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The interrelationship between intelligent agents' characteristics and users' intention in a search engine by making beliefs and perceived risks mediators



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ABSTRACT

This study is to examine the possibility of applying intelligent agents' characteristics to affect users' intention in a search engine. All data were collected using online questionnaires provided in the search engine from users older than 15 years. A total of 890 questionnaires were collected. Based on these data, descriptive statistics analysis, the Pearson product-moment correlation, and hierarchical regression were conducted. All preliminary findings indicate that both beliefs and perceived risks of users in the search engine positively affects their behavioral intention. Therefore, businesses operated using a search engine must always focus on the characteristics of intelligent agents, particularly to eliminate perceived risks to increase the behavioral intention of using the search engine.

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1. Introduction

The thriving and widespread use of the Internet has led to people increasingly relying on online information. The [Foreseeing Innovative New Digiservices \(2015\)](#) conducted a weighted calculation on Internet users of various connection methods and incorporated numerous TANet users after excluding users with multiple accounts, multiple users using a singular account, and users with a low Internet usage. The calculation revealed that, by the end of September 2014, Taiwan had 17.64 million regular Internet users, and the number increases annually. Because of the rapid increase in the number of global information Web sites, the demand and supply of information have increased considerably and rapidly. A search engine is an essential and critical tool that assists Internet users in online searching. The comScore Media Metrix was employed to observe search engine usage by Internet users in the Asia–Pacific region. The results revealed that 375.86 million people (approximately 77.2%) used Internet tools by April 2010 and that

the number increased to 455.10 million people (approximately 78.4%) by September 2010, indicating an increasing trend in search engine usage. Although the arrival rate of search engines has already reached a considerable scale, an increase of 1.2% was still achieved within 6 months and continues to increase ([InsightExplorer, 2010](#)). Therefore, the future development of search engines should not be underestimated.

According to the 2014 Wireless Internet Usage in Taiwan survey conducted by the ([Taiwan Network Information Center, 2015](#)), among the interviewees aged 12 years and older and who have used wireless Internet, the most used wireless Internet function was for social networking, followed by information search and information and Web page browsing. A search engine is generally operated by entering keywords or a short summary of a Web site's contents. However, search results frequently fail to meet the needs of users because identifying Web sites that thoroughly correspond to users' needs from Web site information filled with unstructured data is a difficult task. Regarding such abundant Web site information, one of the primary topics for future development is determining how, among the tens of thousands of Web pages, search engines can assist users by filtering the Web sites that correspond most to the users' needs. Consequently, all major search engines have currently imported the characteristics of intelligent

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agents (hereinafter referred to as IA characteristics) to assist Internet users in searching information that matches their needs.

In recent years, IAs have been applied in numerous fields such as information security (Kuo, 2007), medical science (Corchado, Bajo, de Paz, & Tapia, 2008) and business (Louta, Ioanna, & Lambros, 2008). The combination of a search engine and IA can greatly reduce the complexity of problems, increase the solvability of problems, and enhance the efficiency of problem solving. Therefore, Internet users' reliance on IAs is increasing, which is the key to determining whether IAs are feasible (Ministry of Science and Technology, 2011). Currently, most relevant studies have focused on developing technologies for IAs, and extremely few studies have investigated the perceived quality (i.e., the behavioral intention) of users. The user intention of practically applying IAs is the key to the benefit of such technology application. In addition, an IA is an essential and critical tool in the daily lives of the public. An IA that can enhance its benefits is beneficial for future developments. For the above summarized reasons, this study examined the influences of the IA characteristics of search engines on user behavioral intention (BI) to determine the relationship between the two and to provide practical and specific contributions to the future developments of search engines and IAs.

2. Literature review and research hypotheses

We primarily investigated the influences of IAs employed in a search engine on user BI; therefore, we examined relevant theories and research on search engine development, IAs, the technology acceptance model (TAM), and perceived risk.

