The Impact of Multimodal Inputs on User Adoption in Study Planning Applications

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CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter examines the existing body of knowledge on data collection methods and the effect of chronological technological advancements on their adoption in applications. The review provides operational and conceptual definitions of variables such as ease of use, multimodal inputs and Large Language Models while examining discipline-based theoretical frameworks such as the Technology Acceptance Model, the Theory of Task-Technology Fit and Adoption Theories like UTAUT that underpins this study. This literature review intends to justify this research by investigating existing literature and clarifying the gaps in knowledge.

2.2 CONCEPTUAL AND OPERATIONAL DEFINITIONS

2.2.1 Perceived Usefulness and Ease of Use

The perceived ease of use and usefulness constructs introduced in the Technology Acceptance Model (TAM) have become widely accepted factors influencing technology adoption. According to Davis (1989), the adoption of any new technology by a user is contingent on the user's perceived usefulness and the ease with which one can use it. Davis (1989) operationalised perceived usefulness as the extent to which a user believes a given technology can help increase their efficiency in performing a given task. The constructs of usefulness in its purest form in TAM primarily define the extent to which any technological system provides functionalities to increase users' performance. However, the ease-of-use construct defines the extent to which a user views a system as requiring less effort to use (Davis, 1989). Given the subjective nature of both constructs, several researchers have operationalised them differently. Moore and Benbasat (1991) draw parallels between relative advantage in the diffusion of innovations model (Rogers, 1962) and perceived usefulness. They criticised perceived usefulness as vague and broadly defined, like the relative advantage construct that

Rogers (1962) defined as the degree to which any given innovation exceeds its precursor. The importance of the usefulness construct in TAM is reviewed by Davis (1989) as being based on the expectancy theory, which postulates the influence of beliefs in decision-making (Vroom, 1964). In the context of this paper, perceived usefulness is defined as the user's belief in the desirability of a technology in maximising near-term efficiency. The paper views perceived usefulness using the task-technology fit model (Goodhue & Thompson, 1995) such that the usefulness of a technology is viewed as the role of the technology in impacting performance. Relating it to study planning applications, users' perceived usefulness of such applications is their belief in the ability of the application to enable them to schedule study materials efficiently.

In an attempt to evaluate the influence of the ease-of-use construct, several field studies have been conducted by researchers. The focus of such studies has primarily focused on user interface improvements as a means of improving ease of technology use. One such study by Keil et al. (1995) perceived ease of use as demonstrating the inherent properties of a technology's user interface. However, results from their study failed to correlate user interface enhancements to consumers' perceived ease of use, thereby debunking the idea that continuous improvements of Graphical User Interface (GUI) improve ease of use. Keil et al. (1995) concluded that ease of use deficiencies resulted from a mismatch between the functionalities the user expected and those the system provided. However, such a relation implies ease of use as affected by perceived usefulness and not the contrary, as proposed by Davis (1989). Further research supports the influence of task-technology fit on ease of use (Mathieson & Keil, 1998). This paper views ease of use as a relation between the degree to which a user perceives usefulness and the effort required to use the technology, independent of the technology’s user interface. In the case of study planning applications, the paper considers primarily the ease of

data collection methods and their appropriateness. Overall, the impact of perceived usefulness and ease of use is contextualised in the extent of the customer's satisfaction.

2.2.2. User Adoption

User adoption is influenced by factors categorised as usage-related, agent-related, user-related, attitude and evaluation factors (Ling et al., 2021). These factors encompass perceived usefulness, enjoyment, and ease of use, emotional feedback, and social influence. Among these, Ling et al. (2021) argues utilitarian factors such as perceived usefulness and ease of use to be highly significant. Likewise, Zhou et al., (2010) defines user adoption as determined by a technology's task-technology fit alongside user's perception of the technology. Other researchers define user adoption as a user's intention to continually use a technology fuelled by their user's behavioural intention (Liao et al., 2007). This is further extended by Malik et al., to encompass the extent to which the separation of effort from the functioning of the technology impacts the user's behavioural intentions (Malik et al., 2017). According to them, habit and satisfaction from expectation conformation model are heavy predictors of user continuous use intentions. In this paper, user adoption is viewed as a user's behavioural intention to continuously use a service or technology considering the technology's perceived usefulness, ease of use and performance expectancy.

