enables availability of critical data to create a decision for end users through mobile workforce in an appropriate application and devices in any way considered mobile

Mobile BI in general is using the same concept as BI. Nevertheless, instead of providing all the representation of the data on a desktop application, it uses mobile devices such as smartphones and tablets as a media to deliver the representation of the data. The idea of combining mobile devices and business is obvious as more professionals are using mobile devices to keep up to date with the business information (Airinei & Homocianu, 2010). Ubiquitous remote access also create such phenomenon raised into top level as it creates traditional workspaces like office is obsolete and creates an agility within business process (Airinei & Homocianu, 2010). It allows users to create more dynamic and quality decision based on real-time data (Vitt, Misner, & Luckevich, 2002).

### *2.1.1 Mobile Business Intelligence as a Decision Support System*

Emergent of Mobile BI technology as a decision support system has been predicted by Maas (2000) which argued that mobile technology will be the next major sets of development within the area of the decision support system (DSS). DSS is a computer technology solution that can be used to support complex decision making and problem solving for complex structured, semi-structured and even unstructured decision (Hosack, Hall, Paradice, & Courtney, 2012; Igbaria, Sprague, Basnet, & Foulds, 1996). As a DSS, mobile BI came as a user interface form with the central goal to process and provide suitable information for users to support their decision making task (French & Turoff, 2007; Turban, Aronson, & Liang, 2005). Considered as an advance DSS technology, mobile BI has the ability and capability to provide uninterrupted information in any environment for user to support their decision making process and referred as an advance data-driven decision support application and could directly generate a new value to users as it could increase the number of successful operations (Muntermann, 2007; Power, 2013). Usability of mobile BI is also supported by the routines of people that are more likely have a closer and personal relationship with their mobile devices (Jarvenpaa & Lang, 2005). Hosack et al. (2012, p. 330) stated that, 'Mobile devices provide a new platform for DSS that challenges the traditional approaches to DSS'. These circumstances allow people to access information when they are on the move and resulting a variety of benefits like higher convenience, productivity, and process improvement (Basole, 2008; Gebauer & Shaw, 2004; Junglas et al., 2008).

**Key Takeaways in Mobile Business Intelligence**

Mobile BI is used as a decision support system which is intended to facilitate the users of a mobile BI to make a successful decision. The mobile platform for BI, allows the users to manage their performance from unrestricted locations which is intended to benefit them to increase the efficiency of their work.

## 2.2 Decision Making Process

Mobile BI can be used to present the decision support information in a more attractive approach and it also possesses attributes that enables faster and more flexible decisions which in result facilitates the decision making process for a user (Moss & Atre, 2003). Tona and Carlsson (2013) describes that mobile BI consists of functions and methods that support effective decision making. With the right business information in your hand, it will be easier to make a decision with a positive outcome. Making decisions about changes is often difficult (Goldkuhl & Röstlinger, 1988). There is often a lack of explicit objectives of change and criteria for prioritizing different policy options and makes it problematic to implement impact assessments. Brunsson (1998) argues that decision-making can be described as a problem solving where the implications lie in several future action alternatives. Since the problems relating to future events easily results to uncertainty, there may be indecision as to imagine all the different fields of action, uncertainty about the consequences of various actions or uncertainty in the decision maker's preferences.

### *2.2.1 Strategic Decision Making Process*

Decision-making is according to Harrison (1996), the most frequently occurring activity that individuals engaged in organizational position. Harrison and Pelletier (2000) argue that strategic decisions are particularly vital to an organization's long-term well-being. It is these decisions that set the tone for the decision of each individual within an organization. If the outcome of the strategic decisions from the top level of an organization is ineffective, the decisions at a lower level will also exhibit a lack of efficiency.

Harrison and Pelletier (2000) argues that a strategic decision is designed to effectively match an organization's capabilities and resources with opportunities and threats in its environment. The different strategic decisions in an organization are closely interconnected with each other and reflect the long-term strategy for the entire organization. A successful decision is one that results in the achievement of the goals that was the reason for the decision emergence, within the restrictions that the organization needed to consider in the implementation. These restrictions may accord to Harrison and Pelletier (2000) be time, cost, technological and cognitive constraints.

Harrison and Pelletier (2000) argues that the general approach of strategic decisions that lead to high achievement is based on a process model for the decision making. If a process is completely missing, or if there is an under developed process for strategic decisions, will only coincidences determine whether the decision will be successful. Although a process-oriented approach in no way guarantees the successful decisions, increasing yet the probability of successful decision with a process-oriented approach.

Figure 2.1 can also help us understand how decision making process works. The process begins with the objectives set up and the process culminates when the goals are achieved. During the process, it may be necessary to revise the objectives leading to new cycles will begin the process. In the subsequent phase, the decision maker reading of the external and internal environment to find relevant alternatives that have the potential to meet the objectives. The third phase weighed the options against each other given the available information. This is a limitation that comes from the decision maker's subjective preferences for any specific option. The fourth phase, a decision based on the evaluation of the alternatives. This phase is followed by the implementation when the decision was converted from a theoretical to a practical product. Finally, a follow up of the decision is taken to ensure that the outcome meets the pre-established objectives.

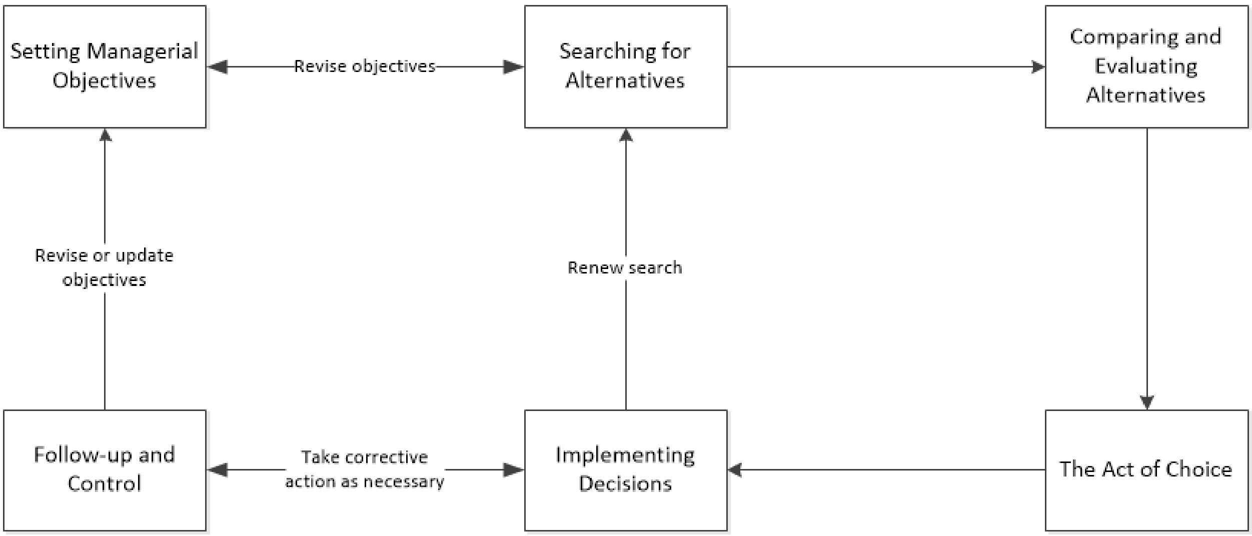



**Figure 2.1: Strategic Decision Making Process (Harrison & Pelletier, 2000)**

In the individual decision making process, (Mintzberg, Raisinghani, and Theoret (1976); Power, Sharda, and Burstein (2015); Saaty (2000)) agree that there are five phases that should be conducted which are the identification and clarification of a decision to be made, identify alternatives, comparing and evaluating alternatives, select the decision and lastly the probability to follow-up and control the decision. Derived from those phases, information gathering and information use arises as the main activities in decision making (Griffith, Northcraft, & Fuller, 2008). This can be applied to the figure 2.1 which consists four of the mentioned phases in the strategic decision making process. Moreover, Power et al. (2015) and Saaty (2000) argues that there are similarities in the management decision making and in the individual decision making where the responsibility is the only distinction factor and according to

Harrison and Pelletier (2000) is the phase of setting managerial objectives that differs strategic decision making process from the individual perspective.

**Key Takeaways in Decision Making Process**

The individual decision making phases which could be identified in the strategic phases in figure 2.1 (the identification and clarification of a decision to be made, identify alternatives, comparing and evaluating alternatives, select the decision and lastly the probability to follow-up and control the decision) will represent as a feature within the construct of the decision making process (DMP).

## 2.3 Cognitive Fit Theory

Considering cognitive aspect within decision support system which has the main purpose to support an entity to create a decision is a crucial step. Not only because it is one of the facet within reciprocal causation model but also it has been proved to predict human behavior and guiding effective intervention (Bandura, 2001). The fact that human have a limited information processing approach make it is essential to have an effective problem solving to reduce the complexity in the task environment. Vessey (1991) proposed a theory called cognitive fit which stated that in order for an individual user to have a fine task performance, the correspondence between task and information presentation is needed. Matching task and information presentation could lead to a consistent mental representation and leads to effective and efficient problem solution which will lead to influence the decision making performance.

In Figure 2.2, it explains the relationship model of cognitive fit theory. The model views problem solution as an outcome from problem representation and problem solving task which lead to the mental representation and in return represents the way the problem is represented in human working memory. In the problem solving context, report format of representation within this model is essential. Two studies that were run by Lucas Jr and Nielsen (1980) and Lusk and Kersnick (1979) found that cognitive type moderated the relationship between report format and decision quality. This study also validated by (Dickson, DeSanctis, and McBride (1986); Hard and Vanecek (1991)) which figured that significant learning effects were found among subjects that use certain format.

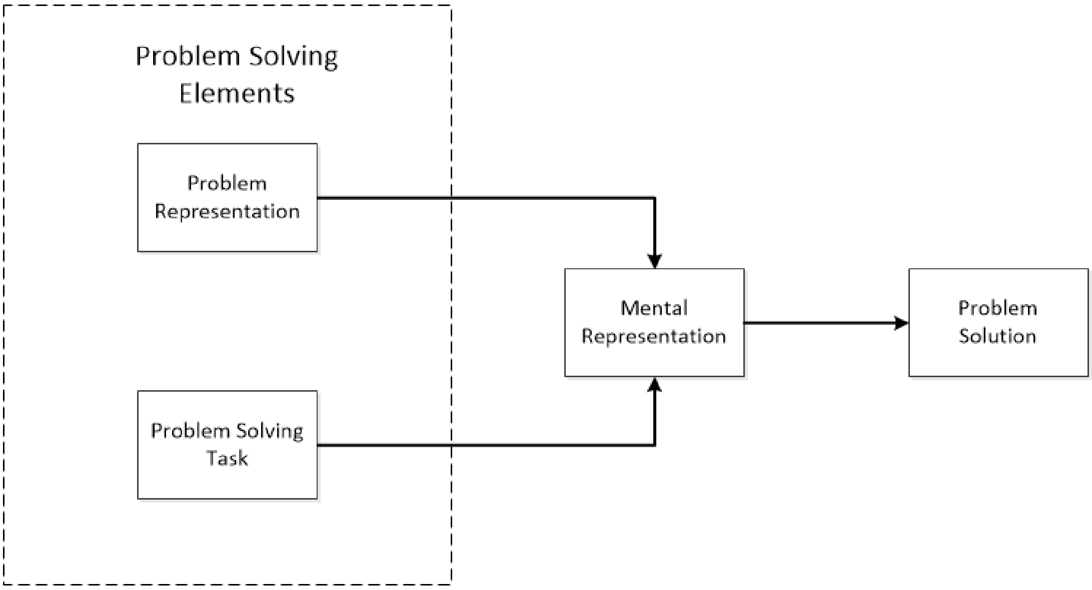



**Figure 2.2: Model of Cognitive Fit Theory (Vessey, 1991)**

The theory as mentioned previously is suggesting that problem representation should match the required strategies (method or process) to complete a task which divided into two categories, spatial and symbolic (Chan, 2001). The motivations behind the development of cognitive fit theory were based on three factors. The first is the evidence from human information processing literature on problem isomorphs to support the processes that problem solver use when solving a problem are similar to problem representation (Hayes & Simon, 1974, 1979; Kotovsky, Hayes, & Simon, 1985), behavioural decision making is the second factors which was described by Bettman and Kakkar (1977) that participant will have tendency to process information in consistent ways with the representation of information. The last one is the propensity of decision makers that use three heuristic aspects of representatives, availability, and anchoring and adjustment (Kahneman & Tversky, 1972; Tversky & Kahneman, 1971, 1974).

When it comes to the problem representation, this theory has stressed two style of data representation which is graph and table. The motivation behind this is because that presentation of data is essential in terms of the decision making (Newell & Simon, 1972), and presentation of data in forms of graphs became a viable alternative to tabular formats due to the availability of computing technology and its attractiveness. According to (Pracht and Courtney (1988); Schmell and Umanath (1988); Umanath, Scamell, and Das (1990)), the difference between graph and table is situated at their representation of data. While graph are “imagistic” with conveying continuous information, tables are more “verbal” in nature and have discrete information in their mode of data presentation. Larkin and Simon (1987) argued that graph is a spatial problem representation as they present spatial related information, whereas tables are more into symbolic data representation since they provide symbolic information which is more suitable with analytical approach. Nevertheless, problem representation within this theory is not restricted to the graphs-versus-tables domain. It can be applied as well to any domain where there is sufficient information to permit analysis of the tasks and the information presentation formats (Vessey, 1991).

Empirically, there are two different task types that validated based on the perspective of Ullman (1984) and Umanath et al. (1990). They divided the task based on the nature of the task whether it is best when it supported by graphs or tables. While spatial task requires associations of relationship within the data with best practice of working on perceptual process, symbolic task need more analytical processes approach as it involves extracting discrete data values (Jarvenpaa & Dickson, 1988; Schmell & Umanath, 1988). However, in a certain manner, both tasks could be restated in either way as cognitive fit paradigm is not a certain theory. Spatial representation could also help people solve symbolic task and vice versa but with lower effectiveness and efficiency in each instance (Vessey, 1991).

Along with the importance of fit between problem representation and problem solving task in this theory, however, as people have the propensity to minimize cognitive effort to perform a task, this phenomenon creates a tendency to choose decision rules that fit the manner in which the data are presented  (Todd & Benbasat, 1999, 2000). Selecting decision processes that match the information presentation could minimizes the efforts of the people as decision makers do not have to alter the information before using it (Dennis & Carte, 1998). Having that stated, from the viewpoint of practice, paradigm of cognitive fit suggests that decision maker will perform better when they have appropriate support for the task. Matching problem solving task (spatial or symbolic task) and problem representation (graph or table) will give better performance in term of time and accuracy, and improved interpretation of problem itself (Vessey, 1991).

As an theory that is combining information system (IS) notion and psychology perspective, cognitive fit has been used effectively to evaluate the effectiveness and efficiency of problem solution in different research area (Crossland, Herschel, Perkins, & Scudder, 2000; De, Sinha, & Vessey, 2001; Hong, Thong, & Tam, 2004; Kamis, Koufaris, & Stern, 2008). Furthermore, table 2.1 will be used to summarized and explain the details variety of studies regarding cognitive fit theory in IS area.

**Table 2.1: Summary of Cognitive Fit Research in Various IS Area**

| Authors | Research Area | Main Findings |
|---|---|---|
| Chan (2001) | Organizational Decision Making Process | The effectiveness of using graphical presentation to minimize the adverse effects of information overload on the quality of a decision in context of a business environment. |
| Chang, Kao, Wu, and Su (2016) | Clinical DSS (CDSS) | More efficient diagnoses and proper treatment was achieved when there is a cognitive fit between physicians and CDSS |
| Dunn and Grabski (2001) | Accounting Information System | Localization is an essential element of cognitive fit |
| Hong et al. (2004) | E-Commerce Web | The online shopping consumers performance (choosing goods) were influenced by the information format that provided by website and shopping task |
| John and Kundisch (2015) | Creative IS | The theory could be used and extended in terms of solving problem in creative IS area such as the design phase of IS. |
| Khatri, Vessey, Ramesh, Clay, and Park (2006b) | Conceptual Modelling | IS domain knowledge does essential to the solution of all types of schema understand tasks and application domain knowledge affects the solution of just schema-based problem-solving tasks. |
| Mahoney, Roush, and Bandy (2003) | Decisional Guidance | Benefits of embedded suggestive decisional guidance to guide the choice between alternative presentations of uncertainty data. Theory-based decisional guidance can improve |

| Authors | Research Area | Main Findings |
|---|---|---|
| | | the accuracy and time of decision-makers. |
| Van Der Land, Schouten, Feldberg, Van Den Hooff, and Huysman (2013) | 3D Virtual Environment | Individual understanding for a task which involves rich visual representation environment is more effective |
| Shaft and Vessey (2006) | Software Comprehension and Modification | Software comprehension and modification should be viewed as interrelated tasks due to the complex interrelationship between the tasks. |
| Song, Chan, and Wright (2016) | DSS in Financial Information | There is an enhancement in risk assessment performance when the DSS display format is congruent with task requirement. |

Having seen the effectiveness and accurateness of cognitive fit theory on different subject area of IS (table 2.1) in measuring how problem representation and problem solving task could influence mental representation which leads to a better problem solution, makes this theory appropriate for our research. Moreover, visual representation and user experience which will be used throughout this study and will be presented later in this section are suitable to be an extended construct from cognitive fit theory as it might have the ability to influence the problem representation.

**Key Takeaways in Cognitive Fit Theory**

To summarize this section, the elements of the cognitive fit theory which are problem representation, problem solving-task, mental representation and problem solving, will represent as features within the construct of cognitive fit theory (CF)

## 2.4 Visual Representation

Models are created and usually presented visually, in the form of a single or multiple graphs (Baker, Jones, & Burkman, 2009). The visual aspect is seen as an advantage in the potential communication. To achieve its potential communication skills, it is essential that visualization is cognitively efficient. This means that greater use and takes assessment of human potential to interpret and read visual representations, such as images and symbols which according to Tona and Carlsson (2013) is common in mobile BI.

