# USER READINESS TO INTERACT WITH INFORMATION SYSTEMS —

# A HUMAN ACTIVITY PERSPECTIVE

A Dissertation

by

JUN SUN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2005

Major Subject: Information and Operations Management

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Major Subject: Information and Operations Management

# ABSTRACT

User Readiness to Interact with Information Systems —

A Human Activity Perspective. (August 2005)

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This study focuses on how and why people become ready to interact with certain information systems (IS) based on their previous experiences with the same and/or similar systems. User-system interaction can be regarded as a mediated and collaborative human activity between a user and a system with the motive of transforming raw information into useful outcome. Using Activity Theory as a paradigm, this study conceptualizes a user-system interaction model that specifies the mediating relationships involved.

Based on the user-system interaction model, this study proposes a psychological construct, Information System Interaction Readiness (ISIR), that indicates how an individual is prepared and willing to interact with a system within a user context. This construct advances a developmental view of how previous IS experiences may affect user future behavior. Compared with other constructs as predictors of user behavior, such as computer self-efficacy and intention to use, ISIR takes how IS user behavior is mediated into account.

To operationalize and measure the ISIR construct, this study develops a measurement instrument for ISIR using the technique of facet analysis and the semantic differential scale type. To explore how user experiences with a system lead to the formation of ISIR, this study identifies the psychological antecedents of ISIR. This enables the discussion of how general IS capabilities, including interactivity, personalization and context-awareness, may affect ISIR through these antecedents.

Because ISIR is a user-, system- and context-specific construct, this study also identifies and discusses the personal and situational factors that may affect ISIR. Putting all these relationships together results in a research framework of ISIR. To validate the ISIR measurement instrument and test the ISIR research framework, several laboratory studies were conducted. The results indicated that the ISIR instrument was valid and the ISIR framework was sound. Finally, the contributions and limitations of this study are discussed.

# DEDICATION

To my mother and father

# ACKNOWLEDGMENTS

I would like to express my gratitude to the chair of my dissertation committee, Dr. Marshall Scott Poole, and to my committee members, Dr. James Leigh, Dr. Marietta Tretter and Dr. Victor Willson. More specifically, I would like to thank Jim for the insight and help he has given since the formation of ideas at the beginning. Thanks to Marietta for helping me in details with the design of the laboratory procedures and questionnaires. Also thanks to Victor for his valuable guidance in methodologies and data analysis. Finally, my utmost respect and appreciation goes to Scott for his unbelievable ability and tremendous effort to “bring me up” from the very first day of my doctoral program to the completion of this work.

Thanks also to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great experience. I want to extend my special gratitude to all the instructors who allowed me to elicit their students to voluntarily participate in this study.

Finally, I would like to express my appreciation to my family. Thanks to my mother and father for their encouragement and support, and to my wife for her understanding and love.

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# CHAPTER I

# INTRODUCTION

*When Tom wants to search for literature for his term paper, he opens the browser on his computer desktop. Among the on-line resources available to him, Tom has used two quite often: google.com and his university's library website. Based on his previous experience, Tom found the library site useful in locating and retrieving articles and books if he already knew details such as title, author and volume. When he had only rough ideas about what kind of literature was available, google.com provided a powerful tool to search for relevant content from the Internet using only a few key words. In this case Tom does not have a very clear idea about what kind of literature might be available, and he decides to try Google first. He types in the key word and a list of files is displayed on his computer. He browses over them and selects a few to have a closer look. He does not find the exact articles he wants, but he finds some references to book and journal articles that may be pertinent. He then logs on to the university library website and checks whether these articles and books are available. He finds that some journal articles are available in electronic form and he downloads them.*

Information systems (IS) based on fast-advancing information technologies such as the Internet and wireless technologies have had great impacts on the way people work

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This dissertation follows the style of *MIS Quarterly*.

and live. People use IS to obtain useful information for the purpose of solving problems or meeting their needs. As our example suggests, IS user behavior at any particular point in time is closely related to their IS-related experiences. Users' previous experiences with particular systems can influence whether and how actively they would use the same or similar systems later on.

For any given application people often have a choice between several different IS options as well as non-IS approaches. In this relatively competitive user environment, the success of particular systems depends largely on how frequently and actively people use them, in comparison with other available options. Unfortunately, the success rate of IS has been quite low. Surveys show that the majority (50% - 80%) of IS in both organizational and non-organizational settings have failed to win user loyalty (Korac-Boisvert and Kouzmin 1995; James 1997; *No Gain* 2000).

To help practitioners and managers make decisions about implementation of and investment in IS, IS researchers have conducted a number of studies attempting to answer the question of "why people use IS".  Research on user acceptance of IS or IT has been identified as the main research stream directed to this question in the contemporary IS literature (Hu et al. 1999). With roots in psychology and sociology, theoretical models in this stream use "individual intention to use technology" as the key construct and most of them can explain over 40 percent of the variance in intention to use (for a review, please see Venkatesh et al. 2003).

However, we will contend that these studies make the error of artificially encapsulating the complex and concrete behavior of using IS into a simple and abstract

“IS use” action as the unit of analysis. This encapsulation enables researchers to evaluate users’ overall perceptions of certain IS, such as perceived usefulness and perceived ease of use (Davis 1989), but it screens out the possibility of examining the specificity of user experiences in interacting with these IS. Unlike simple actions such as reading a novel, IS user behavior is technology-mediated and context-dependent. As indicated in the example at the beginning of this chapter, a user may prefer a particular system in each setting because of the difference in user contexts and how systems mediate user behavior. For example, the library website allows users to retrieve certain electronic documents directly from databases, but it requires users to have rather detailed information about the document available. A system may be useful or easy to use to a person on some occasions, but not so on others. Thus, the mature user acceptance research stream provides insight into the question of “why people would use a given system (e.g. a word processing system) in general”, but it cannot answer the question of “why people use a particular system (rather than others) in particular contexts”, because the encapsulation prevents researchers from studying how various systems mediate user behavior differently.

It is important to address specifically the question of why people use systems in particular contexts, because it will lead to the insights as to what in certain systems “causes” people to choose them over other available options. Exploring this question will also suggest ways to improve system development and implementation so that users would use newly-developed or improved systems more actively.

The encapsulation of “IS use” into a simple action leads to the overemphasis of user acceptance research on the intention and decision to use IS. This overemphasis precludes a deep look into the relation between IS-specific experiences and user choice of IS. The position of this study is that, rather than being simply a cognitive process in which someone decides whether to use a system, the choice of IS depends also on behavioral experiences that create skills and cultivate affect toward using the systems.

As indicated in the example at the beginning of this chapter, when an individual faces alternative IS options, he/she makes a choice that not based simply on reasoning about the gain and pain from using each system, but rather out of a “readiness” towards the whole process of using each system within the given context that is developed based on their previous experience. In order to find out *why* people are ready to use some systems rather than other systems at a given moment, it is necessary to understand *how* people use different systems in different contexts, because this is what provides the experiences that user choices are based on.

Traditionally, the question of “how people use IS” has been an important concern of the field of human-computer interaction as it “involves the design, implementation and evaluation of interactive systems in the context of the user’s task and work” (Dix et al. 1998, p.3) This research stream attempts to understand how users interact with IS in order to provide guidance in system design, especially interface design (Norman and Draper 1986). Better system design is intended to enhance user experience, which in turn, is presumed to promote continuing and deeper use.

Studies of human-computer interaction are generally microscopic in nature and they usually focus on dissecting the psychological and computational processes in users' interaction with a specific system. This focus on the "how" question in studies of user-system interaction tends to direct attention away from the "why" question, and hence an important resource for dealing with the question of "why people prefer certain systems to other options" lies unused.

This project is founded on the premise that the user acceptance and human-computer interaction research streams can shed light on each other in contributing to a better understanding of IS user behavior. In short, it is possible to answer the research question "why people prefer certain systems" by developing a better understanding of "how they interact with these and other systems." This approach is consistent with what has been called for by IS researchers (e.g., Zhang et al. 2002; Zhang and Dillon 2003; Zhang and Li 2004) to combine these two research streams.

This study will apply Activity Theory as a theoretical framework that can bridge the existing gap between two research streams. Based on Activity Theory, this study introduces a new psychological construct, Information System Interaction Readiness (ISIR), in order to explain why people prefer specific information systems to others in specific user contexts.

**Objectives of This Study**

The overall purpose of this study is to answer "why people prefer certain systems" through an understanding of "how they interact with these and other systems".

This statement comprises both the goal and the means of this research. The goal of answering the “why” question suggests that the general approach should be consistent with that of the user acceptance stream. Understanding “how” question, on the other hand, is the means to that goal. Thus, the logical step is to identify the general approach of the user acceptance stream and find a conceptualization of human-computer interaction that “fits” that general approach. The first objective of this study, therefore, is to justify Activity Theory as an appropriate framework that can integrate these two research streams and to use it to develop a model of user-system interaction that specifies how IS user behavior is mediated.

A psychological construct that describes the degree to which an individual is predisposed to use an information system at a particular moment should take into account how prepared and willing the individual is to participate in all the mediated actions within the context. This study proposes Information System Interaction Readiness (ISIR) as a new construct that meets these requirements and operationalizes it based on the model of user-system interaction. Thus, the second objective of this study is to develop an ISIR measurement instrument, and assess its content, construct and predictive validities with data collected in a validation study.

To understand the how ISIR is shaped and why it varies across individuals and user contexts, this study identifies its psychological antecedents, i.e. important user psychological experiences leading to the formation of ISIR, and personal and situational factors. Through the mediation of ISIR antecedents, different IS capabilities can have different impacts on ISIR. Also, various personal and situational factors may explain why different users in different contexts may have different levels of ISIR toward the same or similar systems. Thus, the third objective of this study is to propose a research framework that incorporates the hypotheses of these relationships and test the hypotheses with data collected in an experimental study.

**Organization of the Dissertation**

This dissertation is organized into seven chapters. In addition to this introductory chapter, there are six chapters as follows:

Chapter II consists of a literature review of the user acceptance research stream, including its theoretical background, major models, core constructs, and important individual and situational factors that have been shown to influence IS user behavior. The review leads to the understanding of the theoretical problems of this research stream as well as its valuable insights into IS user behavior.

Chapter III conceptualizes user-system interaction using Activity Theory, leading to the definition and operationalization of Information System Interaction Readiness (ISIR) construct.  First, it gives a brief introduction to Activity Theory and discusses how this well-acknowledged theory of human-computer interaction can solve the theoretical problem faced by the user acceptance research stream. Then, this chapter proposes a user-system interaction model based on Activity Theory, which specifies the mediated relationships involved in this human activity. Based on this conceptualization, the psychological construct Information System Interaction Readiness (ISIR) is introduced as a solution to the theoretical problem of the user acceptance research stream, while being consistent with its general approach. Finally, this chapter describes the development of a measurement instrument for ISIR.

Chapter IV discusses the hypothesized relationships between ISIR and other variables. These relationships are discussed separately in different sections: behavioral consequences of ISIR, ISIR antecedents and IS capabilities, personal and situational factors related to ISIR. Finally, this chapter integrates these relationships into an overall research framework.

Chapter V describes the methodology of this research. There are two major sections: the first section describes the design of a validation study to assess the validity of ISIR measurement instrument; and the second section describes the design of an experimental study to test the research model in a formal way.

Chapter VI presents the statistical analysis of data collected from the validation study and the experimental study. For each, it outlines the statistical results and discusses the potential explanations for these results.

Chapter VII summarizes and discusses the significance of the research. First, this chapter discusses both the theoretical and practical implications of the results. Then, it addresses both the contributions and limitations of the study. Finally, it makes some recommendations for future research.

# CHAPTER II

# REVIEW OF USER ACCEPTANCE RESEARCH

There has been a great deal of research on user acceptance of IS and any theory of why people use IS must take this research stream into account. An understanding of both the strengths and the shortcomings of the user acceptance research stream can provide important guidance in the development of a more encompassing theoretical framework. This chapter reviews important user acceptance models and the key constructs employed. It takes a historical approach in order to illuminate both strengths and limitations of the user acceptance stream. Based on this review, several guidelines for development of the ISIR framework are identified. The chapter concludes with a discussion of theoretical problems with the user acceptance stream that motivate the development of the ISIR framework.

## Theoretical Background

In order to explain why people use IS, researchers in the user acceptance research stream have applied various established theories from social psychology to the study of IS user behavior, such as the Theory of Reasoned Action (TRA) (Fishbein and Ajzen 1975) and Social Cognitive Theory (Bandura 1986). Based on these and other social psychological theories, user acceptance researchers developed various models, such as the Technology Acceptance Model (Davis et al. 1989) and the Computer Self-Efficacy Model (Compeau and Higgins 1995).

In traditional social psychology, the fundamental unit of analysis is the human action (Baron and Byrne 2000). Having its roots in social psychology, the unit of analysis in the user acceptance research stream is the action of using information systems, or “IS usage” (Venkatesh et al. 2003). The underlying assumption is that it is appropriate to conceptualize a case of IS user behavior as a singular action, analogous to purchasing a newspaper or using birth control (two behaviors that have been studied using TRA). This conceptualization has the advantage of simplifying the study of IS user behavior and enabling the application of TRA and TPB in the IS field. However, it also raises some theoretical problems for the user acceptance research stream, which will be discussed at the end of the chapter.

This review of user acceptance research stream will first trace the roots and basic development of its major models with particular attention to how they dealt with the unique nature of IS use. Following this it will discuss the developmental nature of user acceptance models, a particular strength of the stream.

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*Historical Development of User Acceptance Theories*

Several decades ago psychologists realized that there was a gap between attitude and overt behavior (Fishbein and Ajzen 1975) and that existing theories had trouble in establishing direct connections between them. Several theories, including TRA and Theory of Human Behavior (Triandis 1977), were advanced to bridge the gap. TRA for example, posits that Behavioral Intention is a mediator between attitude and overt behavior. In addition to the Attitude toward Behavior, TRA posits that Subjective Norm is another antecedent of Behavioral Intention. Subjective Norm is defined as the "the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein and Ajzen 1975, p302). This modification greatly improves the explanatory power of the model by acknowledging the effect of social rules in human behavior.

User acceptance researchers applied these social psychological theories to the study of IS user behavior. For example, Davis et al. (1989) applied TRA to the study of individual acceptance of technology and derived the Technology Acceptance Model (TAM). Accordingly, TAM uses "intention to use IS" as the key predictor of usage behavior. In addition, Davis et al. (1989) identified Perceived Usefulness and Perceived Ease of Use as the major antecedents of intention to use IS. They found that the explanatory power of TAM in the IS area was largely consistent with that of TRA as applied to other behaviors. The first version of TAM did not include the subjective norm, but later versions included it in the case of mandatory adoption of IS (Venkatesh & Davis, 2000).

Compared with other human behaviors, IS user behavior has several distinguishing characteristics. One of them is that IS user behavior is mediated by IS, a new type of human artifact. Generally speaking, people use IS to obtain and process information in various forms to meet all kinds of needs. In this case, the information system is not the target object of user behavior, but rather like a tool through which users can work on the real object that meets their needs – information (either "raw" such as advice from a help function or "processed", such as a list of hotels in an area ranked according to price). In most social psychological theories, however, the unit of analysis is the human action, with the subject and object as its basic components. In these theories, tools are usually treated as objects. By regarding IS as objects in user actions, user acceptance researchers take exactly the same perspective.

Researchers in the TRA tradition have attempted to account for the role of tools in behavior. One of the these attempts was made by Ajzen (1988,1991) in developing the Theory of Planned Behavior (TPB) on the base of Theory of Reasoned Action (TRA) (Fishbein and Ajzen 1975). In TPB, a new construct, Perceived Behavioral Control, was included as another antecedent of Behavioral Intention and overt behavior. TPB further improved the explanatory power in terms of variance explained, and has been considered to be one of the most influential conceptual frameworks to explain human actions. However, why is the Perceived Behavioral Control construct necessary in addition to the existing Attitude Toward Behavior construct? What is the real difference between two? Fishbein and Ajzen (1975) defined Attitude Toward Behavior as “an individual’s positive or negative feelings (evaluative affect) about performing the target behavior” (p. 216), and Ajzen (1991) defined Perceived Behavioral Control as “the perceived ease or difficulty of performing the behavior" (p. 188). The definition of Perceived Behavioral Control has the potential to overlap with that of Attitude Toward Behavior in that perceived ease or difficulty is exactly one of an individual’s positive or negative evaluations about performing the behavior.

The addition of the Perceived Behavioral Control construct to the existing Attitude Toward Behavior, however, can be justified by differentiating means and objects of human behavior. Attitude Toward Behavior seems to be more closely related to the evaluation of the target object, while Perceived Behavioral Control should be more closely related to how well one would be able to use the means at hand to accomplish the target. When people become more skillful with means or tools, they feel more in control.

Bandura (1986) introduced a similar construct, Self-Efficacy, to his Social Cognitive Theory. In one version, Self-Efficacy was defined as “people’s beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives” (Bandura 1991, p. 257). While this definition is at a general level, another definition of Self-Efficacy, “beliefs in one’s capabilities to organize and execute the courses of action required to produce given levels of attainments” (Bandura, 1998, p. 624), relates it to a specific challenge or task. For clarity, the Self-Efficacy at the general level can be referred to as General Self-Efficacy, and the Self-Efficacy at the specific level can be referred to as the Task Self-Efficacy. By definition, Self-Efficacy (especially Task Self-Efficacy) and Perceived Behavioral Control are very similar constructs. In fact, they are so close to each other that Ajzen (2002) pointed out that they can be considered as a unitary latent variable.

In applying these general social psychological theories in their research, students of IS user behavior imported similar constructs, either intentionally or coincidentally. For example, Compeau and Higgins (1995) adapted Bandura’s (1986) Self-Efficacy construct to study IS user behavior and posited the Computer Self-Efficacy construct. When Davis et al. (1989) developed the Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB) (Ajzen 1988,1991) had not been developed. However, a comparison between TAM and TPB shows a one-to-one correspondence between the constructs in both models.

Specifically, Perceived Usefulness in TAM, like Attitude Toward Behavior in TPB, is an attitudinal construct implicitly related to the target object, information, and its transformation. Perceived Ease of Use in TAM, like Perceived Behavioral Control in TPB, is an attitudinal construct implicitly related to using tools. Both Perceived Usefulness and Perceived Ease of Use in TRA are narrower in semantic scope than their corresponding constructs in TPB, but they are also more specifically adapted to the study of IS user behavior.

*The Developmental Approach of User Acceptance Research*

As the example at the beginning of Chapter I suggests, previous experiences of users with specific IS can influence whether and how they would use the same or similar IS later. This implies that we should take a developmental view of IS use which acknowledges that IS user behavior at any particular moment is closely related to the user's previous experiences with the same or similar IS, and sometimes, even analogous non-IS tools (e.g., command buttons on the IS interface analogous to real buttons on physical tools). A particular strength of user acceptance theories is that they have inherited a developmental view of behavior implicit in TRA and TPB and hence has addressed this issue.

Theory of Reasoned Action, Theory of Planned Behavior, and Social Cognitive Theory all assume that an individual’s history informs the criteria that he or she uses to form attitudes toward a behavior. Moreover, TPB incorporates the construct of Perceived Behavioral Control, which is informed by experience with the means by which the behavior is to be performed, and Social Cognitive Theory incorporates the construct of Self-Efficacy, which is informed by previous experiences as well. This implicitly developmental approach uses intermediate psychological constructs to capture the impact of history on user behavior.

This same approach has been applied in user acceptance models. For example, the Computer Self-Efficacy (CSE) Model (Compeau and Higgins, 1995) based on Bandura’s (1986) Social Cognitive Theory uses Computer Self-Efficacy as an intermediate psychological construct that carries the accumulated effects of previous user experience. Figure 2.1 illustrates the general approach of the user acceptance research stream (adapted from Venkatesh et al., 2003).

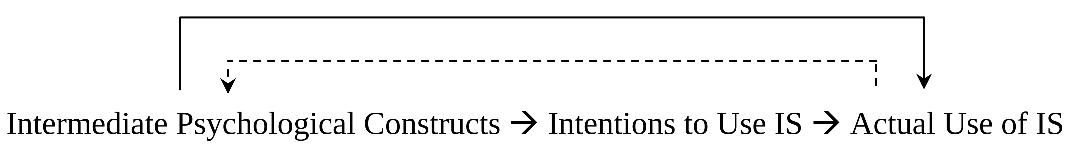


Figure 2.1: **General Approach of User Acceptance Models**

This general approach in using intermediate constructs to carry the accumulated effects of previous experience on future behavior reflects the developmental nature of IS user behavior. Unlike their corresponding general theories in social psychology, user acceptance models such as TAM and CSE explicitly proclaim the developmental view in the specification of their constructs. That is, the names of constructs such as Perceived Usefulness, Perceived Ease of Use and Computer Self-Efficacy indicate that these constructs are all shaped by previous experiences with computer systems that give the user grounds for assessing the systems in terms of themselves, usage and competence.

*Summary*

This section has examined the theoretical background of the user acceptance research stream. The review suggests several ways in which the general approach of user acceptance research can provide guidelines for development of the integrative theory that is the goal of this dissertation. First, this research stream highlights the importance of attitudes toward IS in user acceptance. The robust finding that acceptance of IS is not based only on cognition about IS, but about evaluative reactions to them should be a cornerstone of any theory of why people use IS. Second, the developmental view of user behavior represented in this research stream is a useful way to take user experience into account. The user acceptance research suggests that experiences with IS can be represented by mediating psychological constructs (in our case, the ISIR construct). Third, user acceptance research has developed a large body of empirical evidence on various types of variables that can suggest some of the major classes of constructs that should be included in the theory. In the next section, we present a more detailed discussion of these variables with the focus on comparing and classifying them so that they can be used as reference points in the development of the ISIR framework.

**Key Constructs in User Acceptance Research**

Researchers in user acceptance research stream have identified several types of constructs that may be relevant to IS user behavior and that can guide further development of the theoretical framework for this dissertation. Among these variables, some are constructs directly included in various user acceptance models, and others are personal and situational factors that may influence the constructs in user acceptance models. This section discusses these constructs separately.

*Constructs in User Acceptance Models*

Like TAM, most other models in the user acceptance research stream adopt "intention to use IS" as the psychological predictor of usage behavior (Venkatesh et al., 2003). Among them, the Motivational Model (Davis et al., 1992) applied the concepts of Extrinsic Motivation and Intrinsic Motivation (for a review, see Vallerand, 1997) to the study of IS user behavior. Extrinsic Motivation is the user's instrumental perception of "achieving a valued outcomes that are distinct from the activity itself" and Intrinsic Motivation is the user's perception of engaging in the activity itself "for no apparent reinforcement other than the process of performing the activity per se" (Davis et al. 1992, p1112). Examples of Extrinsic Motivators include job performance, pay or promotion resulting from using IS (Davis et al. 1992), and examples of Intrinsic Motivators include personal interests, curiosity and enjoyment in using IS. Extrinsic Motivation extends the scope of Perceived Usefulness in TAM by including the long-term effect of information outcomes in addition to the short-term effect for specific tasks. Intrinsic Motivation extends Perceived Ease of Use by including the affective aspects of attitude toward using IS in addition to the cognitive evaluation of difficulty.

As mentioned, the Computer Self-Efficacy Model (Compeau and Higgins, 1995) uses Computer Self-Efficacy, adapted from Self-Efficacy in Bandura's (1986) Social Cognitive Theory, as the key intermediate construct to explain IS user behavior. In the context of IS user behavior, Computer Self-Efficacy is conceptualized as "a judgment of one's capability to use a computer" (Compeau and Higgins, 1995, p. 192). As mentioned, Self-Efficacy in SCT is closely related to the Perceived Behavioral Control in TPB. However, there is a subtle but important distinction between Computer Self-Efficacy, inherited from Self-Efficacy, and Perceived Ease of Use in TAM, inherited from Perceived Behavioral Control. Perceived Ease of Use is a judgment of a particular process of using IS, while Computer Self-Efficacy is a general individual belief that is shaped by all previous computer-related experiences and other personal characteristics. For this reason, Venkatesh (2000) adopt its as one of the personal characteristics that moderate Perceived Ease of Use.

Other core constructs in the Computer Self-Efficacy model include: Outcome Expectations-Performance, Outcome Expectations-Personal, Affect, and Anxiety. By definition, Outcome Expectations-Performance, which deals specifically with job-related outcomes (Compeau & Higgins, 1995) is closely related to Perceived Usefulness or Extrinsic Motivation, depending whether the expectation is short-term or long-term. Outcome Expectations-Personal, which pertains to individual esteem and sense of accomplishment (Compeau & Higgins, 1995), is closely related to Perceived Ease of

Use or Intrinsic Motivation, depending whether the expectation is affective or cognitive. Affect and Anxiety, on the other hand, are personal factors related to the general positive and negative feeling and emotions towards using IS.

The Model of PC Utilization (MPCU) is another model proposed by Thompson et al. (1991) based on Triandis's (1977) theory of human behavior, a competing perspective to TRA and TPB. The core constructs of this model include Job-Fit, Complexity, Long-term Consequences, Affect towards Use, Social Factors, and Facilitating Conditions. Job-Fit is defined as "the extent to which an individual believes that using [a technology] can enhance the performance of his or her job" (Thompson et al. 1991, p.129), and is similar to the Perceived Usefulness in TAM. Complexity is defined as "the degree to which an innovation is perceived as relatively difficult to understand and use" (Thompson et al. 1991, p. 128), and is similar to Perceived Ease of Use in TAM. Long-term Consequences is defined as the "outcomes that have a pay-off in the future" (Thompson et al. 1991, p. 129), and is similar to Extrinsic Motivation in MM. On the other hand, Affect Towards Use, similar to Intrinsic Motivation in MM, is "feelings of joy, elation, or pleasure, or depression, disgust, displeasure, or hate associated by an individual with a particular act"(Thompson et al. 1991, p. 127). Social Factors can also find its counterpart in TRA/TPB, Subjective Norms, defined as "the individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations" (Thompson et al. 1991, p. 126). Finally, Facilitating Conditions are objective factors in user environment that make IS-related tasks easier to accomplish, such as technical support (Thompson et al. 1991, p. 129). This is a situational factor that preexists before actual IS user behavior occurs and moderates it.

Regarding user acceptance of new technology, Innovation Diffusion Theory (IDT) provides a framework to examine how a user would accept a new technology in place of its precursor. The core constructs include: Relative Advantage, Results Demonstrability, Ease of Use, Image, Visibility, Compatibility, Voluntariness of Use. While Ease of Use is almost the same as Perceived Ease of Use in TAM, Relative Advantage is closely related to Perceived Usefulness in TAM, because it is defined as "the degree to which an innovation is perceived as being better than its precursor" (Moore and Benbasat 1991, p. 195). In the context of technology innovation, Visibility and Results Demonstrability are related to how likely the Relative Advantage can be perceived by potential users and decision makers. Image, defined as "the degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore and Benbasat 1991, p. 195), and Compatibility, defined as "the degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters" (Moore and Benbasat 1991, p. 195), are both closely related to Subjective Norm in TRA or TAM. Finally, Voluntariness of Use, "the degree to which use of the innovation is perceived as being voluntary, or of free will" (Moore and Benbasat 1991, p. 195), is another situational factor that is a condition moderating how people use IS.

*Personal and Situational Factors*

The key psychological constructs that mediate user previous experience and future use, such as Perceived Ease of Use, are also likely to be affected/moderated by preexisting personal and situational Factors. While situational factors are related to user context, personal factors are rather context-independent. As mentioned, there are two types of Self-Efficacy at different levels: General Self-Efficacy and Task Self-Efficacy. In the study of IS user behavior, General Self-Efficacy is more like a personal factor that is relatively independent of user context but Task Self-Efficacy is more like a situational factor that depend on user context that is task-related. This section discusses other personal and situational factors that may influence IS user behavior.

User acceptance researchers have conducted studies to investigate which personal factors may affect IS user behavior and how they moderate intermediate constructs in the models. For example, in a study of the determinants of Perceived Ease of Use, Venkatesh (2000) identified Computer Self-Efficacy, Perceptions of External Control, Computer Anxiety and Computer Playfulness as the personal “anchors” that may affect Perceived Ease of Use. After a close look at the measurement instrument of Computer Self-Efficacy (Compeau and Higgins, 1995), we found that this construct is measured based on user experience with specific systems. Thus, Computer Self-Efficacy is more like a situational factor than an personal factor. Because Task Self-Efficacy covers Computer Self-Efficacy for a task, we use the former rather than the latter as one of the situational factors. Computer Playfulness and Computer Anxiety, on the other hand, are the personal factors particularly related to people’s affect/emotion in using IS.

Computer Playfulness, as one's positive individual perception of IS use in general, is defined as "the degree of cognitive spontaneity in microcomputer interactions" (Webster and Martocchio 1992, p. 204). Venkatesh (2000) conceptualized it to be part of Intrinsic Motivation. On the other hand, Computer Anxiety, related to the Anxiety in the Computer Efficacy Model (Compeau and Higgins, 1995), is one's negative individual perception of IS use in general, defined as an individual's apprehension, or even fear, when she/he is faced with the possibility of using computers (Simonson et al. 1987). Computer Self-Efficacy, Computer Anxiety and Computer Playfulness have been found to be distinct from while related to each other (Bozionelos 1997; Compeau and Higgins 1995; Heinssen et al. 1987; Igbaria and Ilvari 1995; Webster and Martocchio 1992).

In Venkatesh's (2000) conceptualization based on a review of previous studies (e.g., Ajzen, 1991, Terry, 1993), Perceived Behavioral Control in TPB had two dimensions: Internal Control and External Control, and Computer Self-Efficacy was regarded to be a factor related to internal control. Though not mentioned in Venkatesh's work, Locus of Control is an personal factor potentially related to Perceived Behavioral Control (Ajzen, 2002) and computer use (Coovert and Goldstein, 1980). *Locus of Control* (LOC) refers to the "mastery of one's environment" (Rubin, 1993, p. 162). People with internal LOC feel powerful, and want to have control over their environments (DeCharms, 1972). People with external LOC feel powerless, and prefer to let others have control of their environments (Brenders, 1987). In the context of IS user behavior, people with internal LOC might be more confident and active in their use of IS than users with external LOC. Meanwhile, Ajzen (2002) tried to differentiate

Locus of Control and Perceived Behavioral Control by claiming that the former is personality-related and the latter is performance-related. In his point of view, constructs such as Perceptions of External Control are just part of Perceived Behavioral Control. Thus, LOC might be a more appropriate candidate for this personal factor than Perceptions of External Control.

Like personal factors, situational factors play important roles in IS user behavior, especially in the user's judgment on and choice of various IS in a given context. It has been found that a person makes judgments on a task based primarily on three aspects: (1) the sum of the subject's past experiences, (2) the setting or background, and (3) the stimulus (Helson, 1964; Streitfeld and Wilson 1986). Except the first one, the other two are related to situational factors.

First, individual users differ in their past experience with the same or similar IS. As the example at the beginning of this chapter suggests, system experience is an important personal factor that influences IS user behavior. When users have multiple choices of IS, they are likely to choose a system that they are more familiar and skillful with. Researchers have recognized the importance of previous user experience in various forms such as past training and computer-related job experience in studying IS user behavior (Benbasat et al. 1981; Yaverbaum 1988; Alavi, 1992).

In addition to Voluntariness of Use and Facilitating Conditions, other situational factors related to the setting or background of tasks may also influence IS user behavior. Yaverbaum (1988) identified the nature of task, task environment and task complexity as the major task factors that are critical to IS user behavior. Karimi et al. (2004) specified environmental uncertainty as comprised of dynamism, hostility and heterogeneity and task characteristics as comprised of nonroutine and interdependent to be important moderators of IS user performance and satisfaction. For the purpose of this study, we term these situational factors that are related to the setting of user task “task setting”. Note here that task setting is a general term, not only related to extrinsically-motivated tasks, but also to intrinsically-motivated tasks, such as browsing websites for fun. Thus, Task setting is a subset of user context related particularly to the task.

The other two important situational factors that are related to the stimulus in user tasks are Task Importance and Tension/Pressure. Researchers have found that Perceived Importance of tasks positively correlates with the intensity of involvement in searching for information (Kapferer and Laurent 1986; 1993). Researchers have also found that Tension or Pressure has significant effects on both the task performance and the interaction process of IS users (Benbasat and Dexter 1986; Chen and Tsoi 1988; Hwang 1994; Marsden et al. 2002, McGrath et al. 1991).

### *A Classification of Variables*

The above review and discussion of variables identified to be relevant in user acceptance research indicates that these variables are different in nature. Obviously, these variables are at different levels: some are at the individual level, while others are at the social level. The purpose of taking the perspective of human-computer interaction to study IS user behavior is to determine how individuals use IS in more detail. Thus, the nature of this study determines that variables at the individual level are of main interest.

Also, these variables are related to different stages of IS user behavior: some are related to the preexisting conditions prior to the behavior, some are related to the process of behavior itself, and others are related to the outcome of behavior. Thus, we can classify all the variables as along these two dimensions: level and stage, as shown in Table 2.1. This classification can be used as reference points for ISIR construct development and research model specification.

Table 2.1: **Classification of Variables in User Acceptance Models**

| Stage / Level | Condition-related | Process-related | Outcome-related |
|---|---|---|---|
| Individual | Self-Efficacy (SCT)<br>Anxiety (SCT)<br>Intrinsic Motivation (MM)<br>Computer playfulness<br>Locus of Control<br>System Experience<br>Task Setting<br>Tension/Pressure<br>Task Importance | Intention to Use IS (TAM)/ Behavioral Intention (TRA)<br>Perceived Ease of Use (TAM, IDT)/ Perceived Behavioral Control (TPB)<br>Complexity (MPCU)<br>Affect Towards Use (MPCU, SCT) | Perceived Usefulness (TRA)/ Attitude Toward Behavior (TRA)<br>Relative Advantage (IDT)<br>Job-Fit (MPCU)<br>Outcome Expectations (SCT)<br>Extrinsic Motivation (MM) |
| Social | Voluntariness of Use (IDT)<br>Facilitating Conditions (MPCU) | Subjective Norm (TRA)/ Social Factors (MPCU)/ Compatibility & Image (IDT)<br>Visibility (IDT) | Long-term Consequences (MPCU)<br>Result Demonstrability (IDT) |

For all its strengths, user acceptance research also has some problems which the ISIR framework must address. We turn to these in the next section.

**A Critique of User Acceptance Research**

The user acceptance research stream has made important contributions and must be considered in developing any theory of why people use IS. However, this research stream has several problems that keep it from providing an adequate answer to this question. These problems are rooted in the social psychological paradigm that underlies user acceptance research.

Following the paradigm of traditional social psychology, user acceptance research has adopted the action of IS usage as its basic unit of analysis. The underlying assumption is that it is appropriate to conceptualize a case of IS use as a simple action that the user as the subject takes with a system as the object. This assumes that, conceptually, IS user behavior is not much different from any simple action, such as hammering a nail or choosing a method of birth control.

However, in the study of tool-using behavior such as IS use, researchers should differentiate tools from target objects, because tools mediate the relationship between the subject and target object. Tools are different from objects in several ways. Firstly, complex tools must be human artifacts, but objects may or may not be. In the context of IS user behavior, the human-made tools are IS, and the target object is information, which may exist in an artificial form (e.g., magnetic disks) or in a natural form (e.g., weather conditions). Secondly, people usually do not aim to transform the tools while using them; instead, they transform the target objects. IS users do not change the hardware and software of IS purposefully in the process of using them, but they do transform the target information, by changing its form (e.g., from the natural form to the artificial form), location (e.g., file transfer) and content. Of course, some users can modify or even create their own IS for special purpose, but they are tool modifiers or creators when they do so. After people work on target objects, the objects are more or less different from their original state. Thus, an action is always somewhat unique because one cannot work on the “same” object twice. However, tools are relatively stable and enduring, and that allows people to learn how to use them and become skillful with repeated use. In this way, people do not need to learn how to deal with each unique object, but just learn the skills necessary to use their tools. Once people become skillful with existing tools, they can use those tools to create even more sophisticated tools. Thus, tools greatly facilitate human learning and knowledge accumulation process (Engeström, 1987).

Psychological theories that take human actions as units of analysis, however, generally do not differentiate tools and target objects in specifying the objects of human action. In studying human action involving tools, these theories treat tools as the target objects. While this equation presents few problems for social psychologists, who are usually not much interested in studying the mediating role of tools, it is a great problem for researchers of IS user behavior, who should not ignore the mediating role of IS in their research.

Still, mixing tools with target objects does cause problems for social psychologists. The major problem is that when a researcher tries to measure a theoretical construct, usually an attitude, the response can actually refer to either the real target object or the tool. Depending on which the respondents think of, their answers may be quite different. For example, when students are asked "Would you like to use computers to do your homework?," their answer will be very different depending on whether they think about the using the tool, a computer, or the real target object, homework. Actually, most human actions are tool-mediated, and when tools are not specified in the action, problems result. For example, if we ask a homeowner "do you enjoy mowing the lawn?," the question may elicit different responses depending whether he/she thinks about the lawn before or after mowing or which mowing tools (e.g. push mower, riding mower, scythe) to use. To provide a remedy for this problem, psychologists have introduced several psychological constructs that are specially designed to tap the degree of being comfortable with tools (including psychological tools, such as language; to be discussed later).

While the conceptualization of IS usage as an action with the IS as the object may help to simplify the study of IS user behavior, it turns our attention away from the mediating role of IS in user behavior. It is our contention that rather than reducing them IS the target object of user behavior, an adequate theory would take both the target activity in the context of use—which includes the goals the user has in using the IS, prior experience with the IS, and other aspects—and the mediating role of the IS into account. By taking the IS as the target object, user acceptance models conflate the real target object—information—and the mediating tool, the IS.

This mixing of target and tool leads to conceptual problems. The TAM model, for instance, does not give much guidance as to which of two systems a user would prefer in a particular context when the user has previously found both systems useful and easy to use in other contexts. As in the example at the beginning of Chapter I, the user may prefer system 1 in one context, but system 2 in a different context. Taking the context of behavior into account more explicitly would enable us to explain these differential preferences.

