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# Design Principles Influencing Secondary School Counselors' Satisfaction of a Decision-Support System

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# Design Principles Influencing Secondary School Counselors' Satisfaction of a Decision-Support System

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By

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# DISSERTATION APPROVAL FORM

This dissertation is approved as a credible and independent investigation by a candidate for the Doctor of Science degree and is acceptable for meeting the dissertation requirements for this degree. Acceptance of this dissertation does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department or university.

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# ABSTRACT

In the current era of accountability, secondary school counselors are expected to use data to drive program decision-making, identify and implement evidence-based interventions to create systemic change, and utilize emerging technology. Research shows it is difficult for school counselors to meet any of these expectations. A decision support system (DSS) is a technology that takes minimal effort to learn and can assist in decision-making processes. This design science research builds and evaluates an IT artifact, a decision-support system, in an attempt to solve the problems facing school counselors. To develop this system, four design principles (system usefulness, interface quality, information quality, and customization) were incorporated into the components of a DSS. A field study was then employed to test the DSS in multiple school counseling settings to determine if the IT artifact solved the identified problems, and also to measure the influence of the design principles on school counselors' satisfaction of the system. Results indicated that 91.7% of school counselors agreed the system was in fact useful, indicating technology is capable of assisting school counselors in data-driven decision-making and identifying appropriate interventions for their program, as well as demonstrating the efficacy of design science research to solve problems. Furthermore, the SEM model used to evaluate the system showed that while all design principles were positive, interface quality had the most considerable influence on users' satisfaction. This finding indicates the importance of using consistent interface design in the development of future technologies for non-technical fields. The research concludes with an updated model for decision-making in school counseling that incorporates technology in all phases of the process.

# DECLARATION

I hereby certify that this dissertation constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions or writings of another.

I declare that the dissertation describes original work that has not previously been presented for the award of any other degree of any institution.

Signed,

Kodey S. Crandall

Kodey S. Crandall

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# CHAPTER 1

## INTRODUCTION

Secondary school counselor responsibilities have evolved over the last few decades. In the past, school counselors spent their time meeting with and guiding troubled students, assembling class schedules, arranging vocational training, administering standardized tests, and more. In the current era, school counselors still complete many of these tasks, but in addition, there has been a more recent emphasis on the importance of using data to monitor student progress, drive program decision-making, and create systemic change (Young & Kaffenberger, 2015) by identifying and implementing evidence-based interventions (Zyromski & Mariani, 2019). School counselors are also challenged to keep pace with emerging technologies (Mason, Griffith, & Belser, 2018) despite their discomfort learning and using technology (Mason et al., 2018) and the limited amount of time (Fye & Rainey, 2017).

While there is no shortage of data, many school counselors lack the data use and evaluation skills necessary to effectively engage in the types of accountability efforts (Poynton, 2009). While numerous school counselors have had training in data analysis, most do not have confidence in their ability and struggle to meet the expectation to use data (Young & Kaffenberger, 2015). For this reason, data-driven decision-making (DDDM) “continues to be a stress-inducing, learner-centered pedagogical paradigm shift for which most [educators] are unprepared…” (Dunn, Airola, Lo, & Garrison, 2013, p. 88) and many become burdened when making such decisions (Schwartz, 2016).

Identifying and implementing evidence-based interventions, one phase of the DDDM process, has also been a more recent focus for the profession (Zyromski & Mariani, 2019). School counselors currently search multiple sources, including websites, journals, and other resources, to identify interventions that will help meet the needs of their students (Zyromski, Dimmitt, Mariani, & Griffith, 2018). This search process may lead to "information overload" and impact the school counselor's ability to make decisions (Roetzel, 2019).

Technological solutions are necessary to support data-driven practices as data continues to grow beyond the capacity of humans to handle (Mandinach, 2012). Technology can assist in the DDDM process and expand the school counselor's reach and efficiency in serving all students, however, it is often under-researched and under-utilized in school counseling (Mason et al., 2018). Models of DDDM in school counseling only reference the use of technology in collecting and analyzing data and sharing results, suggesting technology is limited or incapable of prioritizing information for decision-making. This research asserts that technology can assist in all phases of the DDDM. Because many school counselors lack confidence, comfort, and skills learning how to use new technology (Steele, Jacokes, & Stone, 2015; Young & Kaffenberger, 2015), they must believe new technology can make their many required tasks easier and quicker.

School counselors are in need of a decision-support system (DSS) that takes minimal effort to learn, saves them time, and assists them in the data-driven decision-making process, specifically when identifying interventions for school improvement. DSS allows users to effectively make better decisions by delivering solutions to complex problems (Christopher, 2005). This is usually accomplished by aggregating information from multiple knowledgebase sources and making the information available in a structured way using technology (Christopher, 2005).

The purpose of this design science research is to build an IT artifact to improve the information retrieval problem facing school counselors and answer the research question: *What influence do specific design principles have on secondary school counselors' satisfaction of a DSS?* The design principles are identified after a review of the literature, and an examination of an information system school counselors currently use. These design principles drive the development of the IT artifact and are necessary for evaluating the system.

The paper is outlined to follow the steps of design science research methodology (DSRM) proposed by (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). After describing the DSRM approach, the paper identifies the problems facing school counselors by describing their attributes and responsibilities, data-driving decision-making models and processes, and the challenges of identifying and implementing evidence-based interventions. A solution is proposed to address these problems by describing the background, components, and capabilities of DSSs. This solution is supported by research on how these systems have been used to solve problems in other industries. Next, the paper specifies how the IT artifact, a DSS for school counselors, was designed and developed integrating design principles known to influence user-satisfaction of information systems into the components of the DSS. The paper then describes how the DSS was tested in multiple school counseling settings to not only determine if it solved the identified problems but also to measure the design principles influence school counselors' satisfaction with the system. The demonstration of the artifact is then explained: the system was tested in multiple school counseling settings, and after interacting with the system, counselors completed an anonymous online survey. The paper details how these survey results were evaluated using structural equation modeling. The paper concludes with a discussion of the results, the contributions of the research, including a new model for DDDM in school counseling, limitations of the study, and future research directions.

For this study, "school counselor" or "counselor" will refer to secondary school counselors (grades 6-12) working in public schools within the Rocky Mountain Region of the United States of America.

Mason (2018) states, school counselors that do not follow the technology trends of today may find their role in the education system as irrelevant. Therefore, this research is relevant, timely, and essential for all school counselors, whether they've been in their role for three years or three decades.

# CHAPTER 2

# DESIGN SCIENCE RESEARCH

## Overview

This research uses well-established Design Science Research Methodologies (Hevner, March, Park, & Ram, 2004; Peffers et al., 2007) to build and evaluate a DSS, a technology that school counselors can use to identify evidence-based interventions and to explain the influence of the design principles on user satisfaction.

Design science research (DSR) is appropriate when problem-solving technology is needed and where existing theory is insufficient (Hevner et al., 2004). This emphasis on problem-solving makes DSR methodology unique from other methodologies. “Whereas natural sciences and social sciences try to understand reality, design science attempts to create things that serve human purposes” (Peffers et al., 2007, p. 55). DSR is especially adept at addressing “wicked problems” in which there are “complex interactions between subcomponents of the problem and its solutions” (Hevner et al., 2004, p. 81). This framework solves problems by building and effectively evaluating IT artifacts, which is the aim of this research.

## Hevner et al. Design Science Research Guidelines

Hevner et al. (2004) created clear guidelines for understanding, executing, and evaluating DSR. These guidelines describe the characteristics and necessary components needed to carry out effective DSR and are detailed below in Table 1.

Table 1: Seven Guidelines to Design Science Research by Hevner et al. (2004)

| Guideline | Description |
|---|---|
| Guideline 1: Design as an Artifact | DSR must produce a viable artifact in the form of a construct, a model, a method, or an instantiation. |
| Guideline 2: Problem Relevance | The objective of DSR is to develop technology-based solutions to important and relevant business problems. |

| | |
|---|---|
| Guideline 3: Design Evaluation | The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methodologies. |
| Guideline 4: Research Contributions | Effective DSR must provide transparent and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies. |
| Guideline 5: Research Rigor | DSR relies upon the application of rigorous methods in both the construction and evaluation of the design artifact. |
| Guideline 6: Design as a Search Process | The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment. |
| Guideline 7: Communication of the Research | DSR must be presented effectively both to technology-oriented as well as management-oriented audiences. |

**Guideline 1: Design as an Artifact**

The first guideline is the research must produce an artifact created to address a problem. Artifacts are generally defined as constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems). IT artifacts are not independent of people or the organizational and social contexts in which they are used but work together with them in meeting specific needs.

**Guideline 2: Problem Relevance**

The second guideline states the IT artifact should be relevant to the solution of an unsolved and important problem.  DSR usually addresses issues related to some aspect of the design of an information system. Therefore, instantiations produced may be in the form of software tools aimed at improving the process of information system development.

**Guideline 3: Design Evaluation**

Guideline three states rigor must be applied in both the design and evaluation of the IT artifact. According to Hevner (2004), the “utility, quality, and efficacy” (p. 85) must be rigorously demonstrated using well-executed evaluation methods. There are a variety of ways the artifact can be evaluated. The artifact can be evaluated in terms of functionality, completeness, consistency, accuracy, performance, reliability, and usability, and other relevant quality attributes, and can be evaluated using observational, analytical, experimental, testing or descriptive methods.

**Guideline 4: Research Contributions**

The fourth guideline states research should provide a valid and verifiable contribution to the design artifact, design construction knowledge, and/or design evaluation knowledge. Most often, the contribution of DSR is the artifact itself as the artifact enables the solution to an unsolved problem. The artifact may extend the knowledge base or apply existing knowledge in new and innovative ways. The creative development and use of evaluation methods and metrics also provide DSR contributions.