Visual representation is a way to communicate with images (Lurie & Mason, 2007). It is constantly used to envisage information to control our collection of data. As soon as the light hit the retina, it starts a process in the brain to interpret what we see and draw conclusions about how to act or react. Therefore, the visual information is significant when interacting with the outside world and in activities of knowledge transferring (Lurie & Mason, 2007). A visualization can be a hand-drawn sketch or an image created by a computer program. When it comes to making large amounts of data intelligible, various forms of charts or maps is being utilized.

Through visualization, different individuals may obtain the same image of a plan or event and allows communication across barriers of gender, culture and age (Ganapathy, Ranganathan, &

Sankaranarayanan, 2004). Rapid developments in hardware and software also come up as an important breakthrough as it makes people become better at understanding how visions actually works i.e. how viewers interpret and analyze images. The core of visual representation lies on sharing the workload between computers and viewers (Ganapathy et al., 2004). With computers ability to count quickly and correctly and viewers' capability to capture the context and analyzing images could lead to support the decision-making process. Baker et al. (2009) argues that the decision outcomes influenced by visual representation depends on the processing and interaction of the human memory in the implementation of decision strategies which limits the data that is needed for the visual representation. However, visual representation can also be deceived because its quality of data (poor or incomplete data).

### *2.4.1 Features of Visual Representation*

According to Baker et al. (2009) there are three types of features for visual representation, characteristics of the objects, objects within the scene, and lastly a scene. The definition of an object itself according to Henderson and Hollingworth (1999, p. 244) is "*small-scale discrete entities that are manipulable within the scene*". The objects in other hand are entities which can be positioned in various places within the scene. To recap on the abovementioned text, the scene can be visualized as the traditional X and Y graph and the object can be seen as bars from a bar chart. This argument is confirmed by Baker et al. (2009) which suggest that objects possess characteristics which enable it to be compared to other objects and observed. The decisive factor for the characteristics of an object is the sources of distinctions, such as shape, size, colour, texture and orientation. The visual representation can in conclusion possess one scene with one or more objects and within those objects, can possess one or more characteristics.

The objects will be introduced into the scene and based on the interactions of the objects, will information be presented (Henderson & Hollingworth, 1999). This also allows viewer of the constructed visual representation to infer the values of the scene when additional objects are introduced. Bertin (1983) adds that patterns and trends can simply be visualized when additional objects are introduced to the scene. With the characteristics will the viewer be able to interpret additional information from the objects (Henderson & Hollingworth, 1999). The scene itself can be categorized as informative even when an object has not been introduced to the scene because it allows the viewer to repossess knowledge and inflict restraints due to the elicited knowledge.

### *2.4.2 Sensemaking*

The intended design for visual representation is to decrease the cognitive effort and therefore should it strive to emphasize the trends and patterns from the objectives within the scene (Baker et al., 2009). In result will it facilitate the viewers endeavour to derive connotation from the trends and patterns. Baker et al. (2009) has formed the factors of a visual representation to enrich the quality of the understanding of sensemaking which will be later explain in figure 2.3 as follow,

**Support for the four basic visual approaches**

Within the first factor, four approaches were derived by Bertin (1983) from the characteristics of the objects in visual representation and these are:

1. *Association* – Involves finding relationships between objects which has identical attributes and can therefore be congregated.
2. *Differentiation* – Involves finding differences between objects which has various attributes and can therefore be positioned in diverse groupings.
3. *Ordered perception* – Involves finding a definite attributes in comparison to other objects.
4. *Quantitative perception* – Involves finding multiple attributes within an object that is possessed by other objects

**Support for the Gestalt Qualities**

In theory, the gestalt qualities in the visual representation supports pattern seeking action and therefore one can easily capture the association between the objects which in return facilitate for the viewer to perceive associated objects as a unit (Pomerantz & Kubovy, 1986). According to Kosslyn (2006) there is a natural force from viewers of a visual representation to assembly objects into units which they afterwards memorize. This study also confirmed by Wickens and Carswell (1995) which argue that it is common that cumulative functions enable various objects be derived as a unit and decrease the cognitive effort.

**Consistency with the Viewer's Stored Knowledge**

The third feature that supports the enhancement of sensemaking experience involves taking the advantages of the already remaining knowledge from the viewer (Hutchins & Holland, 1986). It evades the redundant cognitive effort that otherwise is necessary when translating the objects and characteristics to its significance (Mennis, Peuquet, & Qian, 2000). Baker et al. (2009) express an input regarding this factor and argues that it should be known that all viewers does not perceive the same knowledge and the outcome of an visual representation can vary from each viewer. In addition to their arguments, examples on how to utilize this factor are being presented. For instance can it be utilized for a significant group of specialist which can be categorized as a "small" audience and therefore it can require certain knowledge which limits the understanding of sensemaking of the visual representation for viewers outside the intended group. In the other hand we have newspaper which is intended for a broader audience and the knowledge that has to be stored from the viewer is more common for an average viewer.

**Support for Analogical Reasoning**

The last feature involves capturing the hidden information in the visual representations with support of analogical reasoning (Rasmussen, 1986). Analogical reasoning supports the viewer to counteract the restrictions of cognitive effort by adapting the mental representation. Continuously is the mental representation used to manage data which enables the stored knowledge to be applied easier and the urge for additional data is reduced. Analogical reasoning invites viewers to apply prior knowledge regarding strategies, models, directions and comparable events to generate problem solution for a problem which have not been faced before. This action often occurs when a viewer attains a state of no sufficient problem solutions and therefore tries to grasp a comparable problem solution by support of analogical reasoning.

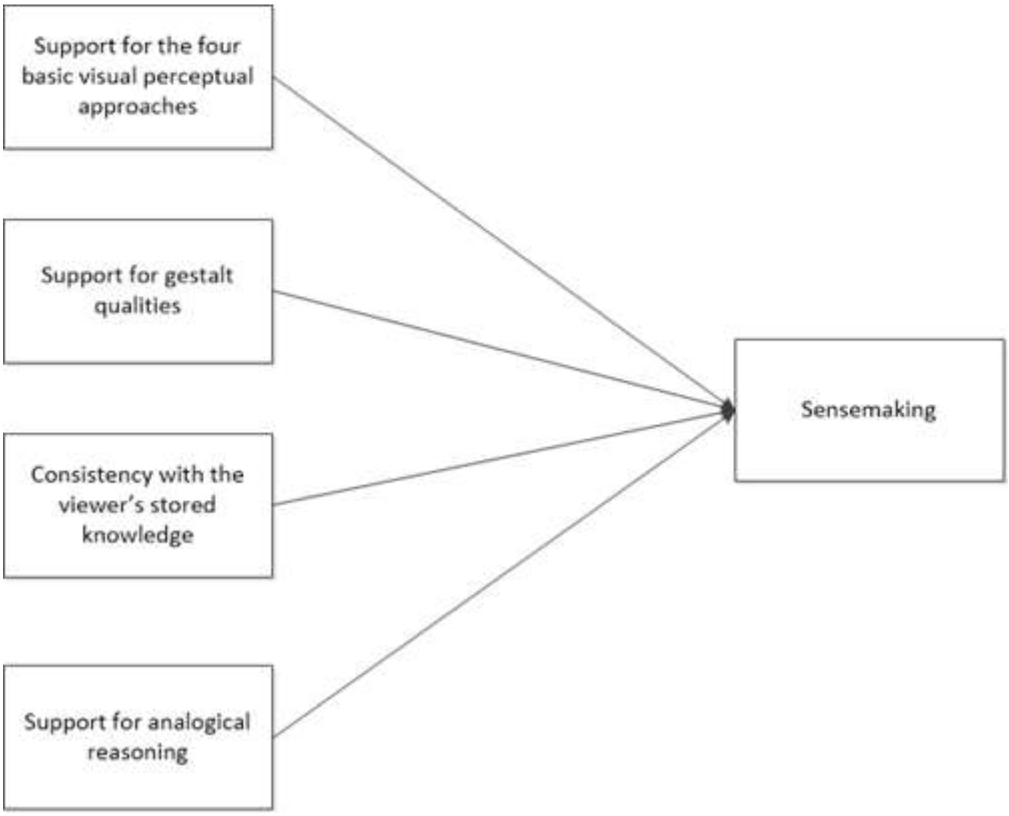



**Figure 2.3: Sensemaking Influential Factors from Visual Representation**

### *2.4.3 The Quality of Data*

Quality of data is considered as the important attribute within the visual representation (Steele & Iliinsky, 2010) and according to Keim, Mansmann, Schneidewind, and Ziegler (2006) the possibility to produce an equitable visual representation depends vastly on the quality of the used data and method. Multiple quality difficulties e.g. missing values, double counts and data capture errors could already be contained in the raw data. Substantial impact within the frames of social and economic could be affected when poor data is forced to be managed (Wang & Strong, 1996). As a result could failures increase from the misleading data and consequences would emerge irregularly which takes time and effort to manage (Borgerson & Schroeder, 2002). Practical approaches to improve data quality by organization cannot adequately increase the quality as data consumers have a broader conceptualization when it comes to data quality (Wang & Strong, 1996). This perspective is critical as each user could have a different criterion to determine the quality of data (Wang, Reddy, & Kon, 1995).

The Mobile platform emerged into decision support tools, shifting focus on strategic long term decision analysis into just in-time operational (Mallach, 2000). This shifting paradigm creates timeliness, completeness, reliability, and relevance of data to be considered as contributing aspects in quality of data (Cowie & Burstein, 2007). Measurement of information quality which combines factors like classifier effectiveness, pragmatic information quality effectiveness, and effectiveness of semantic information is used to assess and comprehensively reviewed the usefulness of provided information quality (Hill, 2004). By providing data that comes close to the good visual representation according to Jobson, Rahman, and Woodell (2002) it could facilitate for the users to perform activities immaculately from the perception of visualization and data quality which results to the users existing knowledge, experience and cognitive capability that are the decisive factors which will determine the outcome of the activity such as decision making. Additionally, Thorvaldsdóttir, Robinson, and Mesirov (2013) mention that visual representation has the capability to refine the data by filtering out the bad aspects of the data.

**Key Takeaways in Visual Representation**

The sensemaking as its four factors (support for the four basic visual perceptual approaches, support for the gestalt qualities, consistency with the viewer's stored knowledge and support for analogical reasoning) and the quality of data will represent as the features within the construct of visual representation (VR).

## 2.5 User Experience

Having a good user experience (UX) in mobile application is according to (Arhippainen and Tähti (2003); Charland and Leroux (2011); Olsson, Lagerstam, Kärkkäinen, and Väänänen-Vainio-Mattila (2013)) is an essential element to manage its functionality. It is considered as an important aspect in interaction design area (Forlizzi & Ford, 2000). Hauser (2016) believes that UX belongs in the delivery stage of the phase of design process and generated by interaction design which is considered as a subset of UX by Kellingley (2016). The technology itself has the ability to associate wide array of dynamic and unclear concepts like emotional, aesthetic, and affective variable and has also facilitate discourses in different subject with their capability to communicate entity in multiple discipline and concepts (Forlizzi & Battarbee, 2004; Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009). However, Desmet and Hekkert (2007) suggested that in order to use such technology, diverse model of foci like value, pressure, and experience should be considered.

Forlizzi and Ford (2000) divides experience into three different categories. *Pure experience* which is a continuous feelings that occur during moment of consciousness of human when performing an activity come as the first category. It plays a huge role in providing pure experience to user as it could regulate the action and the flow of mental events and considered as substance of mental life that could create life more manageable and better (Carlson, 1997). This aspect creates people to have better choices when it comes to selecting, constructing, regulating, and evaluating courses of action (Bandura, 2001). Second category is h*aving an experience* which creates a broader view and perspective when having a feeling when something occurred. It changes the way user thinks, feels, and the context that they felt which lead to different outcome (Dewey, 2005). *Experience as a story* which was raised by Schank (1995) came as the last category. The experience as a story category was seen as a communicative experience as it looks the artefacts as a moving entity that provides user to condense and remember experience.

Based on the mentioned definition of user and experience, we can conclude that UX is the process of getting knowledge and skills which could affect user's feeling and influence the user's behaviour. There is no certainty in UX. Broader perspective must be used to find out what kind of experience fits the users as UX focus on the overall experience between user and products (Hauser, 2016).

### *2.5.1 UX and Human Computer Interaction*

With the emergence of mobile BI technology (Bitterer, 2011; Gartner, 2012; MicroStrategy, 2012; Yuen, 2013), human and computer interaction (HCI) arises as an important aspect in order to tie the users and the system (Law et al., 2009). UX come up as a bond component with its ability to communicate entity in multiple discipline and concepts. Along with the technology improvement and the growth and changing base of users shift today and regardless its complicatedness to understand the experience that must be provided in an interactive system (Forlizzi & Battarbee, 2004), demands of good UX in an interactive system is inevitable today (Hassenzahl & Tractinsky, 2006).

**Interactive System**

Hassenzahl (2003) argued that pragmatic aspect (i.e. fits to behavioural goals) and hedonic aspect such as stimulation, identification, and evocation of interactive product must take into consideration when implementing interactive system. This study also backed by Jordan (2002) as well as Kim and Han (2011) which confirmed the importance of having a good user-product interaction in an interactive system like mobile BI. Attaining good user-product interaction could be done by employs either fluent, expressive, or cognitive approach (Forlizzi & Battarbee, 2004). Along with the approaches, emotion part of human must be taking into consideration as well in user-product interaction. It is an essential component for UX and user-product interaction (Forlizzi & Battarbee, 2004). Gap between product and user from design perspective could be connected and affects human's plans and intentions, the way people organize the procedures related to plans, and the way they evaluate the outcome from psychology standpoint (Carlson, 1997). Derived from this approach and understanding on how to achieve good user-product interaction, perceived ease of use, perceived enjoyment, and quality of experience arise as a relevant form to pursue good UX in an interactive system.

**Perceived Ease of Use and Perceived Enjoyment**

In a current IS ecosystem which advertises hedonic and utilitarian (pragmatic) aspect, both perceived ease of use and perceived enjoyment have an important role in constructing a good UX in an interactive system. While perceived enjoyment will give "the extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated" which maybe later affect the intrinsic motivation (Davis, Bagozzi, & Warshaw, 1992, p. 1113), perceived ease of use will create a degree to a person to not have troubles when using a particular system (Davis, 1989).

In term of measuring UX through perceived ease of use and enjoyment, Novak and Schmidt (2009) in their experiment research have found that these aspects could increase the hedonic stimulation quality in an utilitarian system and influencing the design choice of their respondents which lead to supports the performance. This aspects was also used in other research by Shin (2013) in context of user experience in social commerce.

**Quality of Experiences**

Interaction design is an important part in having a good UX in an interactive system. It is a methodology that produces visual representation which is used by designers and developers for early testing and specification purpose (Axbom, 2011). It has more focus on how to present information through the system or program for the users (Kellingley, 2016). A good interaction design complements a good experience (Arhippainen & Tähti, 2003). Hence, quality of experience must be considered when creating an interaction design. Focusing on how to create a good quality experience is needed to have a good UX as it is a consequence of a user's internal state, system characteristic and the context within which the interaction occurs (Hassenzahl & Tractinsky, 2006).

Aspects of understanding of users, learnable, needed, mutable, effective, appropriate, aesthetic, and manageable should be used as guidance to have a good interaction design (Alben, 1996). Despite it was formed more than 10 years ago, the abovementioned aspects are still considered relevant today in user experience development. It was used recently by Cruz Mendoza, Bianchi-Berthouze, Romero, and Lavín (2015) in their study of movement-based interaction framework, and also by Park, Han, Kim, Oh, and Moon (2013) and Shin (2015) with research of user experience modelling in mobile devices, and the effect of customer experience with smartphone, respectively.

**Key Takeaways in User Experience**

The Perceived ease of use, perceived enjoyment and quality of experiences will represent as the features within the construct of the user experience (UX)

## 2.6 Research Model and Hypothesis

In order to answer the proposed research question, a tested research model with hypothetical construct is needed. We developed our model based on the hypothetical construct that we found important within the literature review phase. In this research model, CFT will be measured by testing the hypotheses through causational relationships between the constructs and the model will also be tested in the context of mobile BI.