The constructs user acceptance theory employs to take the IS-as-tool into account, such as Perceived Ease of Use and Computer Self-Efficacy, basically summarize experience into a single variable. They do not address the basic problem of conflation of user context, the mediating role of IS, and the target object of subject activity. In order to solve the theoretical problems facing the user acceptance research stream, it is necessary to develop a new research framework on IS user behavior under another theoretical paradigm that does not require the unit of analysis to be a simple action between a subject and an object.

Chapter III discusses Activity Theory, a theoretical framework that offers a more comprehensive view of IS use. Activity Theory will be used as the foundation of a theory of IS use that maintains the strengths of and conforms to the guidelines suggested by of the user acceptance perspective, but also overcomes its limitations.

# CHAPTER III

# AN ACTIVITY PERSPECTIVE ON USER BEHAVIOR

The review of the user acceptance research stream in the previous chapter shows that the conceptualization of “using IS” action as the unit of analysis oversimplifies IS user behavior. The focus of this chapter, therefore, is to “restore” IS user behavior as a complex human activity involving mediated relationships, rather than a simple action. First, this chapter discusses why Activity Theory, a well-known paradigm in human-computer interaction research stream, is appropriate to conceptualize IS user behavior. Then it describes a conceptualization of user-system interaction in terms of Activity Theory, which specifies the mediated relationships involved in this type of human activity. Based on this conceptualization, a new psychological construct, Information System Interaction Readiness (ISIR), is proposed as the intermediate construct connecting previous user experiences and future user participation in user-system interaction. Finally, this chapter describes the development of a measurement instrument for ISIR.

## Activity Theory

IS user behavior can be described as the process in which a user tries to meet an information need with the help of a system in a given context. In the example given at the beginning of Chapter I, the user acquires useful information with the help of two systems, Google and the library website. Even for similar purposes, different user contexts can call for use of different systems. In the example, when the user has few clues about what literature is available, he chooses Google because of its ability to search Internet content with key words. However, when more detailed references are available, the user logs onto the library website because he can retrieve the publications from library database with the reference information. The user acceptance research stream, because its unit of analysis is too simplified to take the specific mediating role of IS into account, cannot adequately address the question “why does a user choose to use a particular system (rather than other systems) in a given context?” To answer this question, we must have a deep understanding of another question, namely “how does the user meet his/her information needs with the help of IS?”

The human-computer interaction research stream provides various conceptual schemes to look into the “how” question. In order to answer the “why” question by understanding “how”, it is necessary to choose an appropriate conceptual scheme that also allows researchers to investigate IS user behavior with a developmental view. The ideal scheme should allow researchers to examine how IS user behavior is mediated in a single case and the mediation effects over time, and meanwhile take user contexts into account. Activity Theory (AT), as one research paradigm introduced by Bødker (1991) to the field of human-computer interaction, meets these requirements.

AT was initially developed by the Russian psychologist Vygotsky in 1920’s and later elaborated by his followers, especially Leont’ev (for a review, see Kuutti, 1996). Historically rooted in Hegelian and Marxist philosophies, AT emphasizes a developmental view of human subjects in their mediated interaction with physical objects and other subjects. This perspective is consistent with the developmental view of IS user behavior in the user acceptance research stream. That is, AT is compatible with the general approach of user acceptance models to use an intermediate construct for connecting the user's previous experiences and future behavior.

Unlike many other psychological theories, AT uses human "activities" as the basic unit of analysis rather than "actions", and studies human behavior as evolving activity systems composed of mediated interaction (Leont'ev, 1978). Thus, AT does not require the unit of analysis in the study of IS user behavior to be conceptualized as a simple action involving only a user and a system. Instead, it allows this complex human behavior to be dissected into mediated interaction among the user, system and the real target object – information. This perspective helps researchers gain a deeper understanding of IS user behavior. Compatible with the approaches of both user acceptance and human-computer interaction research streams, AT provides an appropriate scheme to study IS user behavior in order to answer "why people use IS" by understanding "how people use IS".

"Activity", which is the basic unit of analysis in AT, carries the connotation of motivation in its original Russian root, and thus is different from "actions" as they are usually conceptualized in psychological theories. According to AT, an activity is elicited by a *motive* to transform an object into an outcome, an action is something a subject is conscious of doing with an immediate *goal*, and an activity is composed of a series of actions organized by the common motive and may involve multiple subjects (Leont'ev 1978). An action is composed of operations, which are subconscious routines depending on the conditions (mainly tool-related) of attaining the goal of action (Leont'ev 1978). Table 3.1 shows a hierarchical representation of an activity, with an increase in conscious purpose associated with the subject's behavior from bottom to top.

Table 3.1: **Hierarchy of a Human Activity**

| | | |
|---|---|---|
| Conscious | Activity | - Motive (why) |
| | Action | - Goal (what) |
| Non-articulated | Operation | - Condition (how) |

Under this conceptualization of activity, user-system interaction can be regarded as an activity participated in by a user who has a motive to transform raw information into some desirable outcome, such as knowledge. As an activity, it is composed of a series of actions, such as using the interface to enter input to a system (e.g., typing in text-boxes and selecting options), and receiving/reading output to get results from the system.

In each action, AT differentiates subjects, objects and tools by specifying their mediated relationships: subjects transform objects through the mediation of tools (Vygotsky 1978, 1981). Subjects are relatively autonomous and they work on objects as driven by the motive to transform the objects into certain outcomes. Tools, on the other hand, are directly manipulable and they mediate the conscious actions between subjects and objects. According to AT, there are two types of tools: *technical tools* and *psychological tools* (or *signs*). Technical tools "serve as the conductor of human influence on the object of activity; it is externally oriented; it must lead to the changes in objects" (Vygotsky 1978, p. 55). Psychological tools are "directed toward the mastery or control of behavioral processes- someone else's or one's own- just as technical means are directed toward the control of processes of nature" (Vygotsky 1981, p.137). Languages are the basic psychological tools for subjects to cognize and communicate object information (Leont'ev, 1978). Extending this conceptualization to user-system interaction, the interface can be regarded as a combination of both technical and psychological tools: it is an artifact made from technologies, but has the same semantic and communicative function as language. The ability to master tools by becoming skilled in using existing tools and creating more sophisticated tools is what distinguishes human beings from animals and makes human learning a developmental process (Engeström 1987).

AT is concerned with the nature of mediated relationships between subject and object as well as relationships between subject and subject. Subjects can work on objects through the mediation of *tools*, and collaborate with each other on the same object and form a *community* (Leontjev, 1989). How community members share the same object is mediated by the *division of labor*. Often times, the division of labor is  represented by the use of different tools, or "means of production" (Marx 1909). How community members interact with each other is mediated by social *rules*. These rules, which take various forms such as collective traditions, rituals, norms, registrations and so on, regulate the social aspect of human activities. The mediated relationships among subject, object and community in an activity was summarized by Engeström (1987) in the activity model shown in Figure 3.1.

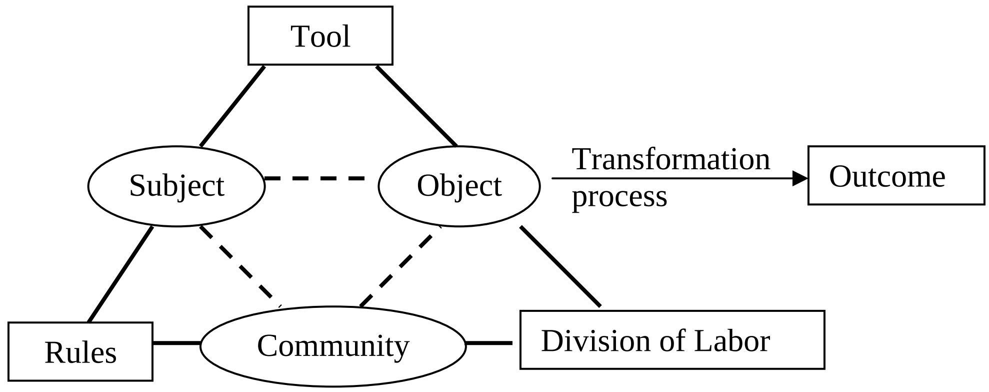


Figure 3.1: **Activity Model**

**User-system Interaction**

Unlike the social psychological paradigm, AT does not require the unit of analysis in studying IS user behavior to be “using IS”. Rather, as mentioned, AT views this type of human activity as composed of a series of actions that are driven by a common motive: to transform raw information into desirable outcomes. Thus, AT allows researchers to inspect user-system interaction from different aspects by specifying mediated actions and relationships involved. However, there are several different ways in which this relatively new and special human activity can be conceptualized in AT. This section will attempt to establish the alternative that can lead to the most comprehensive understanding of IS user experiences, which is the key to answering the question “why people prefer (or not prefer) to interact with certain systems?”.

Probably the most common conceptualization of human-computer interaction with AT treats IS as the tools that mediate the relationship between user and object information (e.g., Christiansen 1996). This is consistent with the traditional metaphor of computer as tool in the human-computer interaction research stream (Norman 1990, 1993, 1994). For example, an on-line library catalog is analogous to a traditional library catalog, which is a tool for readers to search book information. Though this conceptualization is simple, it does not give a rich and broad perspective on the role of computer technology in human life (Nardi and O'Day 1999). Unlike simple tools, computer technologies are so complex that they are not fully under the control of human beings. Rather, modern technologies, or "techniques" in Ellul's (1964) terminology, "ha[ve] taken over all of man's activities, not just his productive activity" (p.4). If we conceptualize IS as tools through which people work on the target object – information – we cannot fully appreciate the complex nature of this type of activities.

Bødker (1991), on the other hand, conceptualizes the user interface as the artifact/tool that mediates users' interaction with objects in the computer (i.e., digitalized information) or other human subjects. Note that this conceptualization distinguishes user interface from computer system. This is consistent with Abowd and Beale's (1991) well-known interaction framework in which interface (including input and output components) mediates the communication between user and system. But most users and most IS researchers generally consider a user interface a part of the information system rather than something separate. To avoid confusion, we will stipulate that an information system is composed of two parts: the user interface (simply, "interface") and the computer system (simply, "system").

Bødker (1991), like most other researchers whose main research interest is the user interface, did not specify the role of computer system itself in human-computer interaction. Whereas it is clear that information is the target object, it remains an issue to decide whether the system should be conceptualized as a tool or as a subject in the activity. In this study, which focuses on user experiences in interacting with a system, we contend that the system can be regarded as an subject that collaborates with the user.

Though computer systems are human-made artifacts, they are not directly accessible to users, but are relatively autonomous in how they retrieve and process information once they have been implemented. Rather, users have direct access to the user interface to specify requests for information to the system through the input component of interface, and to receive/read the result generated by the system through the output component of interface. The system itself is a “black box” to the user, something that engages in activities based on inputs and then delivers outputs back to the user via the interface. In this sense, computer systems have their own “will” and play a social role in their interaction with users. When the main interest is to have a comprehensive understanding of user experiences with the system, therefore, it is more appropriate to take a system as another subject in the conceptualization of user-system interaction with AT.  We can turn for supporting evidence to daily life, in which users tend to treat computer systems as black boxes because these systems are relatively autonomous in what they do (e.g. Kallinikos 2002; Winner 1993). This view has been reflected in IS research and “in the majority of articles over the past decade, IT artifacts are either absent, black-boxed, abstracted from social life, or reduced to surrogate measures” (Orlikowski and Iacono 2001, p. 130). Treating computer systems as black boxes is equivalent to according them a subject status.

People are likely to not only consider computer systems autonomous, but also to assume that computer systems have social properties. Reeves and Nass (1996) observed IS user behavior and found that when people interact with computer systems, they often expect the systems to behave like human partners as in social interaction. For example, users may expect responsiveness and courtesy from the systems that they are interacting with. Thus, users often preconsciously treat computer systems as social actors when they interact with them. In recent years there have been a growing number of studies in IS research to regard computer systems as social actors in studying user behavior (e.g., Lamb and Kling 2003; Nass et al. 1997).

If it is appropriate to treat computer systems as social actors, user-system interaction can be regarded as a collaborative activity involving two subjects, user and system, with the motive of transforming raw information into desirable outcomes for the user. Based on this assumption, it is possible to use the Activity Model to examine the mediated actions and relationships involved in user-system interaction.

In the activity of user-system interaction, the user and system work on the same object and form a community. They collaborate on the transformation of information through the mediation of different tools: the user works on information through the mediation of user interface, and the system works on information through the mediation of various information technologies, such as database technology and sensor technology. Like language, the user interface is the tool through which the user specifies input to and receives output from the system. Information technologies enable the system to acquire, store, process, retrieve and transfer information.

Because there are only two subjects, a user and a system, involved in this collaborative activity, we can specify each in the User-System Interaction Model based on the Activity Model (Figure 3.2). The different tools through which the user and system work on information constitute the division of labor for two subjects. The user is supposed to use the interface to specify input to the system and read output generated by the system. The system is supposed to use information technologies to work on raw information and generate output based on user input. Note that both input and output are special types of information related to the transformation of raw information at different stages. The rules that mediate the interaction between users and systems can be denoted as "interaction rules". Interaction rules regulate the social aspect of user-system interaction activity, mainly the communicative process, between the user and system. Specifically, these rules include the norms and customs supposed to be shared by both the user and system regarding how the communicative process between them should initiate, evolve and end, and what information is supposed to be utilized and exchanged.

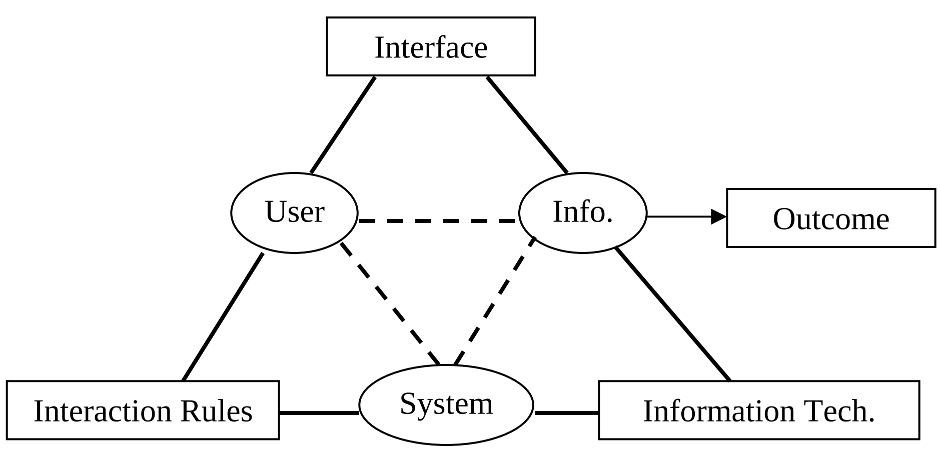


Figure 3.2: **User-System Interaction Model**

This conceptualization of user-system interaction with AT provides an understanding of the mediated relationships between user and information, user and system as well as system and information. The knowledge of how these relationships are mediated may lead to the identification of basic IS capabilities and the understanding of how they influence user experiences in user-system interaction. User experiences, in turn, largely determine how users get ready to use the same or similar IS later.

**IS Capabilities and User Experiences**

This section first identifies basic IS capabilities based on the AT conceptualization of user-system interaction. Then it discusses how these capabilities may influence user experiences. The inclusion of IS capabilities in the discussion is helpful for answering the question of why people prefer some systems over others.

As mentioned previously, user-system interaction can be regarded as a collaborative activity with the common motive to transform raw information into desirable outcomes for the user. It is logical to identify basic IS capabilities that facilitate the fulfillment of this motive, and then discuss how they influence user experiences. The facilitation can be carried out through the mediated relationships in user-system interaction: the user-information relationship through the mediation of the interface, the user-system relationship through the mediation of interaction rules, and the system-information relationship through the mediation of information technologies. Correspondingly, we can delineate three types of IS capabilities: interactivity, personalization and context-awareness (Figure 3.3).

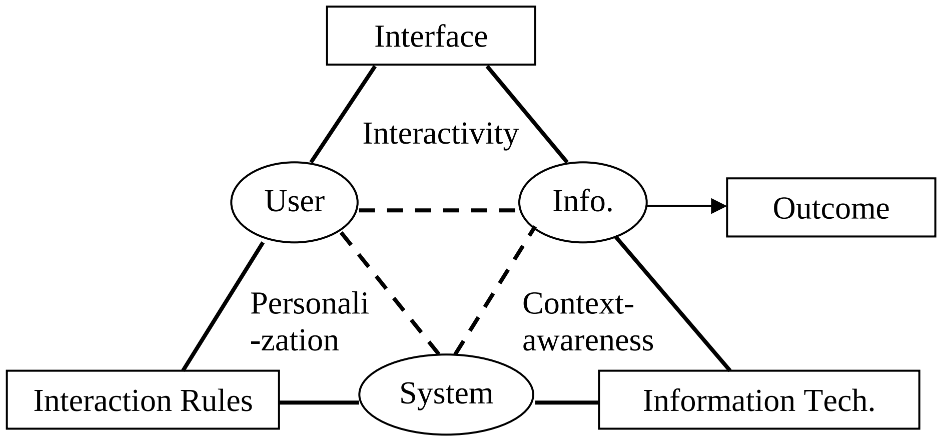


Figure 3.3: **IS Capabilities and User-System Interaction**

These basic IS capabilities are labeled with words drawn from existing terminologies. There have been extensive discussions about each of the capabilities in the literatures of various fields, such as human-computer interaction, human interaction, and e-commerce. These discussions provide valuable insights into what these capabilities are and how they work. However, these capabilities have been defined and discussed in a number of different ways and there is currently little agreement on what the terms personalization, context-awareness and interactivity mean (see McMillan and Hwang 2002, Greenberg 2001, Riechen 2000), making it difficult to discuss the differences and relationships among them. As far as we know, this is the first time that these capabilities are discussed together in a systematic way. Identifying and discussing IS capabilities under the integrative picture of user-system interaction may lead to clearer definitions of and distinctions among these capabilities.

*Interactivity*

Interactivity is the IS capability that facilitates user-system interaction through the design and implementation of interfaces that mediate the relationship between user and information. An interactive IS allows users to specify and modify their requests in the form of convenient system input through the interface during the interaction process. The system on the other hand is supposed to provide quick and sensible responses to user requests. Thus, it is generally agreed that interactivity is primarily concerned with two-way communication, synchronicity, and user control (Guedj et al. 1980). Among these, user control is particularly related to user experiences with the interactivity capability of IS, and the other two are related to the underlying requirements of this capability.

Like language in a speech community (Wardhaugh, 1998), interactivity as manifested through an interface has its “linguistic” characteristics, including: interaction mode (query mode vs. choice mode) and interface characteristics, such as complexity (simple vs. complex), style (verbal vs. graphic) and tone (formal vs. informal). Interaction mode refers to the general approach through which two-way communications between users and systems are carried out. IS Interfaces are usually implemented with two interaction modes: the query mode and the choice mode. The query mode allows the user to specify requests in the form of verbal statements, such as key words for search engines. With the choice mode, information systems provide users options (e.g. hypertext links, menus and checkboxes) to choose. Based on user selection, information systems retrieve relevant information or provide further options. Compared with the choice mode, the query mode gives users more freedom and control, but puts a greater cognitive burden on users because they must specify requests themselves and deal with all the information retrieved by the system.

The characteristics of the IS interface include complexity, style and tone. Researchers have found that the complexity of IS interface can influence communication effectiveness (Geissler et al., 2001), usability (Tarasewich, forthcoming), and flow (Huang, 2003). In the example at the beginning of Chapter I, Google has a simple interface design with only one text-box, but the library on-line catalog has a more complex interface that allows users to specify the information about desired literature in various fields, such as the author, title and subject. Researchers also found that the interface style (e.g. visual aids such as pictures and flash files) and tone can also have positive or negative effects on user behavior (e.g., Shneiderman, 1998). Different interface designs may lead to different levels of interactivity and influence user experiences differently.

*Personalization*

Generally speaking, personalization refers to the capability of a system to tailor the content and/or form of communication for users to their individual preferences (e.g., Brusilovsky and Maybury, 2002; Dyché 2002; Kim, 2002). As mentioned, interaction rules regulate the communication between user and system. Thus, under the human activity perspective of user-system interaction, personalization is the IS capability that facilitates the communication between user and system through tailoring interaction rules according to the individual preferences of users.

Depending on how the rules are set, personalization can be classified into two types: system-recommendation and user-customization. System-recommendation is probably the most well-known type of personalization, due to its wide use by e-commerce websites, such as Amazon. There are two basic approaches to this type of personalization, content-based recommendations and collaborative recommendations (Balabanovic and Shoham 1997). In the content-based approach, systems try to infer the preferences of individual users directly from their previous choices. In the collaborative approach, systems use user profiles to find the closest peer group for each individual user and infer his/her preference based on that of the peer group. User-customization, on the other hand, gives users more control by allowing them to set their personal preferences beforehand so that information systems would tailor output and/or communicative process accordingly (Nunes and Kambil 2001).

Under the human activity perspective, personalization is an IS capability to adapt interaction rules that mediate the user-system relationship for individual users. In the system-recommendation approach, systems initiate the adaptation of interaction rules, and in the user-customization approach, users initiate the adaptation of interaction rules. The adaptations based on understanding of users' individual preferences intend to help users get the result they want quickly and conveniently. However, the key assumption for effective personalization is that user preferences can be inferred or elicited accurately and remain stable over a relatively long period. In many cases, this assumption may not be a valid one. First, individual preferences are subjective in nature, and their inference or elicitation cannot be totally accurate no matter what methods are used and how sophisticated they are. Even if individual preferences are "accurately" inferred or elicited, they may change in different contexts and at different time (Schneider and Barnes 2003). Actually, IS user behavior is found to be highly situated (Suchman 1987), and user choices are largely subject to user contexts. By depriving a user of other choices in each specific context, personalization is likely to impose the contradiction between user control and user convenience. Karat et al. (2003) found that when users interact with personalized systems, they are mostly concerned with their "control of personal data". Therefore, they suggested that "personalization should not be considered in isolation, but rather as a space in which personalization features may take different values depending on user and business contexts." (p. 699).

*Context-Awareness*

According to Activity Theory, a human activity driven by a motive is facilitated and/or forestalled by related elements in the physical and social setting; thus, activity defines context (Nardi 1997). IS user contexts at the individual level, are comprised of task settings and physical surroundings related to user-system interaction for information transformation. Thus, context-aware computing refers to the collection and utilization of user context information by computer systems to facilitate and improve the informational services provided to users (Dey, 2001; Moran and Dourish, 2001). Under the human activity perspective, context-awareness is the IS capability that enables a system to gather and utilize information about user context with information technologies in order to facilitate the transformation of information.

Today the most common context-aware applications are location-based services (LBS) for cell phone users. LBS help users on the move acquire information about their surroundings, including nearby facilities and events (Schiller and Voisard, 2004). Through the mediation of position determination technologies (e.g., GPS technology) and geographic information system (GIS) technologies, location-based service systems obtain user position information and retrieve relevant geospatial information. Of course, the application of context-aware computing is not limited to the user's geospatial environment as in LBS, but can be extended to other types of user contexts, such as job/task settings. For example, the sensors embedded in machines and connected to IS can help engineers to detect mechanical problems and find solutions quickly.

Like personalization, context-awareness is an IS capability enabling the system to have a better understanding of users so that the desired outcome can be achieved efficiently and effectively. However, the understanding that a context-aware system has about users pertains to their physical contexts, rather than subjective preferences. Because user contexts are the settings of user-system interaction, people are less likely to feel deprived of control when systems access relevant information with certain information technologies.

At the social level, nevertheless, some research suggests that users are likely to feel their privacy is being violated if others get access to their contextual information (James 2004). Privacy is also a concern in personalization (Chellappa and Sin 2005).

Because both context-awareness and personalization enable systems to know more about individual users, others may get access to sensitive personal information through the systems. However, the primary interest of this study is how context-awareness and personalization would influence individual experiences in interacting with systems, so user privacy and other social issues will not be discussed further here.

In summary, this section discusses IS capabilities in a systematic way from the human activity perspective. Interactivity, personalization and context-awareness as IS capabilities can be better understood in the context of mediated relationships among user, system and information. These IS capabilities are delivered through the interface, interaction rules and information technologies that mediate different aspects of user-system interaction, and thus they are different from, but complementary to each other. Among these three IS capabilities, interactivity is the basic capability that makes user-system interaction possible. As mentioned, the user interface mediates the direct relationship between user and information, and interactivity gives users the ability to specify input and receive output through the interface. Personalization and context-awareness, on the other hand, are intended to make user-system interaction more efficient and effective by enabling the systems to understand and adapt to user preferences and contexts. In terms of user experiences, these IS capabilities intend to help users meet their information needs by empowering them with control and enabling systems to understand user preferences and contexts. However, users may not perceive performance, control and understanding as being always consistent with one another.

Instead, some IS capabilities may impose contradictions on these user experiences, as in the case of personalization.

**ISIR Construct and Measurement**

Due to the simplified unit of analysis, existing psychological constructs that have been theorized to answer the general research question "why do people use IS?" in the user acceptance research stream are not appropriate for the more specific research question "why are people prepared and willing to interact with certain systems (or not)?" Rather, we need a new construct designed to depict the psychological predisposition of a user toward interacting with a system under the more complex and comprehensive human activity perspective of user-system interaction. In this study, we propose a new psychological construct, Information System Interaction Readiness (ISIR).

To be consistent with the developmental view of IS user behavior, ISIR should be an intermediate attitudinal construct that connects previous user experiences and further interaction with a particular IS. The word "readiness" is chosen because it carries the developmental connotation of "being prepared mentally and physically for some experience or action" as well as "willingly disposed" (Merriam-Webster on-line dictionary). More important, to be consistent with the human activity perspective, ISIR should reflect the mediated actions directly involving the user in the activity of user-system interaction. For a user to be prepared and willing to interact with a system, he/she must have a relatively positive attitude towards engaging in each of these mediated actions. Thus, ISIR can be defined as an individual's overall attitude, formed on the basis of previous experiences, toward engaging in all the mediated actions to interact with a particular information system within a given context.

Being an attitudinal construct predisposing user participation in the complex of user-system interaction, ISIR is a multifaceted construct. Facet analysis, a technique originally developed by Guttman (1954, 1957), provides a useful tool to hypothesize a theoretical framework for the content domain of such constructs. In the next section, we will conduct a facet analysis of ISIR to provide a foundation for systematic development of a measurement instrument for ISIR.

*Facet Analysis of ISIR*

Facets are "semantic or perceptual properties… that characterize basic components of the variables" (Dancer, 1989, p. 3). As defined, ISIR is an attitudinal construct and its measurement should cover all underlying facets. Facet analysis is an appropriate technique to enhance the content and construct validity of measurement instruments (Edmundson et al. 1993). Thus, it is used to guide the development of the ISIR measurement instrument in a systematic way.

To enhance content validity, it is first necessary to define the content domain of a construct. The basic assumption of facet theory is that there are interrelated facets underlying the content domain from which measurement variables are derived (Dancer, 1990). Thus, the first step of facet analysis is to work out what Guttman (1954) called a mapping sentence, a definitional scheme that specifies the facets and their levels, as well as the common range of responses to measurement items. In this study of ISIR, the common range of responses is obviously the degree (from not at all to highly) that a user is prepared and willing to interact with a system within a given context. In the following paragraphs, we will identify the facets of ISIR and their levels.

First, ISIR is an attitudinal construct. Attitude has been typically conceptualized to be comprised of cognitive, affective and conative (behavioral) components (see Katz and Stotland 1959; Rosenberg and Hovland 1960; Zanna and Rempel 1988). There is a long history of support for this tripartite theory of attitude and empirical evidence supports its validity (e.g., Breckler, 1984, Kothandapani, 1971; Ostrom 1969). Thus, from the perspective of attitude theory, ISIR should also have these three underlying components. In studying human-human and human-computer interaction, Burgoon et al. (1999-2000) identifies the cognitive, affective, and behavioral components of an individual's involvement in the interaction. Rather than a psychological state that forms during the process of use, ISIR is a predisposition to being cognitively, affectively and behaviorally involved in mediated actions before the actual interaction begins. Thus, the first facet of ISIR is its attitudinal structure, which has three elements: behavioral, affective, cognitive.

As the overall attitude toward engaging in mediated actions involved in user-system interaction, ISIR should have a second facet related to the mediated actions. Though the design and implementation of IS for various purposes can be very diverse, user-system interaction as an activity is composed of a series of mediated actions that are common for all systems. According to the conceptualization of user-system interaction as shown in Figure 3.2, a user has mediated relationships with the other two elements in the model, information and system. The user works on the target object, information, through the mediation of the user interface, and the user communicates with the other subject, the system, through the mediation of interaction rules. More specifically, a user engages in three mediated actions in user-system interaction: 1) using the (input) interface to enter input to the system; 2) receiving/reading output (in form of the output interface) generated by the system; 3) following underlying interaction rules to communicate with the system. Thus, the second facet of ISIR will be called “mediated action”, which has three elements.

As mentioned, the user interface is a tool, similar to language, that carries meanings in both directions in user-system interaction. Consistent with customary usages such as “interface design”, we use the term “interface” to refer to what people use to enter input into system, or input interface. Because the output generated by the system includes both content and format, it is actually an interface that carries meanings from the system to the user, or output interface. We retain “output” for “output interface” consistent with customary usages such as “computer output”. Note that in each mediated action, the mediator (i.e. interface, output or rules) can be regarded as the *direct object* to the user, which is different from the *target object* or *subject* (i.e., information and system respectively) in our analysis.

In summary, there are basically two facets, “attitudinal structure” and “mediated action”, each having three elements. This underlying structure of ISIR content domain can be specified in a mapping sentence (Table 3.2) as a template for ISIR measurement development. For the sake of content and construct validity, the ISIR instrument should cover all theoretical aspects implied by the mapping sentence. The Cartesian set resulting from drawing one element from each facet of the mapping sentence is a series of 9 structuples (3*3) that define different aspects of ISIR (Table 3.3).

TABLE 3.2: **ISIR Mapping Sentence**

| | | |
|---|---|---|
| A person's | A. *Attitudinal Structure*<br>$a_1$. behavioral<br>$a_2$. affective<br>$a_3$. cognitive | attitudes toward |

B. *Mediated Action*
$b_1$. using interface to enter input to the system
$b_2$. receiving/reading output to get result from the system
$b_3$. following underlying rules to communicate with the system

| | | |
|---|---|---|
| → | *Range*<br>not at all<br>to<br>Highly | ready to participate in user-system interaction. |

TABLE 3.3: **ISIR Structuples**

| |
|---|
| $a_1b_1$. behavioral attitude toward using interface to enter input to the system |
| $a_2b_1$. affective attitude toward using interface to enter input to the system |
| $a_3b_1$. cognitive attitude toward using interface to enter input to the system |
| $a_1b_2$. behavioral attitude toward receiving/reading output generated by the system |
| $a_2b_2$. affective attitude toward receiving/reading output generated by the system |
| $a_3b_2$. cognitive attitude toward receiving/reading output generated by the system |
| $a_1b_3$. behavioral attitude toward following rules to communicate with the system |
| $a_2b_3$. affective attitude toward following rules to communicate with the system |
| $a_3b_3$. cognitive attitude toward following rules to communicate with the system |

*ISIR Measurement Instrument*

To develop a measurement instrument for the attitudinal construct ISIR, a close look at how affective, cognitive and behavioral components of attitude are conceptualized is necessary. Generally speaking, the affective component represents the feelings and emotions associated with the attitudinal object; the cognitive component consists of an individual's beliefs about the facts and relationships related to the attitudinal object; and the behavioral component is the intention to act toward the attitudinal object, or behavioral intention (see Ajzen 2001). Except for the behavioral component, the affective component and cognitive component are evaluative summaries of differentiated and discrete internal elements (Eagly and Chaiken, 1993; Petty and Cacioppo 1986; Zanna and Rempel 1988). Specifically, the affective component consists of qualitatively different feelings and emotions toward the attitudinal object (Ekman 1972; Izard 1972, 1977; Nowlis 1965; Ostrom 1969; Pluchik 1962; Russell 1980; Tomkins 1962, 1963), and the cognitive component consists of beliefs regarding various traits or attributes of the attitudinal object (Abelson et al. 1982; Breckler 1984; Breckler and Wiggins 1989; Osgood et al. 1957).

<u>Scale Type</u>

In order to measure the discrete elements of affective and cognitive components, the semantic differential (SD) scale, devised by Osgood et al. (1957), is most appropriate for the measurement of ISIR. Compared with other scale types, such as those devised by Thurstone (1928) and Likert (1932), the SD scale type explicitly connects scaled measurement with connotative meanings of words (Osgood et al. 1957). Each SD scale uses a pair of bipolar adjectives (such as good/bad) to differentiate respondents' attitudinal intensity for the specific aspect of attitude object. Thus, an ISIR instrument developed with the use of SD scale type can measure the discrete elements of affective and cognitive components with a series of SD scales corresponding to these elements.

SD methodology is known to be a simple, flexible and economical means for eliciting people's responses on a wide variety of attitudinal objects (see Heise 1970). Moreover, Osgood et al. (1957), with the help of factor-analytic procedures, identified that in the multidimensional semantic space, there are three general attitude dimensions underlying the SD responses to most attitude objects, Evaluation, Power/ Potency, and Activity (EPA). The Evaluation dimension is related to the respondent's evaluation of the attitudinal object, corresponding to the unfavorable-favorable dimension that dominates more traditional attitude scales. In addition, the Power dimension reflects the perception of the power/ potency (e.g. weak/strong) associated with the attitudinal object, and the Activity dimension reflects the perception of behavioral properties (e.g. slow/fast) related with the attitude object. Note here that Activity, related to how active the object is perceived to be, is different in meaning from the same word in "Activity Theory". The inclusion of these two dimensions in addition to the traditional evaluative dimension provides researchers with richer information and makes the SD appropriate for a comprehensive assessment of attitude (Ostrom 1989).

The ability of SD to assess attitude from multiple dimensions is very important for the development of ISIR measurement. From the human activity perspective of user-system interaction, a user conducts multiple mediated actions: using interface to enter input, receiving/reading output to get processed information, and following rules to communicate with the system. Thus, how prepared and willing users are to participate in these actions is not only related to the evaluation of direct objects (i.e., interface, output and rules), but also related to the perceptions of behavioral properties and power/control involved in these actions. To cover all these aspects for the sake of content validity, each of the affective and cognitive components corresponding to each mediated action should include items covering the EPA dimensions.

## Item Selection

The instrument developed by Crites et al. (1994) to measure the affective and cognitive properties of attitudes toward a wide variety of concepts provides a good source of items. Based on an extensive review of previous instruments to assess affective/cognitive properties of attitudes (e.g., Abelson et al. 1982; Breckler 1984; Breckler and Wiggins 1989; Nowlis 1965; Osgood et al. 1957; Russell 1980), Crites et al. (1994) followed a systematic procedure to compile an instrument consisting of eight affective word pairs (love/hateful, delighted/sad, happy/annoyed, calm/tense, excited/bored, relaxed/angry, acceptance/disgusted, and joy/sorrow) and seven cognitive word pairs (useful/useless, wise/foolish, safe/unsafe, beneficial/harmful, valuable/worthless, perfect/imperfect, and wholesome/unhealthy). In the validation of the instrument, Crites et al. (1994) used it to measure people’s attitudes towards quite different objects, including snakes, Yale University, microwave ovens, pizza, television and cows. They obtained reliability coefficients of median alpha 0.71 and 0.84 for affective scales and cognitive scales respectively. These SD scales were the most reliable of a set of alternative scales, including a multi-response checklist, a dichotomous checklist and word variation in their validation study.

Among the concepts used in the validation of Crites et al.'s (1994) instrument, microwave ovens and television are artifacts of modern technologies. Still, they are very different from computers or IS, and the adjective pairs used in the instrument may or may not be very relevant to the study of user-system interaction. Researchers have found that it is easier for people to understand and respond to SD items (i.e. bipolar adjective pairs) that relate meaningfully to and make familiar distinctions about the concepts to be judged (e.g. Triandis 1959). One consequence of including irrelevant SD items is the inflation of random error in the variance of ratings on the scales (Koltuv 1962; Mitsos 1961). Of course, not including important and relevant SD items can result in lowering content validity. An examination of the cognitive items Crites et al.'s (1994) instrument showed that "easy/ difficult" was not included in the list. However, this item should be relevant and important for ISIR measurement because Perceived Ease of Use is an important construct in the user acceptance research stream. Thus, it is reasonable to add it to the cognitive items in Crites et al.'s (1994) instrument.

To find out whether the items in Crites et al.'s (1994) instrument plus "easy/ difficult" are relevant to user feelings and beliefs involved in user-system interaction, a pilot study was conducted. In the study, 74 participants from a graduate level business class (8 participants) and an undergraduate level business class (66 participants) filled out a survey questionnaire designed to solicit their evaluations of various scales (see appendix). The questionnaire gave the list of above-mentioned items and asked participants to select multiple feelings and beliefs they were likely to have in entering input, reading output, and following rules for interacting with an IS. In addition to the given list of feelings/beliefs, participants were encouraged to suggest their own terms. The participants were also asked to point out any items that seemed ambiguous, too strong, or overlapping in meanings (with '?', '!' or a line) for them.

Participants did not suggest new adjective pairs, suggesting that the list covered almost all feelings and beliefs that were relevant to IS users. Figure 3.4 and figure 3.5 show the frequencies and percentage of items (affective and cognitive respectively) that participants selected as being relevant to their feeling and beliefs during their interaction with IS. We can see that "sorrow/joy" (1.44%) was not particularly relevant to participants' feelings and "unhealthy/wholesome" (2.5%) was not very relevant to participants' beliefs in interacting with IS. Many participants complained that "angry/relaxed" was somewhat ambiguous and some suggested that its meaning overlapped with that of "tense/calm." Also, a few indicated that "sad/delighted" and "annoyed/happy" were compounded in meaning. Some pointed out that "hateful/love" and "disgusted/ acceptance" was too strong. In contrast, the cognitive items were less problematic. Only a few indicated that "worthless/valuable" and "useless/useful" overlapped in meanings.