**Guideline 5: Research Rigor**

Guideline five ensures research rigor. Rigor relates to the way research is conducted and is derived from the effective use of the knowledge base. To ensure rigor, the construction and evaluation of the artifact should draw from existing theories and research methodology, including behavioral theories, as designed artifacts are often the components of a human-machine problem-solving system. Rigor is regularly assessed in the evaluation of the artifact by adherence to appropriate data collection and analysis techniques.

**Guideline 6: Design as a Search Process**

Guideline six is design as a search process. The objective of DSR is to search or discover an effective solution to a problem, which makes design science inherently iterative. A designed artifact is complete and adequate when it satisfies the requirements and constraints of the problem it was meant to solve. If it does not solve the problem, the researcher should iterate back to the design of the artifact to identify deficiencies and develop solutions to address them.

**Guideline 7: Communication of the Research**

The final guideline is the research must be effectively communicated to appropriate audiences. Technology-oriented audiences should receive sufficient detail to enable the described artifact to be constructed and used within a proper organizational context. Management-oriented audiences, on the other hand, should receive detail necessary to determine if organizational resources should be committed to purchasing and using the artifact within their specific organizational context.

## Peffers et al. Design Science Research Steps

Three years after Hevner et al. (2004) provided guidelines for carrying out DSR, researchers Peffers et al. (2007) developed a framework with specific steps for conducting DSR (Figure 1). This framework incorporates the guidelines proposed by Hevner (2004) as well as other principles, practices, and procedures required to carry out such research. The framework further provides a mental model for presenting and evaluating DS research in IS.

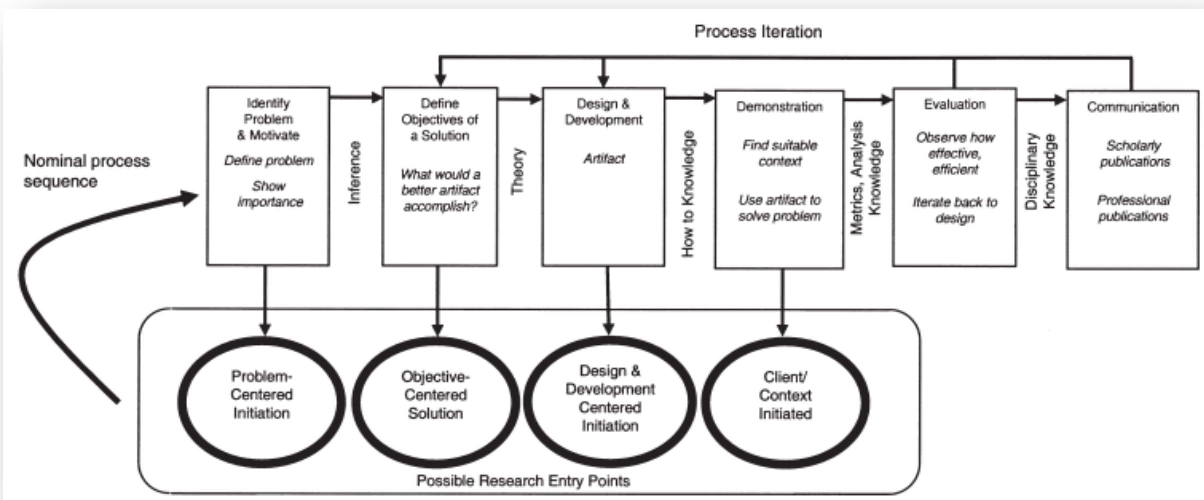


Figure 1: DSRM Process Model by Peffers et al. (2007)

To ensure this research is valuable, rigorous, and publishable in IS research outlets, the study will adhere to the guidelines proposed by Hevner et al., (2004) and follow the design science research steps outlined by Peffers et al. (2007). These steps are listed in **Error! Reference source not found.** and include details and application to this study.

Table 2: Design Science Research Steps by Peffers et al. (2007)

| DS Research Steps | Details | Application to this Study |
|---|---|---|
| Problem identification and motivation | Define the specific research problem and justify the value of a solution. | Counselors struggle to identify evidence-based interventions for program improvement. They also struggle to learn how to use new technology. When counselors are unable to implement evidence-based interventions, they may waste valuable time implementing strategies that do not meet student needs. |
| Define objectives for a solution | Describe how a new IT artifact is expected to support solutions to problems not hitherto addressed. | A DSS can solve these problems by providing a way for counselors to more easily identify evidence-based interventions relating to their individual school's needs and alleviate their challenges regarding technology use. |
| Design and development of the IT Artifact | Create the IT artifact. An artifact can be any designed object in which a research contribution is embedded in the design. | A DSS (instantiation) was designed and developed using research and theory of design principles that influence user satisfaction. The system also incorporated standards components of a DSS (knowledge-base, inference engine, user-interface). |
| Demonstration | Demonstrate the use of the IT artifact to solve one or more instances of the problem. | The system was used in multiple school counseling settings to assist school counselors in decision-making and identifying interventions relevant to the needs of their school. |
| Evaluation | Observe and measure how well the IT artifact supports a solution to the problem using evaluation. An evaluation may include results of satisfaction surveys. Depending on the results, the researchers can decide whether to iterate back to activity 3 to try to improve the effectiveness of the artifact or to continue to communication. | To measure their satisfaction, school counselors completed an online survey using modified questions from the Computer Usability Satisfaction Questionnaire (Lewis, 1995) and SERVQUAL (Parasuraman, Zeithaml, & Berry, 1988) after testing the system. The results of the survey were also used to build an SEM model to explain each construct's influence on user satisfaction. |
| Communication | Communicate the research and findings to researchers and other relevant audiences such as practicing professionals, when appropriate | The results of this research will be published as part of this dissertation. Furthermore, the results will be communicated to school counseling leaders as a way to demonstrate the utility of technology in the profession, and to information system specialists as a call for more technology development in education |

# CHAPTER 3

# PROBLEM IDENTIFICATION

## The Modern School Counselor

As technologies and computerized dependencies have advanced, school counselors have been encouraged to adopt and use digital tools to complete daily tasks and comply with regulations. While technology can broaden a school counselor's ability to efficiently and effectively contribute to student achievement and success, recent research shows many counselors do not feel they are using any technology at all in their school counseling program and are cautious of embracing it within their profession (Mason et al., 2018). One possible explanation for this resistance is the lack of comfort and skill school counselors have reported learning and using technology (Steele et al., 2015; Young & Kaffenberger, 2015), resulting in low computer self-efficacy (CSE).

Adapted from the general concept of self-efficacy (Bandura, 1986), CSE refers to people's judgments about their abilities to use a computer system successfully (Compeau & Higgins, 1995). Unless school counselors believe they can produce desired outcomes by their actions, they have little incentive to act, or in this case, use technology.

According to O*Net (2019), an online database developed under the United States Department of Labor/Employment and Training Administration, professional school counselors are often well-educated and capable and affluent in areas of psychology, interpersonal relations, social organization, and communication. School counselor's areas of strengths include:

- **Active Listening** – Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- **Social Perceptiveness** – Being aware of others' reactions and understanding why they react as they do.
- **Speaking** – Talking to others to convey information effectively.

- **Reading Comprehension** – Understanding written sentences and paragraphs in work-related documents.
- **Service Orientation** – Actively looking for ways to help people.

These areas of expertise matter and are crucial to successful execution in public schools. Because of their importance and a predisposition towards such expertise, school counselors may find themselves placing greater emphasis on and devoting more considerable time to these areas of strength.

School counselors have many responsibilities, including preparing students for post-secondary schooling, improving student achievement levels, improving students' social and emotional well-being, offering counseling services and academic advising, helping students make occupational choices, and planning for their future career (Mau, Li, & Hoetmer, 2016). A large proportion of school counselors are also expected to perform non-counseling tasks (Fye & Rainey, 2017), despite their increasing responsibilities, and mounting caseloads (Devoss & Stillman, 2011).

## Data-Driven Decision-Making

In addition to these responsibilities, data use and analysis have become expected to keep publicly funded schools accountable to governments and local taxpayers (Rubeiro, 2016). Legislation, such as No Child Left Behind, introduced new requirements for public schools to demonstrate their educational practices are effective. The Every Child Succeeds Act (ESSA) has since replaced No Child Left Behind but continues to hold schools accountable for how students learn and achieve (U.S. Department of Education, 2017). Furthermore, school counselors are mandated by the American School Counseling Association (ASCA) Ethical Standards (2016a) to review and make use of school and student data to address inequities (A.3.c), inform interventions (A.3.d.), evaluate the effectiveness of their school counseling programs (A.3.e.), and share outcomes of their program with stakeholders (A.3.g.) (American School Counselor Association, 2019).

Dimmitt et al. (2007) define data-driven decision-making (DDDM) as “a school improvement approach that uses quantitative data analysis techniques to help describe problems and to direct activities and resource allocations” (p. 17). The objective of DDDM is to move educators, schools, districts, and states from being "data rich but information poor" to using data and transforming them into actionable knowledge (Mandinach, 2012).

Data-driven school counseling programs (a) use data-driven approaches to determine student needs, (b) identify research-supported interventions to address the previously identified student needs, and (c) evaluate the impact of the school counseling interventions (Dimmitt et al., 2007).

The data–information–knowledge–wisdom hierarchy (DIKW) (Ackoff, 1989) is one of the earliest models to describe the processes of decision-making. Ackoff defines data, information, knowledge, understanding, intelligence, and wisdom and explores the processes associated with the transformation between these constructs. The implied assumption is that data can be used to create information; information can be used to create knowledge, and knowledge can be used to create wisdom.

This foundational theory paved the way for future DDDM models in education, including the conceptual framework for data-driven decision-making proposed by Mandinach et al. (2008). This theoretical framework is also grounded on a continuum in which data are transformed into information and ultimately to knowledge. At the data level, the two relevant skills are 'collect' and 'organize'. At the information level, the two relevant skills are 'analyze' and 'summarize'. At the knowledge level, the relevant skills are 'synthesize' and 'prioritize'. Once the stakeholder has completed these six steps, a decision is made. The decision is then implemented (or not implemented if complications arise). Finally, the implementation generates an impact, which can then inform the decision-maker if one of the six steps needs to be revisited (creating a feedback loop).