### *2.6.1 Visual Representation and User Experience*

Visual representation allows human ability to recognize meaningful patterns within the data and offers a way to lower cognitive load to human perceptual system (Kolata, 1982; Lohse, 1997). It helps people to make sense of the data and enlarge problem-solving capabilities. In term of mobile BI technology, as it uses a similar concept with the desktop BI application, visual representation arises as aspect that should be examine within the technology. By having such aspect within the application, it will give certain experience to users and affects their feeling and behaviour when using the application (Carlson, 1997). Moreover, relationship between visual representation and user experience has been carried out as well by Kim and Han (2011) in the area of mobile data service. Furthermore, since we wanted to measure the indirect relationship from visual representation to cognitive fit through user experience, hence one should measure the relation between visual representation and user experience. Therefore, our first hypothesis for the research question will be,

***H1: Visual representation has positive effect on user experience for user of mobile BI***

### 2.6.2 Visual Representation and Cognitive Fit Theory

Since the problem representation has the prospect to possess diverse forms, visual representation of a data arises as the most common approach to this premise as it has a direct influence to each other (Vessey, 1991). It has the ability to reduce user's cognitive effort with its potential to convey across cognitive load to users of visual perception system (Lohse, 1997). Sensemaking which is concerned to meaningful effects that have already happened and influenced on how an individual take an action or interaction, come as the way the user understand the data that was delivered through the visual representation in an application (Boland, 2008). In that sense, visual representation has the ability to affect individual user's sensemaking which will lead to evade the redundant cognitive efforts (Bertin, 1983). Furthermore, Benbasat, Dexter, and Todd (1986) also argued that adding the format of the problem presentation is a decisive factor to improve decision making process, hence it creates visual representation has the ability to influence the decision making performance. Thus, the second hypothesis for this study will be,

***H2: Visual representation has positive influence on cognitive fit for individual user of mobile BI***

### 2.6.3 User Experience and Cognitive Fit Theory

Mental representation defined as the way problem that have to be solved by decision maker represented in the individual user's working memory (Vessey, 1991). Although it is formulated based on characteristic of both problem representation and task, specifically, it derives from the interaction that occurred between decision makers and the problem representation. Emotion aspect that is created by interactive-product plays an important role to build the mental representation through the problem representation. The UX can influence various aspects for the individual and according to Hassenzahl and Tractinsky (2006) and Forlizzi and Ford (2000) the cognition is an aspect that by the user's experience of seeing, hearing, touching and interpreting can influence the cognitive fit. Therefore our third hypothesis will be,

***H3: User experience has positive influence on cognitive fit for individual user of mobile BI***

### 2.6.4 Cognitive Fit Theory and Decision Making Process

A central cognitive science issue is how one assimilates and process data, but this also applies to the interactions with the social and physical environment (Vessey, 1991). Pursuing the cognitive fit will lead to facilitation of decision makings. It will generate higher interest in the task and lead to greater effort and higher performance (Davis et al., 1992). This notion has been carried out as well in in e-commerce web, clinical DSS, and financial DSS research area (Chang et al., 2016; Hong et al., 2004; Song et al., 2016). Taking the consideration of human cognitive abilities and limitations, a certain system should be developed by providing support tools based on decision-makers need, in order to assist diverse phases of the decision-making process. Decision-makers would receive support for its limitations, which would make the decision ruling effectively. Mallach (1994) argues that the decision is part of the problem solution and believes that motivation behind problem solving is to eliminate the difference between the world's true conditions and a desirable state. Therefore decision-makers require alternative solutions that can be cogitated. Implications of the results observed to check whether the problem has been solved or not (Mallach, 1994). Nevertheless, despite the phenomena, there is a higher tendency that people switch to other problem solving strategy that fit the manner in which the information is presented (Jarvenpaa, 1989; Schkade & Kleinmuntz, 1994). In this context, we can conclude that decision making process depends on how the fit of cognitive fit model that provided in an application. Therefore, for our last hypothesis will be,

***H4: Cognitive fit has positive influence on decision making process for individual user of mobile BI***

In order to summarize the hypotheses, Figure 2.4 illustrates our proposed research model including the hypothetical constructs and its hypotheses that are represented by arrows. The hypotheses are in the context of mobile BI and will be tested in this research's process. Appendix 1 will provide with a further detailed proposed research model.

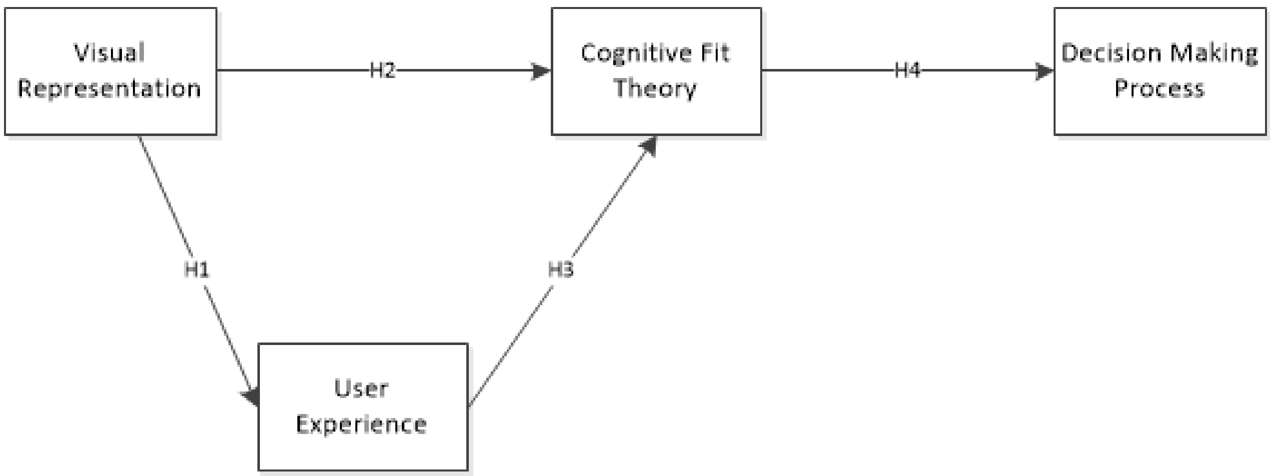



**Figure 2.4: Proposed Research Model**

# 3 Methodology

## 3.1 Research Type

The decisive factors on the categorization of research type depend on the purpose of the research, the form of data is obtained, and how the analysis phase of the obtained data will be proceeded (Ridder & Yin, 2012). According to Bhattacherjee (2012) and Saunders, Lewis, and Thornhill (2009), the research can be categorized as explanatory, exploratory and descriptive.

Seeing the aims of the research, our study considered as an explanatory research since it identifies and measures the relationship between the different variables in our self-developed figure, with attributes from cognitive fit theory, visual representation, user experience, mobile BI and decision making process. This aligns with the argument of Bhattacherjee (2012) which describe explanatory as a research which studies the associations between variables by conducting a study on a problem or phenomenon.

## 3.2 Research Approach

The main purpose of a scientific research whether in basic or applied science is to discover a law and postulate theories that have the possibility to describe natural and social phenomena in the society (Bhattacherjee, 2012). Two main pillars of logic (theory) and evidence (observation) considered as an important fundamental of scientific research. In order to build this pillars, researchers should use whether the inductive or deductive approach (Bhattacherjee, 2012).

Based on the purpose and the research question, in this study, we wanted to test how the user perceived on mobile BI application. Thus, instead of building a new theory, this study was testing a hypotheses model and therefore, we decided to use the deductive approach. Hypotheses were created in order to strengthen the deduction of the phenomena and it was built based on the knowledge that gathered from decision making process, cognitive fit theory, visual representation, and user experience from individual user perspective which were formulated on the research question. The empirical data that will be further used to see the perception of users in regards to the phenomenon were collected quantitatively as it is the main characteristic of deductive approach as suggested by Saunders et al. (2009). After that, the data were collected through questionnaire-based survey and will later be used to explain the causational relationship between the constructs.

## 3.3 Research Strategy

When an assortment of a research strategy occurs, one has to consider if it supports the purpose of the research project and whether the chosen strategy supports the researcher to answer the research question (Saunders et al., 2009). Bhattacherjee (2012) presents that a questionnaire, case study, grounded theory, experiment, archival research, ethnography and action research falls into the category as research strategies and can in addition be applied directly or in combination approach to an explanatory, exploratory and descriptive research.

For this study, we applied the questionnaire and according to Bhattacherjee (2012), using this strategy to obtain data is a persuasive approach for measuring disregarded variables such as behaviours, perceptions and preferences. Those three variables were gained from the developed constructs and it was later used to test the formulated hypotheses. Afterward we observed the respondents standpoint towards the visual representation and user experience in the context of its influence of the decision making process in mobile BI from individual user perspective which is aligned to our purpose and research question. The research strategy also support the purpose and the research question by its capability to use statistical power with numbers effectively in a short time frame which we had and therefore is an appropriate technique to support the method (Bhattacherjee, 2012). Moreover, the questionnaire also allowed us to analyze the collected data quantitatively (Saunders et al., 2009) and also to obtain data remotely from a population that is considered too large to perceive directly (Bhattacherjee, 2012. However, issues like ensuring whether the data is representing the phenomenon and how to avoid and filter out sampling bias, recall bias, non-response bias and social desirability bias were we conscious of when we used the questionnaire strategy and pursued this issue by filtering out respondents with no experience of a mobile betting application.

## 3.4 Empirical Settings

The aim of this study was to obtain data from the main target group of individual users' of a mobile BI application. However, barriers such as the lack of resources of our main target group, it compelled us to compromise and therefore searches for alternatives to obtain the data needed to still fulfil the research question and the purpose of this study. The alternatives were searched through other mobile applications which consists a practice of decision support system (DSS) in individual user level as our target population.

According to Holsapple and Sena (2005), mobile BI is a tool that could support its users to create faster decision because it could lower the reduction of decision cost and has the capability to be used anywhere and anytime. It is considered as another form of decision support system which has a mobile capability. As stated in the problem area of this study, expectations from organization employees to withhold functionality of the workplace applications that is similar to the functionality of the daily applications is arising. Seeing these phenomena, mobile betting application was used as the subject application to grasp its user perception towards decision making when using that application and further applied the result to mobile BI application for all individual users in an organization. Our motivation towards using mobile betting application as the subject application, are because we believe that a mobile betting application has a similar environment with organization as it has the capability to provide direct loss or profit outcomes to its users based on the user's decision.

We would argue that all the mobile betting applications that we obtained from the respondents of our questionnaire based-survey, provided with some form of visual representation and user experience. The applications that have been mentioned by our respondents has in turn been downloaded and tested by us to see if it suits the purpose of this study, otherwise it would have been filtered out which in this research was not required. Additionally, we would also consider a mobile betting application as a mobile decision support system due to its attributes of supporting a user to make a decision based on the approach on how data is provided from the application. Arnott and Pervan (2005) mention that a mobile DSS has to consist of certain attributes such as personal DSS, group support system and intelligent DSS which involves visualizing and interact with the data to make a decision. These attributes would we argue that the mobile betting application in this study consist of in various ranges. Continuously, Power (2013) mention that a mobile BI can also be categorized as a mobile decision support system as it emerges in the decision support system area.

After long considerations and comparisons to its attributes, we decided to use mobile betting applications as a simulation of a mobile BI application which we discover has more similarities instead of divergences.

## 3.5 Data collection Method

### *3.5.1 Literature review*

Constructing based theory through literature review is the core when conducting a quantitative approach (Recker, 2012). The construct will perform as the basic and fundamental for the research and through adequate literature review, the context of problems within the phenomenon will have a vivid view.

Valuable information within the research field were gathered through literature review was LUB search and Google scholar as primary search engine. Both sites were assisted us to discover useful articles, journals, and online books from *ACM digital library, Springer, IEEE Xplore Digital Library, AIS Electronic Library, Taylor & Francis Online, Emerald Insight* and *ScienceDirect.* As for keywords in literature review encompasses subjects like user experience, visual representation, mobile business intelligence, cognitive fit, and decision making process. Moreover, we divide our literature review filtering approach into two categories. As the first category purpose is to find the core of a theory background, therefore the approach for this review will look for the root of a theory and could have generated an old reference (e.g. from 1970s). Meanwhile for second category, we review on how the phenomenon (e.g. Mobile BI) works these days, so it will have more recent references.

### *3.5.2 Survey and Primary Data Sources Approach*

From the literature review process, we developed a model of constructs and formulated hypotheses in regards to the research area. To be able to test the model of constructs and its hypotheses, empirical data were needed. Taking the consideration that we have a short time frame for the study, cross-sectional field survey were used to collect empirical data as it does not take too much time to conduct this kind of survey. Unlike longitudinal field survey that measure independent and dependent variable in separate time, in cross-sectional field survey both independent and dependent variables will be measured at the same time through single questionnaire (Bhattacherjee, 2012). Moreover, in order to find data that related to the research question, structured in a scientific manner, and have a validity of result, instead of taking a secondary data, primary data source were used for this study.

### *3.5.3 Target Population and Sampling*

As this thesis was using a primary data source, thus targeting population and sampling the respondents is essential. Sampling is needed since it is impossible to collect all the empirical data from entire population and therefore we selected a representative sample from the population of the phenomenon for observation and analysis as suggested by (Bhattacherjee, 2012). In order to conduct this process, Bhattacherjee (2012) proposed three sampling process which are (1) defining target population, (2) choosing a sampling frame, and (3) choosing a sample from a sampling frame.

As the first step, *defining target population* means to target all the people (unit analysis) with characteristics that we want to study on (Bhattacherjee, 2012). Since we would like to know the perception in regards to visual representation and user experience in the decision making process of a mobile BI application in individual user perspective, we took all users of mobile devices that have used application that could be considered as mobile BI application in individual level as our target population.

After the search of a mobile application that could act as a simulation of a mobile BI, we identified mobile betting applications as a match due to its similar attributes which are presented in more detail in the third chapter of this study. Therefore, *the sampling frame* for this thesis was users that have used a mobile betting application. As for an illustration of mobile betting application, *BET 365, Sky Bet, Betsson,* and *Ladbrokes* are some of the most used betting application that is available in a mobile platform.

The last step to perform is a *target population and sampling* which is selecting a sample from the sampling frame. Either probability or non-probability sampling could be used to perform this certain phase (Bhattacherjee, 2012). We were aware that performing probability sampling is the best practice to achieve a generalizable result. Nevertheless, probability sampling requires us to give a non-zero possibility for sampling frame which means that each user of a betting application will have a possibility to be chosen for this study. Since there are many limitations like time and resources limitation within this study, we used non-probability sampling techniques which allow us to give zero possibility for the sampling frame. We conducted this process by distributing the survey to some of the active betting forums in Sweden that we have found through Google search engine. The way we found the forums was by using keywords such as *betting, forums, Sverige,* and mobile betting in the Google search engine. Moreover, the survey was conducted without detail requirements for choosing respondents. As long as they have used mobile betting application, then they considered as a valid respondent.

By the end of the distribution of questionnaire, we have collected 77 responses from different betting forum such as *Sharps, Mrbet,* and *rekatochklart*. We went through 17 betting forums which we felt was reliable to share our questionnaire-based survey. However, there were only four forums that allowed us to post our questionnaire and the remaining forums had a policy were certain activity had to be performed by the users of the forums to be able to create a thread with your own interest. Additional forums which is not directing on betting in general, were also used such as *flashback* and *familjeliv*. Having seen the issues that we had, the collection phase did not give a maximum performance as we had anticipated for and this was due to the issues such as time, access and resource limitation. However, we believe that this amount of responses is sufficient for the study as most of the respondents were most likely has been used this application for a long period of time. Details of the responses will be presented later in empirical findings and data analysis section.

## 3.6 Development of Questionnaire

### *3.6.1 Administration of Questionnaire*

The aim of the formulated questionnaire was designed to study how visual representation and user experience that is provided by mobile BI in mobile application could influence the decision making process for individual users. According to Saunders et al. (2009), the questionnaire can be categorized in accordance with the figure 3.1.

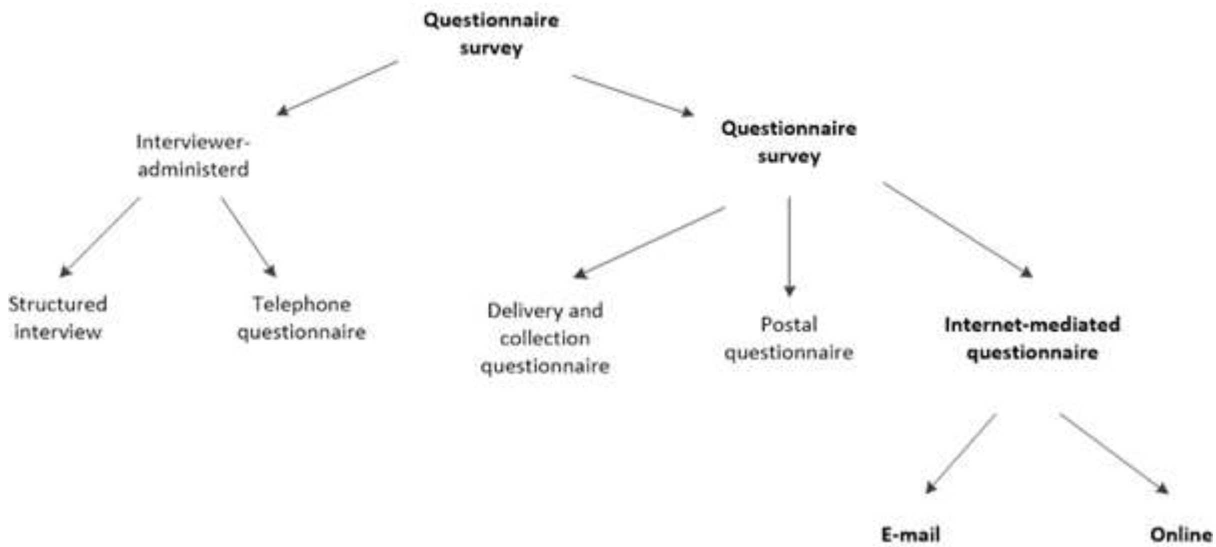



**Figure 3.1: Administration Questionnaire Approach (Saunders et al., 2009)**

In order to obtain the data needed to answer our research question and fulfil the aim of our purpose for this study, we utilized internet-mediated questionnaire in both e-mail and online approach. Henningsson (2004) describes this approach as adequate and less burdened in comparison to the other approaches. Our ulterior motive of selecting the Internet-mediated questionnaire approach was to save time because of its assisting distribution and coding, but it also saved us money for not printing out papers and instead used the function forms in Google. However, the possibility of rejection when using an online questionnaire approach is high in comparison to physical distribution (Yin, 2009). In order to minimize these difficulties, we searched and distributed our questionnaires in relevant meeting points for our potential respondents as for an example betting forums and other forums with threads regarding betting applications.

### *3.6.2 Design of Questionnaire*

Our questionnaire was structured in accordance to Henningsson (2004) design approach of a questionnaire. Initially, the respondents have to feel comfortable and familiar with the subject that is being studied in order for them to provide an honest data transmission. In order to execute, the respondents have to be informed accurately regarding our purpose of the study by a form of required guiding information.

Our questionnaire is based on four constructs (see Appendix 1) in the context of mobile BI. Initially, the first part of this questionnaire is to obtain general information among our target group regarding their usage (e.g. frequency, duration and intention) of the mobile application and personal information (e.g. age). The aim of the first part was to filter from invalidate answers from users who had less experience with the mobile application and obtain valuable responses from experienced users. According to Saunders et al. (2009) the answers from respondents are considered as more valuable when they possess more knowledge regarding the subjects being studied. However, the first part was not heavy included to the analysis section. This was due to the abovementioned aim of this part to increase the overall comprehension and transparency of the study. In total were six questions developed in the first part of the questionnaire with a multiple selection list format.