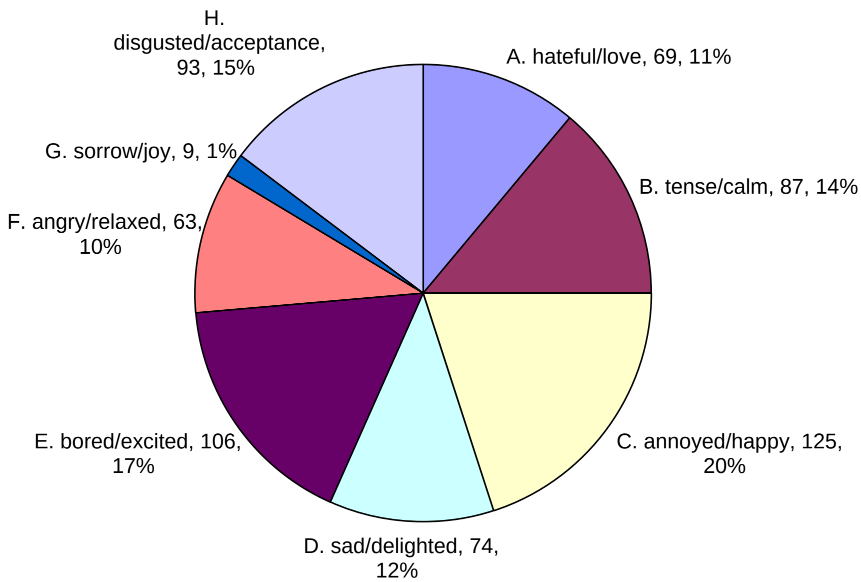


Figure 3.4: **Relevance of Feelings Indicated by Selection Frequencies**

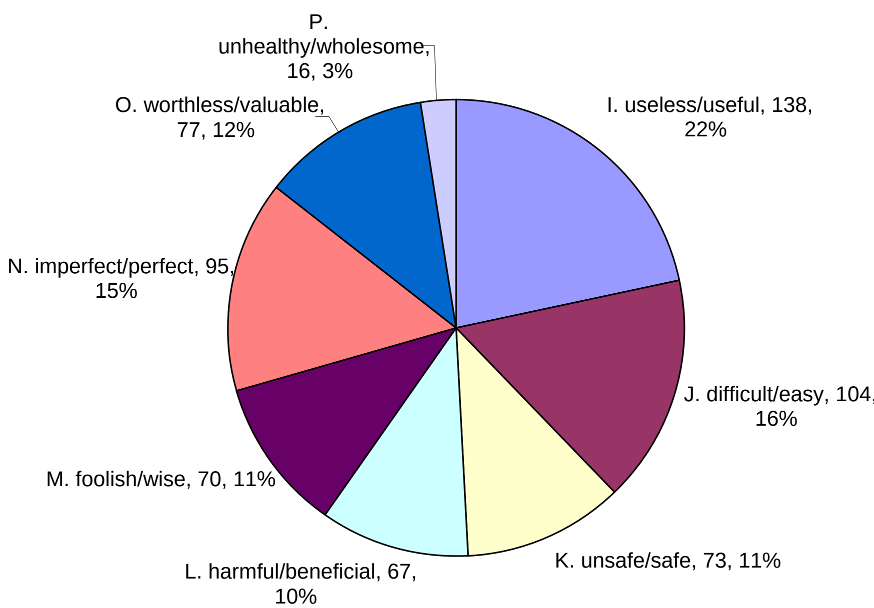


Figure 3.5: **Relevance of Beliefs Indicated by Selection Frequencies**

The items except for “sorrow/joy” and “unhealthy/wholesome” were all found to be relevant (percentage of frequency >10%) to the feelings and beliefs of users in interacting with systems, though some are problematic. After consulting Roget’s Thesaurus from which Osgood et al. (1957) selected bipolar adjective pairs, several revisions were made in the problematic items. First, we changed “annoyed/happy” to “annoyed/content” and “sad/delighted” to “sad/happy”. A comparison between “angry/relaxed” and “tense/calm” suggests that their elements need to be switched to make them true bipolar pairs. While the resulting “tense/relaxed” was retained, “angry/calm” was removed because it was largely redundant with “annoyed/content”. Also, because “hateful/love” and “disgusted/acceptance” are somewhat too strong for IS user feelings, we replaced them with “dislike/like” and “rejecting/accepting” respectively. A close look at the cognitive items suggested that “useful/useless” and “valuable/worthless” were mostly redundant in the context of user-system interaction, that is, the value of the interface, output and rules exist primarily in their usefulness for users. This claim is supported by the emphasis on concepts such as Perceived Usefulness and Usability in the user acceptance and human-computer interaction research streams. Also, the frequency of “useless/useful” almost doubled that of “worthless/valuable”. Thus, we removed “worthless/valuable” from the list, but retained “useful/useless”.

An examination of the revised affective and cognitive items against the core constructs in the user acceptance research stream (Table 2.1) revealed that the connotative meanings of these items cover those indicated by all process- and outcome-related constructs at the individual level. Moreover, our list covers additional items whose connotative meanings are not found in those core constructs, such as tense/relaxed, unsafe/safe, and foolish/wise. The comparison indicated that our list of affective and cognitive items is relatively comprehensive for this study.

Item Structure

The list of cognitive and affective items resulting from the above revisions was then categorized into the EPA dimensions. Compared with traditional attitude objects such as a microwave oven or television, the attitudinal objects related to ISIR are an individual's mediated actions in user-system interaction. As mentioned before, an action is something a subject is conscious of doing with an immediate goal and it comprises a series of operations for attaining the goal (Leont'ev, 1978). Because operations are subconscious routines depending on the mediator-related (e.g. tool-related or rule-related) conditions (Leont'ev, 1978), they can be regarded as the "immediate actions" on the mediators. Whether a user can attain a goal with an action determines the degree to which the person feels in control or power. For example, a user feels in power regarding using the interface if the person can specify requests in form of inputs as desired. Thus, the user's feelings toward a mediated action in user-system interaction are related to the mediator (or direct object, i.e.: input interface, output interface or rules), operation on the mediator (or immediate action on the direct object), and goal attainment, corresponding to the Evaluation dimension, Activity dimension and Power dimension respectively.

In a collaborative activity like user-system interaction, whether the goals can be attained is not totally under the user's control, but depends on the collaborator(s). Thus, a user's beliefs or cognitive perceptions regarding power in interacting with a system is related to the cooperativeness of the system. For example, if the system generates output that is easy to understand and meets the user's request, the user would believe that he/she is in control or has power in the action of receiving/reading the output. Thus, the user's beliefs regarding a mediated action in user-system interaction are related to the mediator, operation on the mediator, and the cooperativeness of the system, corresponding to the Evaluation dimension, Activity dimension and Power dimension, respectively. Based on the above conceptualization of EPA dimensions of both affective and cognitive components for a mediated action in user-system interaction, we can easily categorize the items in our list, as shown in Table 3.4. In addition, the behavioral component of attitude, which is a single dimension –behavioral intention (Ajzen 2001) – can be measured with two items: "disinclined/ inclined" and "hesitant/eager," selected based on Roget's Thesaurus.

Table 3.4: **ISIR Item Structure for a Mediated Action**

| Component | Dimension – orientation | SD Items |
|---|---|---|
| Affective | Evaluation – mediator | dislike/like; rejecting/accepting |
| | Activity – operation on mediator | tense/relaxed; bored/excited |
| | Power – goal attainment | annoyed/content; sad/happy |
| Cognitive | Evaluation – mediator | useless/useful; imperfect/perfect |
| | Activity – operation on mediator | difficult/easy; unsafe/safe |
| | Power – system cooperativeness | foolish/wise; harmful/beneficial |
| Behavioral | Intention – overall mediated action | disinclined/inclined; hesitant/eager |

<u>ISIR Instrument</u>

Applying the item structure to the ISIR mapping sentence (Table 3.2) and structuples (Table 3.3) as discussed in our facet analysis, we compiled the ISIR instrument (see Appendix). In this instrument, we specify the general user context first because ISIR is a context-dependent construct. For example, to access the ISIR of users toward travel agent websites, the context is specified as “In searching for the best travel deal:”. Then, the instrument gives a description of each mediated action to subjects in form of “when I…”, followed by a whole set of items. Each dimension under each mediated action is titled with a short statement of orientation, such as: “I feel _____ toward the output”. Under each dimension title, two items are arranged side by side to prevent subjects to circle straight down in a rush. Because putting all favorable descriptors on the left side of SD scales is likely to have the effect of shifting responses in the more favorable direction, but not vice versa (Friedman et al, 1988), we put all favorable descriptors on the right side.

Compared with the original items in Crites et al.’s (1994) instrument, the items (especially affective items) used in this ISIR instrument are more accurate and less confounded in meaning. Considering that the relatively low reliability of the affective items in Crites et al.’s (1994) instrument, the improvement in items may enhance the reliability of ISIR instrument. Moreover, the ISIR instrument explicitly indicates the EPA structure of affective and cognitive items. This may also enhance the measurement validity and content validity of the instrument by adapting the general EPA dimensions to specific dimensions of IS user attitude and making sure that there are items for each dimension. For the respondents, specific and accurate titling of dimensions helps them understand and respond to individual items in the picture of mediated actions. This may enhance the measurement validity of ISIR, that is, to measure what is intended to be measured rather than something else.

Compared with the one-facet constructs in the user acceptance research stream, such as Computer Self-efficacy, Intention to Use, Perceived Ease of Use and Perceived Usefulness, ISIR is a multi-faceted construct. Developed based on systematic facet analysis and item analysis, the ISIR instrument provides much richer information about user predispositions toward interacting with systems. In the following part, we will discuss what information researchers and practitioners can get from using it.

*Information Provided by the ISIR Instrument*

As mentioned, there are three levels of human activity: the activity level, the action level and the operation level (Table 3.1). The ISIR instrument provides information about user predispositions toward taking all three mediated actions (entering input, receiving/reading output and following rules) at the activity level, the attitudinal components (affective, cognitive and behavioral) for each mediated action at the action level, and user's specific feelings and perceptions along the EPA dimensions (Evaluation, Power and Activity) at the operation level.

At the activity level, researchers and practitioners can use the ISIR instrument to examine how ready people are to participate in different mediated actions and discover which part of the system needs to be improved. Because there are three mediated actions involving the user in interacting with the system, the responses to the ISIR instrument should have three underlying factors, or subconstructs of ISIR. These subconstructs can be labeled Input Willingness, Output Receptivity and Rule Observance. If the responses of most users of a system are relatively negative on one of the factors, it may indicate that the corresponding aspect of system needs to be improved. For example, if most users exhibit low Rule Observance, it indicates that the system algorithms for the implementation of communicative logic or process may need to be improved.

At the action level, user attitudes towards a mediated action are related to what kind of goal or value the user wants to attain from the action. It has been found that the affective component of user or consumer attitude is related to the hedonic value and the cognitive component is related to the utilitarian value (Hirschman and Holbrook, 1982; Holbrook and Hirschman, 1982; Simonson et al. 2001; Spangenberg et al. 1997), and the perceptions of these two types of goal/value are likely to be distinct (Shiv and Fedorikhin 1999). Thus, researchers and practitioners can examine whether users of a system generally perceive that the expected hedonic and/or utilitarian value for each mediated action is attained or not. For example, a travel agency web site that intends to attract users with low prices should lead to more positive responses on cognitive items than affective items for the Output Receptivity subconstruct of the ISIR instrument, but a site that intends to attract users with a quality travel plan should lead to more positive responses on affective items than cognitive items. Inconsistency between the expected values (i.e. goals) and the attained ones from actions involving system mediators (interface, output and rules) can lead to user dissatisfaction.

At the operation level, researchers and practitioners can take an even closer look at user feelings and perceptions with regard to each mediated action along the EPA dimensions. For example, if the response to the Evaluation dimension for the action of receiving/reading output is relatively negative on average, it may indicate that the output content and format need to be improved. However, if the Activity dimension for the same action has relatively low responses, it may indicate that the delivery of output (e.g. speed and steps) need to be improved to facilitate users' receiving/reading the output.

Thus, the ISIR instrument provides both researchers and practitioners rich information about why people are ready or not ready to interact with particular systems. The three-dimensional picture provided by the instrument covers various levels of user motivation/needs, more extensively than the instrumental viewpoint implicit in user acceptance theory (difficult/easy; useless/useful). Taking Maslow's (1970) hierarchy of needs as an example, the items in the ISIR instrument cover physiological needs (e.g. tense/relaxed), safety needs (e.g. unsafe/safe), needs for affection (e.g. dislike/like), esteem needs (e.g., foolish/wise) and self-actuation needs (e.g. annoyed/content).

The comprehensive picture of how users are prepared and willing to interact with a system allows us to investigate the relationships between ISIR and other variables. These variables include the behavioral consequences of ISIR, its antecedents which mediate the effects of IS capabilities on ISIR, and individual and personal factors. The next chapter will discuss these relationships in details, leading to the ISIR research framework that this dissertation will test.

# CHAPTER IV

# ISIR RESEARCH FRAMEWORK

As an intermediate construct between people's previous experiences and future participation in user-system interaction, ISIR has user participation as its behavioral consequences and user experiences as its antecedents. Through the ISIR antecedents, systems with different capabilities can have different effects on ISIR. Also, a number of personal and situational factors may influence ISIR. In this chapter, we will discuss relationships involving ISIR and use them to build a research framework that will be tested in empirical studies.

## Behavioral Consequences

ISIR is a construct that takes the effects of (input) interface, output (interface) and interaction rules on user experiences into account. We expect be able to use the relatively rich information provided by the ISIR instrument, to predict user behavior in real-world scenarios in which users can not only choose among multiple IS, but also among non-IS options. In addition, users responses to the ISIR instrument can be used to predict how they are likely to persist in interacting with the systems until they obtain their desired results. Thus, the behavioral consequences of ISIR can be distinguished on three aspects: 1) choice between non-IS approach and IS approach; 2) choice among multiple IS options; and 3) persistence in interacting with a system. Together these behavioral consequences of ISIR can be referred to as *user participation*, and a person with relatively positive ISIR for a system is likely to participate in interaction with the system. In the user acceptance research stream the corresponding Intention to Use (IU) construct is usually used to predict whether a person will use a given system in a single (usually, organizational) environment (see Venkatesh et al. 2003). ISIR allows researchers and practitioners to study a wider range of user behavior.

The first aspect of ISIR behavioral consequence is user choice between a non-IS approach and IS approach when both are available. In the real world, people can usually acquire desired information not only using IS-approaches but also non-IS approaches. For example, people can search information in paper documents such as newspapers, books, and manuals, or ask others for information face-to-face or on the telephone. Researchers have tried to predict people's choice between non-IS approaches and IS approaches with personal and situational factors, such as demographics, personality traits, cognitive style and situational variables, but the results have been mixed (see Karahanna et al. 2002).

As mentioned, ISIR is not only influenced by personal and situational factors but also by previous experiences with particular systems. Individuals who have positive experiences with certain systems, even though they are of high Computer Anxiety, are still likely to choose an IS approach for a task if these systems are available. On the other hand, if the persons have negative experiences with all systems that they have used on a given task, they may be more ready to take a non-IS approach. For example, if a person found it difficult to search for a telephone number on the Internet, he/she is likely to use the Yellow Book next time. Thus ISIR can be used to predict user choice between non-IS approach and IS approach, leading to the following proposal:

P1. When both IS approach and non-IS approach are available, an individual having positive ISIR with one or more IS options is likely to take the IS approach; an individual having negative ISIR with all the IS options is likely to take the non-IS approach.

The next question is: assuming a person chooses the IS approach, which IS option will he/she choose if multiple systems are available? For example, in e-commerce, there are numerous websites for the same commodities or services. For the same individual and similar user context, ISIR with different systems are directly comparable. Between two e-commerce websites, in the above example, a person having more positive ISIR with one website is more likely to choose it than the other. This leads to the following proposal:

P2. When an individual has multiple IS options, the probability of choosing a given option is directly and positively related to his/her ISIR for the option.

The final question is: after a person chooses a particular system, how persistent will he/she be in interacting with the system? People having relatively positive ISIR with a system are likely to persist in interacting with the system until they accomplish the task. On the contrary, people having relatively low ISIR are likely to abandon their efforts before they get the results they want. For example, when a person wants to solve a problem in Microsoft Excel, he/she can search for the solution with Excel Help, or on the Internet with Google. If the person has a higher ISIR with Google than Help, he/she is more likely to stay on Google than Help until he/she finds the right solution. This leads to the following proposal:

P3: ISIR is directly and positively correlated with the degree of persistence in using an IS.

Note that these proposals concerning the behavioral consequences of ISIR are not research hypotheses to be directly tested with statistical methods. However, these proposals as related to the predictive validity of ISIR instrument will be assessed with data obtained from a validation study. When the next chapter discusses the predictive validity of ISIR instrument, it will address how to assess these proposals and why informal proposal assessment rather than formal hypothesis testing is adopted.

**Antecedents and IS Capabilities**

In this section we will first identify the psychological antecedents of ISIR, Sense of Control, Perceived Understanding, and Motive Fulfillment. Then we will discuss how they mediate the effects of IS capabilities, including interactivity, personalization and context-awareness, on ISIR.

*ISIR Antecedents*

As the antecedent of user participation, ISIR has direct user experiences as its own antecedents so that it can bridge the gap between two. There are various theories explaining the specific mechanisms of how behavior influences attitude, and probably the best known is Daryl Bem's (1967) Self-Perception Theory. Bem argued that people infer attitudes from reflecting on their behavior, and thus behavior leads to attitude formation. In the context of IS use, the perceptions directly resulting from interacting with a system shape a person's ISIR for the system. Thus, the psychological antecedents of ISIR should mediate the effects of objective IS capabilities on ISIR.

For a perception to be qualified as a psychological antecedent of ISIR, it must meet two criteria: 1) The perception must be a direct result of interacting with a system; and 2) It must be linked to at least one of the mediated actions in interacting with a system: using the interface to enter input into the system, receiving/reading output to get results from the system, or following rules to communicate with the system.

The second criterion provides an appropriate starting point for identifying psychological antecedents, because we can draw on the many studies of perceptions which precede user's involvement in human-computer and human-human interactions. Once some initial candidate constructs have been identified, we can use the first criterion as a guideline to judge whether they directly result from experiencing at least one of the IS capabilities discussed previously: interactivity, personalization and context-awareness. Perceptual variables that meet both criteria are good candidates for selection as ISIR antecedents.

### Sense of Control

Perceived Behavioral Control and Self-Efficacy have been well recognized as necessary conditions for people to take initiating actions such as using interface to enter input to a system, as indicated by Ajzen's (1991) Theory of Planned Behavior (TPB) and

Bandura’s (1986) Social Cognitive Theory (SCT). Among the two, Perceived Behavioral Control is also a perception directly resulting from a specific action. Thus, it seems to be eligible for incorporation into a model of ISIR antecedents. However, an ISIR antecedent must be able to represent an overall perception of the user in the activity of user-system interaction. Perceived Behavioral Control, on the other hand, developed within the paradigm of traditional social psychology, is a construct limited to a specific action. Instead, we will employ a similar concept, Sense of Control, to represent a user’s overall perception of control during the whole process of interacting with a system which comprises a series of mediated actions.

Though Sense of Control was initially identified as an ISIR antecedent that was related to using interface to enter input to a system, it can relate to other aspects of interacting with a system. For example, whether a user can receive his/her expected output from a system or enjoy freedom in following the rules to communicate with a system also influence his/her sense of control over the process. A higher Sense of Control, in turn, enhances Output Receptivity and Rule Observance in addition to Input Willingness. Meeting both criteria, Sense of Control will be included in the model of ISIR antecedents.

As mentioned, Self-Efficacy is related to, but a distinct construct from Perceived Behavioral Control. Similarly,  Sense of Control and Self-Efficacy are distinct in that the former is a perception directly “resulting from” an activity, while the latter is a belief “resulting in” doing something, such as operating computers (see Compeau and Higgins 1995). As mentioned, there are two levels of Self-Efficacy, General Self-Efficacy and

Task Self-Efficacy. Compared with General Self-Efficacy, Task Self-Efficacy should be more closely related to Sense of Control.

In studying other perceptions that influence self-efficacy, researchers found that a sense of control enhances (task) self-efficacy (Gist & Mitchell, 1992; Tafarodi, Milne & Smith, 1999), while lack of control lowers perceived competency (Amirkhan, 1998; Judge, Bono & Locke, 2000). Thus, Sense of Control as a specific perception may influence the user's task self-efficacy to some extent. For someone who is very familiar with and has high Self-Efficacy toward interacting with a system, a failure in attaining the desired outcome may not change level of Self-Efficacy much. But for a novice, a failure during initial use of a system is not only likely to cause a sense of lacking control but also to result in low perceptions of self-efficacy. For example, the self-efficacy of someone very familiar with Google to search information on the Internet may not be affected by a single failure to find a piece of desired information, but a novice may. Thus, Self-Efficacy is an situational factor that, along with System Experience, may affect ISIR, rather than an immediate antecedent of ISIR like Sense of Control.

Perceived Understanding

For an individual to be ready to participate in user-system interaction, he/she must be prepared and willing to receive/read the output generated by a system. In studies of human-human and human-computer interactions, Receptivity of output or message has been identified as a part of Mutuality in interactions (Burgoon et al. 1995; Foppa, 1995; Krauss et al. 1995), which can be defined "a sense of connectedness, interdependence, receptivity, collective sense-making, shared understandings, and coordinated interaction" (Burgoon et al. 2000, p. 558).

Among these dimensions, shared understanding and receptivity are closely related to each other. In human-human or human-computer interaction, a person is likely to accept the output/message given by the other if the former perceives his/her request, need and situation understood by the latter. Such a sense of being understood can be labeled Perceived Understanding, "the perception of being understood or misunderstood" (Cahn and Shulman 1984, p. 122).

In terms of supporting empirical evidence of the causal relationship between Perceived Understanding and Output Receptivity, Burgoon et al. (2003) found that among all the dimensions of mutuality, both feeling understood and receptivity have especially strong relationships with trust, which is closely related to the acceptance of output/message in human-human and human-computer interaction. Because Perceived Understanding is a perception directly resulting from involvement in human-human or human-computer interaction, it can be regarded as another antecedent of ISIR.

Like Sense of Control, Perceived Understanding is a perception related to all mediated actions in interacting with a system, not just a condition for and a perception resulting from receiving/reading output from the system. For example, an interface designed to allow a user to specify input flexibly for different tasks or interaction rules implemented properly based on an understanding of the user (e.g., through personalization or context-awareness capabilities) should enhance the user's Perceived

Understanding. Enhanced Perceived Understanding, in turn, leads to more positive Input Willingness and Rule Observance in addition to Output Receptivity.

Motive Fulfillment

A person who is ready to interact with a system must be prepared and willing to follow the interaction rules to communicate with a system until the task is accomplished. ISIR not only depends on the degree to which a user perceives him/herself and the system as capable of functioning properly (leading to Input Willingness and Output Receptivity, respectively), but also whether their collaborations as regulated by interaction rules can lead to expected outcomes. An expectation on the outcome is actually what motivates an activity that comprises a series of actions intended to accomplish immediate goals (Leont'ev 1978). How the motive is generally fulfilled can affect how prepared and willing people are to involve in the activity later on. Thus, the general perception of how well their motives can be fulfilled in user-system interaction is the prerequisite for users to be prepared and willing to follow the interaction rules that regulate the process.

How a user perceives motive fulfillment in user-system interaction may either be directly related to the experience of following rules (e.g., getting the desired results in a quick and convenient way), or be related to the experience of entering input (e.g., specifying one’s requests accurately) and receiving/reading output (e.g., results are found to be arranged in a clear or pleasant way). The goals of these mediated actions are related to the motive of user-system interaction, to transform raw information into desired outcome. Thus, the general perception of how well these goals are attained is closely related to the perception of how well the motive is fulfilled. Thus, Motive Fulfillment can be regarded as a person's overall perception of how well the goals of mediated actions in interacting with a system are attained, and may influence all three subconstructs of ISIR. Motive Fulfillment meets both criteria and hence is qualified to be another antecedent of ISIR.

In the ISIR instrument, the Power dimension of Affective items measure an individual's feelings towards how well the goal for each mediated action is attained. Motive Fulfillment, however, refers to the perception of how well the motive of the whole user-system interaction activity is fulfilled. Thus, they may be measured in different ways. For tasks that outcomes can be measured objectively, the measurement of outcome can be used as a substitute for the measurement of Motive Fulfillment. The rationale for this is that user-system interaction is motivated by outcome expectation, and thus the user perception on Motive Fulfillment is directly related to the how well the outcomes meet the expectation. If a task impose a clear outcome expectation on a user, and there are standard criteria to evaluate the outcome, Motive Fulfillment can be measured objectively with how well the outcome meets the expectation.

Taking a problem solving task for example, a person would perceive high Motive Fulfillment if he/she quickly found the solution with one system, but would perceive low Motive Fulfillment if he/she spent a lot of time with another system but still could not find the solution. However, the user may still perceive interface of first system more difficult to use than the second system, leading to lower responses on Input Willingness items in the ISIR instrument.

In most laboratory settings, there are clear specifications of what is expected from experimental tasks and there are standard criteria to evaluate the outcomes, and thus Motive Fulfillment is objectively measurable. However, for some user contexts in the real world, Motive Fulfillment may not be objectively measurable. This is particularly true when user motivations are intrinsic rather than extrinsic. For example, when users interact with certain systems for hedonic purposes, such as searching for some information about personal interests, they usually do not care how long it takes. In such cases, Motive Fulfillment may need to be measured subjectively with certain self-reported scales, such as the flow scale (Csikszentmihalyi, 1990).

### Other Considerations

We have identified Sense of Control, Perceived Understanding and Motive Fulfillment as the antecedents of ISIR. We need to consider whether this set is complete, or whether any other constructs should be included. Though we extensively reviewed the key constructs in the user acceptance research stream (Table 2.1), it was also necessary to examine other literatures on IS user behavior and human-human/human-computer interaction. After an extensive review, we found that User Satisfaction and Interaction Involvement may warrant a closer look because they are both psychological constructs that are directly related to IS user experience.

User Satisfaction has long been identified as an important psychological construct that is both a result of and driving force behind IS use (DeLone and McLean 1992). Doll and Torkzadeh (1988) defined as User Satisfaction as “the affective attitude towards a specific computer application by someone who interacts with the application directly” (p. 261). While there may be problems with this particular definition because the affective component of attitudes has discrete elements and not all elements are necessarily related to satisfaction (e.g., tense/relaxed), the spirit of the definition makes it clear that user satisfaction is an affective attitude rather than a perception. Similarly, Melone (1990) points out that User Satisfaction is fundamentally an attitudinal construct.

As an attitudinal construct, User Satisfaction is multi-dimensional, including components such as: satisfaction with data, satisfaction with IS, and satisfaction with IS support (Karimi et al. 2004). Thus, User Satisfaction is too complex to be a singular perception resulting directly from interacting with a system. Rather than an ISIR antecedent, User Satisfaction is more appropriately positioned as a construct that is parallel to ISIR, rather than one of its antecedents.

Another problem with including User Satisfaction as an antecedent of ISIR is that Motive Fulfillment, is closely related to User Satisfaction, because the overall perception of how well the motive is fulfilled leads to different levels of user satisfaction. If User Satisfaction was included among the antecedents of ISIR, we would have two highly correlated variables in the model, Motive Fulfillment and User Satisfaction, one of which is an outcome of the other. This would be likely to complicate fitting the model considerably. In view of this problem and the fact that User

Satisfaction is a construct parallel to ISIR, we decided not to include User Satisfaction as an ISIR antecedent.

Another construct related to user experiences is Interaction Involvement, "the degree to which users perceive they are cognitively, affectively, and behaviorally engaged in the interaction" (Burgoon et al. 1999-2000, p.36). Like User Satisfaction, it is a multi-dimensional construct, with cognitive, affective and behavioral components. Thus, it is also too complex to be a specific perception directly resulting from user-system interaction. Moreover, it seems likely that ISIR may have a causal effect on Interaction Involvement, rather than the other way around, since a person who is prepared and willing to interact with a system is more likely to be involved in the interaction. In this sense, Interaction Involvement is one of the behavioral consequences of ISIR, particularly related to user persistence in interacting with a system. As a complex construct influenced by ISIR, rather than contributing to it, Interaction Involvement cannot be an ISIR antecedent.

From the preceding, we can see that not all perceptions related to user experiences in interacting with a system qualify as ISIR antecedents. Instead, the criteria are quite clear and rigid in distinguishing ISIR antecedents from those perceptions that are not. The antecedents Sense of Control, Perceived Understanding and Motive Fulfillment were selected based on careful and systematic analysis of possible candidates and, for the present, seem to be a comprehensive set of antecedents. Later, we will use statistical method to access the causal effects of these antecedents on ISIR by testing whether they can explain the majority of the variance of ISIR.

*IS Capabilities and ISIR Antecedents*

The identification of ISIR antecedents allows us to explore the relationship between ISIR and basic IS capabilities, including Interactivity, Context-Awareness and Personalization. Recall that these IS capabilities do not influence ISIR directly, but through the mediation of the ISIR antecedents, Sense of Control, Perceived Understanding and Motive Fulfillment. In this section, we will examine how IS capabilities influence these ISIR antecedents directly.

As we can see in Figure 3.3, the three IS capabilities influence ISIR in different ways. Interactivity is related to the interface that mediates the relationship between user and information; Personalization is related to the interaction rules that mediate the relationship between the user and system; and Context-Awareness is related to information technologies that mediate the relationship between the system and information. Though Context-Awareness is not related to a mediated relationship that directly involves the user, it influences user perceptions of both system and information as relayed by the other two mediated relationships.

Compared with the other two capabilities, Interactivity is directly related to the mediated relationship involving the user and information. At least some level of Interactivity, as enabled by interface design, is the prerequisite for users to be able to work with the system. At the extreme, a poorly designed interface might involve a non-interactive system that gives users all the stored information in response to their query. For example, a non-interactive library system might just list all the books in the library and leave the user to scroll through it, which is of course not a practical way for the user to find what he/she wants. An interactive system, on the other hand, allows users to specify detailed requests through a well-designed interface at the beginning and/or in the process of interacting with the system, and presents only the information relevant to the requests. For example, an interactive library system would allow user to search for a book with title, author name(s), subject and so on. If there are multiple books for the same criteria, the system would allow the user to select among from the list or further specify the request.

While interactivity enables a user to work directly on information, personalization and context-awareness help make the process more efficient and effective. Compared with Interactivity, these two capabilities are related to the "social" aspect of user-system interaction as they involve the relationship between two subjects, a user and a system. Personalization allows a system to tailor the communication with a user based on an understanding of his/her subjective preferences, while Context-Awareness allows a system to tailor information processing based on an understanding of an individual's objective user contexts.

The difference between the two types of IS capabilities, the enabling capability of interactivity and the facilitating capabilities of personalization and context-awareness, suggests that we should consider two separate, but related research questions: 1) whether an interactive system and a non-interactive system differ in their effects on ISIR; and 2) for an interactive system, what are the effects of personalization and context-awareness on ISIR? The first question tests whether interactivity is a necessary condition for ISIR. The second question tests whether -- assuming the necessary condition is satisfied --

personalization and context-awareness are sufficient for users to become more ready to interact with a system. Because IS capabilities affect ISIR through the mediation of ISIR antecedents, we will discuss the relationships between each capability and IS antecedents.

Interactivity and ISIR Antecedents

As an IS capability that is directly related to the user-information aspect of human-computer interaction, Interactivity may have significant impacts on all ISIR antecedents. First, it is generally agreed that "interactivity" is closely related to reciprocity and user control (e.g., Guedj et al.,1980; Jensen, 1998). While reciprocity is a key aspect of what it means for a system to be interactive, user control is the degree to which an interactive system empower its users. Thus, an interactive system is likely to enhance the user's Sense of Control by enabling users to exert control over the transformation of information.

The ability to exert direct control on information transformation makes it possible for users to obtain the results that they desire. Also, an interactive system should respond to user requests in a quick and sensible way. Thus, Interactivity should enhance Motive Fulfillment. Finally, when an interactive system gives users their expected results, they are likely to feel that the system understands them. Therefore, interactivity enhances user Perceived Understanding as well. In summary, Interactivity is expected to have significant effects on all ISIR antecedents. This leads to the following hypothesis:

H1: Interactivity enhances Sense of Control, Motive Fulfillment and Perceived Understanding.

Context-Awareness and ISIR Antecedents

Unlike Interactivity, which is directly related to a user's relationship with information through the mediation of interface, Context-Awareness is directly related to the system's relationship with information through the mediation of information technologies. Users who do not have direct access to the information technologies experience the effects of Context-Awareness through two routes: the route from the mediated relationship with information and the route from the mediated relationship with system (please refer to Figure 3.3 for a clear picture of these two routes).

Through the first route, users may find the results pertinent to their contexts and/or helpful to solve their problems. In this way, a context-aware system can help users to accomplish their task faster and more effectively than they would with an equivalent non-context-aware system. Thus, Context-Awareness is likely to enhance user Motive Fulfillment.

Through the second route, users may feel that their needs and situations are understood by the system. Context-Awareness is a capability that enables the system to display an understanding of user context. Because a user's needs are closely related to the user context (Nardi, 1997; Greenberg 2001; Sun and Poole 2004), Context-Awareness can make users feel that their needs and situations are understood by the system. Thus, Context-Awareness should enhance user's Perceived Understanding.

Rather than requiring users to make all the decisions regarding what results they want to obtain from interacting with a system, a context-aware system makes some decisions for users related to what information is relevant to their user contexts. Thus, Context-Awareness may have mixed effects on user Sense of Control. On the one hand, this capability helps users accomplish tasks more quickly, making them feel that they have the control over the tasks. On the other hand, it deprives users of a degree of control by making decisions for them regarding what information is relevant.

This negative effect on Sense of Control is especially salient when the system is not interactive, as in the case of some location-based services that push context-relevant information to users (see Rao and Minakakis, 2003; Sun 2003). Users of an interactive system, however, are not as likely to feel deprived of control because the system's decisions are based on how relevant the information is to user contexts that are not under the control of users in the first place. Thus, Context-Awareness may enhance Sense of Control, rather than weaken it, if the system is interactive.

Barkhuus and Dey (2003) examined the relationships between user's perception of control and context-awareness for mobile information services, and their findings are consistent with the above reasoning. They found that context-awareness did weaken user sense of control, especially when the services were not interactive (in their term: "active context-aware applications"). However, they did not find that context-awareness weakened user sense of control if the service was interactive (in their term: "passive context-aware applications").

An illustrative example can make our propositions easier to understand. Today, people can use Internet- and GPS-capable cell phones to search for facilities that are nearby, such as restaurants. A non-context-aware system lets a user enter the zip code or name of place and gives a list of facilities as requested. However, a context-aware system would use the GPS to pinpoint the user's position, calculate the distances between the user and facilities, and list facilities order of distance. Compared with a non-context-aware system, the context-aware system should enhance user Sense of Control (because the person can easily find a suitable place), Perceived Understanding (because the listing of places in order of distance is pertinent to the user context) and Motive Fulfillment (because the person can get the best result in the shortest time). Thus we suggest the following hypothesis:

H2: For an interactive system, Context-Awareness enhances user Sense of Control, Motive Fulfillment and Perceived Understanding, making a user more ready to interact with a system.

Personalization and ISIR Antecedents

Like Context-Awareness, Personalization is an IS capability that enables the system to develop an understanding of users in order to facilitate user-system interaction. For similar reasons, Personalization should enhance both Perceived Understanding and Motive Fulfillment.

However, the difference in the nature of user contexts and individual preferences may lead to different user perceptions of control in interacting with a context-aware system and a personalized system. Unlike user contexts, which are for the most part not under the user's control, individual preferences are subjective and therefore users are aware of them and can make their own choices at any moment. Because people usually do not want others to impose personal decisions on them, Personalization may NOT enhance user Sense of Control, but rather weaken it. That is, users of personalized systems may feel that it is the systems rather than themselves who determine what they want. As a result, Personalization as a means of information automation is generally not welcomed by users (Nunes & Kambil, 2001). These considerations lead to the following hypothesis:

H3: For an interactive system, Personalization enhances user Motive Fulfillment and Perceived Understanding but weakens Sense of Control, making its effect on ISIR weaker.

**Personal and Situational Factors**

The formation of ISIR is not only related to user direct experiences with specific systems, but is also influenced by personal and situational factors. Personal factors are independent of the specific user contexts, but situational factors depends on user contexts. Based on the review of user acceptance models in the second chapter (Table 2.1), we identified Locus of Control, Computer Playfulness, Computer Anxiety and System Experience as potentially personal factors relevant to ISIR.

To identify situational factors that depend on user context in a systematic way, we examined existing theories related to the influence of user contexts on user performance. Among them, Self-Determination Theory (SDT) (Deci and Ryan 1985), which is a macro-theory mainly concerned with how people are motivated within physical and social environment, is particularly relevant. Like Activity Theory, SDT emphasizes the importance of contexts on human behavior. Specifically, SDT posited several psychological constructs that are reflective of the influence of contexts on human behavior, including: interest/enjoyment that is related to intrinsic motivation; perceived importance that is related to extrinsic motivation; perceived competence, tension/pressure and perceived choice that are related to self-regulation (Deci and Ryan 1985). This study focuses on the individual-level factors, but perceived choice is a social-level factor so that it was not included in this study. The other four are related to user contexts, and they can find their corresponding constructs in Table 2.1 (i.e. intrinsic motivation, extrinsic motivation, self-efficacy and anxiety). Because perceived competence is essentially the same with the (task) self-efficacy, we use the term self-efficacy instead. Also, task interest is a more specific term than intrinsic motivation for a task setting. Thus, Interest, Self-Efficacy, Importance and Tension were identified as the major situational factors that may influence IS user behavior. In this section, we discuss how these personal and situational factors may influence ISIR.