Mandinach et al. (2012) stated, "not having technology to support DDDM is no longer an option because there is too much data to handle manually" (p. 75). However, technology tools in this model are only included in two of the three phases (data and information) as shown in Figure 2. Technology tools in the model are not linked to the final step of Mandinach's framework, prioritizing information for decision-making. Prioritization, according to Mandinach, "allows decision-makers to determine what is the most important, most pressing, the most prudent, or the most rational solution to a particular educational problem" (Mandinach, 2012, p. 8). Models of decision-making specific to school counseling follow that of Mandinach and also do not include the role of technology in prioritizing information, one final phase of the decision-making process.

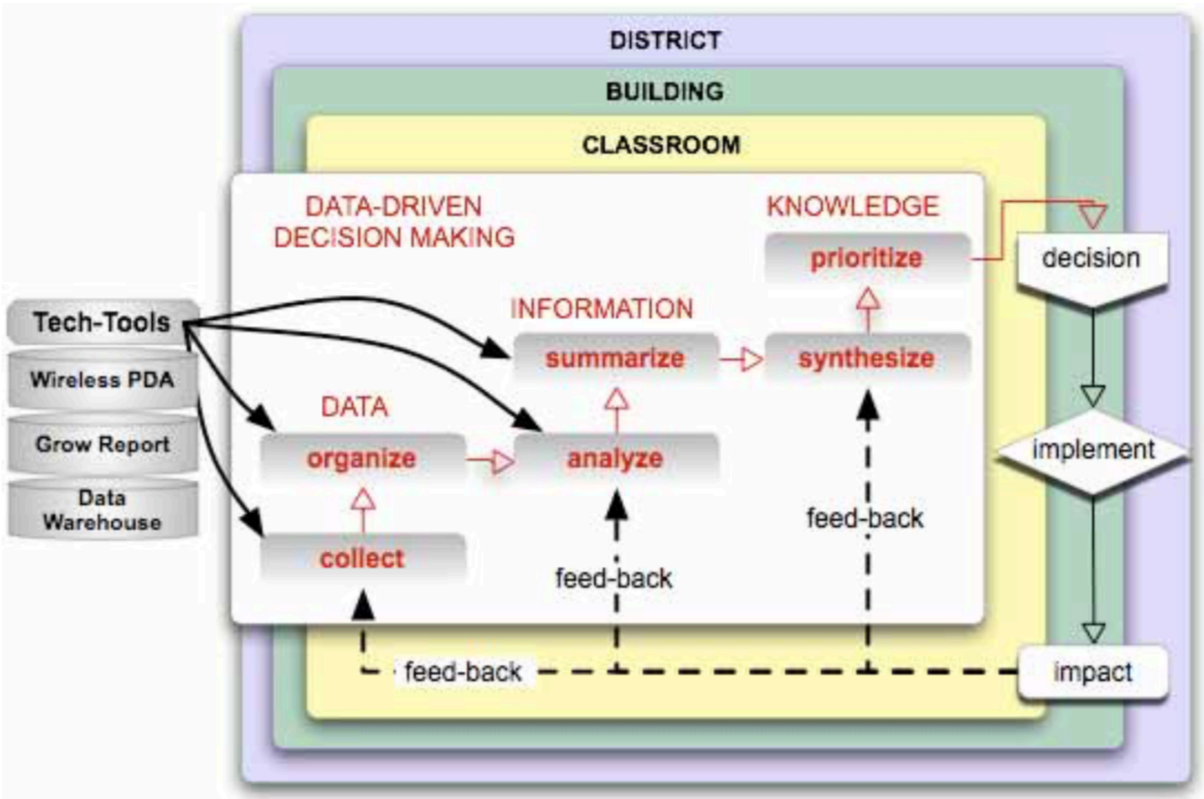


Figure 2: Framework for DDDM Mandinach et al. (2008)

The earliest model of DDDM specific to school counseling was Poynton & Carey's (2006) model for data-based decision-making. This model provided school counselors a sequence to follow for engaging in data-based decision making and was aimed at helping school counselors implement more effective programs. Technology tools in this model were only mentioned in the data analysis and sharing phases. As digitalization efforts increased, later models in school counseling (Dimmitt et al., 2007; Young & Kaffenberger, 2013; Zyromski & Mariani, 2019) evolved to include the role of technology in the data collection, analysis, and sharing phases. However, technology tools are still not present in the decision-making phase of any of these models, perhaps suggesting technology is limited or incapable of prioritizing information for decision-making in school counseling. This research argues that technology is not limited or incapable but is essential for school counselors in this phase of the decision-making process. Table 3 shows a synthesized overview of the phases in foundational and current DDDM models.

Table 3: Foundational Models of Data-Driven Decision-Making in IS and School Counseling

| | | *Collect and Organize Data* | *Analyze & Transform Information* | *Prioritize Information & Decision-Making* | *Evaluate Intervention* | *Share Results* |
|---|---|---|---|---|---|---|
| ***Ackoff (1989)*** | *Phase* | X | X | X | X | |
| | *Technology* | | | | | |
| ***Poynton (2006)*** | *Phase* | X | X | X | X | X |
| | *Technology* | | X | | | X |
| ***Dimmitt, Carey, and Hatch (2007)*** | *Phase* | X | X | X | X | |
| | *Technology* | | X | | | |
| ***Mandinach (2008)*** | *Phase* | X | X | X | X | |
| | *Technology* | X | X | | | |
| ***Young and Kaffenberger (2013)*** | *Phase* | X | X | X | X | X |
| | *Technology* | | X | | X | X |

## Identifying Interventions in School Counseling

Identifying and implementing evidence-based interventions, one phase of the DDDM process in school counseling, and similar to prioritizing information for decision-making (Mandinach, 2012), is a more recent focus for the counseling profession (Zyromski & Mariani, 2019). Using evidence-based or research-based interventions can help school counselors feel more confident that what they are doing will make a difference and meet the needs of their students.

Evidence-based interventions are those which have been evaluated using strong research. “Strong research means randomized control trials (RCT) or quasi-experimental (QE) studies, published in peer-reviewed professional journals, indicating that students who participate in the intervention change more than those who do not” (Brigman, Villares, & Webb, 2017, p. 24).

Research-based interventions have not gone through a robust research process, but may still hold some merit and provide a starting point for researchers to evaluate whether an intervention is of sound practice (Zyromski & Dimmitt, 2019; Zyromski et al., 2018).

Despite the benefits of using evidence-based or research-based interventions, it is challenging for school counselors to identify and implement them. There is an "ongoing challenge getting information to practitioners and counselor educators so that they can use what is now known about effective school counseling practice" (Zyromski & Dimmitt, 2019, p. 3). While there are several interventions available to school counselors, many school counselors are unaware of avenues for finding evidence-based interventions (Zyromski et al., 2018). Research shows that currently school counselors who do try to identify evidence-based or research-based intervention, find them by searching through information on national websites or school counseling and other professional journals (Zyromski et al., 2018).

School counselors frequently collect and analyze student data but then implement interventions chosen due to their ease, affordability, or availability (Zyromski et al., 2018). Zipf's principle of least effort states that an individual will adopt a course of action that requires the least amount of work (Zipf, 2012). The principle of least effort predicts information seekers will minimize the effort necessary to obtain information, even if it means accepting a lower quality or quantity of information (T.-P. Liang, H.-J. Lai, & Y.-C. Ku, 2006).

The field of school counseling is similar to other organizations that must search extensively for relevant information (Aladwani, 2002) and do not know what information is available, where to find it, and what information is consistent, up-to-date, and correct (Laumer, Maier, & Weitzel, 2017). The disarray of using data to drive decisions is typically referred to as information chaos or information overload (Beath, Becerra-Fernandez, Ross, & Short, 2012; Brocke, Simons, Herbst, Derungs, & Novotny, 2011; Roetzel, 2019).

Furthermore, sifting through interventions on databases, websites, and journals require a great deal of time from a population who often report time as one of their major challenges (Devoss & Stillman, 2011). A DSS is advanced software that can assist school counselors in overcoming the information retrieval problem they currently face, help them identify and prioritize information, and save them time. A DSS sifts through and analyzes massive amounts of data, and compiles comprehensive information that can be used to solve problems and aid in decision-making (Power, 2013).

# CHAPTER 4

# DEFINE OBJECTIVES OF A SOLUTION

## Decision-Support Systems

In 1965, Michael Scott Morton was one of the first to define DSS as "using a computer to support the decision-making of a manager" (McCosh, 2004). Research on DSSs evolved from two areas of research: the theoretical study of organizational decision-making done at the Carnegie Institute of Technology in the late 1950s, and later the technical work on interactive distributed systems mostly carried out at the Massachusetts Institute of Technology in the 1960s (Keen & Morton, 1978). Research gained momentum in 1979 when several case studies were published (Keen & Morton, 1978); however, it wasn't until the late 1990s, with the expansion of the World Wide Web and handheld computers, the modern era of DSS research began (Glykas, 2012). As modern DSS systems are more complex and diverse in functionality than earlier systems, the definition has evolved to "any active computer-based support system for making decisions in any complex system, when individuals and/or a team of people are trying to solve unstructured problems on an uncertain environment" (Glykas, 2012, p. 300).

DSSs are usually comprised of data stored in a knowledge base, an inference engine, and a user interface.

- **Knowledge base:** The knowledge base serves as a data bank for the DSS. Data in a knowledge base is stored in such a way that information can be accessed through computerized applications.
- **Inference engine:** The inference engine sets logical rules for the system to help the user make a decision based on stored information as well as new information added (Hayes-Roth, Waterman, & Lenat, 1983).
- **User interface:** The user interface provides the link between the user, the data in the knowledge base, and the inference engine (Sugumaran & Degroote, 2011). The user interface (UI) consists of everything the user comes in contact with while using a particular system. This includes, but is not limited to, physical, perceptual, and conceptual aspects of the system (Satzinger & Olfman, 1998).