Moving into the second part of the questionnaire, the questions were developed in accordance with the hypothetical constructs within the proposed model (figure 2.1). In addition to that, in order to increase the validity of the measurement and questions in the designed parts of the questionnaire, we utilized the acquired knowledge from the literature review that has been conducted previously. By having this approach, it designates that the questions developments was not only formulated by the researchers own view but also strictly followed the literature. The objective of this research is to observe the standpoint of the affecting user's behavioural intent and measure their perceived attitude towards betting applications in context of its user experience, visual representation, cognitive fit and decision making process through testing the hypotheses. Therefore, the majority of the questions used a Likert's scale which refers to a survey question and inquires respondent to rate anything in a certain range (Bhattacherjee, 2012). 5-point range scales from *"Strongly Disagree"* to *"Strongly Agree"* were used in our questionnaire. *"Neutral"* scale represents the median of the range. Moreover, multiple choice grid forms were used to facilitate respondents answering the Likert's scale forms.

The first question from the second part manages questions that relates to the construct of user experience and its features as perceived ease of use, perceived of enjoyment and quality of experience of a betting application. The questions were designed to perceive the respondents perception agreement on the eleven different measurement item of the user experience namely, PEU1, PEU2, PE1, PE2, QE1, QE2, QE3, QE4. QE5, QE6, and QE7 as suggested by (Alben (1996); Davis (1989); Davis et al. (1992)).

The second question was measuring the construct of visual representation and had eight developed questions from its features as quality of data (QD1, QD2, QD3, QD4) and sensemaking with its four factors (SE1, SE2, SE3, SE4) as suggested by (Bertin (1983); Borgerson and Schroeder (2002); Cowie and Burstein (2007); Jobson et al. (2002)). The following question manages to measured the construct of cognitive fit and had three questions, namely CF1,CF2, and CF3 which derived from Vessey (1991).

Lastly the fourth question was about the decision making process from a user's perspective which taken from Harrison and Pelletier (2000) and Saaty (2000) which represented by measurement item of DM1, DM2, and DM3. Furthermore as suggested by Bhattacherjee (2012), in order to increase the easy flow of filling in the answers, the layout design of our questionnaire was brief informally.

Below in table 3.1, is the summary of the sources and constructs from the proposed model and its features that is being used to measure each construct with its measurement items.

**Table 3.1: Hypothetical Factors and Measurement Items**

| The Constructs and its features | | Measurement item | Sources |
|---|---|---|---|
| UX | Perceived ease of use | PEU1: I have a clear and understandable interaction with the application | (Davis, 1989) |
| | | PEU2: I do not find the application as cumbersome | |
| | Perceived of enjoyment | PE1:I find it interesting while using the application | (Davis et al., 1992) |
| | | PE2: I find it fun and enjoyable when using the application | |
| | Quality of Experience | QE1: I could understand the flow of the application | (Alben, 1996) |
| | | QE2: I feel the application is well designed | |
| | | QE3: The application fulfill my needs to have a good bet | |
| | | QE4: I find it easy to learn and use the application | |
| | | QE5: I feel please and satisfy when using the application | |
| | | QE6: The application helps me pick my choice immediately | |
| | | QE7: I never have a lag when using the application | |
| VR | Quality of Data | QD1: The data is up to date, so I could create my bet without hesitation | (Borgerson & Schroeder, 2002; Cowie & Burstein, 2007; Jobson et al., 2002) |
| | | QD2: The application provides me a complete perspective in regards to the game that I want to make bet on | |
| | | QD3: I trust this application as it give me a reliable data of the game | |
| | | QD4: I find the data is relevant to my needs | |
| | Sensemaking | SE1: I can associate objects (e.g. tables, charts and graphs) as a supporting tool to increase my prior knowledge of betting | (Baker et al., 2009; Bertin, 1983) |
| | | SE2: I can see patterns in the data and it increases | |

| The Constructs and its features | Measurement item | Sources |
|---|---|---|
| | my prior knowledge about betting | |
| | SE3: I can utilize my previous betting accomplish-ment to increase my betting approach | |
| | SE4: I can capture hidden information by using my betting experience | |
| Cognitive Fit Theory | CF1: I prefer to have perceptual point of view about the game in the application in order to pick my choice of bet rather than have a discrete data representation | (Vessey, 1991) |
| | CF2: My interaction with the application could help me understand the data representation | |
| | CF3: The experience helps me to understand the data within the application | |
| Decision Making Pro-cess | DM1: The application could convince my choice that I want to make bet on | (Harrison & Pelletier, 2000; Saaty, 2000) |
| | DM2: I could also have an alternative option to choose when using the application | |
| | DM3: I could track the game through the application after I place my bet | |

### *3.6.3 Questionnaire Pilot Test*

To ensure the envisioned quality of the questionnaire, we conducted a pilot test of the questionnaire intended to be used for this study. According to Henningsson (2004) it is rarely that one's designed questionnaire is faultless and in order to reduce the mistakes, it is suggested to conduct a pilot test. Additionally, the aim of a pilot test is to enhance the questionnaire so the respondents would not have any problems with the data transmission and continuously minimize the difficulties of using the empirical data from the questionnaire (Saunders et al., 2009). Additionally, Bhattacherjee (2012) describes that it will increase the validity and reliability to the concepts of the questionnaire.

We distributed the questionnaire to persons in betting forums and other forums with threads regarding mobile betting applications in order to receive proper answers from our targeted group. The respondents also provided with specific propositions on how to increase the quality of our designed questionnaire. The difficulties mentioned in the pilot test were:

The formulation of the questions that was considered to be too intricate

- Avoid the perspectives from organizations and focus on the user's' point of view
- Reformulate the questions to increase make it more understandable for a general user of a betting application
- Spelling mistakes
- Redundancy of the questions

With the recommendations provided to us, enhancements of our questionnaire were conducted. The only difficulty which we were not able to resolve was the redundancy of the questions. Unfortunately, the designed questions followed the direction of the constructs from our proposed model and therefore all of the presented questions have to be answered in order for us to identify and measure the associations between the factors within our proposed model. Adjustments that could be made were reformulating the questions to make it seem dissimilar from the other ones. When the final version was made, we were able to distribute to all the selected forums.

## 3.7 Quantitative Analysis Method

Analyzing the data is the next vital step after the data have been collected. As this study conducted a quantitative method for collecting data, therefore numbers were used to represented values and levels of theoretical construct. Interpretations of data were processed through statistical capability and have shown stronger evidence since through statistical analysis and leads to covered hidden truth of how the phenomenon works (Recker, 2012). The types of analysis that have been used for this study are descriptive analysis and inferential analysis. While descriptive was used to analyze and describe the aggregation between the construct, inferential was used to test the hypotheses that have been created in previous phases (Bhattacherjee, 2012). SPSS, SPSS Amos, and Microsoft Excel were used to perform data analysis.

Before we could analyze the data, converting the raw data (text) into a machine-readable (numerical) format was needed before using SPSS and SPSS Amos as the supporting software since the statistical analysis could only carried out in a numerical data format. Having that stated, preparation of collected data which consist of data coding, data entry, missing value, and data transformation must be obtained (Bhattacherjee, 2012).

On the data coding phase, we converted the data that was generated from the questionnaire into a numeric format through codebook that created as a guideline at the coding process. Since we used five points Likert's scale, then we considered this phase as an important phase since the generated code will represent the data from the questionnaire that will be used for the rest of the analysis process. The anchors range from "*Strongly Disagree"* to *"Strongly Agree"* and we coded *"Strongly Disagree"* as 1 and *"Strongly Agree"* as 5, while 3 represents *"Neutral"*. The data that have already being coded in previous step were entered into an excel spreadsheet before it was processed through SPSS. Although SPSS have the data entry functionality, we prefer to enter the coded data into a spreadsheet because it provides more flexibility when it comes to reorganize and sharing the data for further research. When it comes to missing the data value, we were aware that there is a high possibility on every research of missing a value within the datasets and some supporting software could handle this issue through the ability of listwise deletion which is a function that could drop the entire observation that contains a single missing value (Bhattacherjee, 2012). However, since we have a limited amount of responses, instead of using listwise deletion, we used imputation process that uses the average of the respondent's responses to remaining items on the scale (Bhattacherjee, 2012). Data transformation was not performed as well in this thesis as we do not have a reverse value in the questionnaire.

After the data preparations, the descriptive analysis with univariate analysis approach was conducted to present the result of demographic of respondents and also the results of each factors based on the measurement items that have been assigned previously. Motivation behind this particular process was to allow authors to see the patterns and have a good sense-making through the collected data. Furthermore, bar charts were used to represent the data to see the perceptual point of view of findings. The Following step was conducted using a bivariate analysis to allow authors find the correlation between constructed items. Taking the consideration that this study wanted to prove the proposed hypotheses, therefore finding a correlation within each construct is needed before interpreting the causational relationship between each constructs.

The final step of analyzing the data and the relationship within our proposed model and hypotheses was performing the inferential analysis. Structure Equation Modelling (SEM) technique was used as it could handle both factorial and regression analysis or well known as path analysis to see the causational relationships among the variable (Hox & Bechger, 1998). As we could see in figure 3.2, in order to test our hypotheses we used four unobservable variables (presented in square) whereas the observable variables which represented in circle were used in the questionnaire to measure the unobservable items. Path coefficient and statistical significance within the factors will be calculated once the hypothetical factors were tested through the observed variable. Moreover, on this phase, we also performed a bootstrap approach as suggested by Preacher and Hayes (2008) in order to figure if there is an indirect relationship within the proposed model.

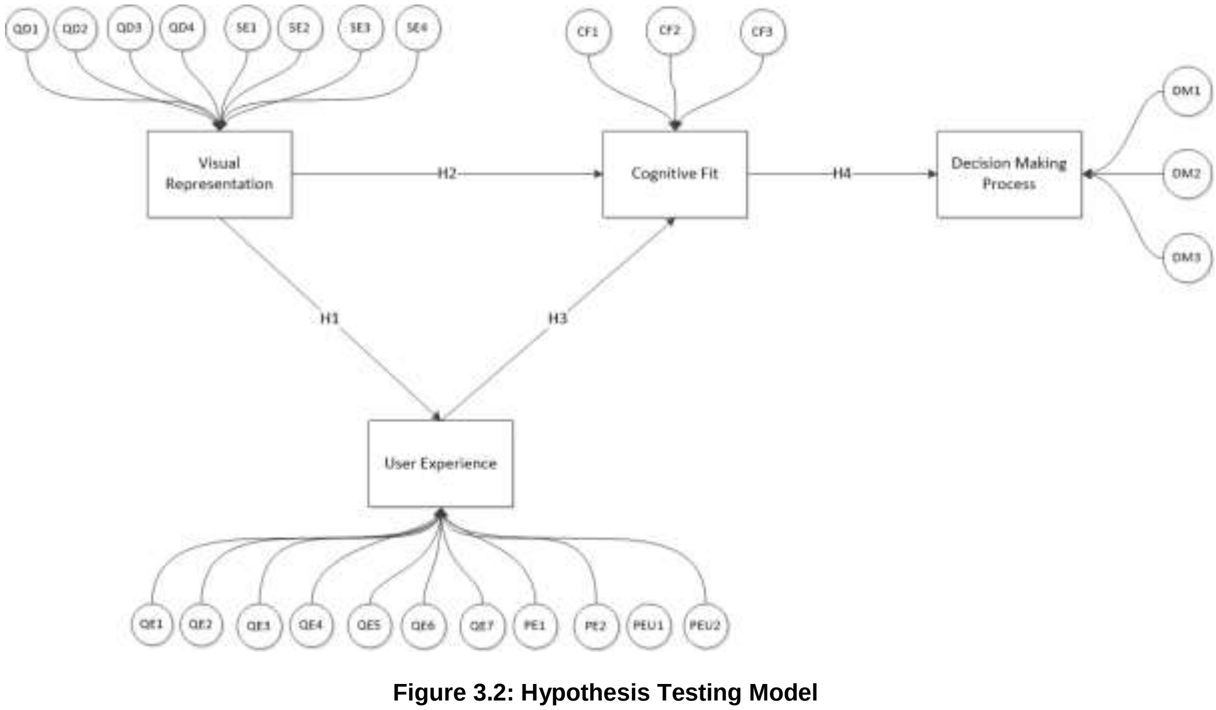



**Figure 3.2: Hypothesis Testing Model**

## 3.8 Quality and Ethics

An important aspect that has to be considered when doing a research is the ethic and quality of a research. Without these two aspects then the research will give a worthless contribution for science. To have a better quality, we followed aspects of research such as validity and reliability which considered as the most important one when it comes to the quality of paper (Seale, 1999).

### 3.8.1 Reliability

According to Bhattacherjee (2012), reliability refers to the degree which is the measure of the construct is consistent. In simple words, if we use this scale of measure within the same construct multiple times, we will have the same result, assuming the context of phenomenon is not altering. Straub, Boudreau, and Gefen (2004) discussed numerous reliability test including internal consistency (Cronbach's alpha), composite reliability, split-half reliability, test-retest reliability, inter-rater reliability and many more. Conducting test-retest reliability to measures the consistency between measurements of the same construct at different type is a best practice method for this study as it could give more reliability standpoint (Bhattacherjee, 2012). Nevertheless, time limitation and limited access to respondents became the biggest issue to conduct such test in this research. Therefore, we used internal consistency reliability test which represented by the coefficient of Cronbach's alpha. This approach measures the constructs through variety of items within the same instrumentation (Straub et al., 2004). The result of internal consistency will be described more detailed on the next chapter.

### 3.8.2 Validity

Validity describes whether the data that has been collected could measure the measurement that has been formed by a researcher (Recker, 2012). According to Bhattacherjee (2012), in order to measure the validity of a research, theoretical and empirical approaches must be conducted. While theoretical approach focusing more on the idea of theoretical construct that is translated into an operational measure, empirical approach is assessing how the measure related to external criterion.

We divided our measurement of the validity into two category which are validity within the questionnaire (measurement items that been used) and within the hypotheses. In order to comprise validity within the questionnaire, the convergent and the discriminant validity test were conducted. We were using the average variance extracted (AVE) which could measure both convergent and discriminant validity (Zaiţ & Bertea, 2011). Throughout the test, AVE coefficient of each construct in convergent will be used further to figure the discriminant validity (Fornell & Larcker, 1981).The result of both convergent and discriminant validity will be presented in the next chapter.

On the hypotheses validity testing, we considered three approaches that proposed by Bhattacherjee (2012) which are, internal validity, external validity, and statistical conclusion validity as our approach to test the validity of each construct of hypothesis. We were aware that when using field survey, it could give high external validity (generalizability) but it will give low internal validity at the same time. In order to avoid the low internal validity, we were using the previous theory by researchers as measurement items in the construct. We assumed that the items were already been validated and suitable for this study. For checking the statistical conclusion validity, as we wanted to check the causal-effect relationship between each model of construct, we followed steps that proposed by Bhattacherjee (2012) and Recker (2012) to analyze the data. Those steps are already mentioned in Quantitative Analysis Method section.

### *3.8.3 Ethics*

According to the dictionary, ethic is defined as a conformance to the standards of conducts within a given profession or group. The standards usually formed in a disciplinary level such as code of conduct (Bhattacherjee, 2012). In this research, we were using four ethical principles that proposed by Bhattacherjee (2012) to have an integrity when doing the research. As for the principles are (1) volunteer participation and harmlessness, (2) anonymity and confidentiality, (3) disclosure, and (4) analysis and reporting.

Since we were using questionnaire as data collection method, at the start of the questionnaire (see Appendix 2) we informed that this questionnaire is a voluntary and respondent could withdraw anytime from the survey. Although we believe anonymity is not a necessarily big issue in this study as in the instrument development process, this survey was designed to be anonymously answered and therefore confidentiality was not an immense problem as well. For the third principle we presented the research purpose, the expected outcome (which will have the benefits and details about their anonymity), confidentiality, and conduct a harmlessness approach for respondents in their participation. Lastly, result of this study was reported as it is, regardless the negativity and unexpected outcome.

# 4 Empirical Results and Data Analysis

## 4.1 Demographic

### *4.1.1 Respondents Profiles*

By the end of this study, we managed to obtain data from 77 respondents and according to A*ppendix 3*, the average age of the respondent's lies between 18-25 years old. Respondents at the age of 18-25 represents 68.7%, age of 26-33 represents 22.9%, age of 34-41 represents 4.8% and lastly age above 42 represents 3.6%. The dominant age group is respondents that are 18-25 years and consequently the recessive age group is respondents above 42 years old. The motive behind the result is probably due to that betting applications being fairly new to the market and often new technologies in context of games and sports is directed to a younger target group rather than the older group. Concerning the experience from the respondents, the majority have more than six month of experience with a betting application which by observing *Appendix 3*, it illustrates the total percentage of each experience-duration for our respondents. Additionally, the frequency of using a betting application also dominates by the age group of 18-25. The majority of the respondents are using a betting application weekly with 44.6% (*Appendix 3*).

Due to the type of application that is being used by the respondents such as *Betsson* and *Bet365* which is the most predominant betting application in the Swedish market, we can assume most of the respondents have a Swedish background. But in regard to the substitute tools that are being used, the majority of the respondents with 56.6% (*Appendix 3*) requires some form of tool that complements the betting application and the majority of the respondents prefer to utilize the information shared in websites with focus in sport news (*Appendix 3*).

## 4.2 Analysis of Proposed Model

This section will discuss about our analysis in regards to the empirical data. Microsoft Excel, SPSS, and SPSS Amos were used to conduct statistical analysis which encompasses both descriptive and inferential analysis to answer the proposed research question.

### *4.2.1 Measurement Assessment Analysis*

As we mentioned in the methodology chapter, reliability and validity of questionnaire that is used for collecting data must be achieved. Therefore, before analyzing the collected data, we assessed our internal consistency to check our measurement reliability and construct validity to measure the validity of our proposed model.