2.3 THEORETICAL FRAMEWORK

2.3.1 Theory of Reasoned Action & Theory of Planned Behaviour

Fishbein and Ajzen (1975) established the Theory of Reasoned Action (TRA) out of frustrations with outdated studies on attitude and behaviour, which primarily had insignificant associations between volitional behaviour performance and attitude (Dillard & Pfau, 2002, p. 259). According to them, the most profound indicator of volitional behaviour is behavioural intentions, which result from a person's effect on intention from their outlook concerning the behaviour and their normative effect on intention from their subjective norms related to that

behaviour (Dillard & Pfau, 2002, p. 260). While TRA has been established to correctly predict volitional behaviour when the proportion of accounted variance in volitional behaviour is compared with typical variance levels (Conner & Armitage, 1998; Sutton, 1998), it has several flaws. Crucial of these flaws lies in the subjective nature of intentions to change, where a person's intention-behaviour liaison can attenuate due to intention changes between the period intention is calculated and the period behaviour performance is evaluated (Sutton, 1998). Criticisms regarding TRA revolve around the intricate relation between normative beliefs and attitudes, the sufficiency of TRA factors in predicting intentions and behaviour, and the limited scale of perception encompassed (Dillard & Pfau, 2002, p. 270). This is because, in its explanatory scope, TRA excludes spontaneous, impulsive, and habitual behaviours (Bentler & Speckart, 1979) as they are non-volitional. This narrow application of TRA to volitional behaviour limits its predictability to instances where behaviour and intention are highly interrelated, making it unsuitable to envisage instances with low volitional control (Yousafzai et al., 2010). However, the Theory of Planned Behaviour resolves these limitations of TRA in predicting non-volitional behaviours.

Propounded by Ajzen (1985), the Theory of Planned Behaviour (TPB) expands the behavioural reach of TRA to encompass behaviours that are not in the volitional grasp of an individual. In addition to mirroring TRA, TPB introduced perceived behavioural control, operationalised as a person's understanding of the difficulty in performing a particular behaviour (Eagly & Chaiken, 1993, p. 185). The perceived behavioural control construct is highly analogous to the self-efficacy construct by Bandura (1982) and directly forecasts behavioural intentions and behaviours (Ajzen, 1985). Self-efficacy defines a person's accuracy level in executing actions to deal with prospective situations (Bandura, 1982). This suggests that self-efficacy affects the activities people undertake, their levels of planning and the effort spent fulfilling such activities (Dillard & Pfau, 2002, p.277). While researchers largely agree

that TPB is successful in the domains where TRA is less appropriate (Eagly & Chaiken, 1993, p. 189), issues arise from the function of planning in planned behaviour, the competence of TPB to guess and justify behaviours and the causal association between intentions and perceived behavioural control (Dillard & Pfau, 2002, p. 280). In addressing the selective perception step of TPB, Fazio (1986, 1990) established a strong correlation between instantly recalled attitudes and behaviour and a relatively weak correlation between behaviour and sluggishly recalled attitudes (Fazio et al., 1980). Nonetheless, research advocates for the extension of TPB to include other variables with increasing empirical confirmation, such as self-identity, past behaviour, moral norms, belief salience and affective beliefs (Conner & Armitage, 1998, p. 1452).

In the context of study planning applications, although students have high intentions to manage their time, the actual behaviour of most students is contrary to TRA's emphasis on the importance of intention more than the reality of usage. Students' intentions to manage their time have not translated to continued use of scheduling applications, making TRA's emphasis on intention influencing behaviour – in this context, continued use – inadequate. However, TPB supplements TRA with its perceived behavioural control concept and highlights the role of an individual's control over planning inefficient management. TPB is relevant to this study as it establishes the role of perceived behavioural control on actual behaviour, thereby establishing the crucial role of activity planning in completing such activities. It informs the need for this paper to prioritise developing an individual's self-efficacy to promote quick attitude recalls.