These three components can be found in many DSS architectures and play a prominent role in their structure (Glykas, 2012).

There are five types of DSSs according to the taxonomy of decision-support systems (DSSs) proposed by (Power, 2002): communication-driven, data-driven, document-driven, knowledge-driven, and model-driven. For this research, a knowledge-driven decision-support system will be utilized as these systems store and retrieve knowledge codified as probabilities, rules, and relationships (Power, 2013) and recommend actions to a user based on an analysis of the knowledge base (Glykas, 2012).

Knowledge-driven systems provide recommendations that aid the user in selecting an appropriate alternative to a problem at hand (Glykas, 2012). Knowledge-driven DSSs are often referred to as management expert systems or intelligent decision support systems. They focus on knowledge and recommend actions to managers based on an analysis of a particular knowledge base. Moreover, they have specialized problem-solving expertise and are closely related to data mining/sifting through large amounts of data to produce content relationships (Glykas, 2012, p. 310). This research will use the general term decision-support system (DSS) when referring to the proposed knowledge-driven decision-support system.

DSSs have been shown to assist in decision-making processes and solve problems in a variety of industries. Jung & Chung (2016) designed and developed a knowledge-based dietary nutritional recommendation system for obesity management to encourage healthy habits and prevent socioeconomic losses. Yang et al. (2016) used a DSS to discover essential elements that allow a smart class, or a class that enables collaboration, sharing, and participation between teachers and students, to achieve positive effects in education. Rho et al. (2016) developed a standard data model for a DSS on adverse drug reactions and found this model was an effective method for early decisions on adverse drug reactions. Park & Han (2016) used a DSS to detect content polluters on social networks by using an approach based on automatic knowledge acquisition from behavioral patterns.

These examples demonstrate how effective DSSs can be at solving “wicked problems” (Hevner et al., 2004); in this case, the problems school counselors face identifying evidence-based interventions and utilizing technology.

# CHAPTER 5

# DESIGN & DEVELOPMENT OF ARTIFACT

A DSS for school counselors must be designed in a way that will quickly and efficiently assist them in identifying interventions. This system should not only include the necessary components of a DSS and limit the amount of information provided to users, but also be designed using design principles and theory.

## Artifact Design

The design principles measured in this study stem from a combination of two well-established research instruments that measure user satisfaction of a system, the IBM Computer System Usability Questionnaire (CSUQ) (Lewis, 1995), and the customized service portion of SERVQUAL (Parasuraman et al., 1988).

The CSUQ was created by IBM researchers in 1995 to identify constructs that influence a user's satisfaction with a system. The outcome of the research identified the following three constructs: 1) system usefulness, 2) information quality, and 3) interface quality (Lewis, 1995). Recent research shows these constructs, or design principles, still influence the user's satisfaction of a system (Perez Medina et al., 2019). Tullis and Stetson (2006) conducted a study to determine the effectiveness of some of the standard questionnaires to measure formative usability and found that the CSUQ was one of the most effective questionnaires.

Since the development of the CSUQ in 1995, advancements in data mining and processing have allowed system designers new methods of customizing data. Customization of data can have a tremendous impact on user satisfaction if the customer feels the data is personalized to his or her needs (T.-P. Liang et al., 2006). Liang et al. (2006) researched customization on a user's satisfaction using questions adapted from the customized service portion of SERVQUAL (Parasuraman et al., 1988) and found customization can indeed increase user satisfaction through an accurate recommendation of relevant content.

To develop the DSS, the design principles, information quality, interface quality, and customization were incorporated into the three components of a DSS, as outlined in Table 4.

System usefulness was included in this research as it measures whether or not school counselors perceive the system as being capable of solving the problems they currently face.

Table 4: Incorporation of Design Principles into the DSS Components

| **Components of a DSS** | **Design Principle** |
|---|---|
| Knowledge Base/Data Sources | Information Quality |
| Inference Engine | Customization |
| User Interface | Interface Quality |

## Knowledge Base/Data Sources

Three different data sources were used to build the knowledge base in this research: CTESurveys.com, What Works Clearinghouse, and school improvement plans from over 200 school counselors in the Rocky Mountain Region of the United States.

CTESurveys.com is an information system software that secondary school counselors currently use to collect data from stakeholders (students, parents, and teachers) to identify the needs of their counseling programs. After the data is collected, it is then transformed into information in the form of analytic reports, showing areas in greatest need of attention. Questions asked on the surveys align with mindsets and behaviors established by the American School Counseling Association and are organized in three broad domains: Academic, Career, and Social/Emotional development (American School Counselor Association, 2019). The purpose of these domains is to enhance the learning process and create a culture of college and career readiness for all students (American School Counselor Association, 2019). These domain areas also align with national regulations, such as the competencies of the Common Core State Standards Initiative.

The What Works Clearinghouse (WWC) is a federal resource of evidence-based information about education programs, policies, and interventions that show promise for improving student outcomes (Polanin, 2019). This website offers many evidence-based and research-based interventions school counselors can filter through and learn about their impact on student outcomes.

Each year school counselors submit data projects to the State Board of Education, demonstrating they understand the needs of their schools and have implemented strategies to meet those needs effectively. Although these data projects contain strategies that do not meet the definition of evidence-based interventions, they may provide a good starting point for other schools facing similar issues. The third data source for the system is over 200 intervention plans that have been collected from school counselors over the past two years in the Mountain West Region of the United States.

These sources were used to build the knowledge base as they all contain either research-based or evidence-based interventions; the quality information counselors are currently lacking.

**Design Principle: Information Quality**

Information quality refers to the information being presented and its consistency in meeting the user's expectation (Office of the Chief Information Officer, 2003). While often understudied, the importance of information quality remains essential as a critical component of information systems (Petter, Delone, & McLean, 2008). The relationship between information quality and user satisfaction is strongly supported in the literature (Iivari, 2005; Wu & Wang, 2006). Gatian (1994) found that information quality was related to decision-making efficiency. Information quality has also been found to be associated with the quality of work and time savings (D'ambra & Rice, 2001; Shih, 2004) and decision-making satisfaction (Bharati & Chaudhury, 2010).

This research refers to "information quality" as the quality of the information provided to school counselors to help them identify interventions. Information quality also refers to the information being presented and its consistency in meeting the user's expectation (Office of the Chief Information Officer, 2003). Additionally, information quality involves correcting defective or incomplete data and implementing improvement procedures that are maintained adequately. We will use the following design principles to evaluate the perceived information quality (Office of the Chief Information Officer, 2003).

1. **Data Definition and Information Architecture Quality**: Proper information definition accurately describes the meaning of the real-world object or event that the data represents and meets the needs of all information customers to understand the data they use
2. **Data Content Quality**: Content quality cannot be measured without a quality definition. Data content quality is the degree to which data values accurately represent the

characteristics of the real-world object or event and meet the needs of the information customers to perform their jobs effectively.

3. **Data Presentation Quality**: Data presentation quality is the degree to which the information presented enables the knowledge worker or end customer to apply the information efficiently and effectively.

## Inference Engine

To build the inference engine, an expert in the field provided the knowledge needed to link the issues counselors are facing to interventions by following Straus & Corbin's (1998) open coding method.

Open coding was used to conceptualize raw data by naming and categorizing the phenomena through a close examination of the data. Two independent coders examined both the interventions as well as the questions asked on CTESurveys.com and categorized them into categories that fit the objectives and competencies of the ASCA model. Having two independent coders ensured that there was no coding bias. Following this coding process set the logical rules for the system to help the system make recommendations from the stored information in the knowledge base. These rules set the bounds to ensure the content provided to counselors was customized to their specific needs.

### Design Principle: Customization/Personalization

Customization, also called personalization, refers to offering a product or service that is tailored to an individual's needs and preferences as opposed to staple articles (Fels, Falk, & Schmitt, 2017). Customization removes irrelevant information and provides only the most critical pieces of information to the users. Accurate content recommendations reduce the effort needed by a user to search for relevant information, and can, therefore, increase user satisfaction (T.-P. Liang et al., 2006).

This research will apply the same principle to determine the user's satisfaction with the proposed IT artifact. Presenting data in a flexible and adaptable way will allow counselors to go beyond the visual appeal and representation of the information, enabling them to make decisions easier and more efficiently (Sandouka, 2019).

Using the principle of customization will allow the DSS system to display relevant information upon each request. To show the interventions displayed by the system are customized, the system will present issues a school is facing (determined by data analysis reports currently provided by CTESurveys.com), in combination with specific, customized interventions. Customized design principles include relevant content and data that is in context (Chen, Härdle, & Unwin, 2008). Customization design principles ensure information is individualized to the school, and interventions are adapted to the needs of the school counselor.

## User Interface

The user interface for non-technical fields must be designed in such a way that it does not hinder the function of the system. The main goal of a UI is to produce an efficient, enjoyable, and user-friendly interplay with the system that minimizes input to achieve the desired output (Shneiderman & Plaisant, 2010).

### Design Principle: Interface Quality

The quality of the interface is related to the user's attitude in the use of the system (Perez Medina et al., 2019). The user interface (UI) is the human-computer interaction that bridges the connection between decision-making processes and the end-users.

The main goal of a UI is to produce an efficient, enjoyable, and user-friendly interplay with the system that minimizes input to achieve the desired output (Shneiderman & Plaisant, 2010). To do this, specific principles must be implemented throughout the development of a system. These principles include widely applicable laws, guidelines, biases, and design considerations applied by designers of systems (Interaction Design Foundation, 2019). These principles derive from many disciplines, such as behavioral science, sociology, physics, and ergonomics.

While many UI's are becoming more complex as the vast amount of devices vary in screen size and graphic processing power, the six guidelines discussed by Smith and Mosier (1986) still apply today.