In regards to check the reliability of the measure of the construct within our model, we applied Cronbach's Alpha methodology to evaluate the consistency as this approach has the ability to measure the consistency between items within a construct (Bhattacherjee, 2012). In general, higher Cronbach's alpha means strong internal correlation among items within the constructs. While coefficient of 1.0 is the maximum amount in Cronbach's alpha, ideally Nunnally and Bernstein (1994) argued that having a coefficient of Cronbach's alpha at least above 0.7 is required to have a reliable measurement. However, this method is quite sensitive to the number of scales. In this particular case, it is appropriate to report the mean inter-item correlation as suggested by Briggs and Cheek (1986) whom recommend an optimal range for inter-item correlation of 0.2 to 0.4. In this approach, we were assessed all the items within our proposed model namely user experience which represented by perceived ease of use, perceived enjoyment, and quality of experience, visual representation which represented by quality of data, and sensemaking, and cognitive fit theory, as well as the decision making process.

In our proposed research model, the Cronbanch's alpha for decision making process construct fall short to attain the limitation that suggested by Nunnally and Bernstein (1994) ($\alpha = 0.629$), this could be caused by the low number of scales that have been used during this study. Drawback of low number of scales could also being seen on cognitive fit construct that only reach 0.705 on Cronbach's alpha. However, these two construct did have a good number of inter-item correlation as suggested by Briggs and Cheek (1986) which illustrate that our model's internal consistency is adequate and it means our measurement of construct is reliable for this study. Coefficient details of each item Cronbach's alpha and its inter-item correlation are presented in table 4.1.

For checking the validity construct of our model, we conducted a convergent and discriminant validity test which was suggested by Bhattacherjee (2012). In the following table 4.1, we could see our convergent validity model which was represented by the amount of Average Variance Extracted (AVE) is high since all the values (ranged from 0.553 to 0.714) are above 0.5 as recommended by Fornell and Larcker (1981). It means that each construct which represented by the measurement items is having a high validity within the related construct.

**Table 4.1: Summary of the Reliability and Validity Measurement**

| Construct/Hypothetical Factors | Cronbach's Alpha / Inter-Item Correlation | Average Variance Extracted (AVE) |
|---|---|---|
| Decision Making Process* | 0.629 / 0.360* | 0.638 |
| Cognitive Fit* | 0.705 / 0.446* | 0.714 |
| Visual Representation | 0.807 / 0.344 | 0.553 |
| User Experience | 0.792 / 0.286 | 0.597 |

(* use only 3 number of scale)

As related construct has been measured through convergent validity, in order to check the validity with the other unrelated constructs, the discriminant validity was used. This approach was comparing the square root of AVE with correlation among any pair of latent construct. Proposed by Fornell and Larcker (1981), larger coefficient of square root of each construct compared to correlation of specific construct with any other construct indicates good discriminant validity. In the following table 4.2, we could see that the entire squared AVE coefficient has a greater amount compared to the square of correlation of each construct which means our questionnaire and hypotheses have a high construct of validity.

**Table 4.2: Discriminant Validity Measurement**

| Component | DMP | CF | VR | UX |
|---|---|---|---|---|
| Decision Making Process (DMP) | **.799** | | | |
| Cognitive Fit (CF) | .520 | **.845** | | |
| Visual Representation (VR) | -.010 | .275 | **.744** | |
| User experience (UX) | .132 | .179 | .466 | **.773** |

### *4.2.2 Descriptive Analysis*

Following section presents the obtained data from our questionnaire-based survey. Main points regarding the constructs and indicators from the proposed model were discussed and in

*Appendix 4* presents the standard deviation, general mean value and the mean value for each item. The lowest mean value is 3.26 which represent the QE6, either way it still leans to represent a positive outcome. PE1 represents the highest mean value with a value of 4.16. The average of the mean values is 3.74 which overall indicates a strong positive perception and attitude towards the constructs but also gives us an indicator that the majority of the answers ranged from neutral to agree. Following figures in this section will present the percentage of the responses for each construct in form of bar charts. *Appendix 5* will also provide a summary of the descriptive statistics.

**Decision Making Process**

According to *Appendix 4,* the average means value of decision making represent the second lowest value in comparison to the other constructs with a score of 3.52. DM1, DM2 and DM3 scored the values of 3.61, 3.65, and 3.66. These values implies that users have a positive perception towards the decision making process in a mobile betting application.

In response to whether the application could convince the user’s choice of betting (DM1), 55.9% answered either ‘agree’ or ‘strongly agree’, 41.6% were ‘neutral’ and only 2.6% was disagreeing. With regard to whether the user could have an alternative option to choose when using the application (DM1), 63.6% were either agreeing or strongly agreeing and 36.4% has a neutral standpoint. Lastly, there was 62.3% that answered ‘agree’ or ‘strongly agree’, 36.4% that answered ‘neutral’ and 1.3% that disagreed to DM3 which was measuring whether the user could track the game through the application after they placed a bet.

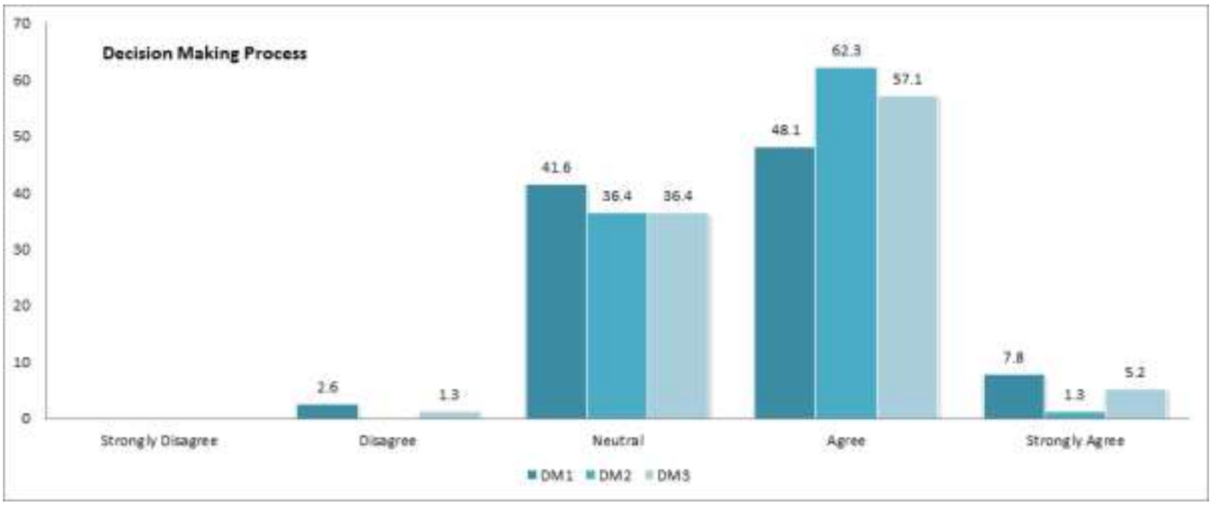



**Figure 4.1: Responses (%) on the Decision Making Process**

## Cognitive Fit

Following construct in this paragraph falls in the category as cognitive fit in context of a mobile betting application. Cognitive fit scored an average mean value of 3.39 and therefore represents the lowest value out of the seven features of the constructs. CF1 and CF2 represent 3, 49 and 3.58 as the mean values. The average mean value still results to a positive perception towards the cognitive fit in a mobile betting application.

Moving on to the CF1 which is measuring whether the user of an application know what team or person they want to place a bet on before using the application, one can observe that 51.9% had a neutral standpoint, approximately 46.8% either agreed or strongly agreed and the whole 1.3% disagreed. Moreover, 49.4% had a neutral standpoint and also 49.4% either agreed or strongly agreed to the interaction with the application could help the user to understand the data representation that is provided by the application (CF2) with only 1.3% disagreeing. Regarding the CF3 which measuring the experience that is offered by the application, helps me the user to understand the data that is provided within the application, had 61% agreeing, 36.4% answering 'neutral' and 2.6% disagreeing.

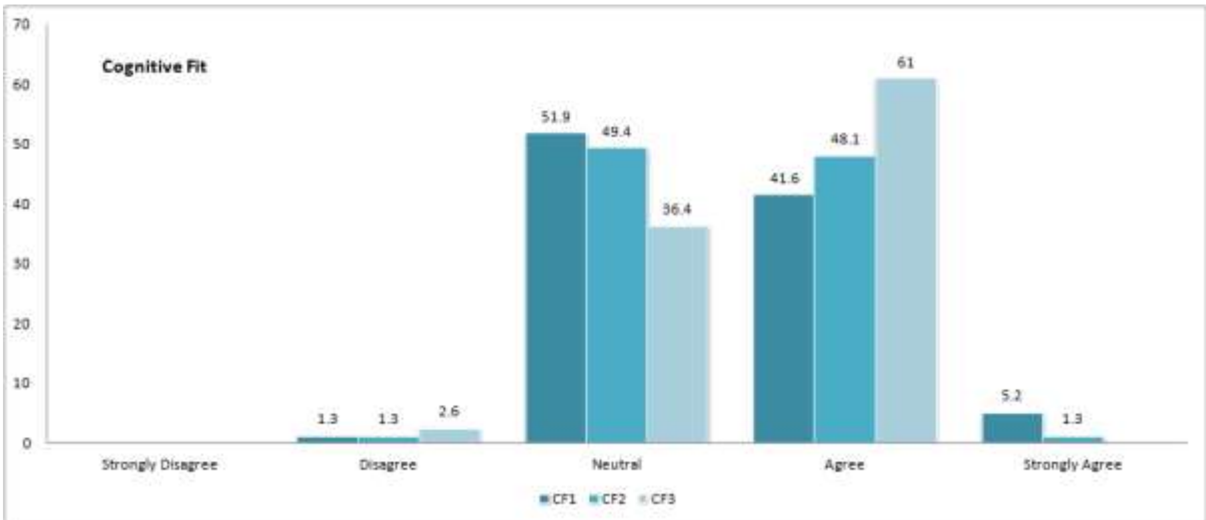



**Figure 4.2: Responses (%) on Cognitive Fit**

### Visual Representation - Quality of Data

The average mean value on the quality of data is 3.95 which in result can translate to a similar perception and attitude towards the quality of the data in a betting application. By perceiving the four questions regarding the quality of the data, one can see in *Appendix 4* that the mean value represents 4, 3.7, 4.06 and 4.05. This result indicates a positive perception towards the quality of data.

Concerning the QD1, which was measuring the data that is presented in the application, is up to date so the user could place a bet without hesitation, only 1.3% disagreed, 10.4% were 'neutral' and 88.3% either 'agree' or 'strongly agree'. Furthermore, 3.9% were answering 'disagree' or 'strongly disagree' to QD2 which was measuring whether the application provided the user a complete perspective in regards to the game. The remaining were answering 29.9% to 'neutral' and 66.2% to either 'agree' or 'strongly agree'. Meanwhile, in the measurement item about whether the user trust the application in regards to its data (QD3), only 1.3% strongly disagreed, 10.4% were 'neutral' and 88.3% either answered 'agree' or 'strongly agree'. For the last item (QD4), 11.7% were 'neutral' and 88.3% either agreed or strongly agreed to the measurement item.

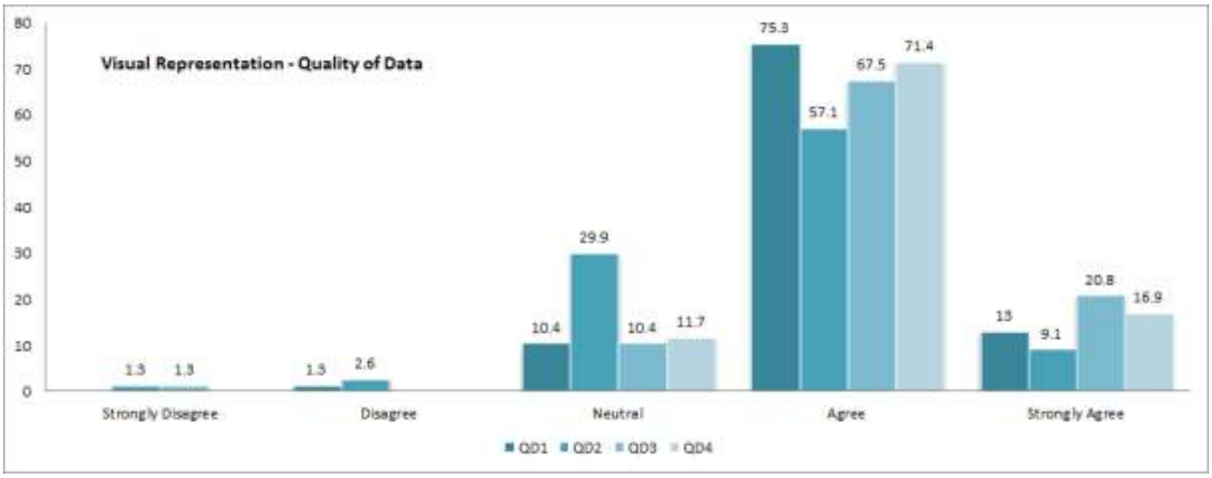



**Figure 4.3: Responses (%) on Quality of Data**

### Visual Representation - Sensemaking

The last construct of visual representation is sensemaking which scored an overall mean value of 3.86. SE1, SE2, SE3 and SE4 accounted for the positive value of 3.88, 4.01, 3.82 and 3.74 respectively.

The first item SE1, which was measuring whether the user can associate objects (e.g. tables, charts and graphs) as a supporting tool to increase the prior knowledge of betting to have better choices when using the application, had 82.8% answering either 'agree' or 'strongly agree', 16.9% were 'neutral' and only 1.3% disagreed. In addition, 85.7% was agreeing and strongly agreeing to the second measurement item (SE2) which was measuring if the user can see patterns in the presented data and it increases its prior knowledge about betting to have better choices. But the remaining 14.3% had a neutral perspective. For S3, there were 6.5% that disagreed to whether the user can utilize the previous betting accomplishment to increase its betting approach to have better choices. Additionally, 18.8% were 'neutral' and 75.3% either 'agree' or 'strongly agree'. Finally, regarding if the user can capture hidden information by using its betting experience to have better choices, only 5.2% answered ‘disagree’, 22.1% answered ‘neutral’ and 72.7% answered ‘agree’ or ‘strongly agree’.

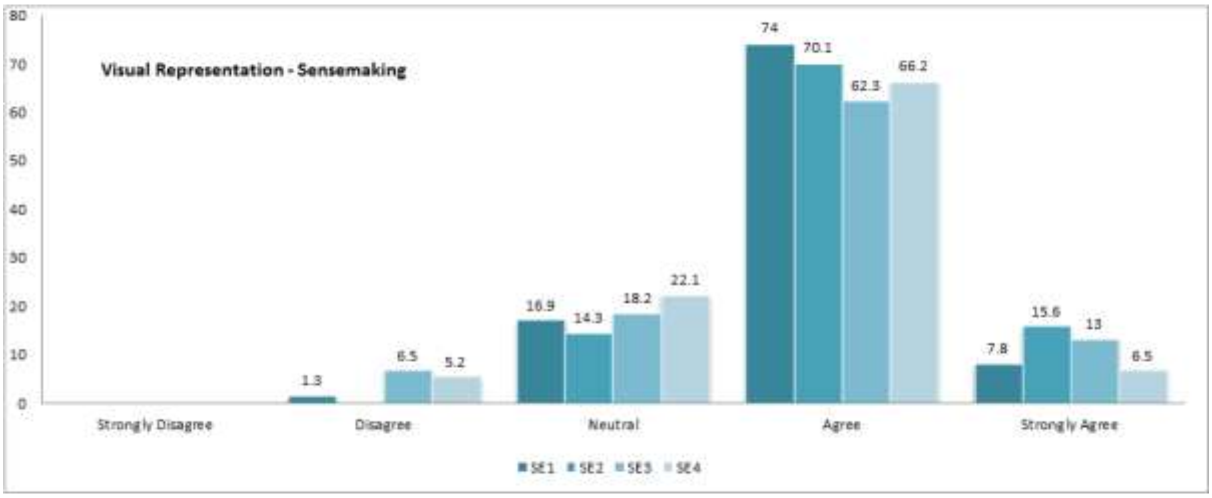



**Figure 4.4: Responses (%) on Sensemaking**

### User experience - Quality of Experience

Starting from the content, the overall mean value for the quality of experience is set to be 3.75 which translate to a positive perception and attitude from the respondents towards the user experience of a betting application. Furthermore, the answers to this subject ranged mostly from neutral to strongly agree. QE1, QE2, QE3, QE4, QE5, QE6 and QE7 scored 4.12, 3.95, 3.71, 3.99, 3.65, 3.26, and 3.58 respectively which in overall indicates that the users of a betting application has a positive perceptions regarding the quality experience.

QE1 represents whether the user could understand the flow of the application and 9.1% of the respondents were ‘neutral’ and the remaining 90.9% were agreeing or strongly agreeing. Moreover, the users feel that the application is a well-designed application (QE2), 24.7% were neutral and 75.3% were either agreeing or strongly agreeing. In addition, 72.7% was either answering ‘agree’ or ‘strongly agree’ regarding the third measurement item (QE3) which represent if the application fulfil my needs to have a successful bet. The remaining respondents answered 23.4% to ‘neutral’ and 3.9% to ‘disagree’. On the other hand, 80.5% either ‘agree’ or ‘strongly agree’ to QE4, this was measuring whether the user did find it easy to learn and to use the application. Unceasingly, 15.5% were ‘neutral’ and 3.9% ‘disagree’. Regarding QE5, this involves if the user is feeling pleased and satisfied when using the application, 63.6% answered ‘agree’ or ‘strongly agree’, 33.8% were ‘neutral’ and only 2.6% disagreed. Furthermore, 48.1% either ‘agree’ or ‘strongly agree’, 33.8% were ‘neutral’ and 18.2% either ‘disagree’ or ‘strongly disagree’ to the sixth measurement item (QE6) which is measuring whether the application supports the user to pick a bet at this instant. Lastly, 59.8% were whether agreeing or strongly agreeing to the last measurement item (QE7). This item involves the degree of lagging in the betting application. The residual were 29.9% to ‘neutral’ and 10.4% either ‘disagree’ or ‘strongly disagree’.