2.3.2. Technology Acceptance Model

Fred Davis (1989) founded one of the primary influential Information Systems (IS) acceptance research models, the Technology Acceptance Model (TAM). TRA (Fishbein & Ajzen, 1975) forms the foundation of TAM and was birthed out of the frustration of other

researchers to establish reliable measures that explain system acceptance or rejection (Davis, 1985). According to the theory, user attitude towards technology usage is influenced by their perception of usefulness and ease of use (Masrom, 2007). TAM operationalises computer usage as influenced by a user's behavioural intents to adopt a technology. Davis (1989) supports such intents with the expectancy theory, the theory of reasoned action, the theory of self-efficacy and the innovation theory. However, research by Bagozzi (2007) debates the poor theoretical relationship among the different constructs in TAM. Bagozzi (2007) highlights that behaviour should be considered a more fundamental goal than a terminal goal and that intention, like in TRA, is not representative enough of actual system use due to uncertainties within the time between intention and adoption (Chuttur, 2009). With the case of a study planning application, TAM's perceived ease of use and usefulness will serve as the essential constructs influencing user technology acceptance. The paper recognises inconsistent empirical research with TAM and as such integrates TAM with much broader adoption theories such as the Unified Theory of Technology Acceptance and Use of Technology (UTAUT) to inculcate variables spanning human and social change processes. Yet, this paper investigates alleged ease of use and usefulness factors that propel technology acceptance and user adoption since the ease of use have been hypothesised to impact a user's perception on technology helpfulness and their attitudes towards the usage of such technology.

2.3.3. Unified Theory of Technology Acceptance and Use of Technology (UTAUT)

UTAUT is a framework designed by Venkatesh et al. (2003) to predict the adoption and use of technology in organisational settings (Chang, 2012). The theory serves as an advancement of dominant models such as TRA (Fishbein & Ajzen, 1975), TAM (Davis, 1989), TPB (Ajzen, 1991) and other diffusion and utilisation theories. Venkatesh proposes performance expectancy – as the extent to which a person thinks that using a technology will produce gains in job performance; effort expectancy – the extent to which ease system use

required effort; facilitating conditions – the extent to which a person perceives the existence technical support infrastructure to support system use; and social influence – the extent to which a person considers other people's believe when considering using a; as the four main factors affecting a person's management information system usage (Chang, 2012). UTAUT2, later proposed by Venkatesh et al. (2012), further extends UTAUT by incorporating hedonic motivation, price value and habit constructs.

2.4 EMPIRICAL FRAMEWORK

2.4.1 Data Collection Methods

The high proliferation of personal computers, from mobile devices through laptops to wearable technologies, has increased the amount of data collected from the consumers of such products. Increased data collection is further exacerbated by the adoption of asynchronous means of communication through emails, SMS, social media (Rodrigues et al., 2022); eating disorder applications and (Devakumar et al., 2021); other health-related applications (Hanbury et al., 2019). Internet-based applications have been deployed by corporate, social and government organisations alike to collect asynchronous data. Participatory action research methodologies have primarily been employed in populations with hard-to-reach participants or sensitive populations through centralised data repositories and anonymity characteristics of such apps (Devakumar et al., 2021; Hanbury et al., 2019). According to Hanbury et al. (2019), web-based information systems can effectively be utilised to enhance the time efficacy, data gathering and commitment among data collectors. However, the means of collecting data in terms of the type, frequency and effort required introduce disincentives to the willingness of users to provide data, resulting in accuracy concerns of collected data. Research by Devakumar et al. (2021) consolidated the disincentives in data logging with participants in their study citing complicated and time-consuming information logging processes as diminishing willingness. They cite the variety in the means of logging data and the frequency at which data logging is

equally detrimental to data collection (Epstein et al., 2015). A user study by Rodrigues et al. (2022) on data collection methods further supports multimodality by advocating for a fusion of experiential and passive data collection methods to alleviate user effort. Devakumar et al. (2021) propose diversifying the means of collecting data and encouraging software development entities to employ different modalities, such as voice inputs and photos, alongside text inputs in data collection. Rodrigues et al. (2022) concluded the need for a mixture of experiential text-entry data collection methods and passive non-text-entry methods, with Devkumar et al. (2021) advocating for multimodality in data collection methods. Nonetheless, neither study explores using Portable Document Format (PDF) files to enhance ease of data collection.