*Personal Factors*

Among the personal factors, Locus of Control is a personal trait not directly related to computer use. While Computer Playfulness and Computer Anxiety are computer-related, they are usually not related to a specific system, but refer to more general tendencies toward computers. However, System Experience is a system-specific personal factor that is related to a user's previous experience of with a specific system. Within the same level,  Computer Playfulness and Computer Anxiety are comparable and may have strong correlations with each other. Strong inter-relationships among these computer-related personal factors have been found by researchers in empirical studies (Bozionelos 1997; Compeau and Higgins 1995; Heinssen et al. 1987; Igbaria and Ilvari 1995; Webster and Martocchio 1992). Thus, it is necessary to discuss how personal factors may influence ISIR at each level.

At the computer-unrelated (personal trait) level, *Locus of control* (LOC) refers to a person's sense of his/her "mastery of one's environment" (Rubin 1993, p. 162).  A person's LOC can be generally categorized as either internal or external. People with internal LOC feel powerful, and want to have control over their environments (DeCharms 1972). People with external LOC feel powerless, and prefer to let others have control of their environments (Brenders 1987). Researchers of human-human interaction found that people with internal LOC are more confident and willing to interact with others than those with external LOC (Brenders 1987; DeCharms 1972; Rubin 1993). Similarly, in user-system interaction, a user with internal LOC should be more ready to interact with a system than a user with external LOC, leading to the following hypothesis:

H4: All else being equal, a user with internal LOC has higher ISIR than a user of external LOC.

At the computer-related level, Computer Playfulness and Computer Anxiety are correlated with each other and each may have an influence on ISIR. A person who is playful in using computers is likely to be ready to play around with a system to explore its capabilities and features. Thus, Computer Playfulness should also have a positive influence on ISIR. When a person is anxious about using computers, however, he/she is unlikely to be ready to interact with a particular system. Thus, contrary to Computer Playfulness, Computer Anxiety should have a negative influence on ISIR.

Though there is no direct empirical evidence for the above propositions in the context of user-system interaction, we can find some indirect evidence in the human-human interaction literatures. For example, Communication Apprehension refers to the level of anxiety associated with interactions with others (McCroskey, 1993) and is analogous to Computer Anxiety in the study of user-system interaction. Communication Apprehension has been found to have a negative influence on the level of motivation to communicate in human-human interaction (Kondo, 1994; Rubin, 1993). Communication Apprehension has also been found to be positively correlated with external LOC (McCroskey et al. 1976), indicating that the directions of influence of both Computer Anxiety and LOC on ISIR in our propositions are correct. This leads to the following hypothesis:

H5: All else being equal, Computer Playfulness has a positive linear effect on ISIR but Computer Anxiety has a negative linear effect on ISIR, and these personal factors are correlated with each other.

At the system-specific level, Previous Experience with the same or similar system(s) should influence how ready the user is to interact with the system. Previous Experience can be operationalized in different ways for different settings, such as past training and computer-related job experience for the organizational setting (e.g., Yaverbaum 1988). At the individual level, we can generally operationalize System Experience as the familiarity of an individual user with the same or similar system(s). When a person is familiar with a system, he/she is more likely to be ready to interact with the system. Thus, we have the following hypothesis:

H6: All else being equal, System Experience has a positive linear effect on ISIR.

*Situational Factors*

The four situational factors, including Interest, Self-Efficacy, Importance and Tension, are all related to the specific task setting. At the task level, individual factors are likely to be correlated to each other. In specific, a user who perceives the task to be important is likely to feel tense during the task, and vice versa. Also, a user who is interested in the task is also likely to perceive the task as important, and vice versa. Finally, a person who does not feel competent for the task is likely to feel tense in the task, and vice versa.

Because it costs a person time and effort to interact with a system, the user's ISIR depends on the degree to which he/she believes that the effort and time are well-invested. For tasks that are driven by purely intrinsic motivation, people feel interested in and enjoy the process and usually do not care how much time and effort they spend.

For example, people who browse websites for leisure or hobby purposes may not perceive the task as important, but still they think that their effort and time are well-spent. For tasks that are driven by purely extrinsic motivation, people participate in user-system interaction solely for the purpose of accomplishing the task, and do not want to spend any more effort and time than necessary. For example, people usually do not use Excel Help unless the user thinks it is necessary to find solutions for problems with Excel. Most IS user tasks lie somewhere in between: some are driven more by intrinsic motivation and others are driven more by extrinsic motivation.

The differentiation between tasks driven by intrinsic motivation and by extrinsic motivation requires a closer look at the effects of situational factors at the task level. While Interest, Importance and Self-efficacy may have a positive influence on user ISIR for tasks driven by both intrinsic and extrinsic motivation, Tension may have a negative influence for tasks only driven by extrinsic motivation but not for tasks driven by intrinsic motivation. For example, users who experience little tension in solving a problem with a system are more likely to get ready to interact with the same system again than another system with which they experience a lot of tension. Tension for intrinsically-motivated tasks, however, may be desirable for the users, such as in the case of video games. The above discussions lead to the final hypothesis:

H7: All else being equal, Interest, Importance and Self-Efficacy have positive linear effects on ISIR. Tension has a negative linear effect on ISIR only when the task is driven by extrinsic motivation. Interest and Importance, Self-Efficacy and Tension, Importance and Tension are correlated with each other.

**Overall Research Framework**

The relationships and hypotheses proposed in this chapter can be integrated in the research framework illustrated in Figure 4.1. This overall framework shows the effects of IS capabilities on ISIR through the mediation of ISIR antecedents, the influence of personal and situational factors on ISIR, and the behavioral consequences of ISIR. ISIR has three subconstructs, Input Willingness (IW), Rule Observance (RO) and Output Receptivity (OR), and three antecedents, Sense of Control (SC), Motive Fulfillment (TA) and Perceived Understanding (PU). Among IS capabilities, Interactivity has the primary effect, and Personalization and Context-awareness have secondary effects on ISIR through ISIR antecedents.

Personal factors that may influence ISIR include Locus of Control (LOC), Computer Anxiety (CA), Computer Playfulness (CP) and System Experience (EXP). Among these, CA and CP are correlated with each other. Situational Factors that may influence ISIR include (task) Interest (INT), Importance (IMP), Self-efficacy (SE), and Tension (TEN), and some of them are also correlated with each other.

The behavioral consequences of ISIR, simply labeled as Participation, include user choice between non-IS and IS approaches, user choice among IS options, and user persistence in interacting with a system. Except for the negative relationships between Computer Anxiety (CA) and ISIR, between Tension (TEN) and ISIR, and between Personalization and Sense of Control (SC), all relationships in the research framework are positive.

This research framework not only provides a summary of this chapter, but also provides the guidelines for the research design that will be discussed in the next chapter. First, this framework specifies which constructs should be included in the design and which measurement instruments should be used in the empirical study. Also, the research framework indicates some parameters to guide experimental design that involves experimental controls and treatments. Finally, the research framework gives guidelines for statistical methods that should be used in analyzing the empirical data.

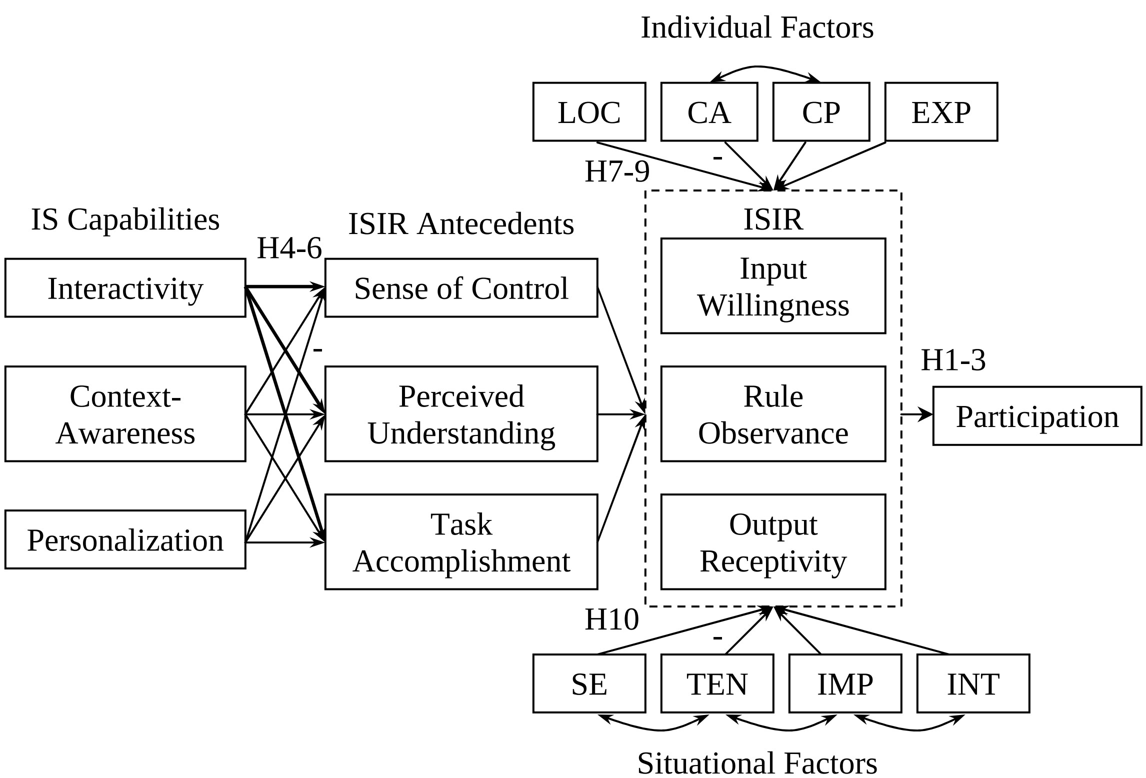


Figure 4.1: **ISIR Research Framework**

# CHAPTER V

# RESEARCH METHODOLOGY

This chapter discusses the methodologies employed in this study for the validation of ISIR instrument and the testing of ISIR research framework. The first section discusses different types of measurement validity and how to assess each type for the ISIR instrument. To validate the ISIR instrument, a non-experimental validation study was conducted. The formal testing of the research framework was conducted using an experimental study that manipulated IS capabilities. Thus, the second section of this chapter discusses the design of the experimental study. These two studies are related but have different emphasis, one on validity and the other on causality. The last section of this chapter discusses the general research design for both the validation study and experimental study, including subjects, measures, and statistical methods appropriate for data analysis.

## Validation of ISIR Instrument

The validity of a measurement instrument generally refers to how well it measures what is theoretically supposed be measured. It is generally agreed that there are three types of validity: Content Validity, Construct Validity and Predictive Validity (Cronbach 1984; Nunnally and Bernstein 1994). In the following sections, we will discuss these types of validity and how to assess each for the ISIR instrument.

*Content Validity*

A careful and systematic development of a measurement instrument enhances its content validity. In the development of the ISIR instrument, systematic procedures such as facet analysis, surveys, and item analysis were employed to ensure that it has a comprehensive coverage of its content domain. The resulting ISIR instrument gives a multi-dimensional picture of user attitude toward interacting with a system. This appearance of measuring what is supposed to be measured (so-called “face validity”) provides basic evidence for the content validity of ISIR instrument.

Generally speaking, the content validity of a measurement instrument cannot be established statistically. However, there are ways to get some important circumstantial evidence through the analysis of subjects’ responses to the instrument (see Henryssen 1971; Cronbach 1971; Hambleton 1980; Rovinelli and Hambleton 1977; Edmundson et al. 1993).

<u>Item Response Internal Consistency</u>

In a valid measurement instrument, all items should measure the same thing and subject responses should exhibit an acceptable level of internal consistency among the items. Specifically, the internal content validity is related to item sampling from the content domain as well as the structure of content domain (Nunnally and Bernstein 1994). Cronbach’s (1951) coefficient alpha ($\alpha$), derived from the domain-sampling theory of measurement error, is appropriate for the purpose of assessing internal consistency of an instrument.

By checking the internal response consistency of items with reference to the proposed structure of the instrument, we can get circumstantial evidence for the internal content validity of the ISIR measure. To recall, the structure of the ISIR instrument is composed of three levels: activity (input willingness, output receptivity and rule observance), action (behavioral, affective and cognitive components for each action) and operation (Evaluation, Power and Activity dimensions within each action-level component). It is necessary to determine the degree to which item responses are internally consistent at each level from the lowest to the highest. The coefficient $\alpha$'s obtained during the whole procedure can provide some evidence as to whether the item sampling of ISIR instrument from its structured content domain was properly done.

First, we calculated the coefficient $\alpha$ for each group of behavioral, affective and cognitive items within each of ISIR subconstructs: Input Willingness, Output Receptivity and Rule Observance. If the resulting nine (3*3) coefficient $\alpha$'s were all at an acceptable level, it would suggest that the operation-level items for each structuple (table 3.3) are internally consistent. Following this, we calculated coefficient $\alpha$ for each subconstruct based on the averages of behavioral, affective and cognitive items within each subconstruct. If the coefficient $\alpha$'s for three subconstructs were all at an acceptable level, it would suggest that the action-level attitude components are internally consistent. Finally, we calculated the coefficient $\alpha$ for the whole ISIR instrument using the scores for each subconstruct. If the overall coefficient $\alpha$ was at an acceptable level, it would suggest that subconstructs at the activity level are internally consistent.

Correlation with Parallel Constructs

If there exists another instrument that measures something theoretically parallel to what is measured by the target instrument, evidence for content validity can be obtained by correlating scores on both instruments. Developed under different paradigms (activity vs. action) to study IS user predispositions toward interacting with or using systems, the ISIR construct and Technology Acceptance Model (TAM) constructs are parallel with each other. In an analogy, if a person is ready to interact with a system, he/she should also be positive toward "using the system", indicated by positive Perceived Usefulness, Perceived Ease of Use and Behavioral Intention.

If these measures are somewhat parallel, it is reasonable to expect that the total score on the ISIR instrument would be moderately correlated with the total score on the TAM instrument. If the two scores were moderately correlated, we could then calculate the correlations among the scores of their subconstructs. If the subconstructs of both ISIR and TAM instruments were also moderately correlated with each other, it would suggest that that the ISIR instrument measures something which is related to but distinct from what the TAM instrument measures. This circumstantial evidence for content validity, unlike item response internal consistency, is related to what target the instrument is developed to measure (Nunnally and Bernstein 1994).

*Construct Validity*

Generally speaking, construct validity of a measurement instrument has two components, a structural component and an external component (Messick 1989). The structural component is concerned with the relations among indicators (i.e. observable items in the measurement instrument or their combined indexes) and the external component is concerned with the relations among constructs (also see Nunnally and Bernstein 1994). For these two components of construct validity, there are different ways to validate the measurement instrument. Each component and the corresponding approach to validate the ISIR instrument will be discussed as follows.

Structural Component

The structural component of construct validity is concerned with how the measurement items are related to the theoretical construct, and there are two related but distinct aspects: convergent validity and discriminant validity (Campbell and Fiske 1959). Convergent validity is concerned with the relationships among indicators within each latent factor that is measured by them, and discriminant validity is concerned with the relationships among latent factors (see Messick 1989; Nunnally and Bernstein 1994). Thus, convergent validity refers to “the cohesiveness of a set of indicators in measuring their underlying factor (rather than something else)” (Sun 2005, p. 241), and discriminant validity refers to “the distinctiveness of the factors measured by different sets of indicators” (Kline 1998, p. 60).

The structure of the ISIR instrument is explicitly specified. There are three subconstructs: input willingness, output receptivity and rule observance, and there are attitudinal components for each: behavioral component, affective component and cognitive component. Within the affective and cognitive components for each factor, there are the Evaluation, Power and Activity (EPA) dimensions. At the operation and action levels, the items within each EPA dimension should be convergent to each other, and the items across different dimensions should be discriminant from each other. At the action and activity levels, the attitude components within each subconstruct should be convergent, and the attitude components across different subconstructs should be discriminant.

Confirmatory factor analysis (CFA) has been recognized as an effective method to assess the structural component of construct validity for both discriminant and convergent aspects (Jöreskog and Sörbom 1979; Gorsuch 1983; Kline 1998). In CFA, responses for an instrument collected from empirical studies can be fit to a hypothesized factorial model of the instrument. Because the model is determined *a priori* based on theory rather than being dependent on the sample data, CFA is less subject to sampling error than the traditional exploratory factor analysis. The overall goodness of fit for the model indicates whether the responses fit well to the hypothesized factorial structure. More specifically, there is evidence for discriminant validity if different factors are not excessively correlated with each other (e.g., > 0.90), and there is evidence for convergent validity if a set of indicators all have relatively high pattern coefficients with the factor that they are specified to measure (Kline, 1998).

For a measurement instrument developed under a theoretical factorial structure, like the ISIR instrument, CFA is particularly appropriate. Because the factorial structure has multiple levels, CFA should be conducted on different levels for different facets of the ISIR construct. At the basic level, the measurement models should include the observables or items. Because the items are repetitive for each subconstruct, there are three measurement models for input willingness, output receptivity and rule observance respectively. As an example, Figure 5.1 shows the measurement model for input willingness. Note that it is a hierarchical measurement model with the intermediate EPA dimensions for both affective and cognitive components. Item responses are to be fit to each measurement model at a time for three subconstructs.

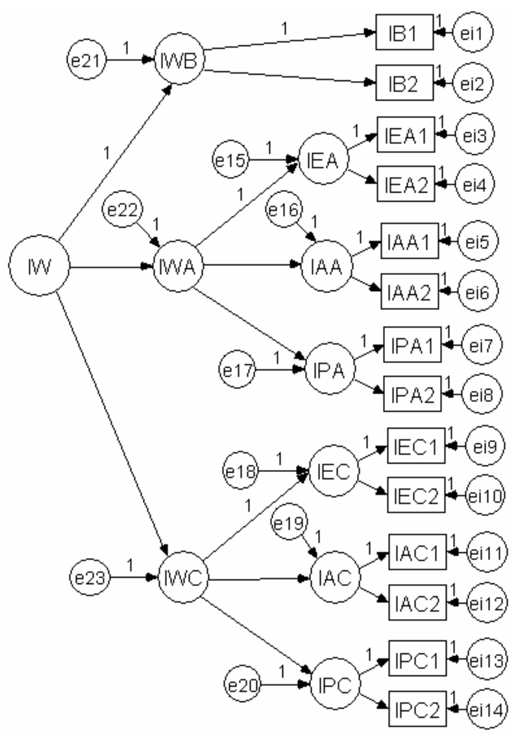


Figure 5.1: **Measurement Model for Input Willingness**

At the higher level, the measurement model that gives the overall picture of ISIR factorial structure should include the indexes as indicators for all ISIR subconstructs rather than repetitive sets of items. As mentioned, there are two facets, the attitudinal structure facet and the mediated action facet, and each has three elements. To depict such a multi-faceted factorial structure, the Correlated Uniqueness (CU) model is appropriate. The CU model, a member of the family of factor analysis models usually applied to multitrait-multimethod data, has error terms correlated for the indicators that are theoretically related to each other, especially for those whose responses are obtained with the same method (Kenny 1976; Marsh 1989; Marsh and Bailey 1991).

For the ISIR instrument, the three elements of the mediated action facet (using interface, receiving/reading output, following rules) represent attribute-related content, and the three elements of attitude structure (affective, cognitive and behavioral) represent ways to indicate people's attitude toward the actions. In Campbell and Fiske's (1959) multitrait-multimethod terminology, the elements of the mediated action facet can be regarded as the attributes or "traits", and the elements of the attitude structure facet can be regarded as different "methods" to measure or elicit people's responses to the attributes.

Thus, the factorial structure of the ISIR instrument can be specified as a CU model (Figure 5.2). In this model, there are three factors (equivalent to attributes or traits), input willingness (IW), output receptivity (OR) and rule observance (RO), and each are indicated by behavioral, affective and cognitive indexes (equivalent to methods). The error terms for the indexes of the same "methods" are correlated with each other.

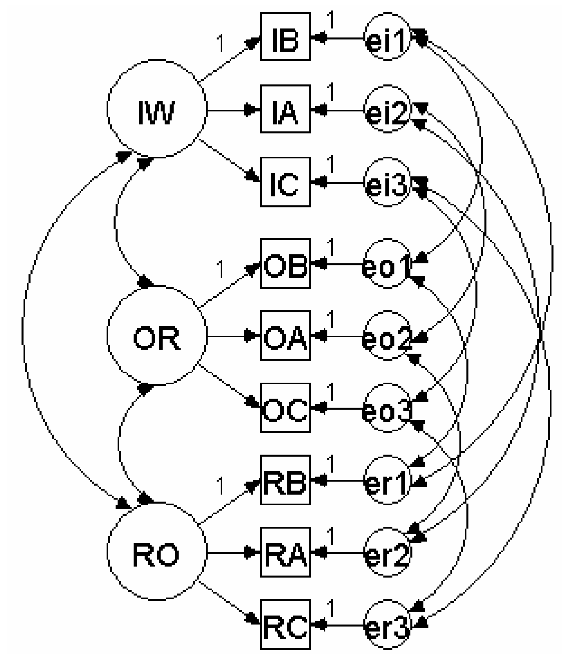


Figure 5.2: **ISIR Factorial Structure**

External Component

The external component of construct validity refers to whether the respondents' scores on the measurement instruments of the target construct and other theoretically related constructs reflect the expected high, low and interactive relations implied in the theory (Loevinger, 1957). Unlike the structural component, the external component of construct validity primarily concerns the inter-construct relationships. In assessing the external component of construct validity, total scores or any subscores of the instrument being validated, rather than individual item responses, are used as indicators (Messick 1989).

The constructs that are related to ISIR include ISIR antecedents as well as personal and situational factors. These constructs have different levels of relationships with ISIR: ISIR antecedents have causal relationships with ISIR, and personal and situational factors have correlational relationships with ISIR. Because correlation is a necessary but not sufficient condition for causality, the causal relationships are at a higher level than the correlational relationships. Thus, the assessment of the external component of construct validity needs to be carried out separately at different levels.

At the causal level, a user's perceptions of experiences with a specific system, or ISIR antecedents, directly affect ISIR with the system, indicated by its subconstructs. This cause-and-effect relation can be described in a Multiple Indicators/Multiple Causes (MIMIC) model as in Figure 5.3. In a MIMIC model, the latent variable has both causal and effect indicators (MacCallum and Browne 1993). Thus the latent variable ISIR has ISIR antecedents, Sense of Control (SC), Perceived Understanding (PU) and Motive Fulfillment (MF), as its causal indicators, and ISIR subconstructs, Input Willingness (IW), Output Receptivity (OR) and Rule Observance (RO), as its effect indicators.

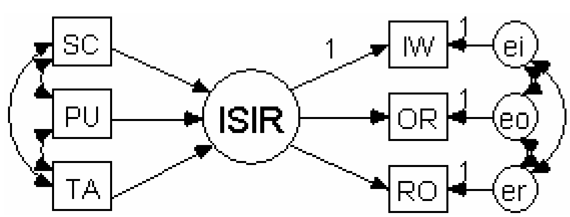


Figure 5.3: **MIMIC Model of ISIR Antecedents**

The MIMIC model can be used to represent Canonical Correlation Analysis (CCA) (Bagozzi et al. 1981, Fan 1997), a statistical method pioneered by Hotelling (1935) to identify and measure the association between two sets of variables. Fan (1997) suggested using the chi-square difference test to test the statistical significance of all possible canonical correlation functions with nested models. Figure 5.2 shows the first-order canonical correlation function, and higher- order canonical correlation functions (the highest order up to the number of variables in the smaller set, i.e. third-order in this case) have other unknown latent variables connecting two sets of variables. We can use this test to verify whether the first-order correlation function explains most of the covariance between two sets of variables through the latent variable ISIR so that no higher-order functions are significant. If so, the test results provide circumstantial evidence for the construct validity of ISIR as having the specified variables as the antecedents and subconstructs.

At the correlational level, the relationships between the target construct and other related constructs compose the so-called nomological network. Thus, the external component of construct validity concerning the correlational relationships among constructs is usually labeled as Nomological Validity (see Messick 1989) or Concurrent Validity (see Nunnally and Bernstein 1994). When the nomological network is sufficiently well developed, it can be tested formally (Cronbach 1971).

Because the personal and situational factors as discussed in Chapter IV influence an individual’s ISIR toward one or more systems under a task context, they compose a nomological network with ISIR. Personal factors are context-independent, and they include: Locus of Control (LOC), Computer Anxiety (CA), Computer Playfulness (CP) and System Experience (EXP). Situational factors are context-dependent, and they include task Self-efficacy (SE), Interest (INT), Importance (IMP) and Tension (TEN). They can be put into a nomological network with ISIR as in Figure 5.4.

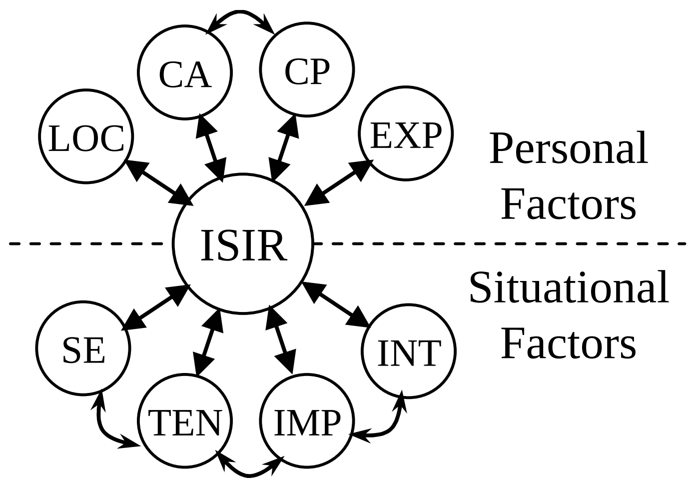


Figure 5.4: **ISIR Nomological Network**

Among the personal factors, LOC is computer-independent, CA and CP are computer-related, and EXP is system-specific. CA and CP should be highly correlated with each other because of their similar nature and previous empirical evidence. Among the situational factors, IMP and INT are related to user motivation and SE and TEN are related to user self-regulation. As mentioned, SE and TEN, TEN and IMP, IMP and INT are correlated with each other.

To assess the nomological validity of the ISIR instrument in the validation study, it is necessary to collect subjects' responses not only on the ISIR instrument, but also on the measurements of these personal and situational factors. Because of the correlations among some of the factors, it is necessary to test their relationships with ISIR together.

*Predictive Validity*

Predictive Validity, also called criterion-related validity, refers to how well the scores obtained from the measurement instrument of the construct in question can predict criterion events (see Cronbach 1984; Nunnally and Bernstein 1994). Unlike nomological validity, which involves the relationship between the construct in question and other theoretical constructs, predictive validity involves the relationship between the construct and factual events that can be used as criteria to judge the measure's predictive power. In empirical research, the common criterion is the rating or mark, which is gathered in concurrent or follow-up studies (Cronbach 1984).

The criterion events for ISIR construct are its behavioral consequences, including user choice between IS approach and non-IS approach, user choice among IS options and user persistence in interacting with a specific system. Thus, we can assess the predictive validity of ISIR by testing how well the scores on ISIR instrument can predict these behavioral consequences.

To obtain this criterion information in the validation study, it is necessary to let the participants try to use at least two systems to solve similar problems and ask them to choose among these systems and a non-system alternative to solve similar problems in the future. This allows us to use ISIR scores to predict the behavioral consequences at the first two levels, that is: user choices among non-IS and IS alternatives. In addition, it is possible to assess the predictive validity of ISIR regarding user persistence in interacting with a specific system by using ISIR scores to predict whether the participants are likely to give up in the middle of problem solving process. Of course, the task should be relatively difficult and there should be quite a few participants who give up.

Thus, with the data obtained from the validation study, the three proposals discussed in the previous chapter as related to the predictive validity of ISIR instrument can be assessed. Note that these proposals are not to be tested statistically in a formal way because this laboratory study was cross-sectional in nature and there was no longitudinal follow-up. User self-reported choices and user persistence observed from the current tasks are not behavioral consequences in a real sense. Rather they are substitutes obtained from the laboratory procedures for the indication of potential behavioral consequences. Thus, we assessed these proposals informally by evaluating how well the ISIR scores "predicted" these "pseudo" behavioral consequences.

Such substitutions cause problems in formal hypothesis testing. In the laboratory procedures, participants neither use the non-IS approach nor give responses on how ready they are to use the non-IS approach. It is difficult to know whether the self-reported choices between the IS approach and non-IS approach are really due to the difference in the readiness to interact with the system and the readiness to use the non-IS approach. Also, user persistence as indicated whether the participants give up in the current tasks caused a critical problem for formal hypothesis testing because users who abandon a task are likely to have a low ISIR toward the system they used for the task. Thus, the observed user persistence can be both a cause and an effect of ISIR.

To solve the problem to some extent, we can adopt a comparative strategy. That is, the predictive power of ISIR scores on the pseudo behavioral consequences can be benchmarked in comparison with the predictive power of the Technology Acceptance Model (TAM) scores on the same pseudo behavioral consequences. Though problems remain, comparisons on an even ground can provide some rough ideas about the predictive validity of the ISIR instrument against that of the established TAM instrument. Logistic regression, a predictive discriminant analysis method, was applied to compare the predictive power of the ISIR instrument and that of the TAM instrument.

*Procedures for the Validation Study*

To validate the ISIR instrument regarding its content validity, construct validity and predictive validity, it was necessary carry out a pilot study to gather empirical data needed for the validation. Unlike the formal experimental study to test the ISIR research framework, this validation study was non-experimental, but in some ways more realistic. It is non-experimental because we do not systematically control the experimental conditions on the independent variables, IS capabilities. Rather, participants are asked to interact with various systems existing in the real world to solve problems that they are likely to encounter in daily life or job.  The use of various real systems for multiple tasks in the validation study enhance validity generalization, the ability to generalize the findings about the validity of the instrument to other systems and tasks, as in Cook and Campbell's (1979) concept of external validity.

There were two types of tasks for the validation study. In the first task, the participants were asked to find proper Excel functions with two different systems to transform customer data for an e-commerce website. There were two replications of this task: the first task was to extract zip codes from the right side of customer addresses, and the second task was to find the number of the weekday (1 for Monday, 2 for Tuesday…7 for Sunday) corresponding to the registration date of customers. To find the proper Excel functions, the participants were asked to use Excel Help or Google for each task. The second task was to find a travel deal for the Spring/Summer break to a fixed venue during a given period of time. The participants were asked to use two travel websites, Travelocity.com and Cheaptickets.com, to search for the deal, which included a two-way airline ticket, hotel and car rental.

The first type of task that asked participants to solve Excel problems involved exploration and uncertainty, though hints were given in the instructions. The second type of task, on the other hand, was quite straightforward and involved little uncertainty. Thus, participants generally perceived the first task more difficult than the second task (see the descriptive statistic for Task Self-efficacy in the next chapter). The two systems for the first task are quite different in nature: Excel Help is a system derived in the domain of Microsoft Help, but Google is a system that has almost an unlimited domain for all the content on the Internet. For different participants, either feature can mean a pro or a con. Because of the general purpose and wide domain of Google, participants usually had more experience with Google than Help (see the descriptive statistic for Previous Experience in the next chapter). The laboratory setting and system selection enable the validation of ISIR instrument for totally different systems.

On the other hand, the systems for the second task are quite similar: Travelocity and CheapTickets are both travel agent websites of the similar functionalities. However, there were two salient differences: 1) Travelocity usually gave cheaper deals than CheapTickets (see the descriptive statistic for Performance in the next chapter); 2) CheapTickets allowed users to search travel deals with airfare, hotel and car rental combined, but Travelocity only allowed users to search for combined travel deals for at most airfare and hotel (see appendix). The relative advantage and disadvantage of each site enable the validation of ISIR instrument for similar systems with different features.

Participants were randomly assigned to one of the two types of tasks. At the beginning of the study, they filled out the pretest part of the questionnaire that included measurements for Locus of Control, Computer Anxiety and Computer Playfulness. Before each task, participants were asked to indicate their previous experience with the system they were going to use. Then they were asked to interact with one of two systems to accomplish each task, and immediately after each task, answer a part of questionnaire that covered the ISIR instrument, ISIR antecedent scales, perceived IS capabilities (discussed later) and TAM instrument. In the final debriefing, participants were asked to choose one option from the two systems and a non-IS alternative (consulting excel manual or calling travel agent), and answer questions about their situational factors, including task Self-Efficacy, Importance, Tension and Interest.

**Testing of ISIR Research Framework**

To test the research framework in a formal way, it is necessary to have a valid experimental design. Experimental design is a control mechanism that control variance in the study: maximizing systematic variance, controlling extraneous systematic variance and minimizing error variance (Kerlinger 1986). For an experimental study, the desired systematic variance is experimental variance which refers to the variance of the dependent variable that is influenced by the experimental conditions; extraneous systematic variance is caused by influential independent variables other than the experimental conditions; and maximizing experimental variance and controlling extraneous variables can minimize of the random error variance (Kerlinger 1986). Thus, we will discuss the research design for the experimental study to test the ISIR research framework with respect to experimental conditions and extraneous variables.

*Experimental Conditions*

The experimental conditions for testing the ISIR research framework are created through manipulation of different levels of IS capabilities. These capabilities include: Interactivity, Context-awareness and Personalization. While Interactivity is the interface-related capability that enables the user to exert direct control on the transformation of information, Context-awareness and Personalization are system-related capabilities that facilitate user-system interaction. Thus, we can distinguish two levels of experimental conditions: a necessity-level condition, that is Interactivity, and sufficiency-level conditions, Context-awareness and Personalization.

To maximize experimental variance, it is necessary to make the experimental conditions as different as possible (Kerlinger 1986). For the initial test of the ISIR research framework, it is reasonable to simplify the treatments and maximize their differences by making each capability binary: either high (indicated by ‘1’) or low (indicated by ‘0’). The binary values of the three IS capabilities result in eight possible combinations, as shown in Figure 5.5. A system mode that is low on Interactivity, Context-awareness and Personalization is indicated by I0P0C0, and a system mode that is high on Interactivity, Context-awareness and Personalization is indicated by I1P1C1.

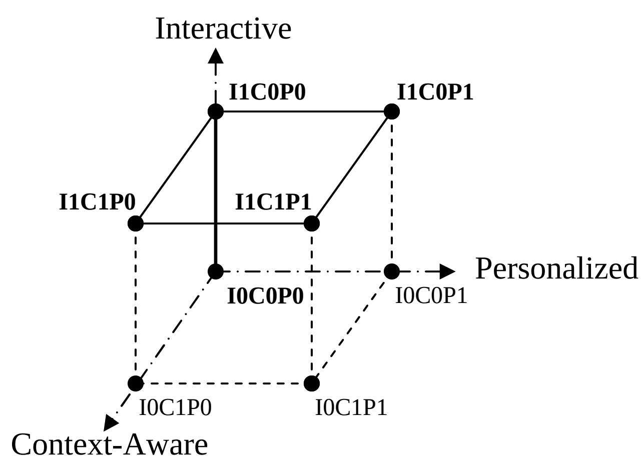


Figure 5.5: **Experimental Treatments**

As mentioned, there are two primary research questions related to the effects of IS capabilities on ISIR: 1) whether Interactivity is a necessary condition for users to be ready to interact with a system; 2) for interactive systems, how Context-awareness and Personalization may enhance or weaken users’ ISIR. For these purposes, we will include only the nodes that are connected with solid lines in Figure 5.5 in the experimental treatments, and they are I0C0P0, I1C0P0, I1C1P0, I1C0P1, I1C1P1. Note that in the real world, there are services that are corresponding to other nodes, such as location-based information pushing service that corresponds to I0C1P0 or I0C1P1. However, inclusion of these nodes (I0C1P0, I0C0P1 and I0C1P1) among the treatments does not contribute much to the understanding of how IS capabilities affect ISIR because people can do little to interact with non-interactive systems.

The first research question requires us to compare the effects of an interactive treatment and a non-interactive treatment on ISIR. In order to filter out the interaction effects from the other IS capabilities, neither treatment should be personalized or context-aware. Thus, two treatments are: I0P0C0 vs. I1P0C0. If this first part of study supports the necessity of ISIR, the second part will study its sufficiency by investigating how the other two capabilities, Context-awareness and Personalization may affect ISIR. A 2×2 factorial design will be used for this part of study, as shown in Table 5.1.

Table 5.1: **2×2 Factorial Design**

| Interactive Modes | Low Personalization | High Personalization |
|---|---|---|
| Low Context-awareness | I1C0P0 | I1C0P1 |
| High Context-awareness | I1C1P0 | I1C1P1 |

Laboratory Setting and Procedure

The Appendix illustrates the laboratory setting and procedure with screen shots from the experimental tool. In the experiment, participants interact with geographic information service (GIS) systems that vary in terms of IS capabilities through the simulated cell phone interface on desktop. The scenario is that the cell phone users are traveling in a city on a Saturday evening and want to find a nearby nightclub to enjoy music they like (e.g. rock, country and jazz etc.) with their cell phones. At the beginning of a session, participants indicated their music preferences by selecting up to three of their favorite music types from 10 options given by the computer.

Five treatments were implemented as follows: Mode 0 corresponding to the I0C0P0 treatment lists all nightclubs in the city by alphabetic order; Mode 1 corresponding to the I1C0P0 treatment allows a user to select a music type from a complete list first, and then gives the relevant clubs in alphabetic order; Mode 2 corresponding to the I1C1P0 treatment allows a user to select a music type from a complete list first, and then gives the relevant clubs in distance order; Mode 3 corresponding to the I1C0P1 treatment lets participants choose from a list of their favorite music types, and then gives the relevant clubs in alphabetic order; and Mode 4 corresponding to the I1C1P1 treatment lets participants choose from a list of their preferred music types, and then lists the relevant nightclubs in distance order.

During the study, participants interact with the five modes in a randomly-assigned sequence to search for the required information. Before trying each mode, the participants selected or were randomly assigned a location on the city map. In each mode, when a participant checks out the information about a nightclub by clicking its link, the system displays its music type and distance for the participant to decide whether to confirm the selection or go back to the previous step(s) and search again. The system calculates the performance of a participant for each mode by taking into account how close the club is to the person, whether the club is of the person's favorite music type and how fast the person find the club information. After using each mode, participants fill out a section of a questionnaire that measures ISIR and its antecedents, as well as their perceived IS capabilities of this mode.  They then go back and try the next mode and fill out another section of the questionnaire.