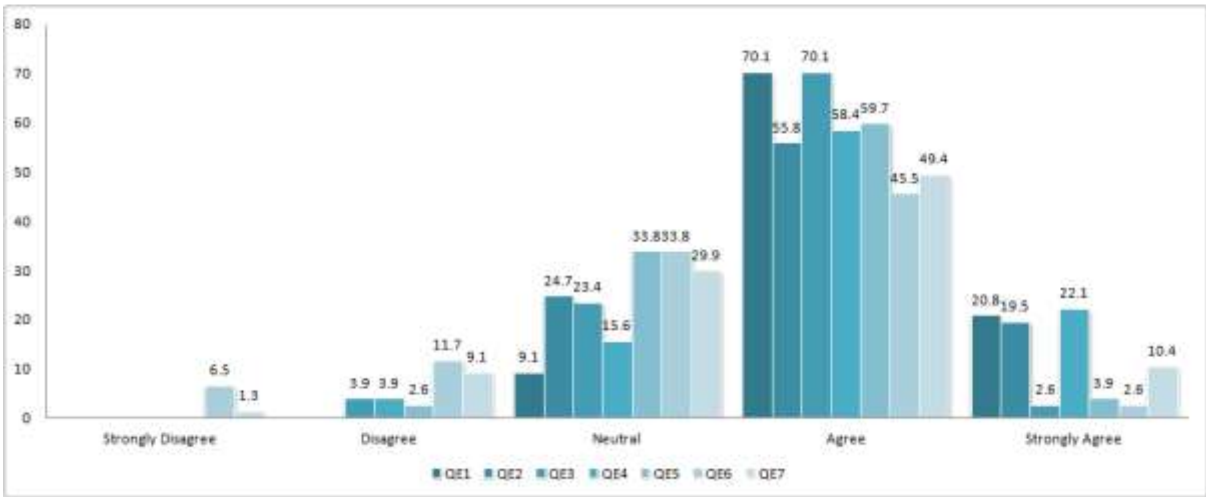



**Figure 4.5: Responses (%) on Quality of Experience**

## User Experience - Perceived Enjoyment

For the perceive enjoyment in the context of user experience, the average mean value is 4.04 which is marginally higher than the quality of experience. By translating the value, one can argue that the respondents have a positive perception concerning the quality of experience of a betting application. PE1 represents the mean value of 4.16 and PE2 scored 3.91. Overall the result implies the users of a betting application have a positive perception towards the perceive enjoyment.

In consideration to the first measurement item (PE1), 87% either 'agree' or 'strongly agree', 9.1% were 'neutral' and the remaining 3.9% 'disagree'. The first measurement item involves the interest degree from the user in regard to the mobile betting application. Alternatively, PE2 which measures the degree of fun and enjoyment of using the application, represent 77.9% as respondents that has answered either 'agree' or 'strongly agree', 20.8% that had a neutral view on the item and only 1.3% that disagreed.

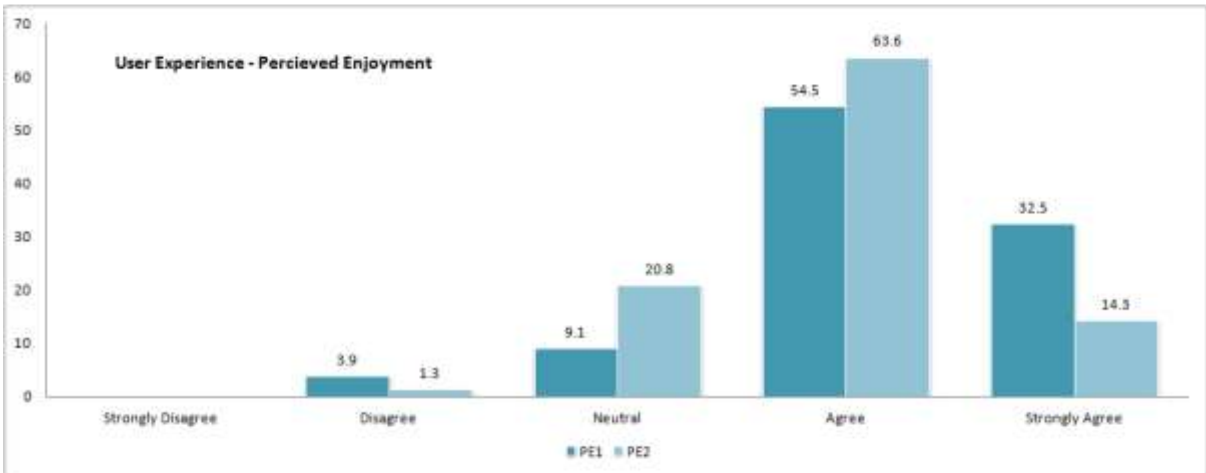



**Figure 4.6: Responses (%) on Perceived Enjoyment**

**User Experience - Perceived Ease of Use**

Regarding the perceive ease of use, its average mean value set to be 3.91. Subsequently, all of the questions regarding the perceive ease of use scored virtually up to the value of 4.0 which shows that more respondents agreed or strongly agreed within this field rather than to have a neutral stand attitude. PEU1 and PEU2 have set a value of 4.01 and respectively 3.81. This indicates a proven and positive perception towards the perceived ease of use from the user of a mobile betting application.

To begin with, 84.4% either 'agree' or 'strongly agree' with PEU1 and this involves the understanding interaction with a betting application. The remaining respondents answered 14.3% as 'neutral' and 1.3% as 'disagree'. Finally, PEU2 which ask the if the user do find the application as a cumbersome application, presents 76.6% that has either 'agree' or 'strongly agree', 20.8% that is 'neutral' and last of all 2.6% that 'disagree'.

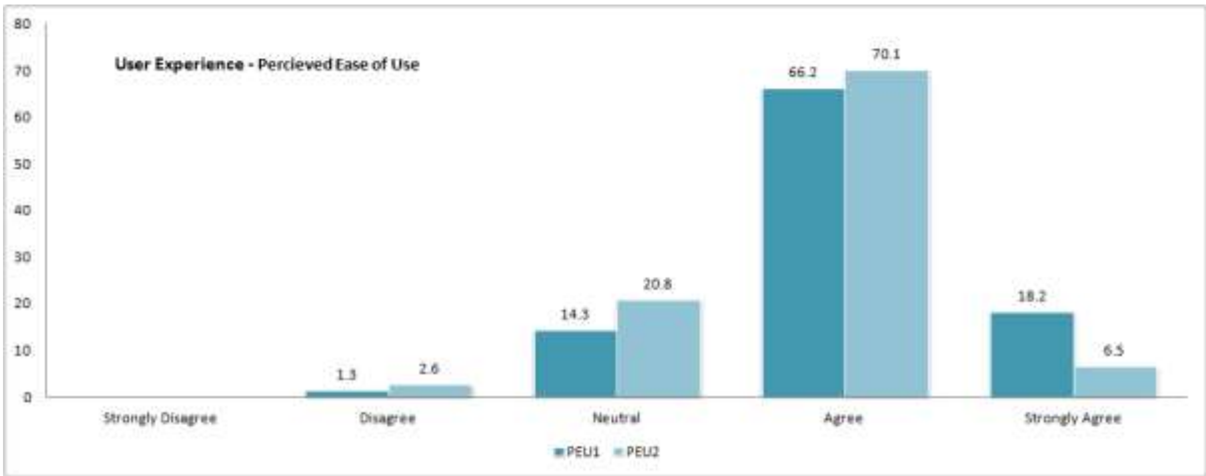



**Figure 4.7: Responses (%) on Perceived Ease of Use**

### *4.2.3 Inferential Analysis*

Before we conducted a path analysis to test the proposed model, correlation between each construct were tested. Pearson's correlation was used in order to find out the correlation between each construct (Bhattacherjee, 2012; Pallant, 2013). While a value from -1 to 0 means there is a negative correlation between the constructs within proposed model, 0 means a neutral correlation, and 0 to 1 means there is positive correlation between the construct. In table 4.3 we could see details of the correlation for each construct within the proposed model. Other than the correlation between user experience and cognitive fit (-0.32), the remaining constructs had a positive correlation with each other. It indicates potentially user experience will not affecting cognitive fit as much as other variables.

**Table 4.3: Correlation between Construct**

| | DMP | CF | VR | UX |
|---|---|---|---|---|
| Decision Making Process (DMP) | 1 | | | |
| Cognitive Fit (CF) | .230* | 1 | | |
| Visual Representation (VR) | .337** | .149 | 1 | |
| User Experience (UX) | .285* | -.032 | .713** | 1 |
| **. Correlation is significant at the 0.01 level (2-tailed). | | | | |
| *. Correlation is significant at the 0.05 level (2-tailed). | | | | |

After conducting a correlation analysis within the construct, path analysis was used for this research in order to test the proposed hypothesis and measure the causational relationship between the constructs within the proposed features. Structural equation model technique (SEM) through IBM SPSS AMOS was used to perform path analysis. Figure 4.8 represents the result of the path analysis, which describes standardized path coefficient and its significance between each construct within the model. (See. *Appendix 6* for more detail in regards to the result of the path analysis)

The proposed hypotheses were represented through each arrow line within the construct model (see. Figure 4.8) and each arrow is pointing to the dependent variable from an independent variable. Asterisk (*) symbol in the middle of the arrow means that the independent variable is statistically significant (in 0.05 level) to the dependent variable which means that 95% of the variable which mean it supports the proposed hypothesis. In contrast, arrow with no asterisk symbol means that causational relationship within the variable is not significant which imply to uncertainty of the proposed hypothesis. Furthermore, the values that were placed in the middle of the arrow are the path coefficient (beta or β) between independent and dependent variable. It is signifying how strong the independent variable could influences dependent variable. R square ($R^2$) in the construct represent percentage of variance on the dependent variable that could be explained other variance by its independent variable.

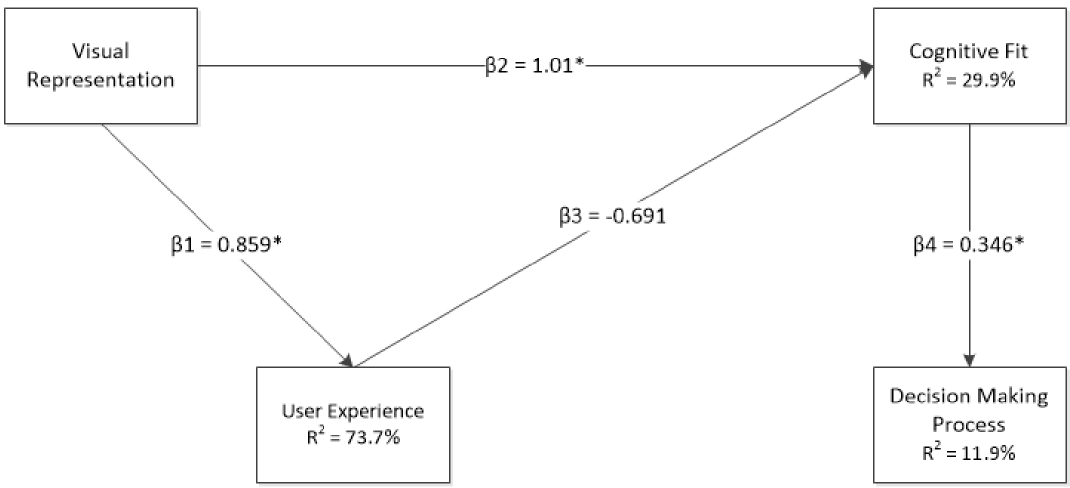



**Figure 4.8: Result of Path Analysis**

Based on path analysis that was conducted for this study, we figured that there are three regressions that were contained within the proposed model. In order to summarize these findings, details on each regression is described in table 4.4. The table contains independent and dependent variable of each regression along with its R square correlation.

**Table 4.4: Summary of Regression**

| Path Analysis | Independent Variable | Dependent Variable | R Square ($R^2$) Correlation |
|---|---|---|---|
| Regression 1 | Visual Representation | User Experience | 73.7% |
| Regression 2 | Visual Representation<br>User Experience | Cognitive Fit | 29.9% |
| Regression 3 | Cognitive Fit | Decision Making Process | 11.9% |

### Regression 1

In the first regression, H1 was tested. The hypothesis addressed a relationship between visual representation and user experience in mobile BI context. As we can see in figure 4.8, visual representation which is an independent variable has a positive effect on user experience of mobile BI. Path coefficient (beta) in this linkage reaches as high as 0.859 with a significance level on 0.05. Thus, it supports the proposed hypothesis (H1). Hence, if better visual representation was provided by a mobile BI application, more likely the user will have a better user experience. In addition, the visual representation could also explicate 73.7% of the variation variable in the user experience.

### Regression 2

Second regression has two independent variables which are the visual representation and the user experience and a dependent variable which represents the cognitive fit. This regression was testing the second and third hypothesis (H2 and H3). Nevertheless, while beta coefficient between visual representation and cognitive fit is 1.01 with a significant level of 0.05 which mean that visual representation has a positive influence to cognitive fit, the relation between user experience and cognitive fit has a statistical significance level above 0.05. Hence from the result that was mentioned above, H2 is supported while H3 is rejected. From this result, it is evident that cognitive fit is positively influenced by the visual representation standpoint in the context of mobile BI application. However visual representation will not give an indirect positive influence to cognitive fit through the user experience despite our first regression has suggested that visual representation is influencing the user experience positively. However, the cognitive fit could explain 29.9% of the variation variable both in visual representation and user experience.

### Regression 3

Lastly, our regression was testing the fourth hypothesis (H4). Cognitive fit come as an independent variable for the decision making process which is the dependent variable. According to the result that was presented previously in figure 4.8, cognitive fit has a positive influence for the decision making process by having a beta coefficient of 0.346 with a significance level on 95% ($p<0.05$) and therefore the fourth hypothesis is supported. Having that stated, we could argue that the better fit occurred within the cognitive fit (See. Section 2.3), the better decision making process will be made by an individual user of a mobile BI application. Moreover, decision making process can explain 11.9% of the variation variable in cognitive fit construct.

The result of regression for each proposed hypothesis is summarized within table 4.5. From all the proposed hypotheses, as mentioned previously, the third hypothesis is not supported.

**Table 4.5: Hypothesis Test Result**

| Path Code | Hypothesis | Result |
|---|---|---|
| VR -> UX | H1 | Supported |
| VR -> CF | H2 | Supported |
| UX -> CF | H3 | Not supported |
| CF -> DMP | H4 | Supported |

### Indirect Relationship

After having the regression testing, we were performing bootstrapping approach (5000 boot-strap sample with 90% confident level) in order to find an indirect relationship between visual representation to cognitive fit through UX, visual representation to decision making through cognitive fit, and UX to decision making through cognitive fit. As suggested by Preacher and Hayes (2008), we were looking at the bias-corrected confidence interval (lower and upper bounds) to carry out the result of our approach. Coefficient below zero (0) showing that there is no indirect relationship between the constructs. Result from the interval is presented in table 4.6 and table 4.7.

**Table 4.6: Indirect Effect: Lower Bounds**

| Path Code | Visual Representation (VR) | UX | CF | DMP |
|---|---|---|---|---|
| User Experience (UX) | .000 | .000 | .000 | .000 |
| Cognitive Fit (CF) | -5.235 | .000 | .000 | .000 |
| Decision Making (DM) | .000 | -3.032 | .000 | .000 |

**Table 4.7: Indirect Effect: Upper Bounds**

| Path Code | Visual Representation (VR) | UX | CF | DMP |
|---|---|---|---|---|
| User Experience (UX) | .000 | .000 | .000 | .000 |
| Cognitive Fit (CF) | -.055 | .000 | .000 | .000 |
| Decision Making (DM) | .882 | -.011 | .000 | .000 |

Having seen the result, we can conclude that visual representation has indirect relationship with decision making process through cognitive fit (lower bounds: .000; upper bounds: .882) while the on the similar context, visual representation does not have an indirect relationship with cognitive fit through user experience (lower bounds: -5.235; upper bounds: -.055). In addition, UX does not have indirect relationship with decision making process through cognitive fit (lower bound = -.3032 and upper bounds = -.011).

# 5 Discussion

## 5.1 Decision Making Process

The result of the descriptive analysis concerning the construct of decision making process for users of a betting application, revealed a commonly positive perception. Overall, this can be translated as an affirmation of the importance in the decision making process because of its potential impact in terms of internal and external influence for an organization (Buchana & Naicker, 2014; Harrison & Pelletier, 2000; Saaty, 2000; Sallam et al., 2014).

However, our questionnaire also provided a section where the respondents could make their decisions based only at a mobile betting application or would instead prefer an additional tool. The majority of the respondents answered that they would prefer a supplementary tool and this could translate to the user's non-familiarity with the functionality of mobile betting applications or there has not been sufficient information within the application even though the phenomenon of mobile BI has grown exponentially since its introduction to the market (Stipić & Bronzin, 2011). This evidence shows that in general, users of a decision support system tools need a lot of information to be able to create a successful decision. And having seen there are various preferences of each user regarding their supplementary support, it also depicts that the information that should be provided in such application could not be generalized. Hence, a good decision support tool (e.g. mobile BI) should have a sufficient data with good quality and robustly fit with the need of its users in order to enhance their decision making process.

## 5.2 Cognitive Fit

The outcome of the descriptive analysis concerning the cognitive fit exposed a positive but not a strong attitude of the respondents. This implies that the general aspect of the cognitive fit could need a further enhancement in betting applications. These enhancements could be initially to circumvent visual clutter such as irrelevant and redundant images, and furthermore reducing the learning to manage the mobile betting application by building on current mental models on how it should operate (Burke, Prewett, Gray, Yang, Stilson, Coovert, Elliot, & Redden, 2006; Gardenfors & Johansson, 2014). The overall interaction could also be improved to minimize the cognitive load, even though this measurement item (CF3) received the most positive response in the questionnaire. The majority of the respondents have more than six months experience with a betting application (61%) and weekly usage of a betting application were the dominant answer from our questionnaire with 44.2%. The above mentioned enhancements, specifically 'building on current mental models' would have a greater influence on the dominant group of our questionnaire. This is due to their composed knowledge and experience from its previous use of a mobile betting application which allows them to continuously build on their existing understanding instead of learning it from the beginning (Gardenfors & Johansson, 2014).