1. Consistency of data display
2. Efficient information assimilation by the user

3. Minimal memory load on the user
4. Compatibility of data display with data entry
5. Flexibility for user control of data display

A widely accepted user interface design ensures consistency in the interface. Consistency involves the end-user throughout the design and development of the system to facilitate ease of learning and use of the system (Satzinger & Olfman, 1998). The user's mental model or schema of the knowledge of an application, coupled with the process of applying such knowledge is referred to as transfer of learning. However, the complexity of interfaces on the various devices makes it nearly impossible to ensure consistency. Thus, the key to understanding the processes behind the development of such systems relies heavily on the user's mental models (Satzinger & Olfman, 1998). Thus, it is critical in the development of the UI to understand end-users, in this case, school counselors.

In school counseling, CSE is low as many still lack the confidence, comfort, and skills to use technology (Steele et al., 2015; Young & Kaffenberger, 2015) and many still report concerns about the time it may take to learn to use new technology (Devoss & Stillman, 2011). This is not to say that the audience is incapable of recognizing the value in technology but rather, it acknowledges a natural deficiency that exists and needs be overcome or changed in such a way that school counselors can feel capable of successfully using technology to help them accomplish tasks (Steele et al., 2015).

Within the last three years, roughly 95.9% of secondary schools in the state of Utah have used CTESurveys.com. Because school counselors in this study currently use CTESurveys.com, the design of its interface was used to build a similar interface for the DSS. This allowed the researcher to ensure consistency and facilitate ease of learning and using the new system.

## Design Principle: System Usefulness

While school counselors are compelled to adopt technology, the new implementation of technology in school counseling must rely heavily on the perceived usefulness of a system (Anni & Haryono, 2018; Mason et al., 2018). System usefulness refers to the opinion of users regarding the ease of use, learning, speed of operation, efficiency in completing tasks, and subjective feeling (Perez Medina et al., 2019).

The Technology Acceptance Model (TAM) proposed by Davis (1989) theorizes that behavioral intention (BI) to use a system is determined in part by a user's perceived usefulness, defined as the extent to which a person believes that using the system will enhance his or her job performance. Note the use of the word "perceived" in this definition. Whether technology is efficient, effective, revolutionary, or anything else, Davis found that perceptions make all the difference in the acceptance of that technology.

When speaking specifically of school counselors, perceptions of usefulness matter in terms of whether or not the tool should be used. The personality and aptitudes of school counselors are those of interpersonal, caring individuals who like to work with people, and who value connections with them. Technology cannot threaten such valued interactions if one hopes to achieve acceptance in the counseling profession (Coy & Minor, 1997; Evraiff & Evraiff, 1997; Preble, 2016). The definition of what is useful and useable is up to school counselors and will be defined by their perceptions (Venkatesh, 2000).

Because a lack of time is often cited as one of the significant challenges of the modern school counselor (Devoss & Stillman, 2011), school counselors need to believe technologies can make their many required tasks easier and quicker. It thus becomes a great paradox, that technology can help save school counselors time, but only if school counselors find time to use the new technology. Technology adoption in the field of school counseling will be much more likely if counselors not only perceive new technology as useful, but also capable of helping them overcome the challenges they face, including using data to drive decision-making and identify interventions.

# CHAPTER 6

# DEMONSTRATION

## Research Approach

To demonstrate the utility of the IT artifact and to determine the influence of the design principles on user satisfaction, a field study was conducted, and an online survey administered for the initial evaluation. Field studies are non-experimental inquiries occurring in natural systems (Boudreau, Gefen, & Straub, 2001) and allow the researcher to evaluate the artifact in multiple settings (Hevner et al., 2004). After obtaining IRB approval (Appendix B), a representative of CTESurveys.com sent an email invitation and consent form to the users of the website asking them to participate in the study. Once school counselors agreed to participate, the representative then sent them a follow-up email with instructions on how to use and interact with the DSS, the data analysis report with the decision-support features outlined in this study, and a link to complete an anonymous online satisfaction survey. A survey design provides a quantitative description of some fraction of the population, that is, the sample through the data collection process of asking questions (Fraenkel & Wallen, 1995). Yin (1989) states a survey design in an appropriate method for answering questions relating to who, what, where, how many and how much, focuses on contemporary events, and does not require control over behavioral events. For these reasons, a field study and online survey were deemed appropriate methods for answering the research question, "*what influence do specific design principles have on secondary school counselors' satisfaction of a DSS?*

To facilitate the process of learning a new technology, the DSS was integrated into analyzed reports provided by CTESurveys.com. School counselors in the study were already familiar with this site, including the design of the user interface, as schools have been using it for the past five years to gather data from stakeholders and determine the needs of their school counseling programs. CTESurveys.com used data from each school participating in the study to determine the needs of that counseling program, and create an analyzed report, another process familiar to school counselors in the study. New to counselors in the study was the DSS that was incorporated into the analyzed reports and provided three to five possible interventions in the form of links for each identified need (Figure 3).

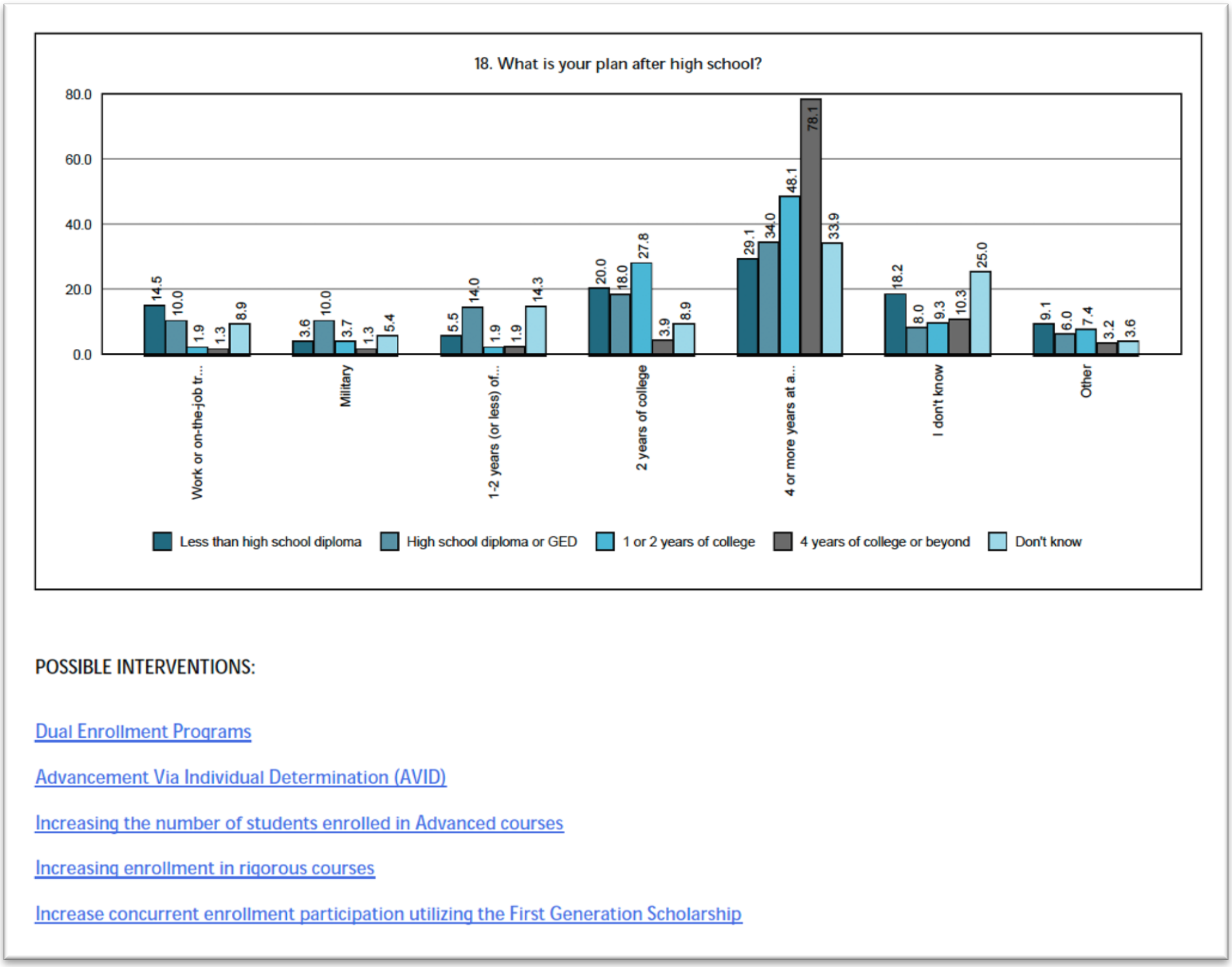


Figure 3: Analyzed Report Showing Possible Interventions

After clicking a hyperlink in the analysis report, the system navigated school counselors to another webpage with the additional details of the specific intervention (Figure 4). These additional details included the type of intervention (evidence-based or research-based), the source of where the intervention originated from (the knowledge base source) and links to supporting documentation.