To check whether the laboratory setting and procedure would work as intended, a pilot study was conducted. In this pilot study, 43 students from an undergraduate business major class were solicited to participate. They were asked to go through the procedure and answer a preliminary questionnaire. Most of them followed the instructions that lead them through all the treatments and steps without any difficulties, and it took most of them 20 to 25 minutes for the entire procedure. At the end, the participants were asked whether they would perceive that these treatments were implemented as intended. Specifically, the questions relates the experimental treatments to IS capabilities: Mode 0 – low on Interactivity; Mode 1 – high on Interactivity, but not low on Context-awareness and Personalization; Mode 2 – high on Interactivity and Context-awareness, but low on Personalization; Mode 3 – high on Interactivity and Personalization, but low on Context-awareness; Mode 4 – high on Interactivity, Context-awareness and Personalization. Most participants indicated that the implementation of experimental treatments was consistent with what was intended, as shown in Table 5.2. All responses were on 7-point Likert scales (from 1-strongly disagree to  7-strongly agree) with a neutral point at 4. As the table shows, all the treatments have the 25$^{th}$ percentile equal to or greater than 4, indicating the participants perceptions of the conditions were in line with the intended manipulations.

Table 5.2: **Check on Treatment Manipulations**

**Frequency Statistics**

| | | MODE0 | MODE1 | MODE2 | MODE3 | MODE4 |
|---|---|---|---|---|---|---|
| N | Valid | 43 | 43 | 43 | 43 | 43 |
| | Missing | 0 | 0 | 0 | 0 | 0 |
| Mean | | 4.95 | 4.91 | 5.26 | 4.98 | 5.63 |
| Std. Deviation | | 1.290 | .868 | 1.432 | 1.144 | 1.254 |
| Percentiles | 25 | 4.00 | 4.00 | 5.00 | 4.00 | 5.00 |
| | 50 | 5.00 | 5.00 | 5.00 | 5.00 | 6.00 |
| | 75 | 6.00 | 5.00 | 6.00 | 6.00 | 7.00 |

*Extraneous Variables*

In the assessment of nomological validity, the correlational relationships between ISIR and personal and situational factors are tested in the nomological network. However, in the experimental study on the causal relationships between IS capabilities and ISIR, personal and situational factors are extraneous variables that were used to control extraneous systematic variance. Thus, these factors were measured in the experimental study as well.

As in the validation study, participants answered questions for Locus of Control, Computer Anxiety, Computer Playfulness and their previous experiences with cell phones at the beginning. In the debriefing, they answered questions about their task Self-Efficacy, Importance, Tension and Interest. These variables were used as covariates to explain the variance contributed by factors other than the experimental conditions, thus minimizing error variance.

Because these personal and situational factors vary from person to person rather than from system to system, they are between-subject covariates rather than within-subject covariates. Because within-subject independent variables and between-subject covariates are at different levels, normal Analysis of Covariance (ANCOVA) is not applicable. Thus it was necessary to adopt a special multi-level modeling method to analyze the data. Because the validation study involved a similar data analysis problem, this statistical method will be discussed in the section of general research design.

**General Research Design**

The previous section discusses the procedures used in the validation of the ISIR instrument and the test of the ISIR research framework. Though the purposes of the two components of the study are different, they share the same general research design and the accuracy of their results depends on some common methodological issues. Both the validation study and the formal experimental study involve repeated measures. For this general design, both the within-subject and between-subject variance should be taken into account. Subject selection is the first issue that may affect both studies. Also, the constructs to be measured in both studies are the same. Thus, the second issue critical for both studies is how to measure these constructs. Finally, most data collected in both studies are from repeated measures, and this requires the same special statistical method for data analysis. Thus, the following parts discuss subjects, construct measurement and statistical methods respectively.

*Subjects*

The target population for both the pilot validation study and the experimental study are people who use various types of information systems in their life, study and work. Computer use has been a basic requirement on university campus for some time, and students need to interact with various types of systems to access course information, library information, academic information and so on. Thus, the undergraduate students in Texas A&M University meet this criteria to be subjects for both studies. Also, because both studies involve laboratory settings and procedures, students are appropriate because they can easily access the on-campus lab where the principal investigator carried out both studies.

In order to find out how personal and situational factors are related to ISIR in the validation study, it was necessary to get heterogeneous subjects that vary in terms of the measured factors. Also, in order to control extraneous systematic variance rather than introducing additional noise due to measurement error in the experimental study, the subjects should also be have variation in terms of these extraneous variables. Thus, the subjects for both the validation study and the experimental study were required to be as different as possible.

The subject pools from which subjects were selected exhibited considerable variation in terms of background and levels of students. The main subject pool was an entry-level non-business course in Management Information Systems. There were 600 freshman and sophomore students in this course from all kinds of non-business majors. There were several smaller subject pools from business major courses, covering both

MIS and non-MIS courses, from junior to senior level. Thus, the subject pools had a good mixture of students of different academic background and at different levels in terms of computer experience.

The elicitation of the participants from the subject pools was conducted on a voluntary basis. The average duration for the validation study was 20-25 minutes and the average duration for the experimental study was 25-30 minutes. The compensation for participants consisted of some extra credit for the courses where they were elicited. In all, 230 subjects participated in the validation study and 112 subjects participated in the formal experimental study. A few participants did not follow the procedures correctly and their responses were discarded. For the validation study, 229 out of 230 responses were usable, and for the experimental study, 106 out of 112 responses were usable.

*Construct Measurement*

In addition to the ISIR instrument described earlier, measures were required for all the other constructs as discussed, most of them in the ISIR research framework. Based on a search for existing scales of these constructs, previously developed and validated measurements were either directly adopted or adapted. Some minor changes in wording were made to some scales to adapt them to the particular settings of the validation and experimental studies. For a few constructs, no validated scales were available, and new measures were developed. Each measure used in this study is described below.

<u>ISIR Antecedents</u>

ISIR antecedents include Sense of Control, Perceived Understanding and Motive Fulfillment. Sense of Control was measured with three items adapted from Ajzen and Madden's (1986) Perceived Behavioral Control scale. Rather than specifying an action such as using a certain system in these items, we specified the general activity over which user control is perceived, such as "How much control do you have over the interaction with (system name) for the desired result?". The internal consistency of these four items was assessed in a pilot study, and the coefficient $\alpha$ was 0.82.

Perceived Understanding was measured by Cahn and Shulman's (1984) Perceived Understanding Instrument. There are eight items for measuring the Perceived Being Understood (PBU) subconstruct, eight items for accessing the Perceived Being Misunderstood (PBM) subconstruct and one item for accessing General Perceived Understanding (GPU). The instructions were adapted from the setting of human-human interaction to that of user-system interaction. For instance, rather than saying "being understood by the other person", the instruction reads "being understood by (system name)". The coefficient $\alpha$ obtained from a pilot study was 0.9428.

Motive Fulfillment (MF) was measured objectively, and its calculation was based on the performance of participants in accomplishing each task with a given system. Two main criteria were results and time, that is, whether or how the results achieved by the subject met the task expectations and how much time the subject spent on the task. In the validation study, MF scores were calculated based on the self-reported solution and time (beginning and end time). In the experimental study, MF scores were calculated by the computer based on the click-stream data recorded by the computer during the interaction process. Each set of MF scores were normalized and standardized using the Box-Cox power transformation (Box and Cox 1964).

<u>TAM Constructs</u>

Serving as the benchmark for both content validity and predictive validity, TAM constructs were measured only in the validation study. The ten items taken from Venkatesh's (2000) study were adapted to measure Intention to Use (two items), Perceived Usefulness (four items) and Perceived Ease of Use (four items). This scale is a shorter form derived from the original one in the studies by Davis (1989) and Davis et al. (1989). In the Venkatesh's (2000) study, coefficient $\alpha$'s above .90 for each of the three subconstructs were observed for multiple times.

<u>Perceived IS Capabilities</u>

To check whether the experimental treatments had the expected effects on user experiences in the experimental study, we needed measures of perceived IS capabilities, including Perceived Interactivity, Perceived Context-Awareness, and Perceived Personalization. A search for existing scales found several instruments to measure Perceived Interactivity, but none for Perceived Context-Awareness or Perceived Personalization.

As mentioned, it is generally agreed that interactivity is related to two-way communication, synchronicity and user control. Among the existing Perceived

Interactivity scales, the instruments developed by Liu (2003) and Wu (2005), in combination, have taken all the underlying dimensions into account. Both scales measure user perceptions on website interactivity and not all items are relevant to general IS. Also, they are a little bit too long for this study: Liu's instrument has 15 items and Wu's has nine items. Thus, it is necessary to select some items that can be adapted to general IS for all three dimensions. From both instruments, six items were adapted to measure Perceived Interactivity, two items for each dimension (see Appendix).

Because there were no scales available for Perceived Context-Awareness and Perceived Personalization, new measures have to be devised. Under the human activity perspective on user-system interaction, Context-Awareness and Personalization are two IS capabilities that are directly related to the system itself rather than to its interface. Thus, user perceptions on the effects of Context-Awareness and Personalization are based on aspects of the system itself and system output. Also, because these IS capabilities are implemented through interaction rules (in the form of algorithms) and information technologies, whether these IS capabilities are implemented as intended provides another perspective for user perception. Thus, for both Perceived Context-Awareness and Perceived Personalization, three items were developed corresponding to user perceptions of the system itself, system output and capability implementation (see Appendix).

In a pilot study for the validation study, all the items for Perceived Interactivity, Perceived Context-Awareness and Perceived Personalization were put into the preliminary questionnaire. After the participants used Google and Help to solve two similar Excel problems and used Travelocity.com and Cheaptickets.com to find and compare travel deals, they were asked to respond to the items based on their experiences with these systems. Twenty-two students from an undergraduate course participated in this pilot study and each did two tasks of a type, resulting in 44 responses to these items. The coefficient $\alpha$ for the Perceived Interactivity scales was .9133, the coefficient $\alpha$ for the Perceived Context-Awareness scales was .8646, and the coefficient $\alpha$ for the Perceived Personalization scales was .8450. The results show that the internal consistencies of these scales were all at an acceptable level.

## Personal Factors

Personal factors that may influence ISIR include Locus of Control (LOC), Computer Anxiety (CA) and Computer Playfulness (CP). They are theoretically independent of the task settings involved in the laboratory procedures, and thus they were measured at the beginning of both validation and experimental studies.

Locus of Control (LOC) was measured with the Abbreviated 11-item LOC Scale (Valecha and Ostrom 1974) based on Rotter's (1966) original Scale. Each item is composed of two statements that intend to differentiate people who have Locus of Internal Control from people who have Locus of External Control. The response format of the abbreviated scale employs the original forced choice format plus a two-level response option with regard to the degree of agreement between the statement and the subject’s opinion: “much closer” and “slightly closer”.

Computer Anxiety (CA) was measured with a scale developed and validated by Brown and Vician (1997) on the basis of the widely used Computer Anxiety Rating Scale (CARS) (Heinssen et al. 1987). The newer scale has addressed some of the reliability and validity issues of the older scale (see Ray and Minch 1990). The newer scale has nine Likert-scale items, and it was used in previous studies, such as Venkatesh (2000).

Computer Playfulness (CP) was measured using a scale adapted from Webster and Martocchio (1992) with some changes in wording of the instructions. This scale uses seven adjectives to elicit subjects' responses on how playful they perceive themselves to be in interacting with information systems. The response format is a seven-level Likert scale format from "strongly disagree" to "strongly agree".

## Situational Factors

Situational Factors are related to the task-settings, and include System Experience (EXP), task Self-Efficacy (SE), Tension (TEN), Importance (IMP) and Interest (INT). Among them, EXP is related to the systems involved in the laboratory procedures. It was measured before each task in the validation study in which a subject used different systems for different tasks, and it was measured once before all treatments in the experimental study in which all treatments are the variations of a mobile GIS system. Other situational factors are related to the task settings, and they were measured at the end of procedures.

User previous experiences with specific systems that they interacted with in the laboratory procedures were measured with one seven-level Likert-scale item developed for this study. This item asked participants how they are familiar with the same or similar systems that they are going to interact with in the laboratory procedure.

To measure subjects' experience with regards to experimental tasks, Ryan (1982) and other members of the Rochester Motivation Research Group (Plant and Ryan 1985; Ryan et al. 1983) developed the post-experimental Intrinsic Motivation Inventory (IMI). There are four dimensions underlying the inventory: interest-enjoyment, perceived competence, importance-effort and pressure-tension. Among them, interest-enjoyment subscale is the only one that is directly related to intrinsic motivation, and can be used to measure Interest. The perceived competence scale can be used to measure Self-efficacy. The importance-effort and pressure-tension subscales can be used to measure Importance and Tension. In this study, we used a 16-item version of IMI validated by McAuley et al. (1989), with four items for each subscale, to measure task Interest (INT), Self-efficacy (SE), Importance (IMP) and Tension (TEN) (see appendix). They observed coefficient $\alpha$'s 0.80 for interest-enjoyment, 0.87 for perceived competence, 0.84 for importance-effort and 0.68 for pressure-tension.

*General Statistical Method*

Both validation and experimental studies involved repeated measures. The appropriate statistical method for data analysis should take variance at both the between-subject level and within-subject level into account in order to minimize the error variance. For the analysis of data that have a hierarchal structure such as repeated measures, multilevel modeling is the best, if not the only, choice (Hox 1998). Because the ISIR research framework includes multidimensional theoretical constructs, which should be represented by latent variables rather than observed variables in statistical analysis, the conventional multi-level multiple regression model (see Cohen and Cohen 1983) is not applicable. However, multi-level structural equation modeling (SEM) enables researchers to do multi-level modeling involving latent variables (see Goldstein and McDonald 1988)

Muthén (1989, 1990, 1994) shows that it is possible to use conventional SEM software packages, such as LISREL (Jöreskog and Sörbom 1996), EQS (Bentler, 1995) and AMOS (Arbucle and Wothke, 1999), to analyze multilevel data. In modeling between-subject and within-subject variables together, a between-subject factor “feeds” its covariance on relevant within-subject variables through latent variables at the between-subject level representing the variances of within-subject variables. The multi-level measurement model for ISIR can be depicted in Figure 5.6. Note that this model is specified for the validation study and the regression coefficients from the variances to the indicators are fixed to 1.414, the square root of the sample size two within each subject (because each subject uses two systems in the validation study). This scale factor is used to make the estimation of structural coefficients meaningful (see Hox 1995). We used the SPLIT2 program (Hox 1999) to compute the pooled within-group and scaled between-group covariance matrices for each set of data.

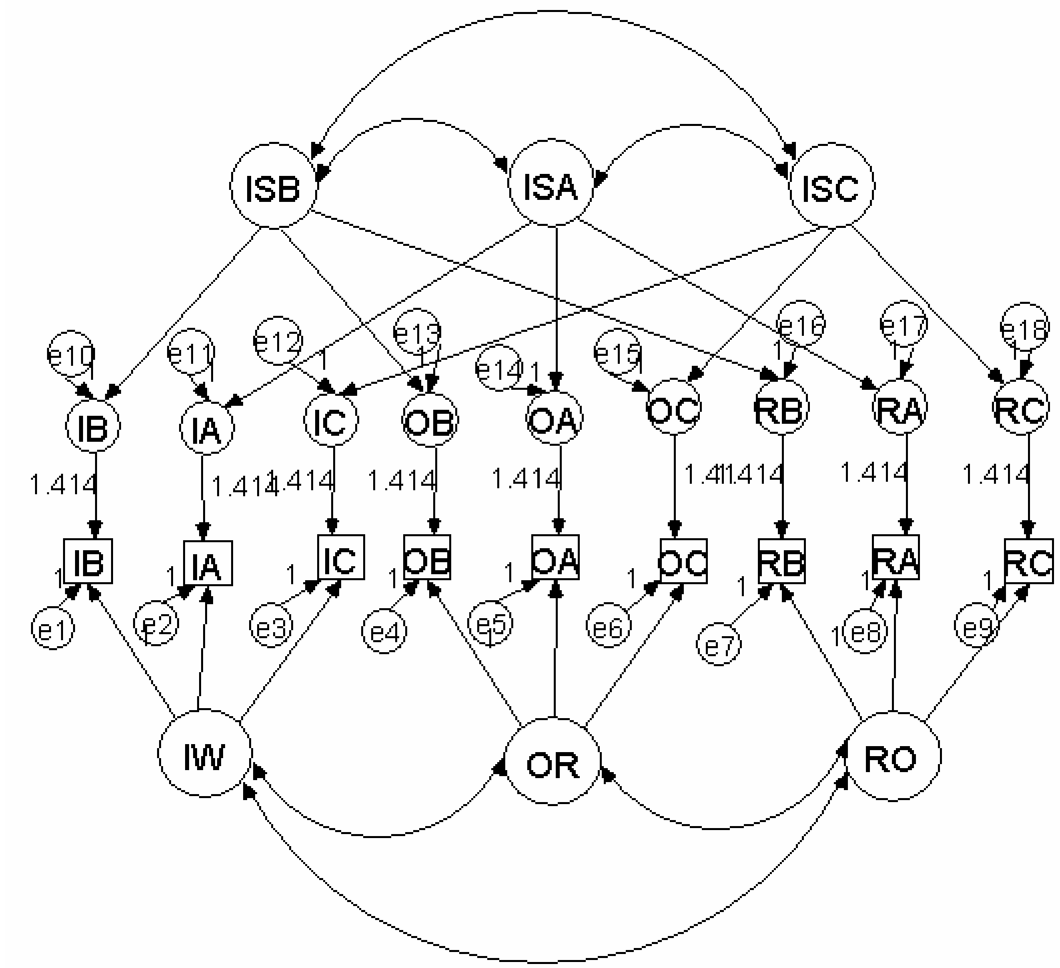


Figure 5.6: **Multi-level ISIR Measurement Model**

In the measurement model, the within model is composed of three factors: Input Willingness (IW), Output Receptivity (OR) and Rule Observance (RO), and the between model is also composed of three factors: IS User Behavioral Attitude (ISB), IS User Affective Attitude (ISA) and IS User Cognitive Attitude (ISC). The between-subject factors are attitude components that are assumed to vary across individuals in relative strength. For example, some people are more rational and others are more emotional in interacting with the same system, resulting in different strength in affective and cognitive components of IS user attitude. The between-subject factors only affect the relevant indicators of the within-subject factors. Specifically, the behavioral, affective and cognitive factors at the between level only affect the corresponding behavioral, affective and cognitive indicators at the within level.

Once the sufficiency of the above measurement model was established, we built the structure models that incorporate ISIR antecedents, independent variables (experimental treatments for experimental study) or the personal and situational factors to test the research hypotheses in the ISIR research framework. For example, Figure 5.7 shows the structural model for the 2×2 factorial design for the experimental study to investigate the effects of Context-Awareness and Personalization on ISIR. For example, compared with traditional GLM, SEM can test both the hypothesized and confounding effects simultaneously (Brown 1997; Mackenzie 2001). Thus, the direct paths from treatments to ISIR can be used to test whether ISIR capabilities really influence ISIR through the mediation of ISIR antecedents (there is supportive evidence if the direct paths are not significant).

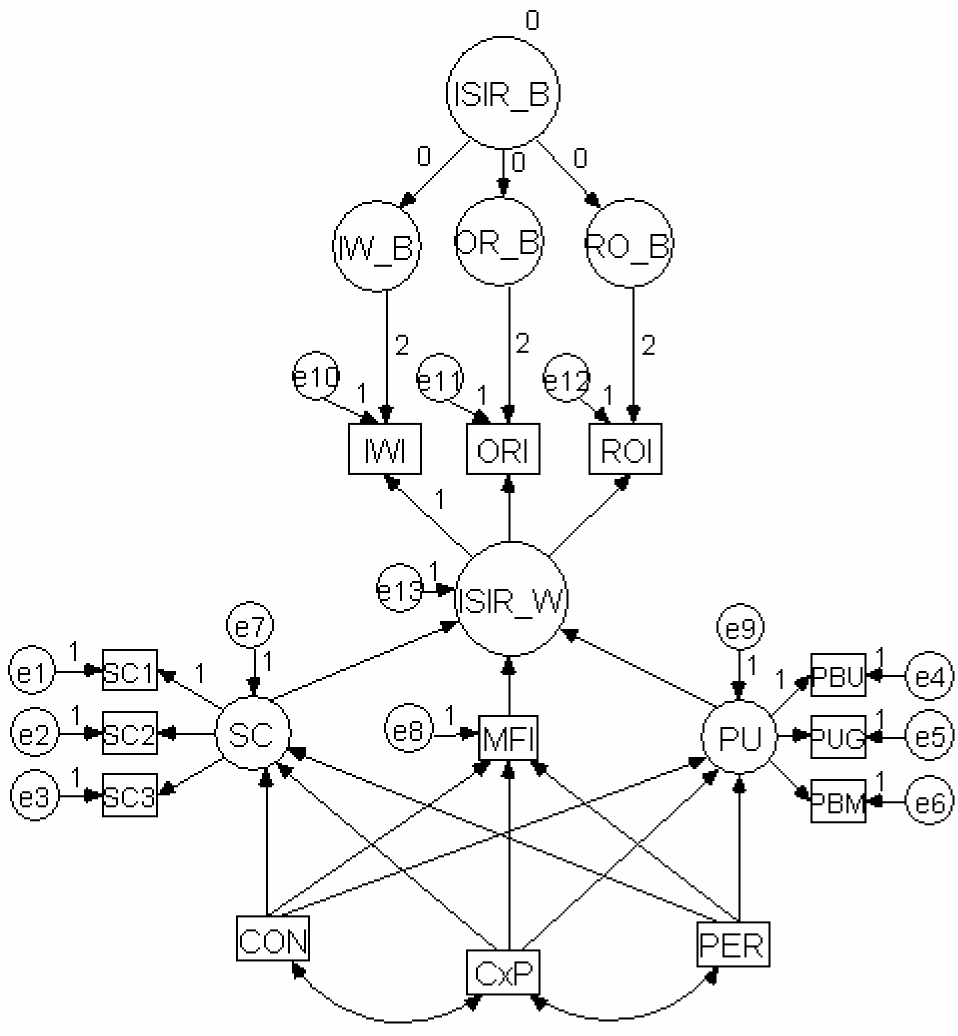


Figure 5.7 **Multi-level Structure Model for 2×2 Factorial Design**

Generally speaking, sample size in SEM should be relatively large. For a moderately complex model with about 15 indicators, a sample of 200 or more is preferred (see Kline 1998). The model depicted by Figure 5.4 is the most complicated model in this study, and it has 13 indicators (including the independent variables) in the within model. Considering the within-subject level sample size is at least 2 (as in the validation study and the non-interactive vs. interactive treatments in the experimental study) and can be as high as 4 (as in the 2*2 factorial design), the least number of subjects required for the study would be 100 (200/2). For multilevel modeling, the higher-level sample size (in this case, the number of participants) should not be substantially lower than 100, that is at least 50 (Maas and Hox 2002). Taking both criteria into consideration, the number of participants for the experimental study is preferred be 100. Considering the fact that there were two different tasks for the validation study, the number of participants is about to double that is required, and is preferred to be 200. These real sample size was 229 for the validation study and 106 for the experimental study, and both should be sufficient.

# CHAPTER VI

# ANALYSIS OF RESULTS

This chapter presents the analysis of the data that were collected in both the validation study and the experimental study. The first goal is to establish the validity of the ISIR instrument so that it can be used in the experimental study. The next goal is to test the model of how IS capabilities as well as personal and situational factors affect ISIR. Thus, this chapter is organized into two major sections. The first section discusses some statistical evidence related to the validity of ISIR measurement. The second section describes statistical analysis as it relates to the research framework. The detailed results are arranged in the same order as that of the methodological issues discussed in the previous chapter.

## Validation of ISIR Instrument

In this section, results obtained from the validation study concerning the content validity, construct validity, and predictive validity of the ISIR instrument are reported. Before the detailed results are discussed in the following parts corresponding to each validity issue, Table 6.1 gives the descriptive statistics for most of the variables in the validation study. The descriptive statistics showed that the task settings have generally the expected effects on these variables as discussed in the previous chapter, that is, participants perceived the first task form to be more difficult than the second, and they had more different experiences with two systems in the first form than in the second.

Table 6.1: **Descriptive Statistics for the Validation Study**

| Variable | Form 1 | | Form 2 | |
|---|---|---|---|---|
| | Task1 | Task 2 | Task1 | Task 2 |
| System Experience (EXP) | 3.37 (1.77 ) | 5.57 (1.45 ) | 3.50 (2.12 ) | 3.00 (2.10) |
| Duration | 9.30 (6.55 ) | 5.66 (4.29 ) | 5.11 (2.14 ) | 2.99 (1.71) |
| Performance | 6.04 (4.89 ) | 7.26 (3.94 ) | 9.03 (1.87 ) | 8.08 (1.08) |
| Persistence | 0.61 (0.49 ) | 0.78 (0.41 ) | 0.99 (0.09 ) | 0.99 (0.09) |
| Input Willingness (IW) | 4.49 (1.17 ) | 5.13 (1.36 ) | 5.71 (0.94 ) | 5.73 (0.99) |
| Output Receptivity (OR) | 4.51 (1.22 ) | 5.05 (1.41 ) | 5.74 (0.95 ) | 5.62 (1.04) |
| Rule Observance (RO) | 4.39 (1.36 ) | 5.04 (1.26 ) | 5.63 (0.99 ) | 5.64 (1.03) |
| ISIR Score | 4.46 (1.15 ) | 5.07 (1.28 ) | 5.69 (0.89 ) | 5.66 (0.95) |
| Sense of Control (SC) | 4.49 (1.41 ) | 5.19 (1.31 ) | 5.75 (0.97 ) | 5.71 (1.06) |
| Perceived Understanding (PU) | 4.68 (0.96 ) | 4.97 (1.01 ) | 5.21 (0.94 ) | 5.29 (0.91) |
| Locus of Control (LOC) | 3.84 (0.74 ) | | 3.86 (0.82 ) | |
| Computer Anxiety (CA) | 2.27 (1.06 ) | | 2.39 (1.28 ) | |
| Computer Playfulness (CP) | 4.94 (1.05 ) | | 4.65 (1.22 ) | |
| Interest (INT) | 3.46 (1.10 ) | | 4.41 (1.38 ) | |
| Self-Efficacy (SE) | 4.12 (1.43 ) | | 5.68 (0.99 ) | |
| Importance (IMP) | 4.70 (1.19 ) | | 4.56 (1.35 ) | |
| Tension (TEN) | 3.63 (1.40 ) | | 2.28 (1.34 ) | |

Note: This table reports Means and Standard Deviations (in parentheses). All variables are scaled to 1 through 7 except Persistence (binary scale), performance (0-10) and Duration (minutes).

*Content Validity*

This section discusses the circumstantial evidence related to the content validity of the ISIR instrument. First, it reports the results related to the item response internal consistency of ISIR instrument. Then it shows how the ISIR construct is related to the parallel TAM constructs. The discussions in these two parts are related to the internal and external aspects of content validity: whether the items of ISIR instrument are measuring the same construct and if they are, whether the construct is what they are supposed to measure.

Item Response Internal Consistency

First, we calculated the coefficient α for each group of behavioral, affective and cognitive items within each of the ISIR subconstructs, Input Willingness, Output Receptivity and Rule Observance. The results shown in Table 6.2 indicate that the resulting nine (3*3) coefficient α's were all at an acceptable level. It suggests that the operation-level items for each structuple (Table 3.3) are internally consistent. Following this, we calculated the coefficient α for each subconstruct based on the averages of behavioral, affective and cognitive items within the subconstruct. The coefficient α's for three subconstructs are all at an acceptable level, indicating that the attitude components for each mediated action are internally consistent. Finally, we calculated the coefficient α for the whole ISIR instrument using the scores for each subconstruct. The overall coefficient α was at an acceptable level, and this suggested that subconstructs at the activity level are internally consistent.

The coefficient α's obtained at different levels provided some evidence that the item sampling of ISIR instrument from its structured content domain was properly done. The relatively high coefficient α's for each component of subconstructs indicated that the items are measuring different dimensions (Evaluation, Power and Activity) of the component. The relatively high coefficient α's for each subconstruct indicated that the attitude components for each mediated action are internal consistent. The relatively high coefficient α for overall ISIR indicated that user predispositions toward different aspects of user-system interaction are correlated with each other.

Table 6.2: **Reliability Analysis of ISIR Instrument**

| ISIR Subconstruct | Component | Items | α | Indexes | α | Indexes | α |
|---|---|---|---|---|---|---|---|
| Input Willingness | Behavioral | 2 | .8419 | 3 | .8979 | 3 | .9386 |
| | Affective | 6 | .9072 | | | | |
| | Cognitive | 6 | .8992 | | | | |
| Output Receptivity | Behavioral | 2 | .8811 | 3 | .9265 | | |
| | Affective | 6 | .9239 | | | | |
| | Cognitive | 6 | .9021 | | | | |
| Rule Observance | Behavioral | 2 | .8880 | 3 | .8979 | | |
| | Affective | 6 | .9211 | | | | |
| | Cognitive | 6 | .9235 | | | | |

Note: Sample size $N = 458$.

We also conducted a parallel form reliability analysis on the subconstruct scores. Because each participant responded to the same instrument twice, which allowed us to conduct an analysis equivalent to a test-retest reliability analysis. The reliability coefficient obtained from the analysis was 0.9384, very close to the overall coefficient α. This indicates that the participants' responses to the ISIR instrument across two tasks were generally reliable. Thus, the ISIR instrument was found to be reliable for both the internal item responses and the repeated responses across different tasks that involved different systems. These desirable characteristics provide confidence in applying the ISIR instrument to empirical studies, whether or not they involve repeated measures.

<u>Correlation with Parallel Constructs</u>

Though developed under different paradigms, both ISIR and TAM measurement instruments address research question of "why people use IS". Through examining how the scores of ISIR instrument are correlated with those of the established TAM instrument, we may have an idea of whether they are targeted toward similar IS user behaviors.

First, we examined the correlation between the overall scores of the ISIR instrument and the TAM instrument. A Pearson correlation coefficient of .742 ($p$-value$<0.01$) was observed. This moderately high coefficient shows that there is a significantly positive correlation between the scores of the two instruments, indicating that they are measuring the similar behavioral constructs. On the other hand, the scores are not highly correlated, suggesting that they are not measuring the same behavioral constructs.

Next, we examine the correlations between the scores of the ISIR subconstructs, Input Willingness (IW), Output Receptivity (OR) and Rule Observance (RO), and TAM subconstructs, Perceived Ease-of-Use (PE), Perceived Usefulness (PU) and Behavioral Intension (BI). Like the ISIR instrument, the TAM instrument was found to be internally consistent (PE-four items: $\alpha = .9274$; PU-four items: $\alpha = .9622$; BI-two items: $\alpha = .9428$). The results reported in Table 6.3 show that they were moderately correlated with each other. Also, we examined the correlations between the attitudinal components of ISIR (affective, cognitive and behavioral) and TAM subconstructs, and similar results were obtained.

Table 6.3: **Correlations between ISIR and TAM Subconstructs**

| TAM \ ISIR | Input Willingness | Output Receptivity | Rule Observance | ISIR Cognitive | ISIR Affective | ISIR Behavioral |
|---|---|---|---|---|---|---|
| Perceived Ease-of-Use | 0.666 | 0.688 | 0.679 | 0.729 | 0.679 | 0.653 |
| Perceived Usefulness | 0.641 | 0.693 | 0.691 | 0.733 | 0.678 | 0.639 |
| Behavioral Intention | 0.584 | 0.619 | 0.615 | 0.632 | 0.621 | 0.584 |

Note: Sample size *N*= 458. All correlations are significant at the 0.01 level (2-tailed).

Note that no clear patterns could be found among the correlations between ISIR subconstructs/components and TAM subconstructs. This indicates that there are no corresponding relationships between ISIR subconstructs/components and TAM constructs. Because each ISIR subconstruct and attitude component includes some or all the elements of TAM subconstructs, this finding was expected.

*Construct Validity*

This section examines the structural and external components of ISIR construct validity. Compared with the internal component of content validity, the structural component of construct validity focuses on the factorial structure rather than internal consistency of item responses. Compared with the external component of content validity, the external component of construct validity focuses on the relationships between ISIR and theoretically-connected constructs, rather than parallel constructs.

Structural Component

Because there is a theoretical factorial structure underlying the ISIR instrument, confirmatory factor analyses (CFA) were carried out at different levels. For each, we examined the goodness-of-fit first to see whether the factorial structure fit the responses at an acceptable level. Then, we examined the estimates of structure coefficients on the fitted model to assess convergent and discriminant validity.

At the first level, the measurement models should include the observables or items as indicators. Preferably the indicators in each model should be non-repetitive so that there will be no inter-item dependency in the factorial structure. These measurement models were specified as hierarchical CFA models because there is a two-level factorial structure for each subconstruct: attitudinal structure (affective, cognitive and behavioral/conative) at the action level and EPA (Evaluation, Power, Activity) dimensions at the operation level.

All the scores in repeated forms (N=458) were fitted to these measurement models. Figures 6.1, 6.2 and 6.3 show the fitted measurement models for Input Willingness, Output Receptivity and Rule Observance, respectively. The structure coefficients of these models were standardized, and all estimates were significant at 0.001 level (two-tailed). The goodness-of-fit indices are reported in Table 6.4 for each model.

Table 6.4: **Goodness-of-fit for ISIR Subconstruct Measurement Models**

| ISIR Subconstruct | $\chi^2/df$ | RMR | TLI | CFI | RMSEA |
|---|---|---|---|---|---|
| Input Willingness | 4.763 | .081 | .931 | .949 | .091 |
| Output Receptivity | 5.134 | .074 | .933 | .950 | .095 |
| Rule Observance | 7.156 | .082 | .908 | .931 | .116 |

Considering the relatively large number of indicators (i.e. 14 indicators) for each model, the fit indices are at an acceptable level. Also, the nature of data in repeated measures violated the assumption that scores were independent. This may also contribute to some relatively poor fit indices, such as $\chi^2/df$ (<4 preferably), and RMSEA (<0.08 preferably). This issue will be addressed later in the multi-level confirmatory factor analysis. However, these models provide a clear picture on how item responses are consistent with the theoretical structure.

All the pattern coefficients or regression weights in these hierarchical CFA models were significant at the 0.001 level. The first-level indicators were strongly correlated with the second-level latent variables, indicating an acceptable convergent validity for the indicators. The first-level latent variables were moderately correlated with each other through the second-level latent variable, indicating an acceptable discriminant validity for the indicators (the product of most of the two regression weights from the second-level latent variables to the first-level latent variables was less than 0.90). Similarly, the second-level latent variables exhibited acceptable convergent and discriminant validity, as did the third-level latent variables.

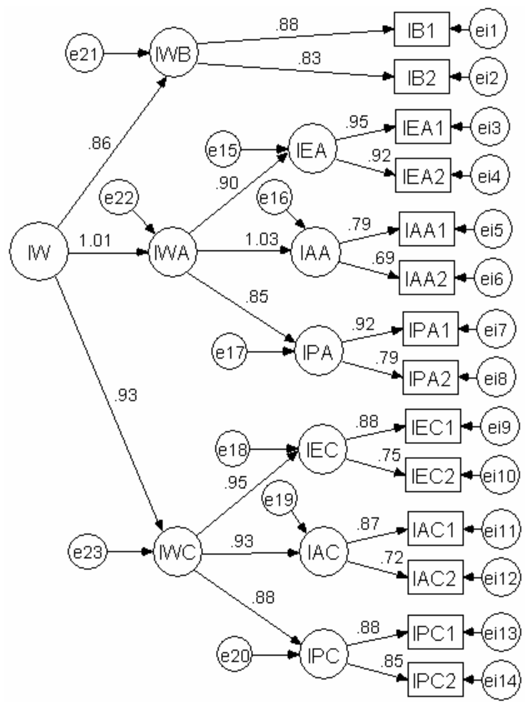


Figure 6.1: **Measurement Model for Input Willingness**

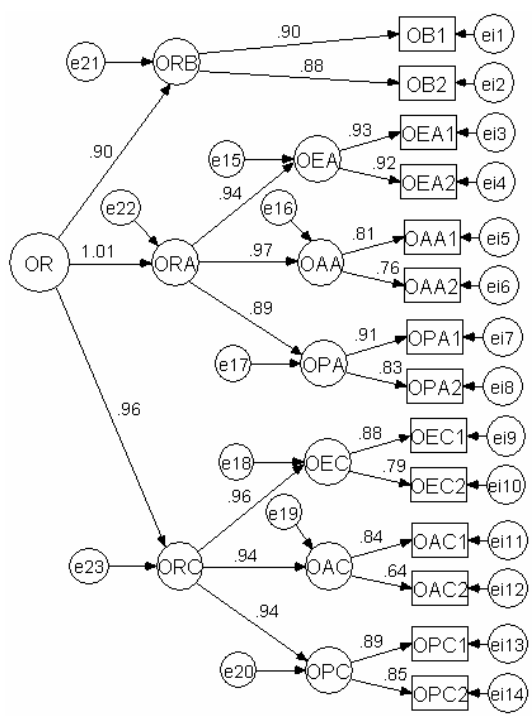


Figure 6.2: **Measurement Model for Output Receptivity**

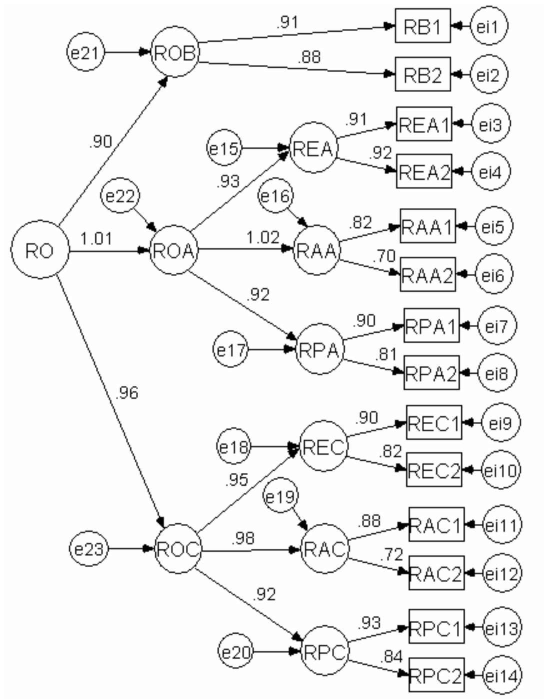


Figure 6.3: **Measurement Model for Rule Observance**

Because the items of the ISIR instrument are repetitive for the three subconstructs, the inter-item relationships should be taken into account in specifying the higher-order measurement models. The repetitiveness results from the existence of two facets, the attitudinal structure facet and the mediated action facet, for the ISIR instrument. The Correlated Uniqueness (CU) model was adopted to depict such a multi-faceted factorial structure. As shown in Figure 6.4, the indicators in the CU model for ISIR instrument were indexes for attitudinal components of each ISIR subconstructs. Because the same components across subconstructs are measured by the same set of items, the correlations among their error terms were freed to be estimated.