2.1. Definition and classification of search engines

A search engine is a type of information retrieval system, and the earliest Web search engine derived from an algorithm and technological development of the conventional information retrieval system. In other words, the search service programs provided by professional search engines enable users to enter keywords for query and subsequently automatically present the eligible relevant items to the users (Chen, 2001). Chanson (2007) indicated that a search engine is an Internet-based tool with functions for information searching and sequencing (i.e., presenting Web sites connecting to the relevant searched items). Jenkins, Kackson, Burden & Wallis, (1998) divided the search engine into three major categories: classified directories, automated search engines, and meta search engines. Battelle (2005) stated that search engines are a critical breakthrough of the Internet era, a breakthrough of ideas, Internet technology, and business model. When information on the Internet is accessed randomly, a search engine is the most effective tool for information navigation for users. The future development of search engines will depart from what we are currently familiar with and will be similar to IAs.

2.2. Theory and property of intelligent agents

Sycara, Paolucci, Ankolekar, and Srinivasan (2003) suggested that an IA is a set of computer programs used to assist users in executing time-consuming information integration, which incorporates searching and accessing online information, researching the inconsistency of collected information, filtering irrelevant and unnecessary information, integrating large volumes of information, and making adjustments according to users' needs from time to time. The Foundation for Intelligent Physical Agents defined IA as playing the critical role of an actor in various specific fields by observing changes in the environment, unifying each module for integration to strengthen the ability for providing

service, and are software that provide appropriate responses according to changes in the environment. In other words, the IA must have the basic ability to observe changes in the environment and learn to provide appropriate responses (Etzinoi & Weld, 1995). Russell and Norvig (1995) defined the IA as a computer program capable of perceiving its situated condition through sensors and generating effects on the environment through actuators (Genesereth & Ketchpel, 1994; Mase, 1994; Wooldridge & Jennings, 1996). Nwana (1996) suggested that the IA is software or hardware encompassed with autonomy and learnability and can, through its experiences, self-improve to accomplish tasks (Tweedalea, Aranjob, Sioutisb, & Consolib, 2007). To summarize the aforementioned statements, we defined the IA as a user-friendly software program that can accurately assist and replace users in executing the time-consuming task of compiling information.

Scholars from different fields have proposed various IA characteristics. Jennings and Wooldridge (1998) proposed the following general characteristics: autonomy, reactivity, proactiveness, and social ability. Schleiffer (2002) proposed crucial IA characteristics: situatedness, subjective rationality, autonomy, robustness, coherence, personalization, and cooperation. In this study, we employed the study by Russell and Norvig (1995) as the basis and integrated the statements proposed by other scholars to investigate the IA characteristics of a search engine. Autonomy (Beale & Wood, 1994; Franklin & Graesser, 1996; Mase, 1994; Wang, Tan, & Ren, 2004; Yager, 2000; Sandholm and Huai, 2000): An autonomous IA in a search engine can actively execute instructions according to its own perception and does not rely on users for instructions. Reactivity (Etzinoi & Weld, 1995; Franklin & Graesser, 1996; Mase, 1994; Schleiffer, 2005; Yager, 2000): A reactive IA in the search engine can understand the results that are generated after executing actions and can perform the most appropriate corresponding actions. Learnability (Esmahi, Dini, & Bernard, 2000; Franklin & Graesser, 1996; Mase, 1994; Nwana, 1996; Schleiffer, 2005): A self-learning IA in the search engine can, through the items it perceives and the search records of the users, enhance its own ability and knowledge by monitoring and learning.

2.3. Technology acceptance model

Davis (1989) employed the theory of reasoned action and theory of planned behavior as the basis, used the user cognitive perspective to explain user acceptance behavior, and emphasized that behavioral attitude is more influential than the subjective norm when technology is accepted for actual usage behavior. Therefore, the factors influencing attitude are simplified into beliefs, which are classified into two dimensions: perceived usefulness (PU) and perceived ease of use (PEOU). After the subjective norm was removed, the TAM was constructed. Davis (1989) further indicated that the PEOU is the antecedent variable of PU. In other words, when a condition remains unchanged, an easy-to-operate system enables users to focus highly on their work performance and realize the efficacy of the system. Numerous studies have verified that the functionality of the system is determined according to the level of ease of use of the system. The TAM provides a theoretical foundation to investigate the influences of external factors on beliefs, attitude, and intention of users as well as to change the actual condition of technology usage. The TAM was amended from the theory of reasoned action; however, unlike the theory of reasoned action that has universality in applicable situations, the TAM is a specifically developed mode for predicting and explaining the user usage behavior in information systems.

Currently, the TAM is widely used to explain user behavior toward the technology adoption behavior. The investigated variables comprised the following: external variables, PU, PEOU, attitude

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