A single hypothesis was formed in the proposed construct model between cognitive fit and decision making process. The association confirmedly has a positive influence by reaching path coefficient β as high as 0.346. Moreover, the study also discovers that cognitive construct could be a mediator for indirect relationship between visual representation and decision making process. Our finding adds evidence that cognitive fit is indeed having a strong influence to decision making as this result is align with Chang et al. (2016) which proposed to use cognitive fit theory as a guidelines to design Clinical DSS (CDSS) for physicians because its ability to increase problem-solving process ability. In managerial decision context, Mahoney et al. (2003) also suggested decisional guidelines should be based on cognitive fit theory since it could improve decision performance by having a fit within cognitive fit (accuracy: $F=75.641$; response time: $F=83.686$, both in 0.001 significance level).

The idea that we can grasp from this phenomena is that although cognitive fit theory is developed when the supporting technology is not as sophisticated as today, the theory is still a valid and must be taken into consideration when it comes to build a tool for decision making process. it has a positive influence on decision making process context and could be a measurement form for determining whether the visual representation that possessed by an application could effectively affects the decision making process.

## 5.3 Visual Representation

Generally, the users perceive the visual representation in a mobile betting application as positive. The findings from the descriptive analysis indicate that users of a mobile betting application strongly value the importance of data quality and sensemaking in order to make a successful decision. These findings align with the arguments from Ganapathy et al. (2004) which describes that attractive visual representation should consider the quality of the data. Furthermore, Wang and Strong (1996) also argues that this circumstance regarded as important thing since substantial standpoint of problem could be affected by the quality of data.

Align with the result of importance of data quality, most respondents are likely to have a positive tendency when it comes to how visual representation could help them increasing their sensemaking. It indicates that they are able to decrease their cognitive effort to understand the data, based on the visual representation that is provided within the application in order to understand the problem that they have to solve through their sensemaking ability. This finding amplify previous research from Baker et al. (2009) that argues main purpose of design for visual representation is to decrease the cognitive effort and enrich the quality of understanding of the sensemaking.

In the hypothesis that tested in our proposed model, visual representation is an independent variable for both user experience and cognitive fit. Firstly, we examine whether the visual representation is having a positive influence on cognitive fit. The result confirmed that there is a positive relationship between this two constructs (β = 1.01). This result also confirms the previous evidence by Van Der Land et al. (2013) which describe that individual understanding is reached when the information is presented in better way, hence create user have a better cognitive fit. Huang, Chen, Guo, Xu, Wu, and Chen (2006) which carried out a research on comparing data in self-organizing map (SOM), multi-dimensional scaling (MDS) display and tabular in context spatial task (associating, comparing, and distinguish) also confirm this finding by average significance of more than 95%. Lastly, (Khatri et al., 2006b) found a 0.53 Cohen's measurement (medium correlation) in circumstance of effect between cognitive fit and representation on comprehension performance. The second hypothesis involves visual representation and user experience. Positive association at β = 0.859 also found in this causational relationship. This result is strengthening the previous result of Kim and Han (2011) which found that quality of information which were used as one of the facet within our proposed construct is positively influence hedonic value of UX (β = 0.334) in mobile data service area.

As we can see from aforementioned hypotheses, high path coefficient is generated from both relations. The proven phenomenon could be motivated by the increasing supporting technologies which enhance the quality of visual representation itself. One of the examples is how good functionality of mobile application could be achieved easily today as programming language such as *HTML5* could be carried out in native application. It makes everything is possible to attain and creates discretion within the ecosystem of mobile application. Undoubtedly, abovementioned circumstance regarding visual representation relationship with cognitive fit could affects the quality of sensemaking and level of cognitive fit of users directly as suggested by Lohse (1997) and Benbasat et al. (1986). In addition, as stated by Bertin (1983) and Mennis et al. (2000), stored knowledge management of user could be affected as well by the level of sensemaking and could evade the redundant cognitive effort and easily understand the problem representation and what to do to solve the task. Meanwhile, in UX context, Axbom (2011) suggested that visual representation is generated by interaction design and according Arhippainen and Tähti (2003) a good interaction design could lead to a better UX. Hence, the phenomenon of increasing supporting technology of visual representation also provokes the quality of UX.

Consequently, in general, from individual users perspective of mobile BI, visual representation still considered as one of the most influential aspect that should take into deliberation when developing a mobile BI application from cognitive fit perspective. It is evident that having a better visual representation could amplify the fit on user's cognitive. Moreover, user experience which considered as a critical aspect in mobile application could also affected by having a better visual representation.

## 5.4 User Experience

According to the outcome from the descriptive analysis, the user experience of a mobile betting application has a generally positive perception on every features of the construct on the user experience. By looking at the quality of experience, perceive enjoyment and perceive ease of use, the majority of the variables follow the same structure with most respondents' express their stand from a neutral standpoint to strongly agree. The majority of the respondents agrees with the construct and therefore specifies to the importance of user experience in a betting application. Additionally, Law et al. (2009) notes that user experience can facilitate the use of various tools and therefore enhance the communication in multiple discipline and concepts. This can therefore be applied to the device as mobile platform with a betting application.

Moving to the hypothesis that was established in the proposed model, despite the positive result in the respondent's responses, the regression result signify that the proposed causational relation hypothesis between user experience (UX) and cognitive fit is not significance and therefore it is not accepted. This result is interesting since visual representation is evidently providing a positive influence to both cognitive fit and user UX, but that association does not make UX indirectly influence visual representation relationship with cognitive fit. It seems in the mobile BI context, users do not take UX as a consideration in terms of problem solving when the application has a good visual representation.

Our conclusion would be that experience that provided by the application including quality of experience, perceived enjoyment and ease of use is not consciously taking effect on users. Instead, they get more assistance from the visual representation. According to Bandura (2001), experience could affect people to have better choices when it comes to selecting, constructing, regulating, and evaluating courses of action. Nevertheless, as suggested by Carlson (1997), these circumstances could only be achieved if it affects your emotion consciously and in this case UX fall short to accomplish that. This notion is also carried out by Hong et al. (2004) which found that experience that are provided in shopping websites does not give any effect to its users, the users are more affected by the provided information format. On the other study, Mandel and Johnson (2002) and Yu and Roh (2002) also having the same findings in the context of web page design and menu design in an information seeking context in a website area.

# 6 Conclusions

## 6.1 Research Question

The aim for this study was to examine the influence of visual representation and user experience within the area of mobile business intelligence to the decision making process from the perspective of an individual user. As a linkage from the visual representation and user experience to the decision making process, we decided to apply the cognitive fit because of this theory has the ability to enhance the possibility of an effective problem solution which leads to a better decision making process. Moreover, this theory has been effectively carried out by many researchers in different information system area (see table 2.1).

In order to achieve the purpose of our study, we formulated a research question that measures the perception from the users of a mobile BI. Furthermore, these measurements were obtained by the distribution of a questionnaire-based survey from users of a mobile betting application which we simulated as a mobile BI because of its similarities in the decision making context. As a result, we obtained the respondents perception and attitude towards the constructs of our proposed model (figure 2.1) and test its associations (hypotheses). By the usage of Microsoft Excel, SPSS, and SPSS Amos, we were able to analyze the empirical findings and consequently, answer our research question.

**Research Question**

*How does visual representation and user experience in a mobile business intelligence application influence the decision-making process from an individual user's perspective?*

After conducting the study, we came up with the result that visual representation has a positive indirect influence on decision making process through cognitive fit. It shows that this aspect has the ability to enhance the cognitive fit within individual users and improve their decision making process. As a result, mobile business intelligence (mobile BI) application which has a good visual representation will enhance the decision making process of individual users.

Moving into user experience (UX), the study shows that UX does not indirectly influence the decision-making process through cognitive fit. Furthermore, although it is evident that visual representation has a positive influence on user experience (UX), this circumstance does not help UX significance level to provide a positive influence in a mobile betting application in terms of the decision making process. Consequently, mobile BI application with good user experience does not merely influence the decision making process even the application has a really good visual representation.

Thus, we can claim that mobile BI application with good visual representation tends to influence decision making process of its users regardless the UX that provided by the application. Therefore, if one wants to improve their mobile BI application within the substance of decision making process, improving visual representation is a first priority as it evidently enhances the cognitive fit which influences decision making process from individual user's perspective.

## 6.2 Implications

The conduction of this study lead to a knowledge extension of mobile BI towards the decision making process for individual users and also to an extension that the intention of individual users to proceed utilizing such technology. Moreover, the result also provided a cogency that visual representation can be utilized to influence an enhancement of the decision making process in context of a mobile BI. Conversely, the user experience exposed a contrary result. Thus, the study is offering an insight on the motives that contributes to the individual users of a mobile BI.

The cognitive fit theory has been proven suitable to address the constructs of visual representation and user experience of perception and attitude towards the decision making process for mobile BI. Even though the user experience does not have a significant meaning in the context of the decision making process in mobile BI, one should not completely ignore its features and advantages it can provide to a mobile BI application. But concerning the enhancement of merely the decision making process in mobile BI, the prioritization should apply on the visual representation to enable a positive influence for the individual users to make a decision with the highest possible success outcome. Accordingly, the visual representation has a responsibility to offer data with highest possible quality and sensemaking which will in return reduce the cognitive fit. In regards to the theoretical implications, there may be other constructs which has the possibility to influence the cognitive fit and therefore the decision making process in mobile BI that could be addressed.

## 6.3 Limitations

Due to resource and practical limitation, we were not able to employ the best possible methodology approach when conducting the study. We used non-probability sampling with convenience approach in our study. This approach should be utilized since we have issues to reaching the respondents. As the result, our responses for this study came from the members of betting applications forum in Europe. We realized that as we wanted to measure the visual representation and user experience feature on mobile BI by simulating it through mobile betting application, a constant measurement should be used by respondents to have a better reliability. Fortunately, most responses have used the same application which is *BET 365*, so we could cover the reliability within this study. However, external validity for this study is affected because of this matter because the responses do not cover all the applications. Nevertheless, we believe that almost all betting application that is available in mobile application today will maximize the feature of user experience and visual representation regardless the developer, therefore generalization could be provided for this study conceptually.

## 6.4 Contributions

Having seen the result of our proposed model, we have broaden the knowledge concerning how individual users of everyday mobile application that could considered as a mobile BI application perceived decision making based on the visual representation and user experience that provided by the application. The result proposed a new perspective and later could be a valuable comparison point of view for the organization since there is a tendency of entity within the organization wanted to have a similar capability and experience of consumer level mobile application in their workforce mobile application. This study could also be a starting point for academia ecosystem to have a research on individual user's perspective in regards to a system that used by organization to make workforce system or application more similar to everyday application. Moreover, considering the massive growth of mobile application in coming years (not only in BI context) and seeing the tendency of most of the application will likely used as a decision support tools, this study shows that cognitive fit is an important aspect to be pursued as it could enhance the problem solving ability.

## 6.5 Suggestions for Further Study

As the aim of this study has been prospered, there were obstacles along the process which involves practical and method restrictions. This can in turn be investigated in further studies. Following section will present our thoughts on how this study can be researched in different directions.

**Apply to Other Models**

In regards to the proposed model, we based it on the cognitive fit theory which resulted to its structure. Further study could identify other potential models with another central factor that could test the visual representation and user experience in the decision making process of mobile BI.

**Apply to Other Constructs**

As for this study, we focused on the influence of visual representation and user experience to the decision making process but further studies could identify additional potential constructs and thereby its features.

**Apply to Other Perspectives**

Concerning this study, we examined our chosen subject from a users' perspective. Further study could apply other potential perspectives.

**Apply to Other Contexts and Sample**

The majority of our respondents were from Sweden due to our approach on obtaining data from mostly Swedish forums regarding mobile betting applications. Further study could obtain data from other countries which could explore if there are any cultural or maturity differences, concerning the decision making of mobile BI in users' perspective. Additional suggestion could be to conduct the proposed model on other computer-based application. As mentioned before, in this study we obtained data from users' of a mobile betting application but further study could apply real mobile BI applications to identify the difference between these two.

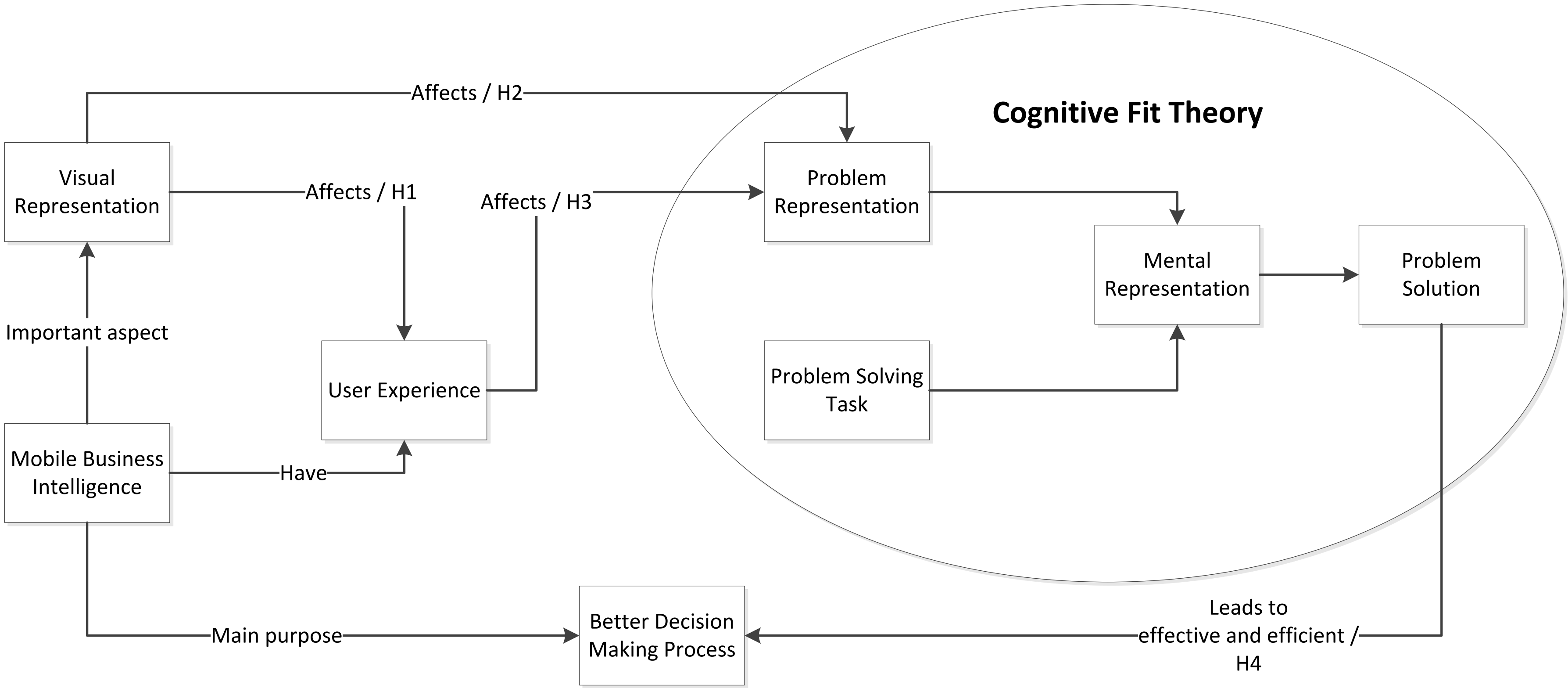
**Increase the Sample Size and Use Probability Sampling**

Further studies could increase the external validity by obtaining larger sample of data using probability sampling. Reasons behind our selection of a convenience sampling method were due to the time and accessibility limitations.

**Longitudinal Approach**

The answer we received from our distributed questionnaires cannot be assured to receive the same answer again from the respondents in a different time. By distribute the questionnaires once again would explore if there are any changes or not from the respondents perception towards the constructs. The respondents also had different experience with a mobile betting application and by conducting a study where the experience from the users would be the same, could also be another approach worth exploring.

# Appendix 1 – Detail of Hypothesis Proposed Model



# Appendix 2 – Thesis Questionnaire

## Questionnaire for Thesis

Hi,

We are two students studying Master of Information System at Lund University, Sweden. We are in process of writing our master thesis about the effects of user experience in mobile business intelligence (mobile BI) application. For our thesis purpose, we would like to invite you to take part in our short survey as your opinion and views are important for our thesis.

This questionnaire aims to identify and measure the associations and correlations between certain aspects that provided by betting application in mobile devices and see how it supports your betting choices. Following section in this questionnaire will be based on your impression towards the user experience, visual representation and decision making process in betting application that you have used.

Approximately, this survey will take around 4-6 minutes. Participation within this questionnaire is voluntary and anonymous, so we will not take your personal data during the survey, your answer will confidentiality be guaranteed, and you can withdraw anytime by leaving the survey. The result of this study will be presented in our thesis which will be published publicly by Lund University, Sweden.

Thank you for your participation.