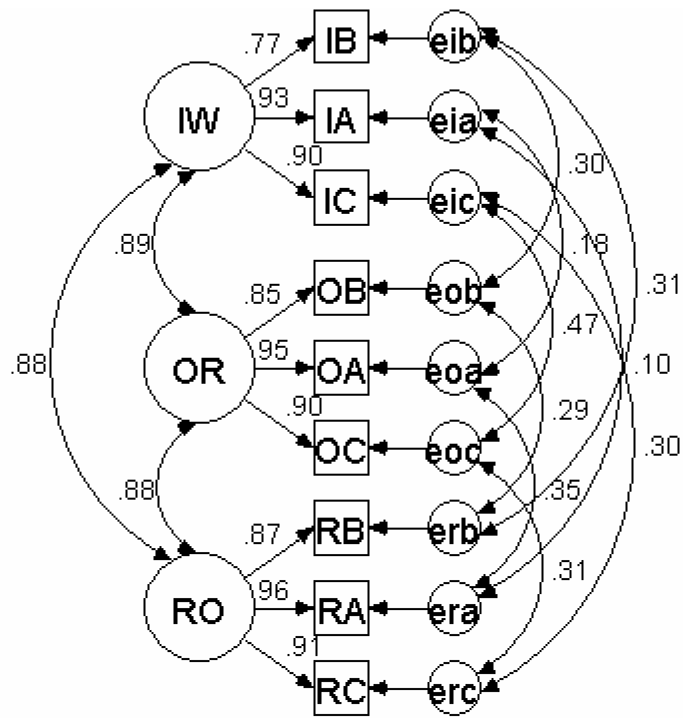


Figure 6.4: **ISIR Correlated Uniqueness Model**

The goodness-of-fit for this model was generally acceptable ($\chi^2$/df=5.035; RMR=.040; TLI=.970; CFI=.987; RMSEA=.094). All the parameter estimates were significant at 0.01 level except the correlations between the error terms of the affective component of Input Willingness and that of Output Receptivity (eia<-->eoa; p-value=.106) as well as that of Rule Observance (eia<-->era; p-value=.359). In this case, it indicated that the affective attitude of participants toward using interface to enter input to a system is relatively independent from those toward reading system output and following interaction rules. Generally speaking, the CU model depicted the overall factorial structure of ISIR instrument well. The fitted CU model exhibited some evidence for the convergent and discriminant validity for the index scores (all standardized regression weights from latent variables to indicators are above 0.75, and all correlations between latent variables are below 0.90).

Finally, we conducted a multi-level CFA on the scores of ISIR instrument. Compared with single-level CFA, multi-level CFA takes the between-subject factors into account. Like the CU model, the multi-level measurement model uses indices for attitudinal components of each ISIR subconstruct as indicators. But instead of correlating their error terms directly, there is a latent variable corresponding to each indicator at the between-subject level. These latent variables depict the dependency of multiple responses on the same set of items for each individual as in the case of repeated measures. These latent variables are then the indicators of between-level factors if there is a theoretical factorial structure. In this case, they are related to the general user attitude toward interacting with information systems. Thus there are three factors at the between-level, corresponding to the affective, cognitive and behavioral components of general IS user attitude. Figure 6.5 shows the fitted multilevel measurement model.

Because the multi-level measurement model takes the interdependency of user responses on the same instrument into account, it exhibits almost the same goodness-of-fit with its single-level equivalent CU model ($\chi^2/df$=4.592; RMR=.096; TLI = .944; CFI=.963; RMSEA = .089). But because of the inflation effects of sample size on RMR, TLI and CFI (see Sun 2005), the bigger the sample, the better values for these fit indices. Considering the decrease in the sample size by half (i.e. 229 rather than 458), the slightly worse values of these fit indices actually indicate that the multilevel model performs better than the CU model. This improvement, due to the tapping of the interdependency between the responses of a participant on the ISIR instrument during the validation study, is indicated by the decrease in $\chi^2/df$ and RMSEA. All the estimates of regression weights and correlation coefficients were significant at 0.001 level. This model exhibited the acceptable discriminant and convergent validity for not only the within-level indicators but also the corresponding between-level latent variables.

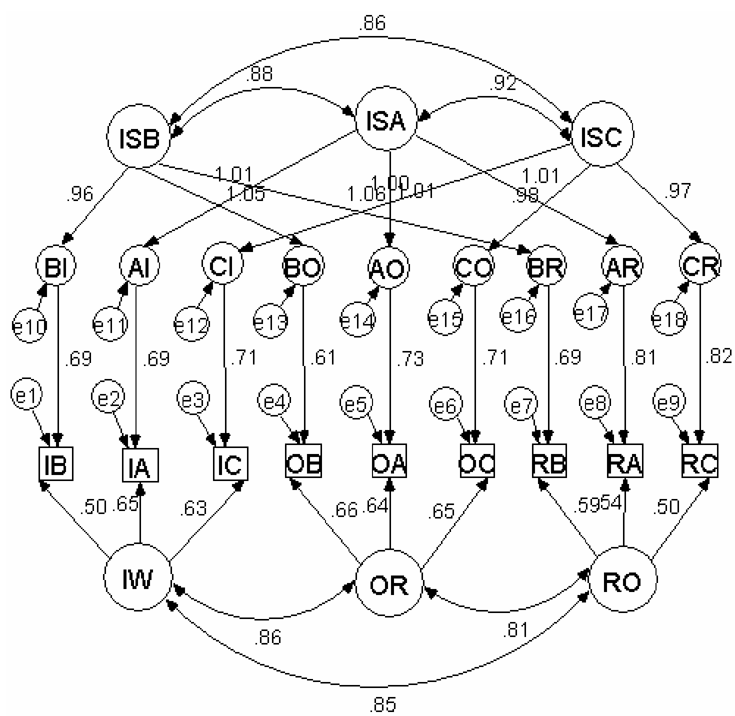


Figure 6.5: **ISIR Multilevel Measurement Model**

<u>External Component</u>

The external component of ISIR construct validity concerns the empirical connections between the ISIR construct and other theoretically-related constructs. Generally speaking, there are three types of constructs that have theoretical connections with ISIR: ISIR antecedents, personal factors and situational factors. ISIR antecedents include Sense of Control (SC), Perceived Understanding (PU) and Motive Fulfillment (MF). Personal factors include Locus of Control (LOC), Computer Anxiety (CA) and Computer Playfulness (CP). Situational Factors include task Self-efficacy (SE), Interest (INT), Importance (IMP) and Tension (TEN). Table 6.5 reports the coefficient α's for these constructs except the objectively-measured MF.

Table 6.5: **Reliability Analysis for Other Measures**

| Category | Construct | Items | Coefficient α |
|---|---|---|---|
| ISIR Antecedents | Sense of Control (SC) | 3 | .8508 |
| | Perceived Understanding (PU) | 17 | .9538 |
| Personal factors | Locus of Control (LOC) | 11 | .6625 |
| | Computer Anxiety (CA) | 9 | .8982 |
| | Computer Playfulness (CP) | 7 | .8858 |
| Situational Factors | Self-efficacy (SE) | 4 | .8963 |
| | Interest (INT) | 4 | .8615 |
| | Importance (IMP) | 4 | .7851 |
| | Tension (TEN) | 4 | .8646 |

Unlike the personal and situational factors that comprise the nomological network with ISIR, ISIR antecedents have causal relationships with ISIR. The Multiple Indicators/Multiple Causes (MIMIC) model shown in Figure 6.6 depicts that a user's experiences with a specific system in the form of ISIR antecedents, primarily SC, PU and MF, directly affect his/her ISIR with the system, indicated by its subconstructs, Input Willingness (IW), Output Receptivity (OR) and Rule Observance (RO). Because index scores are fitted to the model, 'I' for "index" was put at the end of each acronym. This model exhibited an acceptable goodness-of-fit ($\chi^2$ = 2.695; $\chi^2/df$ = .674; RMR= .012; TLI =1.003; CFI = 1.000; RMSEA= .000) and all regression weights were significant at the 0.01 level.

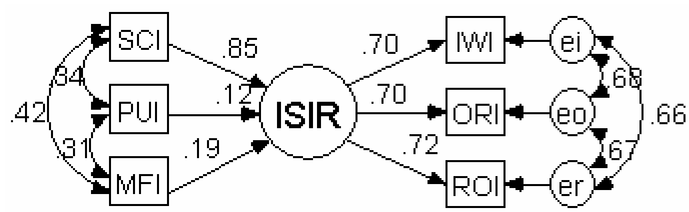


Figure 6.6: **Fitted MIMIC Model of ISIR Antecedents**

Because of its equivalence to Canonical Correlation Analysis (CCA), the MIMIC model can be used to test the significance of canonical correlation functions between ISIR antecedents and ISIR subconstructs. The MIMIC model in Figure 6.6 is equivalent to the first-order canonical correlation, and its significance can be tested with the null model with all paths to and from ISIR constrained to be zero. Figure 6.7 shows the fitted null model of which the chi-square statistic was 365.213. The second-order canonical correlation function is equivalent to a MIMIC model with two latent variables between two sets of variables. Figure 6.8 shows the fitted second-order model of which the chi-square statistic was .521.

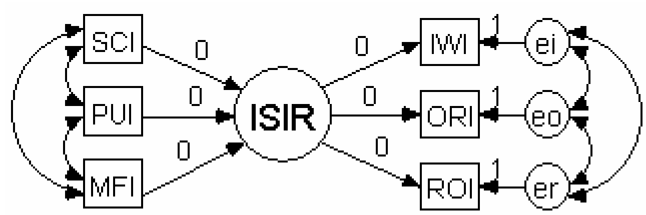


Figure 6.7: **Null MIMIC Model of ISIR Antecedents**

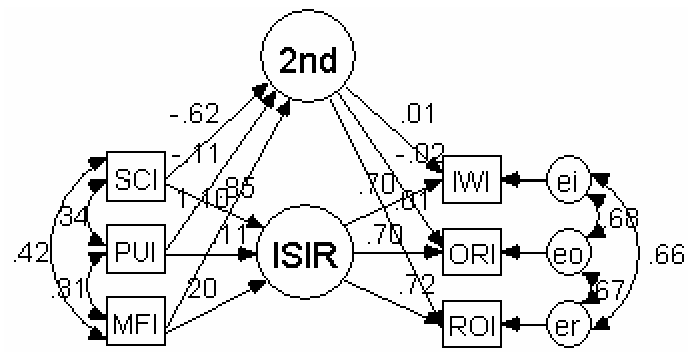


Figure 6.8: **Second-Order MIMIC Model of ISIR Antecedents**

The significance of the first-order canonical correlation and second-order canonical correlation can be tested using the chi-square difference test. In each case, the difference in degrees of freedom was six, and the chi-square statistics were obtained from model fitting. Though a third canonical correlation existed in this case, it was ignorable if the second-order canonical correlation was not significant. Table 6.6 shows the results of chi-square difference tests for the first- and second-order canonical correlation functions.

Table 6.6: **Significance Tests for Canonical Correlation Functions**

| Null Hypothesis | Difference in $\chi^2$ | Difference in *df* | P-value |
|---|---|---|---|
| 1st $r_c$=0 | 362.518 | 6 | <0.001 |
| 2nd $r_c$=0 | 2.174 | 6 | 0.90 (table value) |

The result indicated that the first-order canonical correlation function was significant, but the second-order canonical correlation function was not. Using standard canonical correlation analysis procedures, we obtained the canonical correlation coefficient and the standardized canonical function coefficients for the first canonical correlation (Table 6.7). All canonical function coefficients were significant at the 0.001 level. The square of the canonical correlation coefficient was more than 0.5, indicating that the majority of the covariance between ISIR antecedents and ISIR subconstructs were explained by the first canonical function. The results provided circumstantial evidence for the construct validity of ISIR measurement as having the specified variables as its antecedents and subconstructs.

Table 6.7: **First Canonical Correlation Function of ISIR Antecedents**

| Variable Set and Function | Coefficient |
|---|---|
| ISIR Antecedents | |
| Sense of Control | .7335 |
| Perceived Understanding | .3503 |
| Motive Fulfillment | .4438 |
| ISIR Subconstructs | |
| Input Willingness | .7008 |
| Output Receptivity | .7044 |
| Rule Observance | .7230 |
| Canonical Correlation | |
| Coefficient *r* | 0.752763 |
| *r* Square | 0.566651 |

Finally, it was necessary to examine how well ISIR antecedents mediated the relationships between user direct experiences with a system and ISIR. Because IS capabilities, including interactivity, context-awareness and personalization, facilitate user-system interaction in different ways, user perceptions of these capabilities can be regarded as indicators of their direct experiences. Though a system may not be designed purposefully with one or more of the capabilities in mind, users are still likely to perceive how easily they can work on the information and how well the system is adapted to user contexts and personal needs based on its output. Table 6.8 lists the reliability coefficients of Perceived Interactivity, Perceived Context-Awareness and Perceived Personalization as well as their descriptive statistics for all the tasks in the validation study.

Table 6.8: **Perceived IS Capabilities in the Validation Study**

| Constructs | Coefficient α | Task Form 1 | | Task Form 2 | |
|---|---|---|---|---|---|
| | | Help | Google | Travelocity | CheapTickets |
| Perceived Interactivity | .8995 (6 items) | 3.99 (1.32) | 4.81 (1.32) | 5.47 (1.10) | 5.46 (1.25) |
| Perceived Context-awareness | .8154 (3 items) | 3.91 (1.66) | 4.86 (1.60) | 5.57 (1.14) | 5.53 (1.41) |
| Perceived Personalization | .8767 (3 items) | 3.93 (1.30) | 4.77 (1.45) | 5.49 (1.18) | 5.66 (1.28) |

Note: The total sample size $N = 240$, each cell had a sample size of 60. The descriptive statistics include the means and the standard deviations (in parenthesis) of the index scores. All items were of the 7-level Likert scale type.

Figure 6.9 shows the fitted multi-level model (standardized) for the testing the mediating effects of ISIR antecedents on the relationship between ISIR and user perceptions of IS capabilities. The goodness-of-fit for the within-level model was at an acceptable level ($\chi^2/df = 2.818$; RMR= .296; TLI =.865; CFI = .900; RMSEA= .124), indicating that the structure model was generally sufficient. Some fit indices, especially TLI (preferably >.90) and RMSEA (preferably <.08), did not meet the rule-of-thumb thresholds, but this might be due to the relatively small sample size ($N$=120) and relatively large number of indicators (13 indicators) at the within-subject level.

To test whether there were significant confounding effects, additional direct paths were added from the perceived capabilities to ISIR at the within-subject level (not shown in this figure). None of these direct paths were significant (see Table 6.9), indicating that the effects of direct user experience on ISIR are indeed mediated through the ISIR antecedents.

Also, we tested the effect of task setting on ISIR by freeing the path between Task Form (FORM) and ISIR at the between-subject level. The path coefficient was significant at 0.05 level, indicating that participants who were in different task settings (Excel problem solving and travel planning) had different levels of ISIR towards the systems they had interacted with. This finding provided supporting evidence that ISIR is not only a system- and user-specific construct, but also a context-dependent construct.

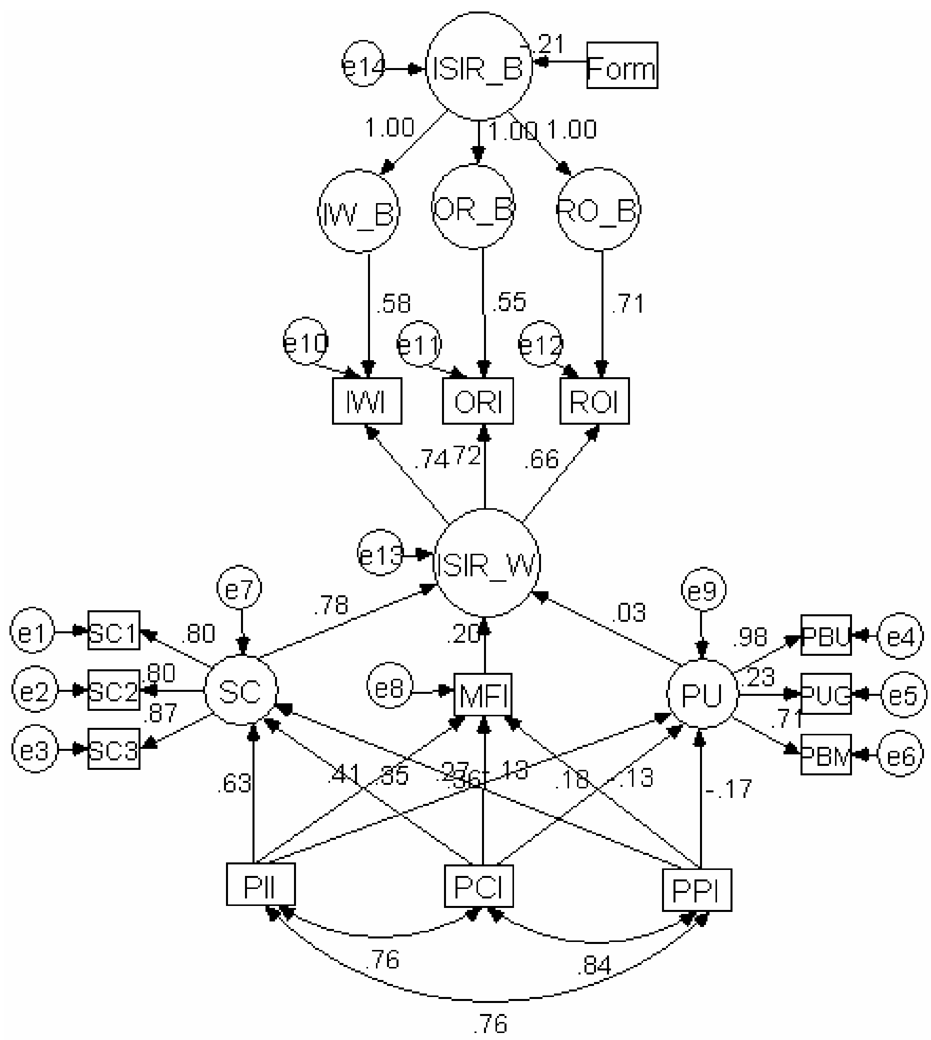


Figure 6.9: **Perceived IS Capabilities and ISIR**

Table 6.9: **Mediated Effects of Perceived IS Capabilities on ISIR**

| Level | Constructs | Path | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Within | Perceived Interactivity | SC <--- PII | .449 | .077 | 5.871 | *** |
| | | MFI <--- PII | .482 | .137 | 3.509 | *** |
| | | PU <--- PII | .257 | .140 | 1.836 | .066 |
| | Perceived Context-awareness | SC <--- PCI | .211 | .071 | 2.962 | .003 |
| | | MFI <--- PCI | .349 | .136 | 2.571 | .010 |
| | | PU <--- PCI | .141 | .139 | 1.019 | .308 |
| | Perceived Personalization | SC <--- PPI | -.085 | .080 | -1.074 | .283 |
| | | MFI <--- PPI | -.139 | .154 | -.903 | .367 |
| | | PU <--- PPI | -.150 | .158 | -.951 | .341 |
| | Direct Paths* | ISIR_W <--- PII | .112 | .084 | 1.335 | .182 |
| | | ISIR_W <--- PCI | -.059 | .071 | -.832 | .405 |
| | | ISIR_W <--- PPI | .090 | .073 | 1.220 | .222 |
| | ISIR Antecedents | ISIR_W <--- SC | .822 | .094 | 8.748 | *** |
| | | ISIR_W <--- PU | .026 | .043 | .595 | .552 |
| | | ISIR_W <--- MFI | .132 | .040 | 3.316 | *** |
| | Sense of Control | SC1 <--- SC | 1.000 | | | |
| | | SC2 <--- SC | 1.130 | .117 | 9.687 | *** |
| | | SC3 <--- SC | 1.186 | .110 | 10.812 | *** |
| | Perceived Understanding | PBU <--- PU | 1.000 | | | |
| | | PBM <--- PU | .846 | .214 | 3.948 | *** |
| | | PUG <--- PU | .276 | .126 | 2.196 | .028 |
| | ISIR-Within | IWI <--- ISIR_W | 1.000 | | | |
| | | ROI <--- ISIR_W | .951 | .056 | 17.007 | *** |
| | | ORI <--- ISIR_W | 1.038 | .074 | 14.046 | *** |
| Between | Task Form | ISIR_B <--- Form | -.148 | .073 | -2.029 | .042 |
| | ISIR-Between | IW_B <--- ISIR_B | 1.000 | | | |
| | | OR_B <--- ISIR_B | 1.019 | .102 | 9.945 | *** |
| | | RO_B <--- ISIR_B | 1.300 | .096 | 13.557 | *** |

Note: * - The direct paths are not shown on Figure 6.9.
*** indicates that the regression weight for the path is significantly different from zero at the .001 level (two-tailed).

The regression weights reported in Table 6.9 indicate that Perceived Interactivity (PI) has the strongest effects on ISIR antecedents and Perceived Personalization (PP) has the weakest effects on ISIR antecedents.  This is expected because interactivity is the primary IS capability that directly facilitates user-system interaction by making it easy for users to work with information, while context-awareness and personalization are the secondary capabilities that facilitate user-system interaction indirectly through adapting the system to user task contexts and personal preferences, respectively. Perceived Context-Awareness (PC) exhibits a stronger effects on ISIR antecedents than Perceived Personalization (PP) because user contexts are more closely related to user motives that drive user-system interaction than are personal preferences in most cases.

How ready a person is to interact with a system, directly subject to user experiences, is also likely to be affected by personal and situational factors. Among these variables, System Experience (EXP) is system-specific and others are person-specific or task-specific. To test the nomological network between ISIR and these variables, it is necessary to conduct a multilevel analysis. The system-specific variable EXP would be loaded to the within-level ISIR construct and the individual-specific variables would be loaded to the between-level ISIR construct.

To avoid the interference among the variables, we conducted separate analysis on the variables that are related to the setting, personal factors, and situational factors. As a system-specific personal factor, System Experience was loaded to ISIR at the within-subject level for all the models. The setting variables include Gender and the Task Form that the participants had no control over. Figure 6.10 gives the fitted structure model depicting the relationship between ISIR and the setting variables. All regression weights are significant at 0.001 level except that from Gender to between-level ISIR, which has a p-value of .451 (see Table 6.10). This result indicates again that the task setting had significant effects on how ready the participants were to interact with the systems in the study. On the other hand, the Gender effect can be ignored.

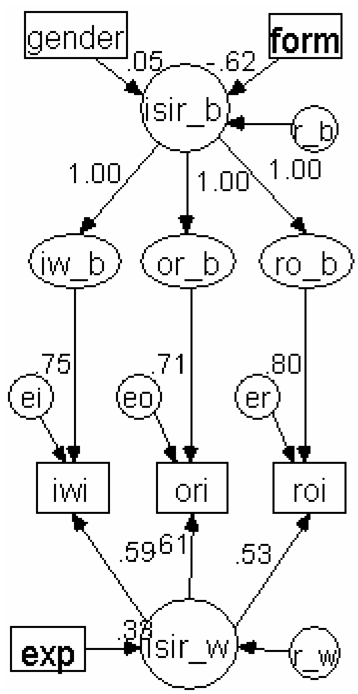


Figure 6.10: **Relationships between Setting Variables and ISIR**

The personal factors except the System Experience, including Locus of Control (LOC), Computer Anxiety (CA) and Computer Playfulness (CP), are all between-level variables. Thus, they were loaded to ISIR at the between-subject level in the structure model. Previous studies have found that CA and CP are negatively correlated with each other, and so their correlation was freed to be estimated. Figure 6.11 shows the fitted structure model depicting the relationships. The results in Table 6.10 indicated that users' previous experience with a system had significant effects on ISIR toward the same system (p-value <0.001). Among all the personal factors at the between-subject level, only CA had a significant effect on ISIR (p-value=.004), but LOC (p-value=.893) and CP(p-value=.297) did not (see Table 6.10). Though CP and CA were found to be significantly correlated as expected (*r*=-.54; p-value <0.001), CP did not have a significant effect on ISIR (the path coefficient was even negative). The effect of LOC on ISIR was ignorable, suggesting that this general personality construct is not particularly pertinent to IS user behavior.

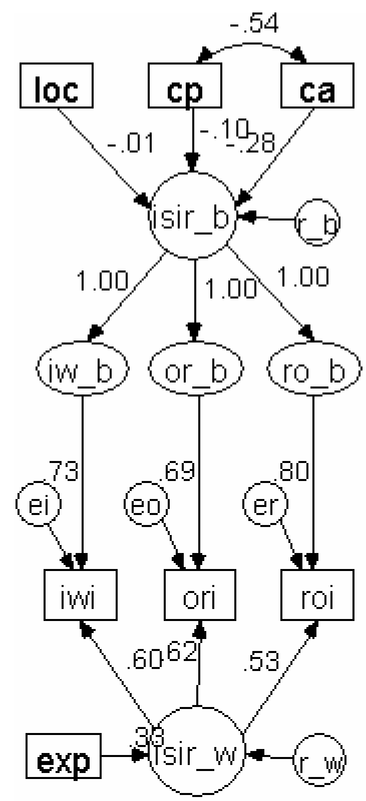


Figure 6.11: **Relationships between Personal Factors and ISIR**

The situational factors, including task Self-efficacy (SE), Interest (INT), Importance (IMP) and Tension (TEN), are related to a task in general rather than a specific system. Measured at the end of study after the participants had interacted with both systems in the study, these variables were all at the between-subject level. Unlike the personal factors that were measured at the beginning in the pretest questionnaire and were supposed to remain stable, these situational factors were likely to be related to the specific user experiences during the study. Thus, there might be two channels through which they can affect ISIR at the within-subject level, through the between-level ISIR and through the ISIR antecedents at both the between- and within-subject levels.

First, all the situational factors were loaded to the between-level ISIR in the structure model as previously done for personal factors. As mentioned in Chapter IV, INT and IMP, IMP and TEN, and TEN and SE are likely to be correlated with one another. Figure 6.12 shows the fitted structural model depicting the relationships between situational factors and between-level ISIR. Among these, all are significant except the relationship between task importance/effort (IMP) and between-level ISIR (see table 6.10). Though IMP does not have a direct effect on between-level ISIR, it may have effects on the within-level ISIR though the mediation of ISIR antecedents at both levels. The same mediation effects may be applicable to the other situational factors, as discussed subsequently.

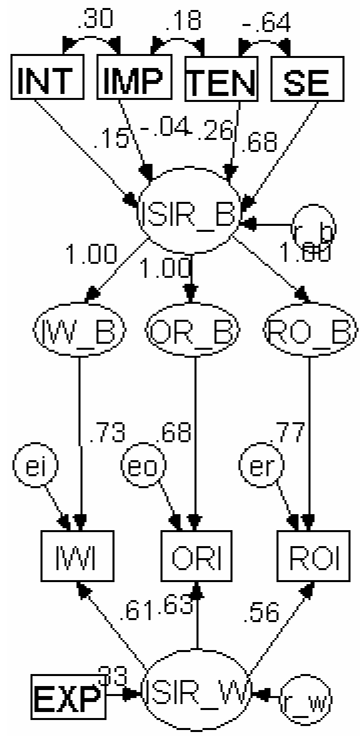


Figure 6.12: **Relationships between Situational Factors and ISIR**

Rather than having direct effects on between-level ISIR, situational factors are likely to have mediated effects on within-level ISIR through ISIR antecedents at both levels. To take the mediation effects into account, it is necessary to include the ISIR antecedents in the structure model. Because of the close relationship between Sense of Control and Self-Efficacy, Task Self-efficacy is likely to affect Sense of Control at the between-subject level. Because Tension and Effort are related to one's task performance, they may together have a significant effect on the between-level Motive Fulfillment. Finally, Task Interest may be significantly related to Perceived Understanding at the between-subject level because they are all affective constructs related to the mutuality involved in user-system interaction. If a person is interested in the tasks, he/she is likely to care whether the systems understands him/her. On the other hand, if a person is not interested in the tasks, he/she is likely to be indifferent to whether the systems understand him/her or not.

Table 6.10: **Testing of ISIR Nomological Network**

| Category | Variables | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|
| Setting | Task Form (FORM) | -.676 | .081 | -8.354 | *** |
| | Gender | .059 | .078 | .754 | .451 |
| Personal | System Experience* (EXP) | .120 | .031 | 3.920 | *** |
| | Computer Playfulness (CP) | -.046 | .044 | -1.043 | .297 |
| | Computer Anxiety (CA) | -.126 | .043 | -2.910 | .004 |
| | Locus of Control (LOC) | -.007 | .054 | -.134 | .893 |
| Situational (Task-related) | Self-Efficacy (SE) | .242 | .029 | 8.326 | *** |
| | Interest (INT) | .059 | .025 | 2.403 | .016 |
| | Importance/Effort (IMP) | -.015 | .027 | -.571 | .568 |
| | Tension (TEN) | -.089 | .028 | -3.252 | .001 |

Note: * - System Experience is at the within-subject level and others are at the between-subject level.
*** indicates that the regression weight for the path is significantly different from zero at the .001 level (two-tailed).

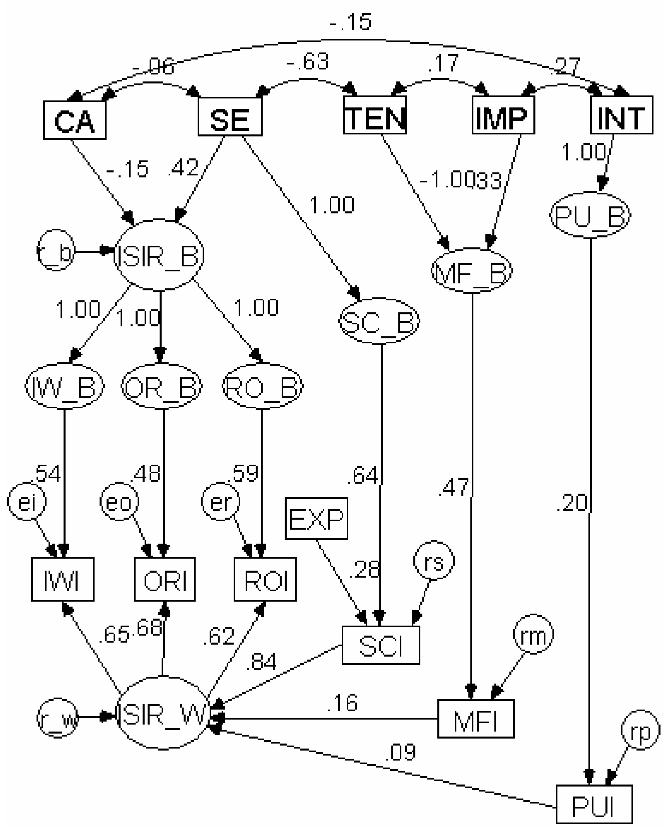


Figure 6.13: **Multilevel Model of Personal and Situational Factors**

Figure 6.13 shows the final structure model depicting the direct and mediated relationships between ISIR and situational variables. Because of the possible relationships between personal factors and ISIR antecedents as well as situational factors, the significant personal factor, System Experience (EXP) and Computer Anxiety (CA) were also included. EXP is likely to have significant effect on Sense of Control (SC) because a person who is familiar with a system is likely to know what to do and feel at control. CA is likely to be correlated with task Interest (INT) and Self-Efficacy (SE) because an individual who is anxious about using computer is not likely to be interested and feel comfortable in a task requiring computer usage. As mentioned, SE is related to both the general personality and a specific task. Thus, it is likely to have a direct effect on between-level ISIR as well as the mediated effect on within-level ISIR through SC.

Table 6.11: **Estimates of Parameters for the Model in Figure 6.13**

| Level | Variable | Path | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Between | Interest | PU_B<--- INT | .071 | .024 | 2.998 | .003 |
| | Tension | MF_B<--- TEN | -.247 | .031 | -8.003 | *** |
| | Importance | MF_B<--- IMP | .096 | .037 | 2.587 | .010 |
| | Self-efficacy | SC_B<--- SE | .312 | .024 | 12.825 | *** |
| | | ISIR_B<--- SE | .115 | .020 | 5.703 | *** |
| | Computer Anxiety | ISIR_B<--- CA | -.052 | .025 | -2.107 | .035 |
| | ISIR | IW_B<--- ISIR_B | 1.000 | | | |
| | | OR_B<--- ISIR_B | .913 | .068 | 13.370 | *** |
| | | RO_B<--- ISIR_B | 1.103 | .065 | 16.934 | *** |
| | Covariances | CA<-->INT | -.453 | .197 | -2.304 | .021 |
| | | CA<-->SE | -.203 | .169 | -1.196 | .232 |
| | | SE<-->TEN | -2.769 | .339 | -8.175 | *** |
| | | TEN<-->IMP | .660 | .193 | 3.419 | *** |
| | | INT<-->IMP | .911 | .220 | 4.138 | *** |
| Within | Experience | SCI<--- EXP | .168 | .036 | 4.675 | *** |
| | ISIR Antecedents | ISIR_W<--- SCI | .567 | .038 | 15.039 | *** |
| | | ISIR_W<--- PUI | .095 | .036 | 2.609 | .009 |
| | | ISIR_W<--- MFI | .097 | .025 | 3.916 | *** |
| | ISIR | IWI<--- ISIR_W | 1.000 | | | |
| | | ORI<--- ISIR_W | 1.081 | .071 | 15.206 | *** |
| | | ROI<--- ISIR_W | .971 | .060 | 16.141 | *** |

Note: *** indicates that the regression weight for the path is significantly different from zero at the .001 level (two-tailed).

Table 6.11 gives the estimates of relevant parameters and all were significant at the 0.05 level except for the covariance between Computer Anxiety (CA) and Self-Efficacy (SE). The results indicated that through the mediation of between-level ISIR and ISIR antecedents, the situational and personal factors had significant effects on within-level ISIR. The results provided some evidence for the direct and mediated relationships between ISIR and personal and situational factors as posited above.

*Predictive Validity*

The criterion events for testing the predictive validity of ISIR instrument are the behavioral consequences of ISIR, including: 1) user choice between an IS approach and a non-IS approach; 2) user choice among IS options;  and 3) user persistence in interacting with a specific system. The marks on the first two criterion events were self-reported by the participants in the form of choice among two IS options and one non-IS approach. The marks on the third criteria event were calculated from user performance logs. To serve as a benchmark, Technology Acceptance Model (TAM) constructs were used to predict the same behavioral consequences. Because user choices were categorical data rather than continuous data, logistic regression was adopted as the statistical method because it is more robust when the dependent variables are discrete.

Among the 115 participants for the first task form, 17 (14.78%) selected the non-IS approach. However, among the 114 participants for the second study form, only six (5.26%) selected the non-IS approach. Thus, the first task form was used to examine the predictive validity of ISIR instrument for the first behavioral consequence. We first compared the ISIR summary scores of each participant for both systems to find out which one is higher. Then, we used the index scores of the three attitudinal components for three ISIR subconstructs (for a total of 9 ISIR indexes for each subject) to predict user choices between the IS approach and the non-IS approach. The rationale is that if a user is not ready to use either system, he/she is likely to prefer the non-system approach. The same procedure was taken with TAM subconstructs (Perceived Ease of Use, Perceived Usefulness and Behavioral Intention) to predict user choices. The results shown in Table 6.12 indicated that the ISIR instrument performed better than the TAM instrument in predicting this behavioral consequence. Specifically, ISIR did a much better job of telling whether people would take a non-IS approach than TAM.

Table 6.12: **Prediction of Behavioral Consequences**

| Consequence | User Choice | ISIR Instrument | | | TAM Instrument | | |
|---|---|---|---|---|---|---|---|
| I | Observed / Predicted | Non | IS | % Correct | Non | IS | % Correct |
| | Non-IS approach | 8 | 9 | 47.1 | 1 | 16 | 5.9 |
| | IS approach | 3 | 95 | 96.9 | 1 | 97 | 99.0 |
| | | Overall | | 89.6 | Overall | | 85.2 |
| II | Observed / Predicted | 1st | 2nd | % Correct | 1st | 2nd | % Correct |
| | 1st system | 30 | 4 | 88.2 | 29 | 5 | 85.3 |
| | 2nd system | 3 | 61 | 95.3 | 6 | 58 | 90.6 |
| | | Overall | | 92.1 | Overall | | 88.8 |
| III | Observed / Predicted | N | Y | % Correct | N | Y | % Correct |
| | Not Persistent (N) | 18 | 29 | 38.3 | 17 | 30 | 36.2 |
| | Persistent (Y) | 8 | 115 | 93.5 | 9 | 114 | 92.7 |
| | | Overall | | 78.2 | Overall | | 77.1 |

To make the results comparable with the findings for the first behavioral consequence, results from the same task form (form 1) were used to assess the predictive power of the ISIR instrument on the second behavioral consequence, that is user choices between two IS options. For those who selected the IS approach, we calculated the differences between nine ISIR indexes for the two systems that each subject interacted with, and used the difference scores to predict user choice between the two systems. The rationale is that when a user is more ready to interact with a system, he/she is likely to choose the system later for a similar purpose. The same procedure was adopted for the TAM subconstructs to predict this behavioral consequence. The results shown in Table 6.12 indicated that ISIR subconstructs had somewhat better predictive power than TAM subconstructs for the second behavioral consequence.