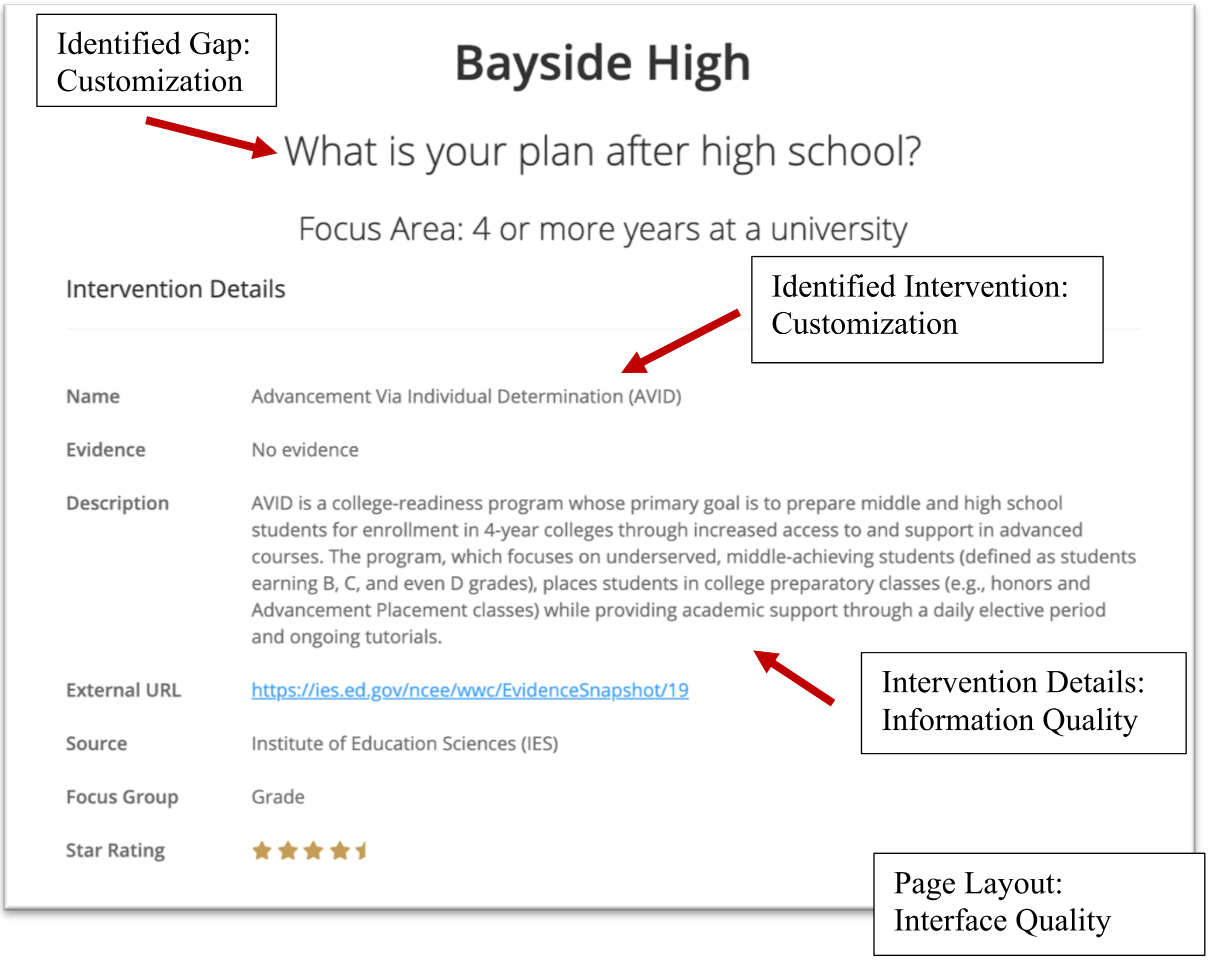


Figure 4: Example of Interventions Suggested by the DSS

## Survey Instrument

After interacting with the system, school counselors then completed an anonymous online satisfaction survey, administered through Qualtrics. The survey used for this study modified questions from The Computer System Usability Questionnaire (CSUQ) and the SERVQUAL. The CSUQ is a validated instrument that usability practitioners apply in the evaluation of usable systems. This 19-item instrument is used for assessing user satisfaction with system usability and allows participants to provide an overall assessment of the system they used. This measurement was chosen as it is appropriate for a field-testing situation and focuses on measuring: (1) the usefulness, (2) the quality of the information, and (3) the quality of the interface (Lewis, 1995). This instrument also allows the addition of items to questionnaires when particular circumstances suggest the need (Lewis, 1995), in this case, measuring the additional design principle, customization.

To measure customization, this research also modified questions from the customized service portion of SERVQUAL, a multiple-item scale for measuring consumer perceptions of service quality (Parasuraman et al., 1988). This concise multiple item instrument has excellent reliability and validity and is valuable when used in conjunction with other forms of system satisfaction measurements (T. Liang, H. Lai, & Y. Ku, 2006).

Questions were theoretically derived from past research and were contextualized for evaluating the design principles outlined in this research and helping counselors better understand the terminology. For example, on the satisfaction survey given to counselors, the word "system" (taken from the CSUQ) was changed to "interventions," as this term is more familiar to school counselors. These questions were asked on a 7-point Likert-scale, as suggested by Lewis (1995) and coded to quantify the responses (Table 5).

Table 5: 7-Point Likert Scale Coding

| *Likert Coding Scale* | |
|---|---|
| *Strongly agree* | 1 |
| *Agree* | 2 |
| *Somewhat agree* | 3 |
| *Neither agree or disagree* | 4 |
| *Somewhat disagree* | 5 |
| *Disagree* | 6 |
| *Strongly disagree* | 7 |

The survey questions used to measure the variables in this research were explicitly created for this study. In addition to these theoretical derived questions, demographic questions were also added to the survey instrument to allow for additional analysis. Questions asked can be found in Appendix A.

## Participants

Study participants were secondary high school, middle school, or intermediate/middle school counselors currently working in public schools in Utah and active users of CTESurveys.com.

Fifty-eight school counselors completed the satisfaction survey. The sample population consisted of 23 high school counselors (40%), 17 junior high school counselors (29%), and 18 middle school counselors (31%). Additionally, six participants had been practicing school counselors less than two years (12%), 10 participants had been practicing 2-4 years (19%), 15 participants 5-10 years (29%), and 21 participants had been in the field for more than 10 years (40%) as shown in Table 6. School counselors who completed the survey and evaluated the DSS had over 588 years of collective experience in the field. The years of experience as a practicing school counselor ranged from 1 year of experience (counseling intern) to roughly 30 years in the field.

Table 6: Sample Population Years of Experience

*Descriptive Statistics of School Counselors'*

| | **Experience** | **Age** |
|---|---|---|
| **Mean** | 10.15 | 45.5 |
| **Median** | 8 | 45 |
| **Standard Deviation** | 8.04 | 9.31 |
| **Skewness** | 0.93 | .03 |
| **Minimum** | 1 | 27 |
| **Maximum** | 30 | 63 |
| **Count** | 58 | 57 |

The sample population of school counselors in this research accurately represents the population of all school counselors. By comparing the gender and age of the sample population to that of all school counselors identified by the National Survey of School Counselors (2012), gender for both populations are almost identical and not statistically significant at a 95% confidence level, as shown in Table 7. The age ranges for both the sample population and the actual population were nearly identical; however, the p-value was not calculated as the actual population data were not available to conduct the analysis.

Table 7: Comparison of Sample Population to Actual Population

| | ***Sample Population*** | ***Actual Population*** | ***P-Value*** |
|---|---|---|---|
| *Female* | 79% | 78% | .4123 |
| *Male* | 21% | 22% | .4562 |
| *Age Range* | 27-63 | 25-65 | N/A |

The "rule of 10" and G*Power were both used to determine the needed sample size for this research. Using the PLS-SEM "rule of 10", a commonly used principle to assess significance and power of the sample, participant count needs to be at least ten times the largest number of formative indicators used to measure a single construct, or ten times the largest number of structural paths directed at a particular construct in the structural model (Hair, 2017). The proposed path model (Figure 9) shows four structural paths directed at the dependent variable. Therefore, a sample size of 40 is needed to satisfy the requirements of the "rule of 10".

G*Power, a commonly used statistical analysis tool, uses Cohen's guidelines (1988) to determine the number of responders needed in a study. This approach allows the researcher to set appropriate $\alpha$ (probability of Type I false positive) and $\beta$ (Probability of Type II false negative) values in combination with the number of latent variables. A value set of $\alpha$ = 0.05 is conventional for information systems and social science research, and a $\beta$ of .80 is also commonly used to determine the requisite sample size. The relationship between $\alpha$ and β is shown in Figure 5. G*Power revealed 55 school counselors were deemed the necessary sample size for the proposed path model based on an $f^2 = 0.15$, two-tailed, $\alpha = 0.05$, power = 0.80 ( $\beta$ = 0.20), and 4 predictors (Figure 5).

These finding indicate the sample population of 58 school counselors is sufficient in meeting the requirements for both the "rule of 10" and G*Power.

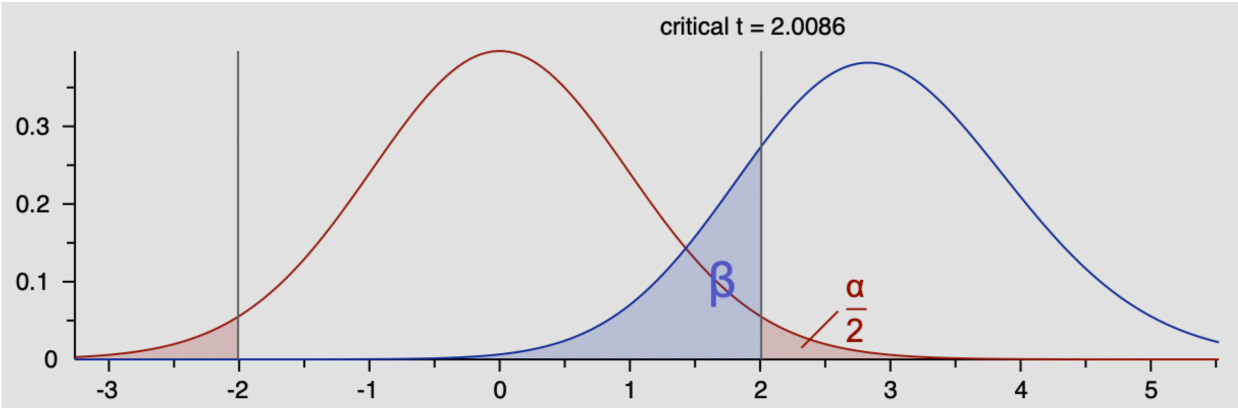


Figure 5: Relationship between α (Type I False Positive) and β (Type II False Negative) levels using G*Power

# CHAPTER 7

# EVALUATION

Before evaluating the survey responses, the data were assessed for any suspicious response patterns, outliers, or missing values. The data is positively skewed in the years of experience of the school counselors. This indicates that most counselors in this research had fewer years of experience in the field. While this is interesting to note, it did not have a significant impact on the results as counselors with more years of experience had similar patterns of responses in the survey to those with less years of experience.