Regards,
Akram Chelong & Indrayosa Pratomo

* Required

1. **Have you ever used betting application in your mobile device (i.e. smartphone, tablet)? ***
*Mark only one oval.*
- Yes
- No (Sorry, but you cannot participate in this survey) *Stop filling out this form.*

## Personal data collection

2. **How old are you?**
*Mark only one oval.*
- 18-25 years old
- 26-33 years old
- 34-41 years old
- More than 41 years old

3. **How long have you used the application? ***
*Mark only one oval.*
- I just installed the application
- 1-3 Month
- 4-6 Month
- More than 6 Month

4. **How often do you use the application?** *
*Mark only one oval.*

- ◯ Only once
- ◯ Monthly
- ◯ Weekly
- ◯ Daily

5. **What mobile betting application have you used?** *
*Check all that apply.*

- ☐ BET 365
- ☐ Sky Bet
- ☐ Ladbrokes
- ☐ William Hill
- ☐ Other: ____________________

6. **Will you be able to only use a mobile betting application in order to make a betting decision?**
*Mark only one oval.*

- ◯ Yes (If yes, you can skip the next question) *After the last question in this section, skip to question 8.*
- ◯ No (If no, please answer the next question)

7. **If no, what kind of tools do you use besides a mobile betting application?**
*Check all that apply.*

- ☐ TV
- ☐ Social media, like Facebook and Twitter
- ☐ Websites, such as ESPN, Eurosport, and SKY Sports
- ☐ Mobile applications, such LiveScore and Statszone
- ☐ Other: ____________________

## User Experience

8. **Please describe your experience while using the application** *

Mark only one answer per question

*Mark only one oval per row.*

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| I could understand the flow of the application | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I feel the application is well designed | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| The application fulfill my needs to have a good bet | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I find it easy to leam and use the application | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I feel please and satisfy when using the application | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| The application helps me pick my choice immediately | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I never have a lag when using the application | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I find it interesting while using the application | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I find it fun and enjoyable when using the application | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I have a clear and understandable interaction with the application | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I do not find the application as cumbersome | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |

## Visual Representation

9. **Please describe the visual representation of the data while using the application** *

Mark only one answer per question
*Mark only one oval per row.*

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| The data is up to date, so I could create my bet without hesitation | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| The application provides me a complete perspective in regards to the game that I want to make bet on | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I trust this application as it give me a reliable data of the game | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I find the data is relevant to my needs | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I can associate objects (e.g. tables, charts and graphs) as a supporting tool to increase my prior knowledge of betting | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I can see patterns in the data and it increases my prior knowledge about betting | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I can utilize my previous betting accomplishment to increase my betting approach | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I can capture hidden information by using my betting experience | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |

## Cognitive Fit

10. **Please describe the cognitive effort that is necessary from you when using the application** *

*Mark only one oval per row.*

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| I prefer to have perceptual point of view about the game in the application in order to pick my choice of bet rather than have a discrete data representation | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| My interaction with the application could help me understand the data representation | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| The experience helps me to understand the data within the application | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |

## Decision Making Process

11. **Please describe how you choose your bet while using the application** *

Mark only one answer per question
*Mark only one oval per row.*

| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|
| The application could convince my choice that I want to make bet on | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I could also have an alternative option to choose when using the application | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |
| I could track the game through the application after I place my bet | ⬭ | ⬭ | ⬭ | ⬭ | ⬭ |

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# Appendix 3 – Summary of Users Demographics

| Categories | Range | Frequency | Percentage |
|---|---|---|---|
| Age | 18 – 25 Years Old | 52 | 67.5% |
| | 26 – 33 Years Old | 19 | 24.7% |
| | 34 – 41 Years Old | 4 | 5.2% |
| | More than 41 Years Old | 2 | 2.6% |
| Application Experience | I just installed the application | 14 | 18.2% |
| | 1-3 month | 8 | 10.4% |
| | 4-6 month | 8 | 10.4% |
| | More than 6 month | 47 | 61.1% |
| Frequency of Use | Only once | 13 | 16.9% |
| | Monthly | 16 | 20.8% |
| | Weekly | 34 | 44.2% |
| | Daily | 14 | 18.2% |
| Type of Betting Apps | BET 365 | 32 | 41.6% |
| | Betsson | 11 | 14.3% |
| | More than one application | 28 | 36.3% |
| | Others | 6 | 7.8% |

# Appendix 4 – Summary of Descriptive Measurement Items

| Descriptive Statistics | | | | |
|---|---|---|---|---|
| **Code** | **Content Description** | **N** | **Mean** | **Std. Deviation** |
| QE1 | I could understand the flow of the application (how the application works) easily | 77 | 4.12 | .537 |
| QE2 | I feel the application is a well-design app | 77 | 3.95 | .667 |
| QE3 | The application fulfill my needs to have a good choice of bet | 77 | 3.71 | .582 |
| QE4 | When using the application, I find it easy to learn and easy to use | 77 | 3.99 | .734 |
| QE5 | I feel pleased and satisfied when using the application | 77 | 3.65 | .602 |
| QE6 | The application help me pick my choice of bet right away | 77 | 3.26 | .938 |
| QE7 | I never have a lag when using the application | 77 | 3.58 | .848 |
| PE1 | I found it interesting while using the application | 77 | 4.16 | .745 |
| PE2 | I found it fun and enjoyable when using the application | 77 | 3.91 | .632 |
| PEU1 | I have a clear and understandable interaction with the application | 77 | 4.01 | .618 |
| PEU2 | I do not find the application as a cumbersome application | 77 | 3.81 | .586 |
| QD1 | The data that is presented in the application is up to date, so I could create my bet without hesitation | 77 | 4.00 | .538 |
| QD2 | The application provides me a complete perspective in regards to the game that I want to make bet on | 77 | 3.70 | .727 |
| QD3 | I trust this application as it gave me a reliable data of the game that I want to bet on | 77 | 4.06 | .656 |
| QD4 | I found that the data that is used in the application is relevant to my needs | 77 | 4.05 | .535 |
| SE1 | I can associate objects (e.g. tables, charts and graphs) as a supporting tool to increase my prior knowledge of betting to have better choices when using the application | 77 | 3.88 | .537 |

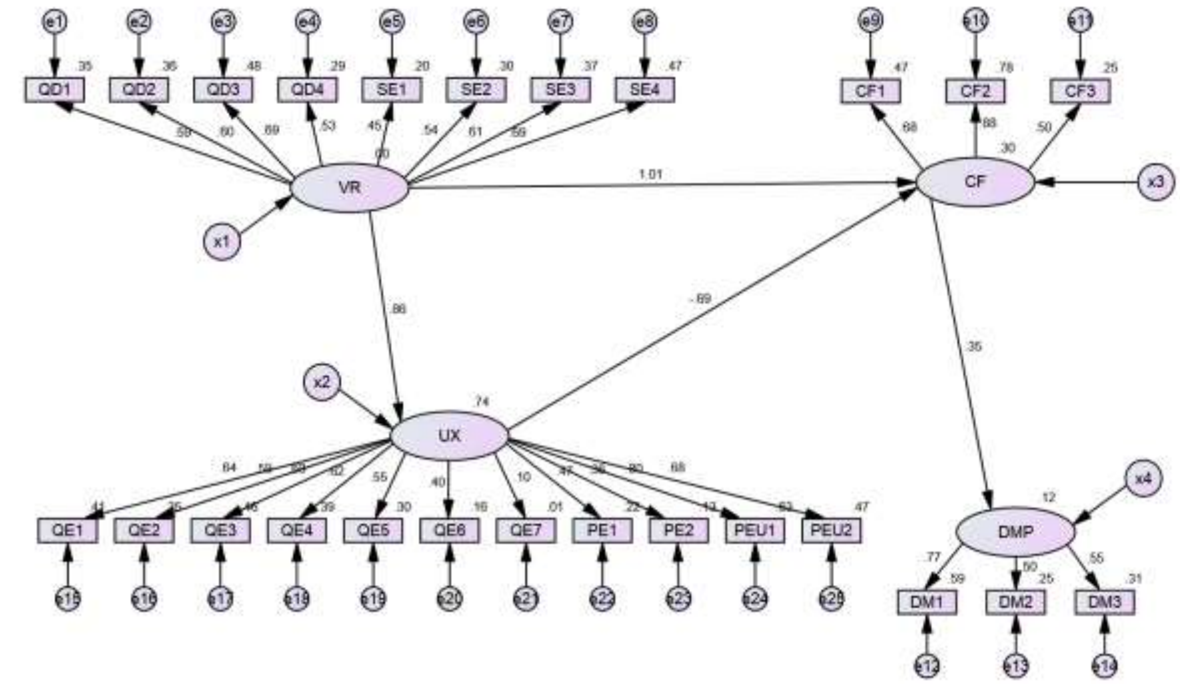
| | | | | |
|---|---|---|---|---|
| SE2 | I can see patterns in the the presented data and it increases my prior knowledge about betting to have better choices when using the application | 77 | 4.01 | .550 |
| SE3 | I can utilize my previous betting accomplishment to increase my betting approach to have better choices when using the application | 77 | 3.82 | .739 |
| SE4 | I can capture hidden information by using my betting experience to have better choices when using the application | 77 | 3.74 | .657 |
| CF1 | I prefer to have perceptual point of view about the game in the application in order to pick my choice of bet rather than have a discrete data representation | 77 | 3.51 | .620 |
| CF2 | My interaction with the application could help me understand data representation that is provided by the application | 77 | 3.49 | .553 |
| CF3 | The experience that is offered by the application, helps me to understand the data that is provided within the application | 77 | 3.58 | .547 |
| DM1 | The application could convince my choice that I want to make bet on | 77 | 3.61 | .672 |
| DM2 | I could also have an alternative option to choose when using the application | 77 | 3.65 | .507 |
| DM3 | I could track the game through the application after I place my bet | 77 | 3.66 | .598 |

# Appendix 5 – Summary of Descriptive Statistics

| Construct | Code | Measures | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| User Experience | QE1 | Frequency | | | 7 | 54 | 16 |
| | | Percentage (%) | | | 9.1% | 70.1% | 20.8% |
| | QE2 | Frequency | | | 19 | 43 | 15 |
| | | Percentage (%) | | | 24.7% | 70.1% | 20.8 |
| | QE3 | Frequency | | 3 | 18 | 54 | 2 |
| | | Percentage (%) | | 3.9% | 23.4% | 70.1% | 2.6% |
| | QE4 | Frequency | | 3 | 12 | 45 | 17 |
| | | Percentage (%) | | 3.9% | 15.6% | 58.4% | 22.1% |
| | QE5 | Frequency | | 2 | 26 | 46 | 3 |
| | | Percentage (%) | | 2.6% | 33.8% | 59.7% | 3.9% |
| | QE6 | Frequency | 5 | 9 | 26 | 35 | 2 |
| | | Percentage (%) | 6.5% | 11.7% | 33.8% | 45.5% | 2.6% |
| | QE7 | Frequency | 1 | 7 | 23 | 38 | 8 |
| | | Percentage (%) | 1.3% | 9.1% | 29.9% | 49.4% | 10.4% |
| | PE1 | Frequency | | 3 | 7 | 42 | 25 |
| | | Percentage (%) | | 3.9% | 9.1% | 54.5% | 32.5% |
| | PE2 | Frequency | | 1 | 16 | 49 | 11 |
| | | Percentage (%) | | 1.3% | 20.8% | 63.6% | 14.3% |
| | PEU1 | Frequency | | 1 | 11 | 51 | 14 |
| | | Percentage (%) | | 1.3% | 14.3% | 66.2% | 18.2% |
| | PEU2 | Frequency | | 2 | 16 | 54 | 5 |
| | | Percentage (%) | | 2.6% | 20.8% | 70.1% | 6.5% |
| Visual Representation | QD1 | Frequency | | 1 | 8 | 58 | 10 |
| | | Percentage (%) | | 1.3% | 10.4% | 75.3% | 13% |
| | QD2 | Frequency | 1 | 2 | 23 | 44 | 7 |
| | | Percentage (%) | 1.3% | 2.6% | 29.9% | 57.1% | 9.1% |
| | QD3 | Frequency | 1 | | 8 | 52 | 16 |
| | | Percentage (%) | 1.3% | | 10.4% | 67.5% | 20.8% |
| | QD4 | Frequency | | | 9 | 55 | 13 |
| | | Percentage (%) | | | 11.7% | 71.4% | 16.9% |
| | SE1 | Frequency | | 1 | 13 | 57 | 6 |
| | | Percentage (%) | | 1.3% | 16.9% | 74% | 7.8% |
| | SE2 | Frequency | | | 11 | 54 | 12 |
| | | Percentage (%) | | | 14.3% | 70.1% | 15.6% |
| | SE3 | Frequency | | 5 | 14 | 48 | 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Percentage (%) | | 6.5% | 18.2% | 62.3% | 13% |
| | SE4 | Frequency | | 4 | 17 | 51 | 5 |
| | | Percentage (%) | | 5.2% | 22.1% | 66.2% | 6.5% |
| Cognitive Fit | CF1 | Frequency | | 1 | 40 | 32 | 4 |
| | | Percentage (%) | | 1.3% | 51.9% | 41.6% | 5.2% |
| | CF2 | Frequency | | 1 | 38 | 37 | 1 |
| | | Percentage (%) | | 1.3% | 49.4% | 48.1% | 1.3% |
| | CF3 | Frequency | | | 2 | 28 | 47 |
| | | Percentage (%) | | | 2.6% | 36.4% | 61% |
| Decision Making Process | DM1 | Frequency | | 2 | 32 | 37 | 6 |
| | | Percentage (%) | | 2.6% | 41.6% | 48.1% | 7.8% |
| | DM2 | Frequency | | | 28 | 48 | 1 |
| | | Percentage (%) | | | 36.4% | 62.3% | 1.3% |
| | DM3 | Frequency | | 1 | 28 | 44 | 4 |
| | | Percentage (%) | | 1.3% | 36.4% | 57.1% | 5.2% |

# Appendix 6 – Hypotheses Testing & Result




**Regression Weights: (Group number 1 - Default model)**

| Dependent Variable | | Independent Variable | Esti-mate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| UX | <--- | VR | .935 | .226 | 4.140 | *** | |
| CF | <--- | VR | 1.353 | .621 | 2.179 | .029 | |
| CF | <--- | UX | -.850 | .517 | -1.645 | .100 | |
| DMP | <--- | CF | .421 | .192 | 2.196 | .028 | |
| QD1 | <--- | VR | 1.000 | | | | |
| QD2 | <--- | VR | 1.376 | .327 | 4.210 | *** | |
| QD3 | <--- | VR | 1.430 | .307 | 4.651 | *** | |
| QD4 | <--- | VR | .903 | .234 | 3.854 | *** | |
| SE1 | <--- | VR | .757 | .227 | 3.333 | *** | |
| SE2 | <--- | VR | .945 | .242 | 3.913 | *** | |
| SE3 | <--- | VR | 1.414 | .333 | 4.244 | *** | |
| SE4 | <--- | VR | 1.422 | .307 | 4.628 | *** | |
| CF1 | <--- | CF | 1.000 | | | | |
| CF2 | <--- | CF | 1.152 | .249 | 4.634 | *** | |

| Dependent Variable | | Independent Variable | Esti-mate | S.E. | C.R. | P | Label |
|---|---|---|---|---|---|---|---|
| CF3 | <--- | CF | .638 | .168 | 3.801 | *** | |
| QE1 | <--- | UX | 1.000 | | | | |
| QE2 | <--- | UX | 1.135 | .254 | 4.465 | *** | |
| QE3 | <--- | UX | 1.143 | .227 | 5.031 | *** | |
| QE4 | <--- | UX | 1.328 | .283 | 4.697 | *** | |
| QE5 | <--- | UX | .962 | .228 | 4.228 | *** | |
| QE6 | <--- | UX | 1.092 | .343 | 3.179 | .001 | |
| QE7 | <--- | UX | .254 | .300 | .848 | .397 | |
| PE1 | <--- | UX | 1.019 | .277 | 3.687 | *** | |
| PE2 | <--- | UX | .658 | .230 | 2.865 | .004 | |
| PEU2 | <--- | UX | 1.158 | .229 | 5.056 | *** | |
| PEU1 | <--- | UX | 1.426 | .250 | 5.695 | *** | |
| DM3 | <--- | DMP | .639 | .222 | 2.882 | .004 | |
| DM2 | <--- | DMP | .493 | .176 | 2.807 | .005 | |
| DM1 | <--- | DMP | 1.000 | | | | |

**Standardized Regression Weights: (Group number 1 - Default model)**

| Dependent Variable | | Independent Variable | Estimate |
|---|---|---|---|
| UX | <--- | VR | .859 |
| CF | <--- | VR | 1.010 |
| CF | <--- | UX | -.691 |
| DMP | <--- | CF | .346 |
| QD1 | <--- | VR | .589 |
| QD2 | <--- | VR | .600 |
| QD3 | <--- | VR | .691 |
| QD4 | <--- | VR | .534 |
| SE1 | <--- | VR | .447 |
| SE2 | <--- | VR | .545 |
| SE3 | <--- | VR | .606 |
| SE4 | <--- | VR | .686 |
| CF1 | <--- | CF | .685 |
| CF2 | <--- | CF | .884 |
| CF3 | <--- | CF | .495 |
| QE1 | <--- | UX | .642 |
| QE2 | <--- | UX | .588 |

| Dependent Variable | | Independent Variable | Estimate |
|---|---|---|---|
| QE3 | <--- | UX | .678 |
| QE4 | <--- | UX | .624 |
| QE5 | <--- | UX | .551 |
| QE6 | <--- | UX | .402 |
| QE7 | <--- | UX | .103 |
| PE1 | <--- | UX | .472 |
| PE2 | <--- | UX | .359 |
| PEU2 | <--- | UX | .682 |
| PEU1 | <--- | UX | .797 |
| DM3 | <--- | DMP | .553 |
| DM2 | <--- | DMP | .504 |
| DM1 | <--- | DMP | .771 |

**Squared Multiple Correlations: (Group number 1 - Default model)**

| Variable | Estimate |
|---|---|
| VR | .000 |
| UX | .737 |
| CF | .299 |
| DMP | .119 |
| DM3 | .306 |
| DM2 | .254 |
| DM1 | .594 |
| PEU2 | .466 |
| PEU1 | .634 |
| PE2 | .129 |
| PE1 | .223 |
| QE7 | .011 |
| QE6 | .161 |
| QE5 | .304 |
| QE4 | .389 |
| QE3 | .460 |
| QE2 | .345 |
| QE1 | .412 |
| CF3 | .245 |
| CF2 | .782 |
| CF1 | .469 |

| Variable | Estimate |
|---|---|
| SE4 | .470 |
| SE3 | .368 |
| SE2 | .297 |
| SE1 | .199 |
| QD4 | .285 |
| QD3 | .477 |
| QD2 | .360 |
| QD1 | .347 |

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