Among the 230 cases for the first task form, there were 70 cases (30.43%) in which participants abandoned the task in the middle. However, among the 228 cases for the second study form, there were only two cases (0.88%) in which the participants abandoned the task. Since persistence is not an issue for the second task form, the data from the first task form were used to examine the predictive validity of ISIR instrument for the third behavioral consequence.

Participants who abandoned the task prematurely were considered to be not persistent in interacting with the system. Thus, we found out who abandoned the task within a relatively short period of time, say 10 minutes, and tagged them as not persistent in interacting with the system. Then, we used the nine ISIR indexes to predict who were not persistent. The rationale here is that the people who are not ready to interact with a system are likely to abandon the task prematurely. The same procedure was adopted for TAM subconstructs. The results shown in Table 6.12 indicated that the ISIR instrument did a slightly better job than the TAM instrument in this case.

A close look at the significance tests on predictors for each case indicated that they did not contribute equally well to the prediction (Table 6.13). Specifically, the cognitive component for Input Willingness and the affective and the behavioral (marginally significant) components for Rule Observance predicted the first behavioral consequence (choice between IS and Non-IS approaches) better than the other indexes. On the other hand, all three subconstructs of the TAM instrument were nonsignificant in the prediction of the first consequence. All indices of ISIR contributed evenly to the prediction of the second behavioral consequence (choice between two IS options), and though none of them were significant, the prediction result was the best among the three behavioral consequences. However, Perceived Ease of Use of the TAM instrument was much more salient than other TAM subconstructs in predicting user choices in this case. For the third behavioral consequence (user persistence in interacting with a system) the cognitive component for Input Willingness is a much better predictor that the other eight constructs. This time, Perceived Usefulness of the TAM instrument was the only significant predictor among three subconstructs.

Table 6.13**: Predictors of Behavioral Consequences**

| Instru -ment | Cons. / Index | 1. IS vs. Non-IS | | | 2. IS Options | | | 3. Persistence | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | B. | S.E. | Sig. | B. | S.E. | Sig. | B. | S.E. | Sig. |
| ISIR | IB | -.443 | .503 | .378 | -.183 | .422 | .665 | -.172 | .212 | .417 |
| | IA | -.549 | .763 | .472 | -.603 | .524 | .250 | .363 | .340 | .285 |
| | IC | 2.229 | .763 | .003 | -.864 | .755 | .253 | .611 | .324 | .059 |
| | OB | -.398 | .448 | .374 | -.268 | .413 | .516 | -.370 | .252 | .141 |
| | OA | -.192 | .787 | .808 | -.569 | .995 | .567 | -.030 | .373 | .937 |
| | OC | -.470 | .773 | .544 | -1.018 | .929 | .273 | -.069 | .357 | .848 |
| | RB | -1.120 | .648 | .084 | .155 | .527 | .768 | .377 | .266 | .157 |
| | RA | 2.013 | .963 | .037 | -.300 | .718 | .676 | -.312 | .410 | .446 |
| | RC | 1.338 | .862 | .121 | -.659 | .864 | .446 | .293 | .394 | .458 |
| TAM | PE | .087 | .409 | .831 | -1.342 | .534 | .012 | -.055 | .259 | .832 |
| | PU | .343 | .412 | .406 | -.504 | .498 | .312 | .681 | .266 | .011 |
| | BI | .180 | .366 | .623 | -.636 | .419 | .129 | .052 | .228 | .820 |

Note: I-Input Willingness; O-Output Receptivity; R-Rule Observance; B-Behavioral; A-Affective; C-Cognitive; PE- Perceived Ease of Use; PU – Perceived Usefulness; BI – Behavioral Intention; B.-Slope Estimate; S.E.- Standard Deviation; Sig.- P-value for significance testing.

Table 6.14 gives the results of chi-square tests and the variances explained for using ISIR and TAM scores to predict the three behavioral consequences. Again, the result indicated that ISIR instrument performed much better than the TAM instrument to predict the first behavioral consequence, slightly better for the second and slightly worse for the third. The results of chi-square difference tests indicated that the ISIR instrument did perform much better than the TAM instrument for the first behavioral consequence. But they did not differ much in the prediction of the second and third behavioral consequences.

Table 6.14: **Comparisons of Predictive Power**

| Behavioral Consequence | ISIR Instrument | | | TAM Instrument | | | $\Delta\chi^2$ Test ($df$=6) | |
|---|---|---|---|---|---|---|---|---|
| | $\chi^2$ ($df$=9) | Sig. | $r^2$ | $\chi^2$($df$=3) | Sig. | $r^2$ | $\Delta\chi^2$ | Sig. |
| 1. IS vs. Non-IS | 50.621 | <.001 | .628 | 8.144 | .043 | .120 | 42.477 | <.001 |
| 2. IS Options | 85.392 | <.001 | .802 | 80.345 | <.001 | .772 | 5.047 | .50 |
| 3. Persistence | 33.957 | <.001 | .261 | 35.756 | <.001 | .274 | 1.799 | .95 |

Note: $r^2$ - Nagelkerke R Square; $\Delta\chi^2$ - Chi-square difference.

**Testing of ISIR Research Framework**

This section describes the statistical results obtained from the experimental study to test the ISIR research framework that was described in Chapter IV. First, we report manipulation checks on the experimental treatments. Then, we examined the ISIR measurement model of participants' responses on ISIR instruments. Once the sufficiency of the measurement model was established, the experimental data were fitted to several structure models to test the effects of experimental treatments on ISIR. Finally, the effects of personal and situational factors on ISIR in this setting were examined.

*Experimental Treatments and Perceived IS Capabilities*

In the experimental study, each participant used all the five modes to search for geographical information in a randomly-assigned order. To test the research framework in the experimental study, it is necessary to make sure that the manipulation of experimental treatments had the effects as expected. The Perceived Interactivity, Perceived Context-Awareness and Perceived Personalization scales were used to check whether the participants' perceptions on the experimental treatments were indeed consistent with what was intended. Table 6.15 gives the descriptive statistics of perceived IS capabilities on all the modes.

Table 6.15: **Experimental Treatments and Perceived IS Capabilities**

| Perception | Mode 0 | Mode 1 | Mode 2 | Mode 3 | Mode 4 |
|---|---|---|---|---|---|
| Interactivity | 2.24 (.78) | 3.56 (.95) | 6.15 (.70) | 3.73 (1.05) | 6.39 (.61) |
| Context-awareness | 2.25 (.79) | 3.74 (.94) | 5.43 (.97) | 4.93 (1.07) | 6.18 (.95) |
| Personalization | 3.38 (.40) | 4.86 (.86) | 5.20 (.84) | 5.78 (.76) | 6.04 (.63) |

Note: This table reports Means and Standard Deviations (in parentheses).

As the results in Table 6.15 indicate, the non-interactive, non-context-aware and non-personalized Mode 0 had the lowest scores on Perceived Interactivity, Perceived Context-Awareness and Perceived Personalization. The other four modes are interactive, and their Perceived Interactivity scores were all significantly higher than mode 0. Among the four, Mode 1 was neither context-aware nor personalized, and it had the lowest scores on both Perceived Context-Awareness and Perceived Personalization. Mode 2 was context-aware but not personalized and Mode 3 was personalized but not context-aware and each had relatively high scores on Perceived Context-Awareness or Perceived Personalization as expected. Finally, Mode 4 is interactive, context-aware and personalized, and it had the highest scores on all perceptions. These results suggested that the implementation of experimental treatments were generally valid.

*ISIR Measurement Model*

The ISIR measurement model as shown in Figure 6.14 were fit to the responses of participants on the ISIR instrument. It had an acceptable goodness-of-fit ($\chi^2/df$=6.065; RMR= .793; TLI =.956; CFI= .971; RMSEA= .098), and all regression weights and covariances were significant at 0.001 level. The sufficiency of the ISIR measurement model for the data collected from the experimental study provided some confidence in putting ISIR subconstructs in the structure models later used for testing the effects of experimental treatments as well as situational and personal factors.

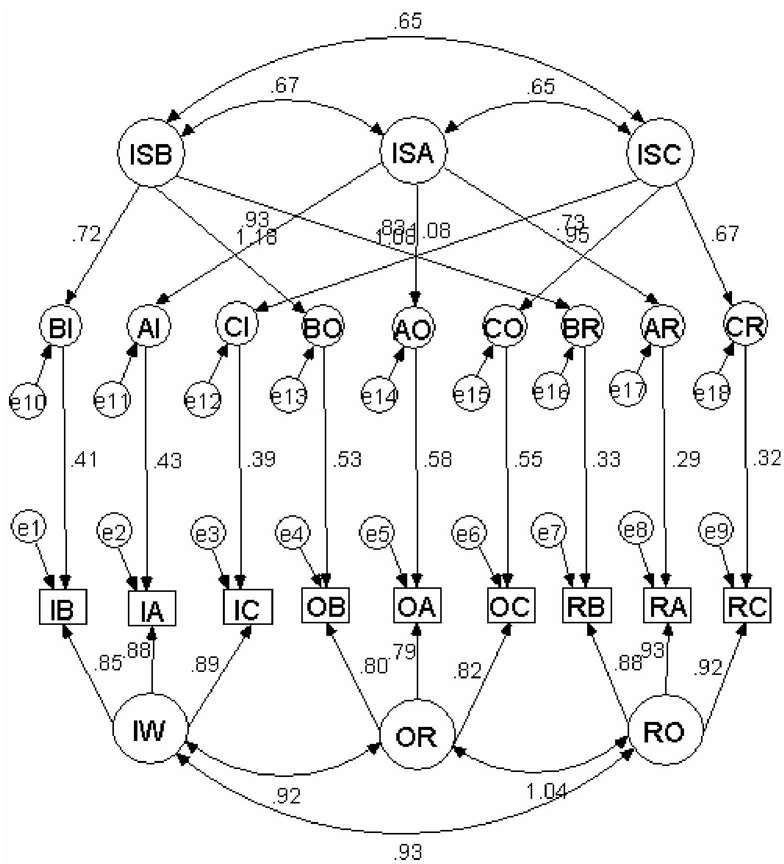


Figure 6.14: **ISIR Measurement Model for the Experimental Study**

*Structure Model for Interactivity*

The structure model for testing the effects of interactivity on ISIR include the experimental treatment Interactivity (ITV) as the independent variable. Psychological constructs except for the Motive Fulfillment (MF) are represented as latent variables. Figure 6.15 shows the fitted model with standardized parameter estimates. The goodness-of-fit for the within-level model was generally acceptable ($\chi^2/df = 2.668$; RMR=.106; TLI=.947; CFI =.961; RMSEA = .126). The non-standardized estimates of relevant parameters as well as their significance tests are included in Table 6.16.

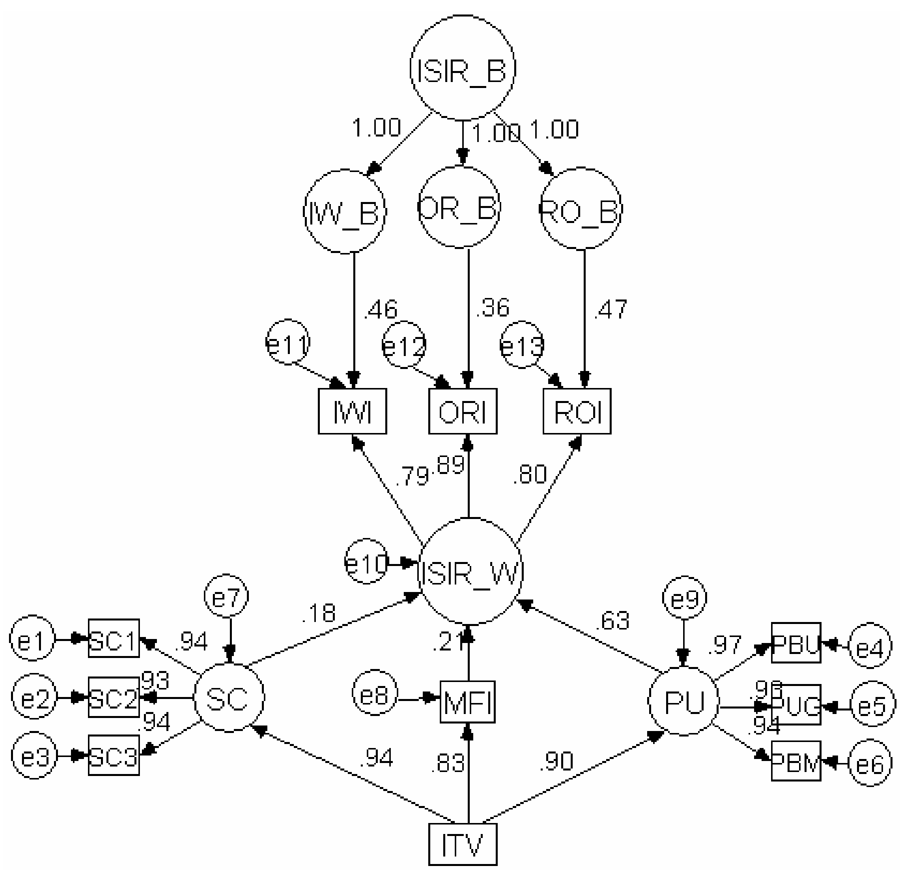


Figure 6.15: **Testing the Effects of Interactivity**

There were altogether 106 participants, and for each there were two data points for this test (Mode 0 and Mode 1). Thus, both the within-level and the between-level sample sizes were 106. The results indicated that Interactivity had significant effects on all three ISIR antecedents, and all ISIR antecedents had significant effects on ISIR. This suggested that Interactivity had significant effects on ISIR through the mediation of the ISIR antecedents. Thus, research hypothesis 1 in the research framework was supported.

Table 6.16: **Estimates of Parameters for the Model in Figure 6.15**

| Level | Variable | Path | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|---|---|
| Within | Interactivity | MFI | <--- | ITV | 1.958 | .127 | 15.429 | *** |
| | | SC | <--- | ITV | 1.953 | .103 | 18.892 | *** |
| | | PU | <--- | ITV | 1.567 | .083 | 18.905 | *** |
| | ISIR Antecedents | ISIR_W | <--- | SC | .105 | .051 | 2.048 | .041 |
| | | ISIR_W | <--- | PU | .431 | .061 | 7.044 | *** |
| | | ISIR_W | <--- | MFI | .105 | .034 | 3.135 | .002 |
| | Sense of Control | SC1 | <--- | SC | 1.000 | | | |
| | | SC2 | <--- | SC | 1.036 | .057 | 18.206 | *** |
| | | SC3 | <--- | SC | 1.000 | .054 | 18.534 | *** |
| | Perceived Understanding | PBU | <--- | PU | 1.000 | | | |
| | | PBM | <--- | PU | 1.043 | .045 | 23.401 | *** |
| | | PUG | <--- | PU | 1.120 | .053 | 21.276 | *** |
| | ISIR-Within | IWI | <--- | ISIR_W | 1.000 | | | |
| | | ORI | <--- | ISIR_W | 1.241 | .078 | 15.995 | *** |
| | | ROI | <--- | ISIR_W | 1.055 | .075 | 14.121 | *** |
| Between | ISIR-Between | IW_B | <--- | ISIR_B | 1.000 | | | |
| | | OR_B | <--- | ISIR_B | .852 | .131 | 6.528 | *** |
| | | RO_B | <--- | ISIR_B | 1.060 | .158 | 6.696 | *** |

Note: *** indicates that the regression weight for the path is significantly different from zero at the .001 level (two-tailed).

*Structure Model for Context-awareness and Personalization*

The structure model for testing the effects of interactivity on ISIR included the experimental treatments Context-Awareness (CON), Personalization (PER) and their interaction term (CxP) as the independent variables. Because there were four sets of data for each participant corresponding to mode 1 through mode 4, the total number of data points at the within-subject level (*n*=318) was triple that of the test of Interactivity (*n*=106). To avoid the problem of having too much power in testing the effects of Context-Awareness and Personalization, half of the data points were selected from the dataset by using the odd numbers of user ID. Thus, the within-level sample size was 159 and the between-level sample size was 53. Figure 6.16 shows the fitted model with standardized parameter estimates. The goodness-of-fit for the within-level model was generally acceptable ($\chi^2/df$ = 2.912; RMR=.056; TLI=.948; CFI =.963; RMSEA = .110). The non-standardized estimates of relevant parameters are reported in Table 6.17. The model were fit to the other half of data points and similar results were observed.

Compared with the similar model in the pilot study, both structure models here in the experimental study had several parameters that had significantly different estimates. The major distinctions were the strengths of Sense of Control and Perceived Understanding in two studies. While Sense of Control had a dominant effect on ISIR in the validation study, Perceived Understanding had a dominant effect on ISIR in the experimental study. The possible explanation is that systems that the participants interacted with in validation studies were different systems in the real world, and they had different interface design. The difference in interactivity may have caused significant difference in Sense of Control. However, the systems that participants interacted with in the experimental study had similar interface design, and the major variation was in the interaction rules and information technology implementation. This variation may have had significant effects on Perceived Understanding.

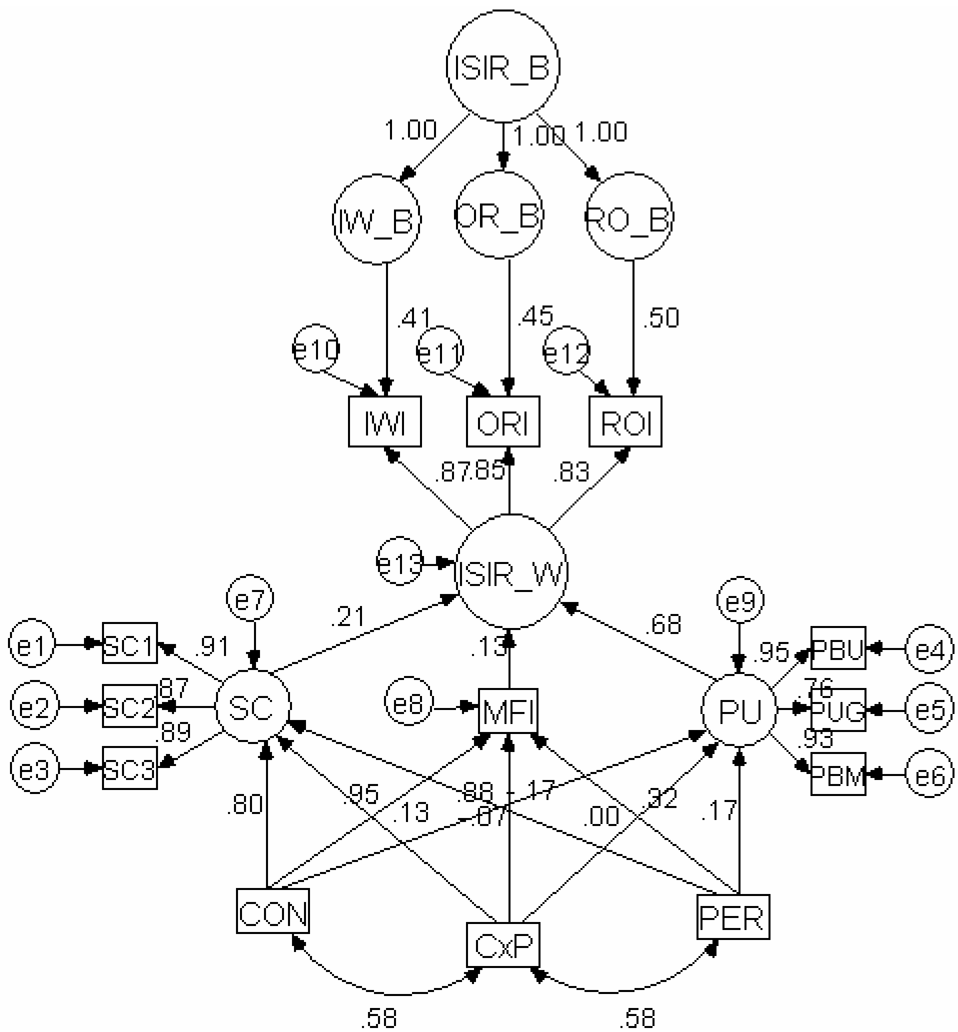


Figure 6.16: **Testing the Effects of Context-Awareness and Personalization**

Table 6.17: **Estimates of Parameters for the Model in Figure 6.16**

| Level | Variable | Path | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|---|
| Within | Context-awareness | SC <--- | CON | 1.653 | .136 | 12.169 | *** |
| | | PU <--- | CON | 1.643 | .107 | 15.293 | *** |
| | | MFI <--- | CON | 1.929 | .070 | 27.478 | *** |
| | Personalization | SC <--- | PER | -.348 | .127 | -2.753 | .006 |
| | | PU <--- | PER | .323 | .103 | 3.142 | .002 |
| | | MFI <--- | PER | .643 | .070 | 9.154 | *** |
| | Context-awareness × Personalization | SC <--- | CxP | .318 | .178 | 1.783 | .075 |
| | | PU <--- | CxP | .006 | .144 | .039 | .969 |
| | | MFI <--- | CxP | -.155 | .099 | -1.561 | .119 |
| | ISIR Antecedents | ISIR_W <--- | SC | .165 | .042 | 3.949 | *** |
| | | ISIR_W <--- | PU | .584 | .060 | 9.668 | *** |
| | | ISIR_W <--- | MFI | .104 | .050 | 2.094 | .036 |
| | Sense of Control | SC1 <--- | SC | 1.000 | | | |
| | | SC2 <--- | SC | .918 | .057 | 16.071 | *** |
| | | SC3 <--- | SC | .966 | .057 | 17.054 | *** |
| | Perceived Understanding | PBU <--- | PU | 1.000 | | | |
| | | PBM <--- | PU | .955 | .040 | 23.631 | *** |
| | | PUG <--- | PU | .869 | .064 | 13.530 | *** |
| | ISIR-Within | IWI <--- | ISIR_W | 1.000 | | | |
| | | ORI <--- | ISIR_W | 1.085 | .039 | 28.003 | *** |
| | | ROI <--- | ISIR_W | 1.076 | .038 | 28.290 | *** |
| Between | ISIR-Between | IW_B <--- | ISIR_B | 1.000 | | | |
| | | OR_B <--- | ISIR_B | 1.019 | .102 | 9.945 | *** |
| | | RO_B <--- | ISIR_B | 1.300 | .096 | 13.557 | *** |

Note: *** indicates that the regression weight for the path is significantly different from zero at the .001 level (two-tailed).

The results indicated that Context-Awareness and Personalization had significant effects on all three ISIR antecedents. The directions of effects were as expected: all had positive effects except that Personalization had a negative effect on Sense of Control. The interaction term did not have significant effects on any ISIR antecedents. All ISIR antecedents had significant effects on ISIR. Thus, the research hypotheses 2 and 3 in the research framework were supported: Context-Awareness has significant effects on ISIR through the mediation of the ISIR antecedents, and Personalization has mixed effects on ISIR because it weakens a user's Sense of Control.

*Check for Confounding Effects*

To make sure that the IS capabilities had effects on ISIR through the mediation of ISIR antecedents rather than through other factors, we checked for possible confounding effects. As mentioned, confounding effects can be examined by adding a direct path from independent variables to dependent variables bypassing the mediators in between. Figure 6.17 gives the model for testing the confounding effect of Interactivity, and the confounding effects of Context-Awareness and Personalization were tested in the same way. The results reported in Table 6.18 indicated that there were no significant confounding effects suggesting that IS capabilities affect ISIR through ISIR antecedents.

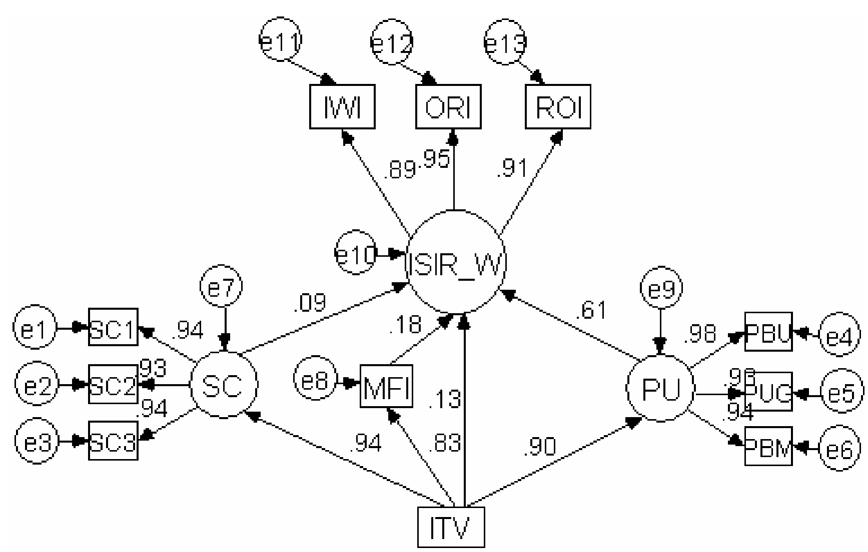


Figure 6.17: **Testing the Confounding Effects of Interactivity**

Table 6.18: **Confounding Effects of IS Capabilities**

| Variable | Path | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|
| Interactivity | ISIR_W <--- ITV | .154 | .198 | .776 | .437 |
| Context-awareness | ISIR_W <--- CON | .220 | .174 | 1.265 | .206 |
| Personalization | ISIR_W <--- PER | .003 | .049 | .061 | .952 |

*Personal and Situational Factors*

Similarly to what we have done in the validation study, we fit the model in Figure 6.18 to the data obtained from the experimental study and the results are reported in Table 6.19. Like the model in validation study, most of the effects of personal and situation factors were significant as posited except the effect of System Experience (EXP) and Tension (TEN). Unlike what was found in the validation study, System Experience in the experimental study did not have a significant effect on ISIR through Sense of Control. This may be due to the fact that the experimental study used simulated mobile GIS systems that no participants had actual experiences with before the study. Thus, user experiences with mobile information systems such as text messaging and on-line gaming through cell phones that were measured in the study were not directly related to the systems they would interact with in the study. This gap may explain the lack of connection between System Experience and ISIR.

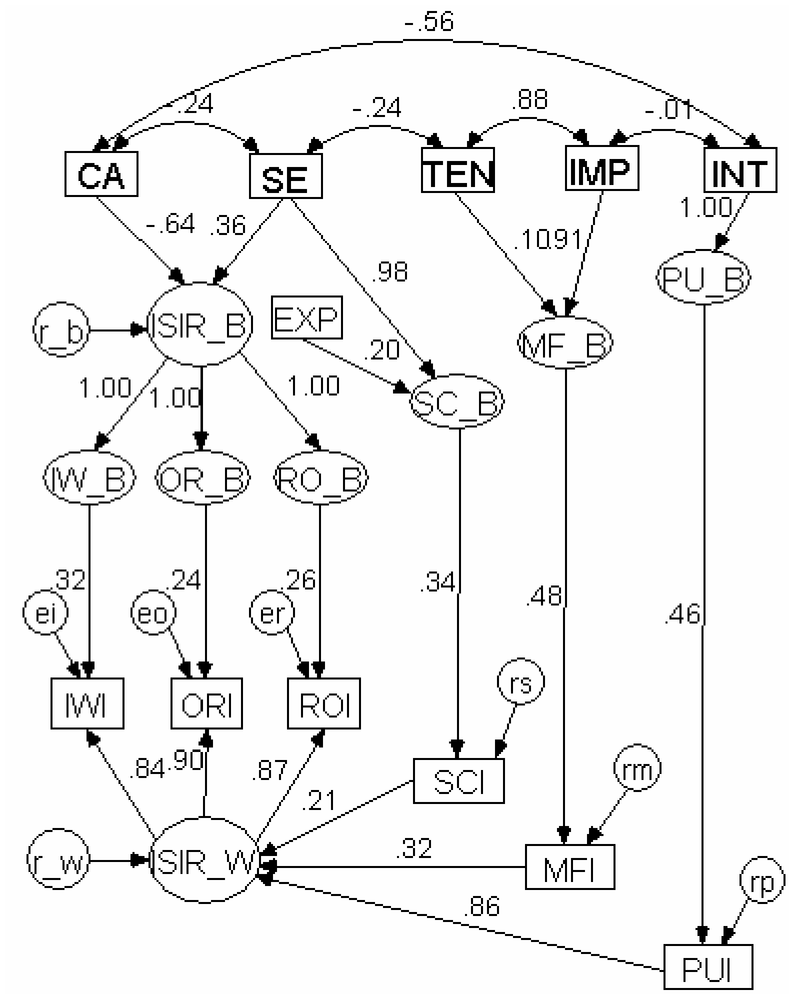


Figure 6.18: **Testing the Effects of Personal and Situational Factors**

Tension did not have a significant effect on Motive Fulfillment at the between-subject level. A comparison between the tasks (solving Excel problems and finding travel deals) in the validation study and the task (searching for a facility nearby) in the experimental study found that the tasks in the validation study involved more problem solving while the task in the experimental study involved more exploration. Thus, the tasks in the validation study were more extrinsically motivated and the task in the experimental study was more intrinsically motivated. Though this may not be an direct evidence for part of the research hypothesis 7 which posits that the Tension may have negative effects on ISIR only when the task is driven by extrinsic motivations, it provided some circumstantial evidence.

Table 6.19: **Estimates of Parameters for the Model in Figure 6.18**

| Level | Variable | Path | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Between | ISIR-Between | IW_B<--- ISIR_B | 1.000 | | | |
| | | OR_B<--- ISIR_B | .750 | .126 | 5.950 | *** |
| | | RO_B<--- ISIR_B | .786 | .139 | 5.662 | *** |
| | Computer Anxiety | ISIR_B<--- CA | -.045 | .010 | -4.615 | *** |
| | Experience | SC_B<--- EXP | .021 | .027 | .767 | .443 |
| | Self-Efficacy | ISIR_B<--- SE | .056 | .022 | 2.617 | .009 |
| | | SC_B<--- SE | .245 | .066 | 3.695 | *** |
| | Importance | MF_B<--- IMP | .122 | .051 | 2.405 | .016 |
| | Interest | PU_B<--- INT | .402 | .075 | 5.388 | *** |
| | Tension | MF_B<--- TEN | .019 | .075 | .256 | .798 |
| | Covariances | CA<-->SE | -.638 | .197 | -3.234 | .001 |
| | | SE<-->TEN | -.517 | .108 | -4.804 | *** |
| | | CA<-->INT | -1.276 | .248 | -5.151 | *** |
| | | INT<-->IMP | -.037 | .097 | -.386 | .700 |
| | | TEN<-->IMP | 5.204 | .752 | 6.917 | *** |
| Within | ISIR Antecedents | ISIR_W<--- SCI | .121 | .012 | 10.354 | *** |
| | | ISIR_W<--- MFI | .173 | .012 | 14.607 | *** |
| | | ISIR_W<--- PUI | .475 | .014 | 33.670 | *** |
| | ISIR-Within | IWI<--- ISIR_W | 1.000 | | | |
| | | ORI<--- ISIR_W | 1.085 | .027 | 40.004 | *** |
| | | ROI<--- ISIR_W | 1.012 | .028 | 36.273 | *** |

Note: *** indicates that the regression weight for the path is significantly different from zero at the .001 level (two-tailed).

Also, a strong correlation was identified between Computer Anxiety and Self-Efficacy. This can be explained that in the experimental study, participants who were less anxious about using computers felt more confidence in interacting with the systems. In the validation study, however, this relationship was found to be insignificant. This may be due to the fact that task in the validation study involved problem solving that distinguished task self-efficacy from computer self-efficacy, the latter related to Computer Anxiety. However, the task in the experimental study involved exploration that did not distinguish the two types of self-efficacy, and thus task Self-Efficacy was strongly correlated with Computer Anxiety.

Together with the results obtained from the validation study, the above results obtained from the experimental study tested the nomological network posited in research hypotheses 4-7 in the ISIR research framework. Except for the Locus of Control and Computer Playfulness, other personal and situational factors were found to have relationships with ISIR that were consistent with the research hypotheses in the validation and/or experimental studies. There were a few exceptions but they were explainable.

# CHAPTER VII

# CONCLUSIONS

This dissertation is comprised of a theoretical component and an empirical component. In the theoretical component, we discussed the strengths and problems of current user acceptance research, and proposed the ISIR construct and research model based on Activity Theory. The empirical component consisted of a validation study which examined the validity of the ISIR instrument and an experimental study, which tested the effects of IS capabilities on ISIR through its antecedents. Both studies were conducted in laboratory setting. Undergraduate students at Texas A&M University were used as experimental subjects.

This chapter provides a summary of the theoretical framework proposed in this dissertation and the related empirical results. After the summary, it gives a list of the theoretical and pragmatic contributions of the study, as well as a consideration of the limitations of this research and their implications for future research.

## Summary

The review of user acceptance research stream indicated that there was a necessity to overcome the theoretical problems underlying this stream due to its primary grounding in the social psychological paradigm. To this end, the ISIR construct and framework were developed under one of the paradigms of the human-computer interaction research stream, Activity Theory. Taking human activity rather than singular action as the unit of analysis, Activity Theory enables researchers to take mediated relationships and user contexts into account when they study IS user behavior.

The development of the ISIR construct and framework took previous user acceptance research as the reference point. The approach of developing an intermediate construct that mediates previous experiences of users with IS and future behavior is consistent with the general approach of the user acceptance research stream. Also, the ISIR framework include some constructs, especially personal factors, that have been identified to be relevant to IS user behavior in user acceptance models.

The ISIR measure provides a lens to look at user attitude toward interacting with IS at different levels. At the activity level, it measures ISIR subconstructs, Input Willingness, Output Receptivity and Rule Observance, that are related to how ready users are to take part in different mediated actions involved in interacting with IS. At the action level, the instrument looks into user attitudinal components for each of the mediated actions, including affective, cognitive and behavioral components. At the operation level, the instrument provide information about users' specific feelings and beliefs about direct experience with (input) interface, output (interface), and interaction rules. This multiple-level view provides a comprehensive understanding of users' attitude toward interacting with IS.

The results obtained from the validation study provided some supporting evidence for the content, construct and predictive validity of the ISIR instrument. Specifically, the high internal item response consistencies at different levels indicated that the items are measuring the same psychological construct. The moderately high correlation between the scores on the ISIR instrument and the scores on the Technology Acceptance Model (TAM) instrument suggested that ISIR instrument measured what it is purported to measure. These findings provided circumstantial evidence for the internal and external components of content validity.

We also examined the structural and external components of construct validity, which focus on the pattern of responses to the items of ISIR instrument and the relationships between ISIR and other constructs respectively. The confirmatory factor analysis conducted on user responses to the ISIR instrument with various measurement models showed that the factorial structure of ISIR instrument as theorized was consistent with the user responses. The analyses using multi-indicator multi-causes (MIMIC) and canonical correlation analysis (CCA) on ISIR subconstructs and ISIR antecedents (Sense of Control, Perceived Understanding, Motive Fulfillment) indicated that these antecedents were correctly identified. The testing of the nomological network between ISIR and personal and situational factors indicated that System Experience, Computer Anxiety, Interest, Importance, Tension and Self-Efficacy were particularly relevant to ISIR. They affect ISIR directly and/or through the mediation of ISIR antecedents.

We assessed the predictive validity of ISIR instrument by comparing its predictive power in terms of three behavioral consequences with the TAM instrument. Specifically, the ISIR instrument performed better than the TAM instrument in predicting the first two behavioral consequences regarding whether the participants would choose the IS approach or the non-IS approach and which IS options they would select if they chose the IS approach. Particularly, ISIR instrument gave a much better prediction for the choice between IS and non-IS approaches. This makes sense, as ISIR taps readiness overall, which encompasses IS and non-IS options both, while TAM only is concerned with reactions to IS. This is a way in which ISIR differentiates itself from TAM.

The ISIR instrument performed at an equivalent level with the TAM instrument in predicting the third behavioral consequence, user persistence in interacting with a system. The criterion event for user persistence in future interaction with a system was not directly observed, but inferred from current participant task performance records (continuance and time). However, user motive fulfillment indicated by task performance is an ISIR antecedent that leads to ISIR formation, and the cause and effect were mixed when ISIR scores were used to "predict" current user persistence. Because of this problem, the results for the third consequence can only serve as a preliminary check.

Another concern is related to the sequence of laboratory procedure. When the participants completed a task in the validation study, they filled out the ISIR instrument at first and then the TAM instrument after. Theoretically speaking, however, TAM constructs are relatively independent of specific task settings. Thus, they should be measured at the beginning of each task before participants actually use the systems, which is likely to lower the predictive power of TAM.

The ISIR research framework hypothesizes that user experiences with IS lead to the formation of ISIR and that personal and situational factors may influence ISIR. Specifically, the framework posited how basic IS capabilities, including Interactivity, Context-Awareness and Personalization, may affect primary user experiences as ISIR antecedents, including Sense of Control, Perceived Understanding and Motive Fulfillment, which shape user readiness to interact with a system.

The statistical analysis using a multi-indicator multi-cause (MIMIC) model and canonical correlation analysis on user responses obtained from the validation study provided supporting evidence that these experiences were indeed the antecedents of ISIR, and they could explain the majority of ISIR variance. The empirical results obtained from the experimental study indicated that IS capabilities had expected effects on ISIR through the mediation of its antecedents. In details, Interactivity and Context-Awareness had positive effects on all three antecedents, and Personalization had positive effects on Perceived Understanding and Motive Fulfillment, but negative effects on Sense of Control. All the paths carrying the effects of IS capabilities onto ISIR were found to be significant.

Part of the remaining variance that ISIR antecedents cannot explain may be explained by personal and situational factors. Personal factors are independent of specific user contexts, and we identified Locus of Control (LOC), Computer Anxiety (CA), Computer Playfulness (CP) and System Experience (EXP) as relevant personal factors based on a review of previous studies of IS user behavior. On the other hand, situational factors are dependent on user contexts, and we identified task Interest (INT), Self-Efficacy (SE), Importance (IMP) and Tension (TEN) as important situational factors based on the review of Self-Determination Theory (SDT) and other IS and non-IS research.