Values incorrectly formatted were modified to allow for easier analysis. For example, if a participant responded “10 years” for how many years they have worked as a counselor, the number was changed to the integer “10”. There were less than 5% of missing values per indicator, and those that were missing were treated using mean replacement (Hair et al., 2014).

## User Satisfaction

To evaluate if the IT artifact helped school counselors in the DDDM process and in identifying meaningful interventions, user satisfaction was calculated for each of the design principles. Lewis (1995) states user satisfaction for each principle is determined by calculating the average response of each question relating to the principle. The average response for "Agree" included those who responded to questions with "Strongly Agree," "Agree," or "Somewhat Agree." The average responses for "Disagree" included those who responded to questions with "Strongly Disagree," "Disagree," or "Somewhat Disagree." School counselors had the option to select "Neither Agree or Disagree" for each question. The summary of responses is shown in Table 8.

Table 8: Response Summary of Agree vs Disagree

| System Usefulness | | Interface Quality | |
|---|---|---|---|
| Agree | 91.77% | Agree | 85.78% |
| Neither Agree or Disagree | 2.81% | Neither Agree or Disagree | 3.88% |
| Disagree | 5.41% | Disagree | 10.34% |

| Information Quality | | Customization | |
|---|---|---|---|
| Agree | 88.62% | Agree | 90.91% |
| Neither Agree or Disagree | 4.48% | Neither Agree or Disagree | 1.30% |
| Disagree | 6.90% | Disagree | 7.79% |

## Components of Structural Equation Modeling

Structural Equation Modeling (SEM) was used to evaluate and explain the influence of the design principles of user satisfaction. SEM is an analytical approach that researchers use to comprehend and understand complex relationships within a given set of multivariate data (Hair, 2017). Structural equation modeling is the process of measuring relationships of a set of dependent variables (Hair, Black, Babin, & Anderson, 2014). This evaluation is appropriate when the primary objective of applying structural modeling is prediction and explanation (Rigdon, 2012). Therefore, an SEM approach to this research will help assess each relationship simultaneously, all while accounting for measurement error associated with each of the scales.

Hair (2017) states the five components necessary for conducting SEM analysis are: 1) composite variables, 2) measurement, 3) measurement scales, 4) coding, and 5) data distributions.

### Composite Variables

Composite variables ensure construct reliability, validity, and internal consistency of the constructs themselves and can be determined using Cronbach's alpha, composite reliability, and average variance extracted (AVE). A Cronbach's alpha provides an estimate of the reliability based on the intercorrelations of the observed indicator variables (Hair, 2017). Values greater than 0.7 show high reliability. Each of the constructs in this research meets or exceeds that threshold, as seen in Table 9. However, using Cronbach's alpha alone may lead to invalid assumptions as the reliability assumes that all indicators are equally reliable (Hair, 2017). For this reason, additional measures of reliability, including composite reliability, and average variance extracted (AVE), were calculated.

Table 9: Construct Reliability Calculations

| | CRONBACH'S ALPHA | COMPOSITE RELIABILITY | AVERAGE VARIANCE EXTRACTED |
|---|---|---|---|
| **CUSTOMIZATION (C)** | 0.867 | 0.917 | 0.787 |
| **INFORMATION QUALITY (IMQ)** | 0.951 | 0.965 | 0.872 |
| **INTERFACE QUALITY (IFQ)** | 0.935 | 0.959 | 0.886 |
| **SYSTEM USEFULNESS (SU)** | 0.977 | 0.981 | 0.881 |
| **USER SATISFACTION (US)** | 0.946 | 0.961 | 0.861 |

Composite reliability allows researchers to gain a better understanding through internal consistency and takes into account the different outer loadings of the variables (Hair, 2017). Composite reliability scores over 0.7 are considered reliable measures, and, as shown in Figure 6, all construct measurements in this study meet this minimum threshold.

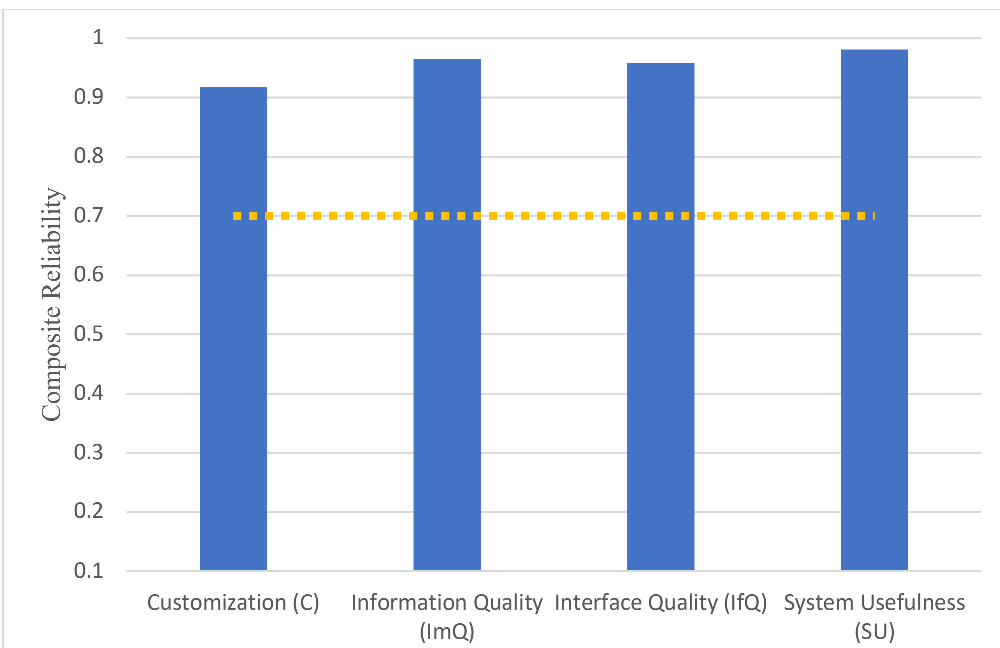


Figure 6: Composite Reliability Measures of Constructs

The last measure used to check for construct reliability was AVE. The AVE evaluates convergent validity of reflective constructs and, like composite reliability, checks the outer loadings of the indicators (Hair, 2017). Calculations greater than 0.5 are reasonable indications that the reliability is high. Figure 7 shows each of the variables of the model, all of which are above the minimum threshold.

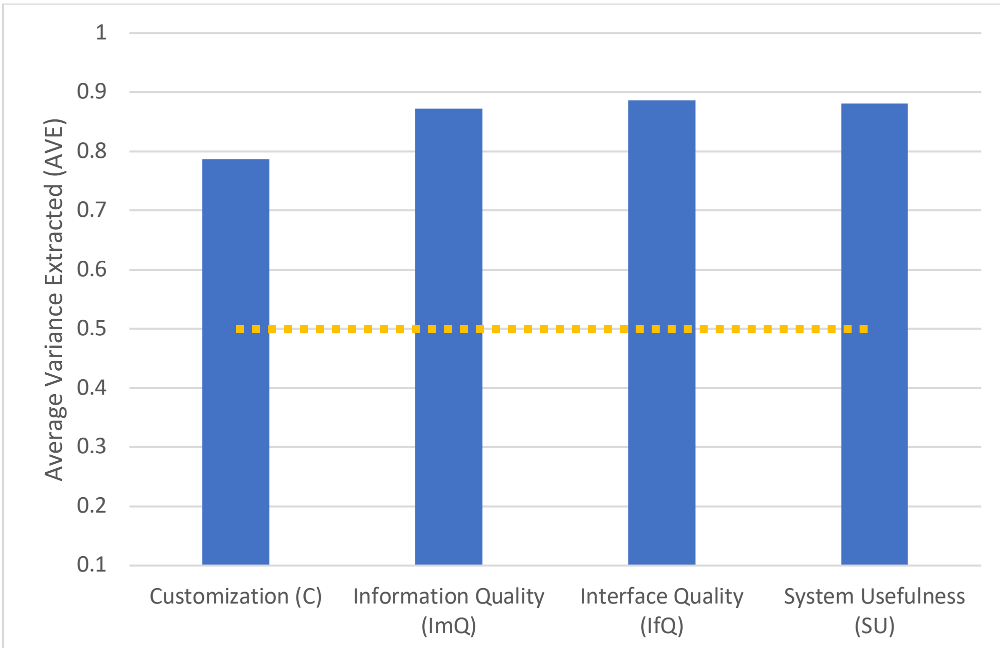


Figure 7: Average Variance Extracted (AVE) of constructs

All of these calculations, Cronbach's alpha, composite reliability, and average variance extracted (AVE), met the specified guidelines and therefore ensures construct reliability, validity, and internal consistency of the constructs themselves.

**Measurement**

Measurement refers to the fundamental concept of assigning numbers to variables based on a set of rules (Hair, 2017). Because we cannot directly measure user satisfaction, we measured specific questions as indicators, and then indirectly measured the constructs and the overall concept of user satisfaction. The design principles identified in this research (system usefulness, interface quality, information quality, and customization) were the constructs used to build the model. These operationalized constructs are defined in Table 10.

Table 10: Construct Definitions for the Proposed Model

| Construct | Definition | Theoretical Support |
|---|---|---|
| **System Usefulness (SU)** | The degree to which the users believe the system is easy to use and/or learn, speed of operation, and/or efficiency in completing tasks. | Lewis (1995) and Perez Medina et al. (2019) |
| **Information Quality (ImQ)** | The degree to which the information being presented is consistent, comprehensive, and meets the user's expectations. | Lewis (1995) and Office of the Chief Information Officer (2003) |
| **Interface Quality (IfQ)** | The degree to which the user interface provides a link between the user, the data in the knowledge base, and the inference engine. | Lewis (1995) and Sugumaran & Degroote (2011) |
| **Customization (C)** | The degree to which data within a DSS is organized and presented in a way that allows the user to feel it is customized and personalized to their specific situation. | Parasuraman et al. (1988),<br>Ling et al. (2006), and Fels, Falk, & Schmitt (2017) |

The assumption is that using multiple constructs, or design principles, to measure a concept (user satisfaction) will be more likely to represent all the different aspects of that concept (Hair, 2017).