2.4.2 Scheduling Applications

Time management information systems have been widely developed and deployed into the mainstream to streamline and enhance the management of projects, tasks, and feedback. The management information systems provide features ranging from account management to project, tasks and feedback management while considering collaboration (Jonathan et al., 2019). Researchers and developers have explored more personalised scheduling applications, exploring a mobile-based digital assistant that enabled users to manage their daily activities using to-do lists (Jonathan et al., 2019; Khan et al., 2018; Adewumi et al., 2016). In the context of scheduling study plans, applications have been developed to help students and organisational institutions collaborate and manage semester activities (Kunekar et al., 2023). Yet other applications have focused on curbing procrastination by developing applications that mimic the Pomodoro technique to create focus study sessions (Zhao et al., 2023). While these applications provide essential and useful functionalities such as task management and collaboration, their primary means of collecting user information through text-entry inputs does not separate the effort required to use the applications from their functionalities.

2.4.3 User Technology Acceptance

From the 1970s onwards, persistent failures of system adoption by organisations and people and the never-ending emerging technology needs propelled research into predicting system use (Chuttur, 2009). Widely accepted theories have been developed to predict the probability of factors that influence adoption from TRA, through TAM and TTF to UTAUT and others. Several conceptual frameworks have been developed from these theories, although a majority of them eliminate subjective norms to reduce the subjectiveness and help ascertain generalisable factors that influence technology acceptance (Chang, 2012; Venkatesh, 2012; Yousafzai, 2010; Masrom, 2007; Ajzen, 1985; Bandura, 1982). Most of these research theories employing TAM identified attitude, social influence, and perceived usefulness as primary determinants of the intention of users to adopt technology (Rodríguez Del Bosque & Herrero Crespo, 2011; Dillard & Pfau, 2002; Lederer, 2000). However, a study by Chau (1996) demonstrated that though professed long-standing usefulness exercised a progressive influence on the behavioural intention to use technology, perceived immediate usefulness has the most substantial impact.

Nevertheless, Chau identified an insignificant direct association between a user's behavioural intention to use technology and their professed ease of use (1996, p. 185). However, such studies have mainly operationalised ease of use in relation to the intuitiveness of user interface design (Keil et al., 1995), performance expectancy of system functionalities and actual system functionalities (Malik et al., 2022; Venkatesh, 2012; Liao, 2007) and perceived usefulness (Bagozzi, 2007; Chuttur, 2009). While performance expectancy and perceived usefulness are suitable measures of ease of use, the ease of data collection is even more crucial. This is because though the extent of functionalities incentivises users to continuously use an application even if they are not satisfied with the effort required to use it, such use cannot be categorised as complete adoption. The user is most likely to change

technologies when a new technology with similar functionalities but less effort is developed from the relative advantage construct of the diffusion of innovations model (Rogers, 1962).

2.5 CONCEPTUAL FRAMEWORK

Study Planning applications present a large market comprising all individuals, and institutions in academia. Scheduling application have an even huge market size as they extend to industrial organisations. However, the extent to which such applications are developed to encompass factors that influence user satisfaction are essential to ensuring user adoption of such applications. From the theoretical and empirical frameworks highlighted, the following variables have been identified to have causal relationships that impact adoption. The extent to which an application can utilise PDF input formats as a means of data collection coupled with the natural language processing capabilities of Large Language Models will influence the ease of data collated. As such, *PDF Data Extraction* and *LLM* capabilities of a website acts as independent variables affecting the *Ease of Data Collection*. Consequently, the *Ease of Data* Collection variable impacts users' *Perceived Ease of Use* of applications. This paper proposes *Performance Expectancy* as accounting for user's *Perceived Usefulness* of application features in maximising efficiency in the short-term.

Moreover, *Perceived Ease of Use; Perceived Usefulness* and *Facilitating Conditions* stemming from the ability of the user to use the application from, but not limited to, internet-enabled technological devices and internet access affects the user's overall *Satisfaction* with the use of the application. Such *Satisfaction* if consistent will influence the user's *Adoption* of the technology. Yet, the paper equally considers the role of *Social Influence* of satisfied or adopted users of technology in converting other people to use the application and consequently, adopt the technology as well. The paper postulates the cycle of *Satisfaction, Adoption, Social Influence and Satisfaction* again as forming a vicious cycle of user technology adoption. Refer to *Figure 1* below for a diagram of the user adoption process explained in this section.