Among the personal factors, Computer Anxiety was found to have a significant negative linear relationship with ISIR as expected in both experimental and validation studies. System Experience was found to have significant positive linear relationship with ISIR as expected in the validation study. Because users did not have direct experience with the system used in the experimental study, the effect of System Experience on ISIR was inconclusive in the experimental study. In neither the validation study nor the experimental study was Computer Playfulness or Locus of Control found to have a significant linear relationship with ISIR.

In summary, the results obtained from both the validation and experimental studies indicated that the ISIR instrument and framework were generally valid and sound. The results provide some confidence in applying the ISIR instrument and framework to study IS user behavior in other settings. In the following sections, we will discuss the theoretical and pragmatic contributions of this study, as well as its limitations and implications for future studies.

## Contributions

Generally speaking, this study made two types of contributions related to the ISIR instrument and the ISIR framework respectively. First, this section discusses how the ISIR instrument may provide researchers and practitioners a better lens to examine IS user predispositions. Then, this section is devoted to the discussion of how the ISIR framework may help researchers and practitioners study the relationship between IS artifacts and user behavior.

*Contributions Related to the ISIR Instrument*

The empirical results concerning the validity of the ISIR instrument indicated an acceptable level of content validity, construct validity and predictive validity. As mentioned, the ISIR instrument provides a multi-level picture of user attitude toward participating in different mediated actions involved in interacting with a systems within a given user context. Compared with other measurement instruments, such as the TAM instrument, the ISIR instrument provides researchers and practitioners comprehensive information about how users are predisposed to interact with specific systems within given contexts.

In particular, the ISIR instrument provides information about user specific feelings and beliefs toward direct operations on mediators, including input (interface), output (interface) and interaction rules. Compared with the secondary evaluations (e.g. favorable and unfavorable) on general constructs (e.g. Perceived Ease of Use and Perceived Usefulness) elicited by other instruments, these specific feelings and beliefs elicited by the ISIR instrument are closely related to user first-hand perceptions.

Theoretically speaking, the closer user responses are related to user direct and specific perceptions, the better. This closeness leads to the accuracy in the elicitation of user responses. Compared with other instruments that measure general constructs, it is less likely for the ISIR instrument to elicit user responses that are secondary or even irrelevant to their real experiences with a system. When user responses are not directly related to user direct and specific perceptions, however, the responses are likely to be influenced by other factors, such as social expectations, leading to the introduction of artificial effects.

Practically speaking, the ISIR instrument provides detailed information about user beliefs and feelings toward specific mediators, including the (input) interface, output (interface) and interaction rules, from user direct experiences with them in interacting with a system. This information is valuable to practitioners who want to check whether the system designs and implementations as related to these mediators have intended effects on user reactions. For example, the designer of the (input) interface of an IS can check whether users find the interface easy to use with user responses to the specific item in the ISIR instrument. With the TAM instrument, for example, the designer can only get the information about how users find the whole system easy to use, which may not be specifically relevant.

Of course, easy/difficult is only one of the items for the evaluation dimension of cognitive component in the ISIR instrument. ISIR instrument measures three subconstructs as related to interface, output and rules. User feelings and beliefs toward each of these mediators are indicated by 12 items for the EPA (Evaluation, Power and Activity) dimensions. The richness as well as the specificity of information provided by the ISIR instrument enable the practitioners to have a comprehensive understanding of how well user interaction with a system is mediated.

Taking both attitudinal components and mediated actions into account, ISIR allows more detailed consideration than the general TAM model does in predicting user behavior. This contributed to the better performance of ISIR instrument in predicting user behavior than the TAM instrument in the validation study. Moreover, it allows practitioners to find out what users cares about and why they are satisfied/unsatisfied with a system in establishing the stable relationship.

For example, the significance tests of the ISIR indexes in the prediction of user persistence suggested that it is the user's cognitive beliefs about the input interface that is the primary predictor of persistence. TAM indexes, on the other hand, suggested that Perceived Usefulness was most relevant, but it cannot specify whether the input interface, the output interface or the interaction rules have to be useful for users to be persistent. Having useful/useless as one item for the cognitive component in the ISIR instrument, ISIR instrument allows detailed examination of specific cognitive beliefs about a specific mediator, input interface in this case, in terms of its influence on user behavior. This may help practitioners pinpoint different aspects of the system that could be tweaked so that improved systems can retain more users.

*Contributions Related to the ISIR Framework*

Developed under the Activity Theory paradigm, the ISIR framework solves some theoretical problems of the user acceptance research stream. First, the ISIR framework allows researchers to examine user-system interaction through the mediated relationships involving IS artifacts. Rather than treating an IS as a whole unit like a "black box", the ISIR framework breaks it into Interface, Information Technologies, and Interaction Rules. The specification of these IS artifacts allows researchers to study the specific relationships between these artifacts and IS user behavior. This approach is actually consistent with what was called for by Orlikowski and Iacono (2001) to break down the IT artifacts.

More specifically, the ISIR framework specifies the relationships between the IS artifacts and ISIR through the mediation of ISIR antecedents. These ISIR antecedents are direct user experiences that were identified to be particularly relevant to ISIR. The clarification of these relationships helps researchers and practitioners understand the causal relationships between user experiences of IS artifacts and ISIR. This systematic understanding of the whole causal process connecting IS artifacts, user experiences and user predispositions is generally unavailable in user acceptance models.

Systematic deliberation on the process provides a meaningful explanation of why people prefer to interact with certain IS rather than others due to the differences in system design and implementation. Theoretically speaking, systematic and process theorizing provides more explanatory power than simple causal theorizing involving psychological constructs. Specifically, systems thinking, which takes the IS artifact into account, and the process thinking, which emphasizes the mediation of IS experiences between IS artifacts and ISIR, enable the ISIR framework to tap the real difference made by the design and implementation of IS artifacts on user behavior. Simple causal theorizing based on the oversimplification of complex IS user behavior and evaluative summary constructs, on the other hand, may tap the confounding effects, rather than the real and specific effects caused by IS artifacts. For example, people are likely to be elicited to judge something as generally favorable or unfavorable and report their predispositions accordingly. Though this type of causal relationships can be found to be highly statistically significant, the information it provides is not very meaningful and does not provide much insight into user specific experiences underlying the formation of user predispositions.

Practically speaking, the systematic elaboration of the ISIR framework of the process connecting IS artifacts, user experiences and user predispositions can help IS practitioners understand why different system designs and implementations lead to different levels of user participation. This understanding may help IS practitioners find out how to improve the design and implementation for existing and future systems. For example, if a system is implemented to be highly personalized for its users but the users exhibit a low ISIR, the practitioners may find out that this is due to the effect of personalization in lowering user sense of control. Knowing the reasons behind user reactions, the practitioners may be able to revise the interaction rules in the system to make it less obtrusive to the users, but give them more choices. Practitioners can check whether revisions in a system have expected effects by examining user responses on ISIR antecedents and the ISIR instrument, especially the Sense of Control scale and the ISIR items on the power dimension. Of course, practitioners should take all the IS capabilities into account at the same time rather than one at a time. In doing so, the practitioners can obtain a comprehensive picture of how a system design and implementation may impact user behavior.

In addition to the problem due to the oversimplification of IS user behavior, another major problem of user acceptance research stream results from its exclusion of specific user contexts in the study of IS user behavior. Like the first theoretical problem, this problem is also due to the limitations of the social psychological paradigm under which the user acceptance models have been developed. In general, these models regard user behavior as relatively context-free, that is, they assume user behaviors are not likely to change across specific user contexts. This limits researchers to study IS user behavior only in a general environment, such as organizations, rather than particular user contexts, such as various task settings.

However, IS user behavior is highly situated in user contexts (Suchman 1987), and the exclusion of this makes it difficult to understand why people choose different systems on different occasions. The ISIR measure and framework, on the other hand, takes user contexts, especially task settings, into account. In this study, ISIR was measured as related to a task setting and the ISIR research framework included situational factors to reflect the effects of the task setting on individual users into account. This allows researchers and practitioners to understand why people prefer certain systems to others for a given task.

In the example at the beginning of Chapter I, there are two task settings for the user to find the literature: one in which reference information is incomplete and one in which reference information is complete. Across these two task settings, the user's ISIR scores toward the library online catalog and Google are likely to be different. Even under the same task setting, user perceptions related to the task setting, or situational factors, are likely to be different. For example, some may perceive themselves to be more competent at the task than others, leading to different levels of ISIR. Based on the measurement of both ISIR and situational factors, researchers and practitioners can arrive at a better understanding of the effects of task settings on IS user behavior.

In summary, the ISIR instrument and framework provide some solutions to the major theoretical problems of the user acceptance research stream. Specifically, they allow researchers and practitioners to examine the specific effects of IS artifacts and user contexts on user behavior. On the other hand, there are certain important limitations of this study, which implies the directions for future research.

**Limitations and Future Research**

This section discusses two major limitations of this study and their implications for future research. First, this study only includes the individual-level factors that are related to IS user behavior. However, social-level factors have also been identified to have significant impacts on IS user behavior. Second, the laboratory procedures used in this study limit the generalizability of its results to the real world. In the following paragraphs, these two limitations and their implications for future research are discussed in more detail.

Social-level factors were not taken into account in this study to avoid possible complications. The exclusion of social-level factors does not mean that they are not important. Instead, the review of the user acceptance research stream indicates the importance of social-level factors in the study of IS user behavior. However, social-level factors are relatively hard to manipulate in laboratory settings and their effects are relatively hard to observe compared with individual-level factors. Though this exclusion is justifiable for focus and simplification at this stage, it is still a major limitation of this study.

This limitation mainly stems from methodological constraints rather than constraints related to its theoretical framework. Actually, the concept of user context is capable of incorporating social-level factors (e.g. social rules) that are embodied in social relationships. User contexts include the physical environment, the task setting, and the social relationships that are related to IS user behavior. Among these elements, the physical environment and task setting are related to the motives and self-regulation of individual users and social relationships are related to the social regulation among the relevant group of people including the users. Theoretically speaking, the ISIR framework itself is able to take both individual contexts and social contexts into account.

When researchers and practitioners are mainly interested in how IS design and implementation may influence user behavior in general, social contexts of use may not be particularly relevant. However, when researchers and practitioners are interested in why certain IS are successful in some groups or organizations but not in others, social contexts must be taken into account.

A study with a focus on how social contexts may affect user ISIR must address the issue of how to control or compare the social contexts and observe their effects. As mentioned, the effects of individual contexts on user behavior may be measured in the form of situational factors. To capture the effects of social contexts, however, other quantitative measurements and qualitative observations are required. Once these methodological issues are resolved, it is possible to adapt and apply the ISIR framework to study IS user behavior in social contexts, such as specific groups and organizations. This indicates one direction for future research.

Another limitation of this study is the laboratory approach taken in the empirical studies. Compared with studies carried out in the real world, laboratory studies are more controllable in terms of the treatment manipulation. However, the results obtained from laboratory studies are less generalizable than those obtained from studies in the real world. The use of undergraduate students as the participants also put a limitation on the generalizability of the results. This limitation implies that future studies be conducted on people in realistic task settings with real systems.

One challenge in doing so is how to control or compare the differences among real IS. In the experimental study, system modes varied on two levels of IS capabilities. But in the real world, IS capabilities vary in more complicated ways. Though we have discussed the IS capabilities in more detail in Chapter IV and we have developed perceived IS capability scales, their sufficiency need to be examined against real IS in future studies.

In conclusion, the ISIR instrument and framework were found to be theoretically sound and empirically valid. However, to apply them to study IS user behavior in real world, more efforts are necessary. The limitations of this study imply directions for future research.

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# APPENDIX

## A: A Survey about Common Feelings and Beliefs of IS Users

The purpose of this survey is to find out what kinds of feelings and beliefs people may have when they interact with information systems. Your participation is greatly appreciated!

Here is a list of positive and negative feelings and beliefs in pairs:

**Feelings:**

| | | | |
|---|---|---|---|
| *A*. hateful/love | *B*. tense/calm | *C*. annoyed/happy | *D*. sad/delighted |
| *E*. bored/excited | *F*. angry/relaxed | *G*. sorrow/joy | *H*. disgusted/acceptance |

**Beliefs:**

| | | | |
|---|---|---|---|
| *I*. useless/useful | *J*. difficult/easy | *K*. unsafe/safe | *L*. harmful/beneficial |
| *M*. foolish/wise | *N*. imperfect/perfect | *O*. worthless/valuable | *P*. unhealthy/wholesome |

We are interested in what kinds of feelings and beliefs that you are *likely* to have when you interact with a system, such as a course site, on-line library catalog, Microsoft Excel Help, www.google.com, www.travelocity.com, www.amazon.com, and so on. For each of the following questions, please write down the letters corresponding to the feelings/beliefs (e.g., ***A*** for hateful/love). They can be repeated for different questions, and you are welcome to use your own terms. If you find a pair ambiguous or too strong, please put '?' or '!' next to it. If the meanings of two pairs seem to overlap with each other, please put a line between them.

*The first question refers to entering input into the interface of a system:*

**1. When I enter my input into the interface of a system:**

The *feelings* that I may have (up to 3 pairs):

1. ________________________; 2. ________________________; 3. ________________________;

The *beliefs* that I may have regarding the ***interface*** (up to 3 pairs):

1. ________________________; 2. ________________________; 3. ________________________;

*The second question refers to reading output from the interface of a system:*

**2. When I read the output generated by a system:**

The feelings that I may have (up to 3 pairs):

1. ________________________; 2. ________________________; 3. ________________________;

The beliefs that I may have (up to 3 pairs):

1. ________________________; 2. ________________________; 3. ________________________;

*The third question refers to following rules (e.g. steps/sequence, user terms, privacy/security…) underlying my interaction with a system:*

**3. When I follow the underlying rules during the whole session of using a system:**

The feelings that I may have (up to 3 pairs):

1. ________________________; 2. ________________________; 3. ________________________;

The beliefs that I may have (up to 3 pairs):

1. ________________________; 2. ________________________; 3. ________________________;

## B: ISIR Instrument

(Specify User Context at the beginning, e.g. **In searching for a travel deal:**)

1. When I use [system name] interface to enter my input (e.g. requests, choices, personal info.)

I **am** _____ *to do so*. **(Please answer both columns)**

…disinclined -3 -2 -1 0 1 2 3 inclined | …hesitant -3 -2 -1 0 1 2 3 eager

I **feel** _____ toward *the interface*.

…dislike -3 -2 -1 0 1 2 3 like | …rejecting -3 -2 -1 0 1 2 3 accepting

I **feel** _____ in *entering my input*.

…tense -3 -2 -1 0 1 2 3 relaxed | …bored -3 -2 -1 0 1 2 3 excited

I **feel** _____ in terms of *goal accomplishment*.

…annoyed -3 -2 -1 0 1 2 3 content | …sad -3 -2 -1 0 1 2 3 happy

I **find** *the interface* _____.

…useless -3 -2 -1 0 1 2 3 useful | …imperfect -3 -2 -1 0 1 2 3 perfect

I **find** it _____ *to enter my input*.

…difficult -3 -2 -1 0 1 2 3 easy | …unsafe -3 -2 -1 0 1 2 3 safe

I **find** that *the utilization of my input* is _____.

…foolish -3 -2 -1 0 1 2 3 wise | …harmful -3 -2 -1 0 1 2 3 beneficial

2. When I receive/read the output (e.g. text, links, graphics, files) generated by [system name],

I **am** _____ *to do so*.

…disinclined -3 -2 -1 0 1 2 3 inclined | …hesitant -3 -2 -1 0 1 2 3 eager

I **feel** _____ toward *the output*.

…dislike -3 -2 -1 0 1 2 3 like | …rejecting -3 -2 -1 0 1 2 3 accepting

I **feel** _____ in *receiving/reading the output*.

…tense -3 -2 -1 0 1 2 3 relaxed | …bored -3 -2 -1 0 1 2 3 excited

I **feel** _____ in terms of *goal accomplishment*.

…annoyed -3 -2 -1 0 1 2 3 content | …sad -3 -2 -1 0 1 2 3 happy

I **find** *the output* _____.

…useless -3 -2 -1 0 1 2 3 useful | …imperfect -3 -2 -1 0 1 2 3 perfect

I **find** it _____ *to receive/read the output*.

…difficult -3 -2 -1 0 1 2 3 easy | …unsafe -3 -2 -1 0 1 2 3 safe

I **find** that *the generation of output* is _____.

…foolish -3 -2 -1 0 1 2 3 wise | …harmful -3 -2 -1 0 1 2 3 beneficial

3. When I follow the underlying rules (e.g. steps/sequence, user terms, privacy/security etc.) during the whole session of interacting with [system name],

I **am** _____ *to do so*.

…disinclined -3 -2 -1 0 1 2 3 inclined | …hesitant -3 -2 -1 0 1 2 3 eager

I **feel** _____ toward *the rules*.

…dislike -3 -2 -1 0 1 2 3 like | …rejecting -3 -2 -1 0 1 2 3 accepting

I **feel** _____ in *following the rules*.

…tense -3 -2 -1 0 1 2 3 relaxed | …bored -3 -2 -1 0 1 2 3 excited

I **feel** _____ in terms of *goal accomplishment*.

…annoyed -3 -2 -1 0 1 2 3 content | …sad -3 -2 -1 0 1 2 3 happy

I **find** *the rules* _____.

…useless -3 -2 -1 0 1 2 3 useful | …imperfect -3 -2 -1 0 1 2 3 perfect

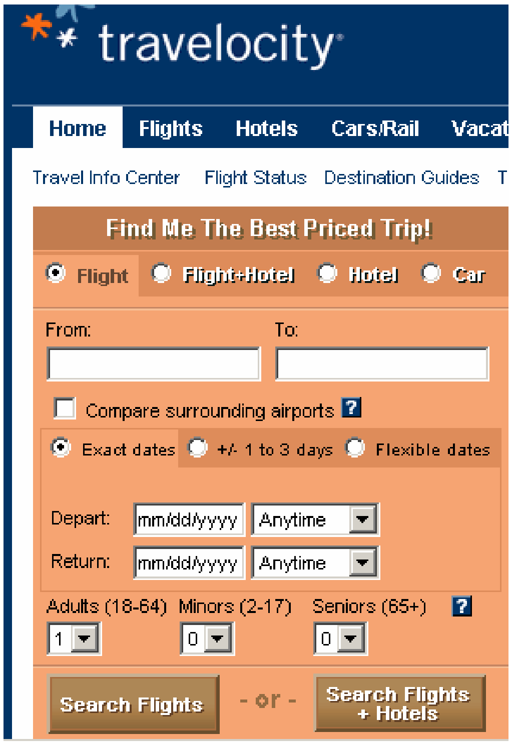
I **find** it _____ *to follow the rules*.

…difficult -3 -2 -1 0 1 2 3 easy | …unsafe -3 -2 -1 0 1 2 3 safe

I **find** that *the implementation of rules* is _____.

…foolish -3 -2 -1 0 1 2 3 wise | …harmful -3 -2 -1 0 1 2 3 beneficial

## C: Screenshots of Travel Websites used in the Validation Study




**Travelocity.com**

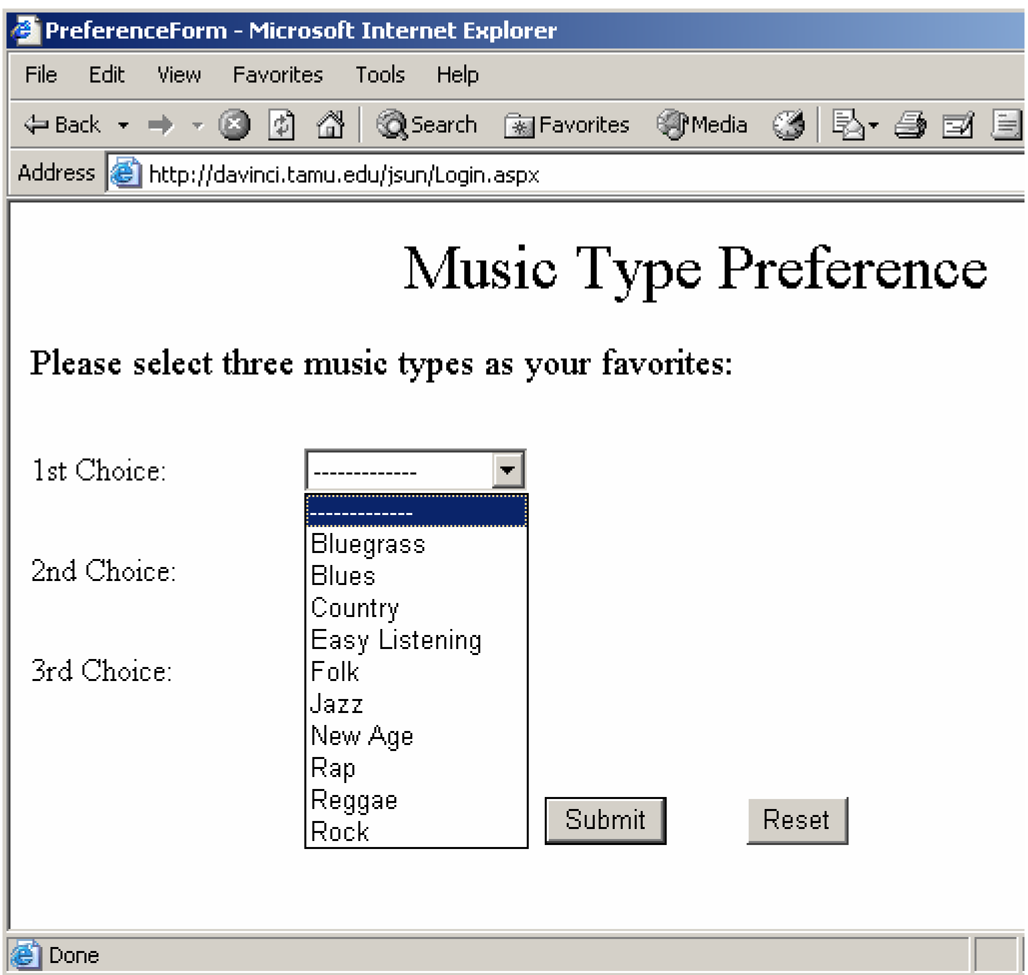

**CheapTickets.com**

## D: Illustration of Experimental Conditions

In this experiment, users imagine that they are traveling in a big city at evening with a GPS-embedded cell-phone. Their tasks are to use cell-phones to find a nearby nightclub playing their favorite music. In this experiment, there are five different system modes, which are of different combinations of IS capabilities (“interactivity”, “personalization” and “context-awareness”).

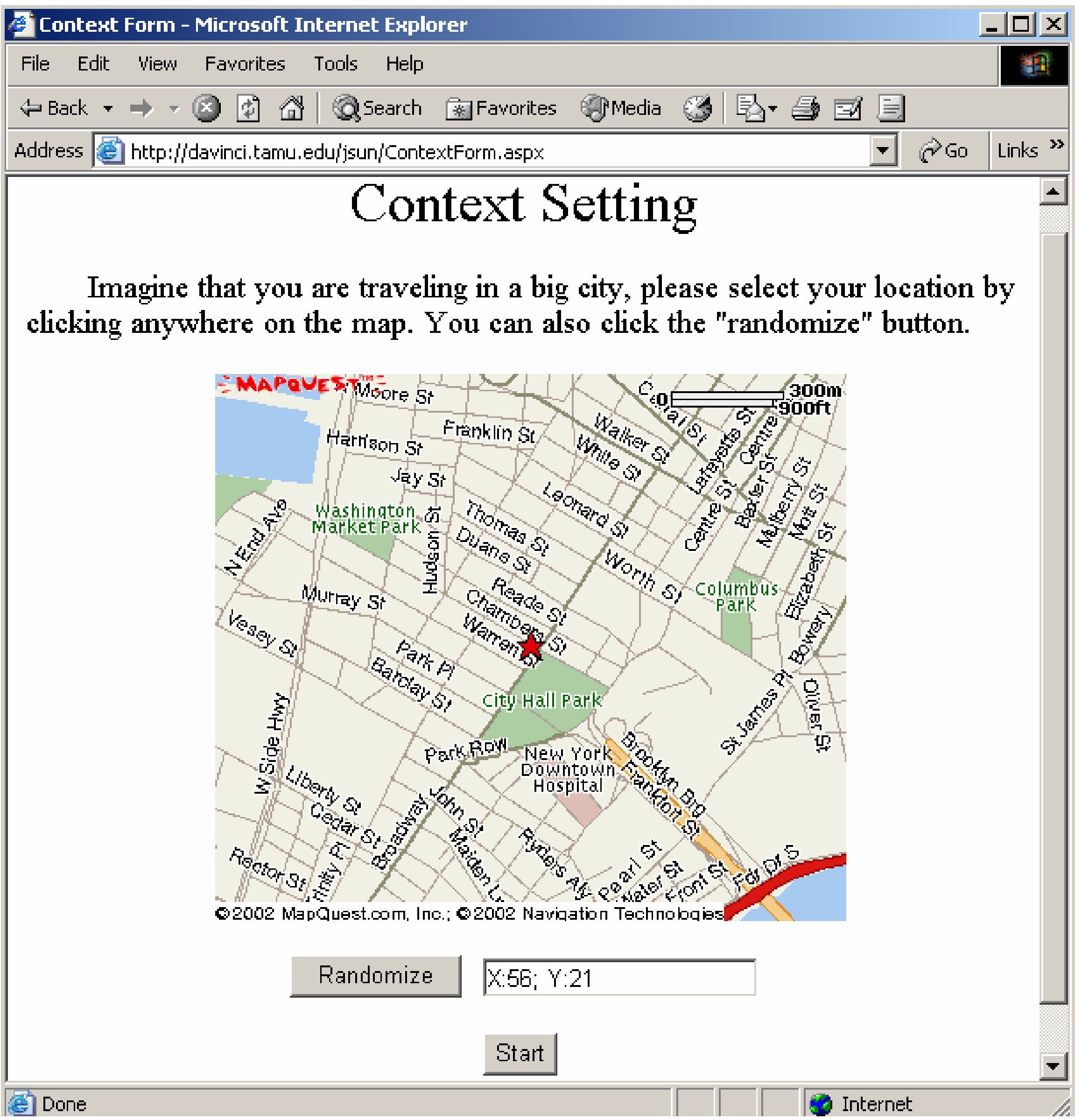
*Preference Setting*

At the beginning, participants make a one-time selection of three favorites from 10 common music types as shown in the figure below:



*Context Setting*

Before using each mode, participants determine their “current locations” by clicking anywhere on a city’s map or clicking the “randomize” button, as shown in the next figure (the values shown in the text box simulate the GPS coordinates):



*Mode Descriptions*

There are 100 nightclubs randomly distributed in the area, and each nightclub is playing one of 10 music types. Participants can use five system modes to look for a nearby nightclub that play their favorite music types. In each mode, a participant clicks the link "nightclub" on the simulated cell phone to start the session. After interacting with the system of a given mode, the participant gets a list of nightclubs of certain length and order. These system modes are described as follows:

Mode 0

In this mode,  the system gives a list of all nightclubs in alphabetical order.

Mode 1

The system gives a list of all music types available in alphabetical order. When the participant selects one, it will give relevant nightclubs in alphabetical order.

Mode 2

The system gives a list of all music types available in alphabetical order. When the participant selects one, it will give relevant nightclubs in distance order.

Mode 3

The system gives a list of the participant's favorite music types. When the participant selects one, it will give relevant nightclubs in alphabetical order.

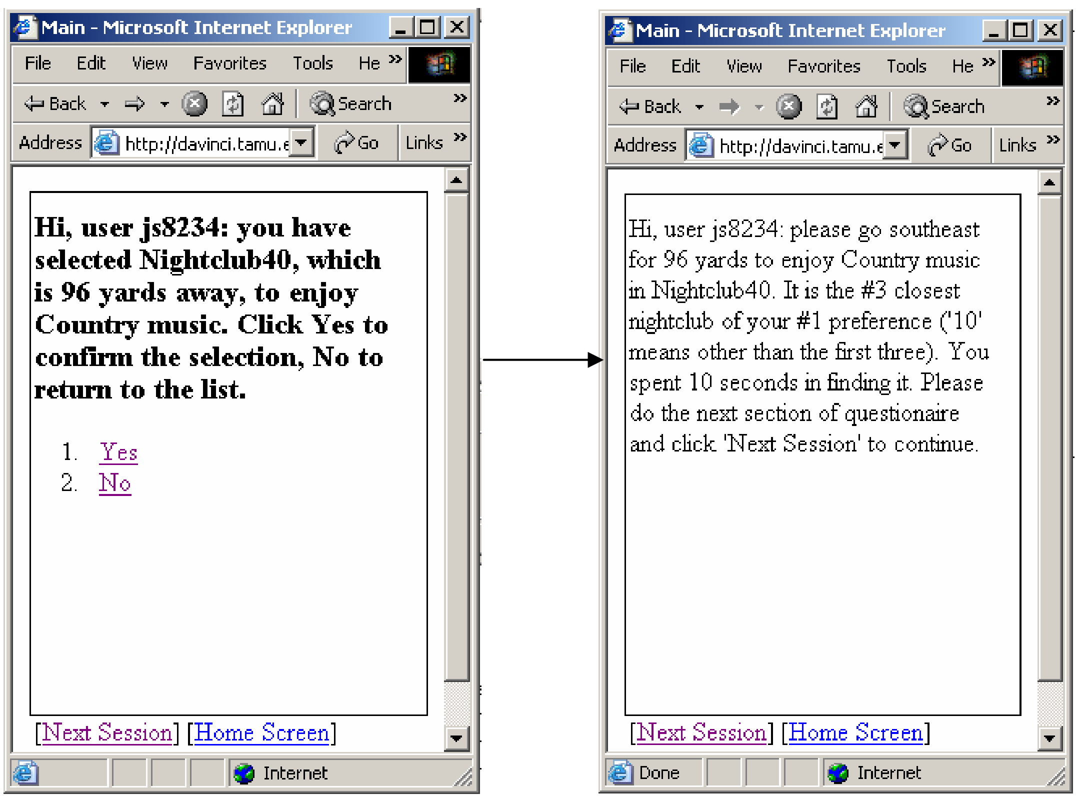
Mode 4

The system gives a list of the participant's favorite music types. When the participant selects one, it will give relevant nightclubs in distance order.

*Illustration of System Modes*

*Selection and Confirmation*

When the participant clicks a link to a club, it will display the music type and distance information, so that participants can make comparison. After choosing a nightclub, the participant can confirm the selection. The confirmation output shows the directions and user performance, including the distance hit, preference hit and time spent. The participant completes the session by clicking "Next Session".



## E: Construct Measurements

This appendix lists all the scales used in this study to measure constructs in the ISIR Research Model. The parentheses in the item stem indicate the places where the names of specific systems in the study, such as Google, were filled in.

*ISIR Antecedents*

Sense of Control

1. It is mostly up to me how I get what I want from (system name).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Strongly disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly agree |

2. There is very little I can do with (system name) to acquire information as I wish.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Strongly disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly agree |

3. How much control do you have over the interaction with (system name) for desired result?

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| No control at all | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Complete control |

Motive Fulfillment

Motive Fulfillment was measured objectively from the records of user performance. User performance in terms of result and time was either reported by the participants themselves in the validation study or gathered by the experiment system in the experimental study.

Perceived Understanding

You have just finished interacting with (system name). The following terms refer to feelings that may be relevant when people attempt to make themselves understood by information systems. Please indicate the extent to which each term describes how you generally felt when and immediately after trying to make yourself understood by (system name). Respond to each term according to the following scale:

| | **very little** | **little** | **some** | **great** | **very great** |
|---|---|---|---|---|---|
| … Satisfaction | 1 | 2 | 3 | 4 | 5 |
| … Relaxation | 1 | 2 | 3 | 4 | 5 |
| … Pleasure | 1 | 2 | 3 | 4 | 5 |
| … Good | 1 | 2 | 3 | 4 | 5 |
| … Acceptance | 1 | 2 | 3 | 4 | 5 |
| … Comfortableness | 1 | 2 | 3 | 4 | 5 |
| … Happiness | 1 | 2 | 3 | 4 | 5 |
| … Importance | 1 | 2 | 3 | 4 | 5 |
| … Dissatisfaction | 1 | 2 | 3 | 4 | 5 |
| … Annoyance | 1 | 2 | 3 | 4 | 5 |
| … Discomfort | 1 | 2 | 3 | 4 | 5 |
| … Insecurity | 1 | 2 | 3 | 4 | 5 |
| … Sadness | 1 | 2 | 3 | 4 | 5 |
| … Failure | 1 | 2 | 3 | 4 | 5 |
| … Incompleteness | 1 | 2 | 3 | 4 | 5 |
| … Uninterestingness | 1 | 2 | 3 | 4 | 5 |

*Technology Acceptance Model (TAM) Constructs*

All the items use 7-level Likert scale with Strongly Disagree on the left side and Strongly Agree on the right side, as:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Strongly disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly agree |

<u>Behavioral Intention to Use</u>

Assuming I had access to (system name), I intend to use it.

Given that I had access to (system name), I predict that I would use it.

<u>Perceived Usefulness</u>

Using (system name) improves my performance in the task.

Using (system name) in the task increases my productivity.

Using (system name) enhances my effectiveness in the task.

I find (system name) to be useful in the task.

(Change “my job” to “the task” in my questionnaire)

<u>Perceived Ease of Use</u>

My interaction with (system name) is clear and understandable.

Interacting with (system name) does not require a lot of my mental effort.

I find (system name) to be easy to use.

I find it easy to get (system name) to do what I want it to do.

*Perceived IS Capabilities*

All the scales use 7-level Likert scale with Strongly Disagree on the left side and Strongly Agree on the right side, as:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Strongly disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly agree |

Perceived Interactivity

1. I was in total control of my navigation through (system name).
2. I had no control at all over the content of (system name) that I wanted to see.
3. (System name) had the ability to respond to my specific requests quickly and efficiently.
4. I was able to obtain the information I want without any delay.
5. (System name) facilitated two-way communication between me and it.
6. (System name) made me feel it was listening to me.

Perceived Context-awareness:

1. (system name) gave information that was irrelevant at all to what I was trying to accomplish.
2. It seemed to me that (system name) were aware of my situation in________. (what I am doing. e.g.: looking for the proper function; searching for the best deal; finding a best place to go.
3. The design of (system name) enabled it to adapt to the context of what I was doing.

Perceived Personalization:

1. The result given by (system name) was tailored to my personal preferences.
2. (System name) was not sensitive at all to my personal needs and preferences.
3. The design of (system name) made it appropriate to cater for my personal needs.

*Personal Factors*

Locus of Control

Instruction:

For each pair of statements, please indicate which one is closer to your opinion by writing the corresponding letter in the blank. Then indicate how much closer to your opinion it is than the other statement by checking the appropriate box.

Response Format:

___ Statement closer to my opinion. □ Much closer □ Slightly closer

1. a. Many of the unhappy things in people's lives are partly due to bad luck.
   b. People's misfortunes result from the mistakes they make.

2. a. In the long run, people get the respect they deserve in this world.
   b. Unfortunately, an individual's worth often passes unrecognized no matter how hard he tries.

3. a. Without the right breaks one cannot be an effective leader.
   b. Capable people who fail to become leaders have not taken advantage of their opportunities.

4. a. Becoming a success is a matter of hard work; luck has little or nothing to do with it.
   b. Getting a good job depends mainly on being in the right place at the right time.

5. a. What happens to me is my own doing.
   b. Sometimes I feel that I don't have enough control over the direction my life is taking.

6. a. When I make plans, I am almost certain that I can make them work.
   b. It is not always wise to plan too far ahead because many things turn out to be a matter of good or bad fortune anyway.

7. a. In my case, getting what I want has little or nothing to do with luck.
   b. Many times we might just as well decide what to do by flipping a coin.

8. a. Who gets to be the boss often depends on who was lucky enough to be in the right place first.
   b. Getting people to do the right thing depends upon ability; luck has little or nothing to do with it.

9. a. Most people don't realize the extent to which their lives are controlled by accidental happenings.
   b. There is really no such thing as "luck."

10. a. In the long run, the bad things that happen to us are balanced by the good ones.
    b. Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

11. a. Many times I feel that I have little influence over the things that happen to me.
    b. It is impossible for me to believe that chance or luck plays an important role in my life.

Computer Anxiety

All the scales use 7-level Likert scale with Strongly Disagree on the left side and Strongly Agree on the right side, as:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Strongly disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly agree |

1. Computers do not scare me at all.
2. Working with a computer makes me nervous.
3. I do not feel threatened when others talk about computers.
4. It wouldn't bother me to take computer courses.
5. Computers make me feel uncomfortable.
6. I feel at ease in a computer class.
7. I get a sinking feeling when I think of trying to use a computer.
8. I feel comfortable working with a computer.
9. Computers make me feel uneasy.

Computer Playfulness

Instruction:

The following questions ask you how you would characterize yourself when you use computers:

| | **Strongly disagree** | | | **Neutral** | | | **Strongly agree** |
|---|---|---|---|---|---|---|---|
| . . . spontaneous | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| . . . unimaginative | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| . . . flexible | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| . . . creative | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| . . . playful | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| . . . unoriginal | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| . . . uninventive | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

*Situational Factors*

All the scales use 7-level Likert scale with Strongly Disagree on the left side and Strongly Agree on the right side, as:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Strongly disagree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly agree |

<u>Importance</u>

1. I put a lot of effort into this.

2. It was important to me to do well at this task.

3. I tried very hard on this activity.

4. I didn't try very hard to do well at this activity.

<u>Tension</u>

1. I felt very tense while doing this activity.

2. I felt pressured while doing these.

3. I was anxious while working on this task.

4. I was very relaxed in doing these.

Self-Efficacy

1. I think I am pretty good at this activity.

2. After working at this activity for a while, I felt pretty competent.

3. I was pretty skilled at this activity.

4. This was an activity that I couldn’t do very well.

Interest

1. I enjoyed doing this activity very much.

2. This activity was fun to do.

3. I would describe this activity as very interesting.

4. This activity did not hold my attention at all.

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