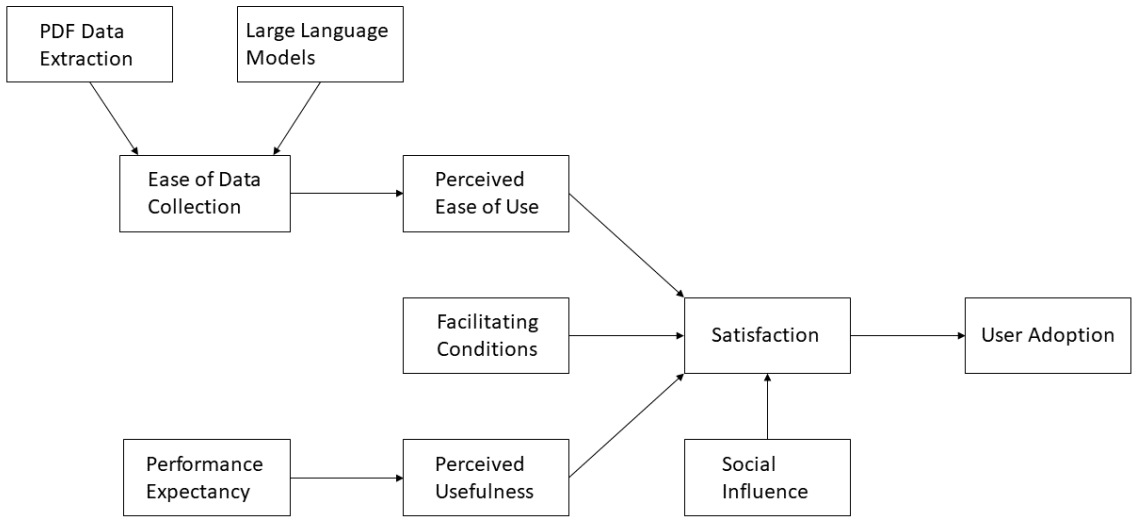

Figure 1 shows the conceptual framework for modelling user adoption of study planning applications.

CONCLUSION

This chapter reviewed widely utilised adoption theories and their frameworks. The theoretical framework begins with the Theory of Reasoned Action, which postulates that behavioural intentions are the major predictor of volitional behaviour. The Theory of Planned Behaviour is discussed next to plug the gap in TRA such that non-volitional behaviours could equally be predicted. The Technology Acceptance Model is reviewed next to expound the application of TRA and TPB primarily with technological product adoption. TAM proposes that the adoption of any technology is influenced by the user's perceived usefulness and ease of use of the technology. TAM was further extended with the Unified Theory of Technology Acceptance and Use of Technology, which introduces social influence, performance expectancy, hedonic and other facilitating factors as primary drivers of the adoption of user adoption. These theories form the basis on which the research hypothesis raised will be explored.

An empirical review of existing literature on data collection methods, study planning applications and user acceptance of technology was carried out. From the review, researchers advocated for a blend between experiential and passive data collection methods in order as the text-entry data collection method and information logging can be cumbersome and time-intensive. However, existing research and software on study planning applications primarily adopt text entry as a means of data collection, impacting users' perceived ease of use and serving as a disincentive to adopting such scheduling applications, although they provide valuable functionalities.

In light of these observations from the theoretical and empirical review, the paper develops a conceptual framework to determine the factors that impact user satisfaction and, consequently, adoption, especially in data collection. The framework defines an application's ability to utilise multimodal data collection methods, especially PDF input format, as essential in enhancing an application's ease of use. With the advent of Large Language Models, the synthesis of data from highly unstructured formats like PDFs can be improved so that effort from manually collecting such data can be separated from the functioning of the application. The perceived ease of use, perceived usefulness and other facilitating factors are considered to influence satisfaction and, in turn, adoption. Even so, the role of social influence from satisfied or adopted users in attracting new users is equally important. Overall, the paper postulates that study planning applications must employ multimodality in data collection to increase user adoption.

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