## Measurement Scales and Coding

A measurement scale is a tool that has a predetermined number of close-ended responses and can be used to obtain answers to questions. Coding is the process of assigning numbers to categories that facilitates the measurements (Hair, 2017). This research used a 7-point Likert ordinal measurement scale to obtain answers to questions in the satisfaction survey (Table 5) as variables obtained from a Likert scale can be used in SEM (Hair, 2017). Likert scales allow individuals to express how much they agree or disagree with a particular statement and assume attitudes can be measured numerically on a continuum. This research utilized this scale as it was consistent with the survey instrument developed by Lewis (1995).

## Data Distributions

Data distribution refers to the frequency of the observations in the data. While a normal distribution is desirable, PLS-SEM generally makes no assumptions about the data distributions (Hair, 2017). The data distribution in this research is right-skewed (Figure 8), indicating school counselors were more likely to agree than disagree with questions relating to the satisfaction of the system.

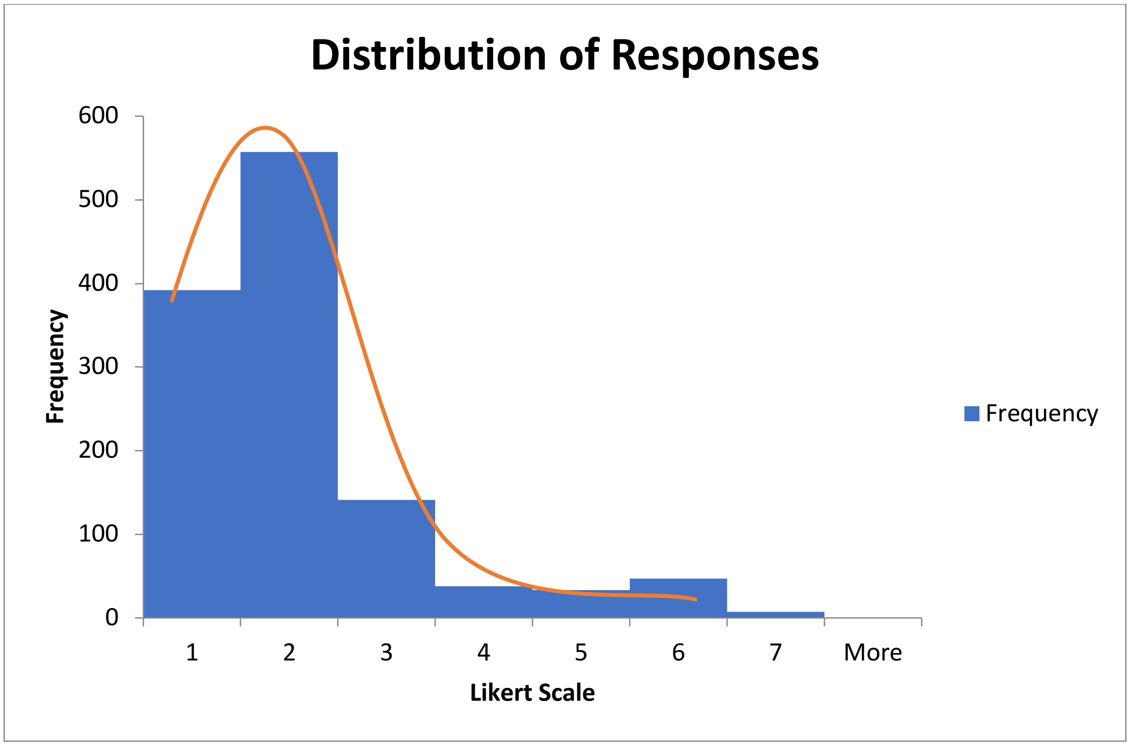


Figure 8: Distribution of Responses

### Structural and Measurement Models

A PLS-SEM model consists of two elements: the structural model (Figure 9), and the measurement model (Figure 10).

### Structural Model

The structural model, often referred to as a path model, represents the theoretically derived constructs and displays the relationships between them. This model also illustrates the hypotheses of the research (Hair, 2017).

The path model was built using SmartPLS, an SEM software that checks for convergent validity, discriminant validity, and significance. This software also allows for latent variable modeling that combines sophisticated and state-of-the-art methods of Prediction-oriented

Segmentation (PLS-POS), Importance-Performance Map Analysis (IPMA), complex bootstrapping, and more.

Because satisfaction can be defined at different levels of abstraction, oftentimes they are represented by first-order components that capture separate attributes of satisfaction (Hair, 2017). The design principles in the path model were the theoretical derived constructs used to measure the user's satisfaction with the DSS in secondary school counseling. The overall structure of the path model is depicted in Figure 9Figure *9* shows each of the constructs (design principles) and the hypotheses. Circles in the path model represent constructs, and the rectangles represent indicators.

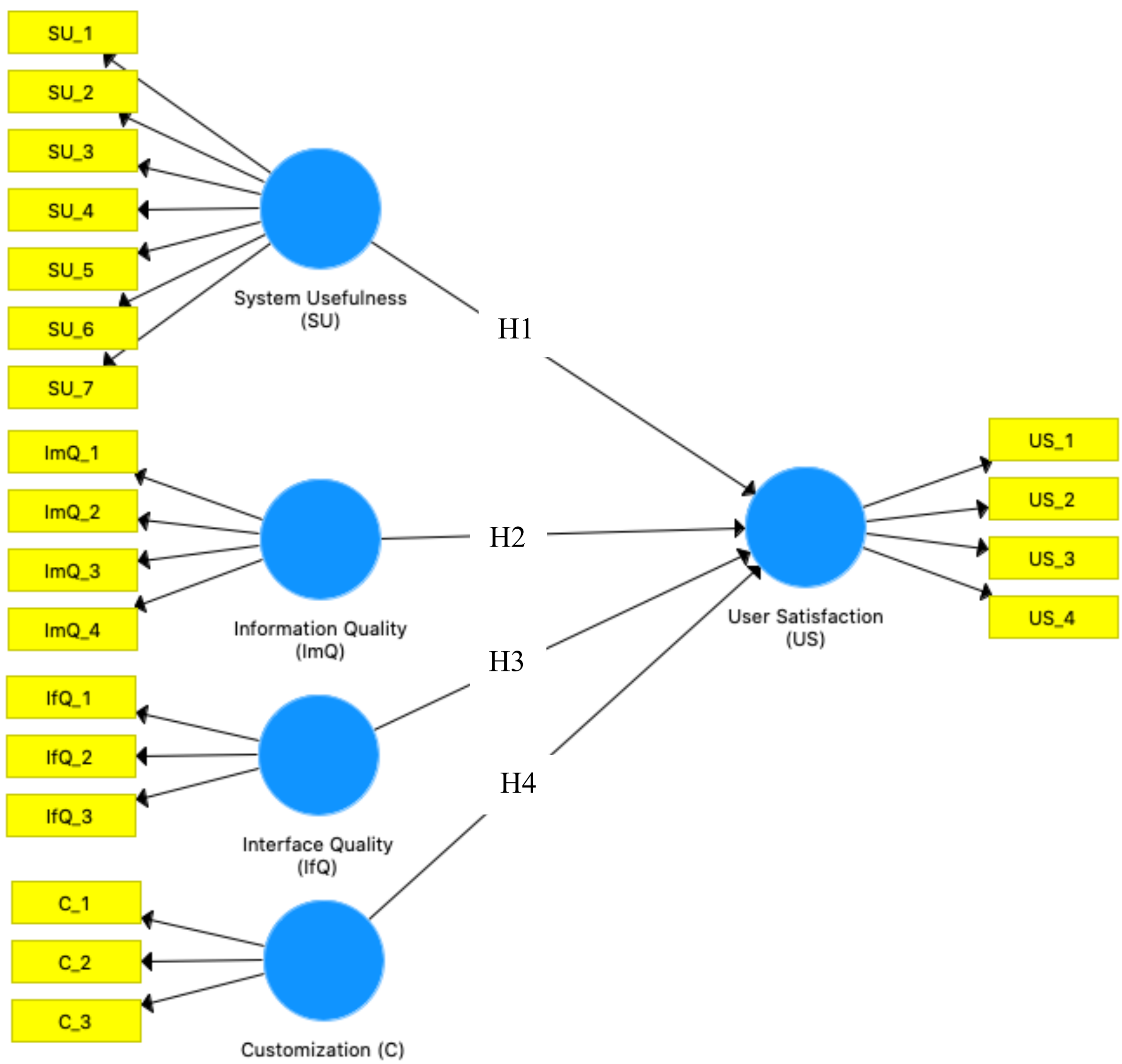


Figure 9: Proposed Path Model & Hypotheses

The relationships between the indicators and the latent variables, as well as the relationship between the design principles and user satisfaction, are displayed in the path model with arrows symboling the hypothesized direction of the relationship. These hypotheses are described in more detail in Table 11.

Table 11: Path Model Hypotheses

| Hypothesis | Explanation |
|---|---|
| **H1** | SU → US: System usefulness is positively related to user satisfaction |
| **H2** | ImQ → US: Information quality is positively related to user satisfaction |
| **H3** | IfQ → US: Interface quality is positively related to user satisfaction |
| **H4** | C → US: Customization is positively related to user satisfaction |

### Measurement Model

The measurement model displays the relationships between the latent variables (design principles and user satisfaction) and the indicator variables (theoretically derived questions). The measurement model determines path coefficients and T-statistics to validate each hypothesis. The strength of the measurement model lies in its ability to decompose the relationships (Schreiber, Nora, Stage, Barlow, & King, 2006).

SmartPLS created the measurement model by analyzing the 58 survey responses to determine the relationships and measurements between the indicators and constructs (Figure 10).

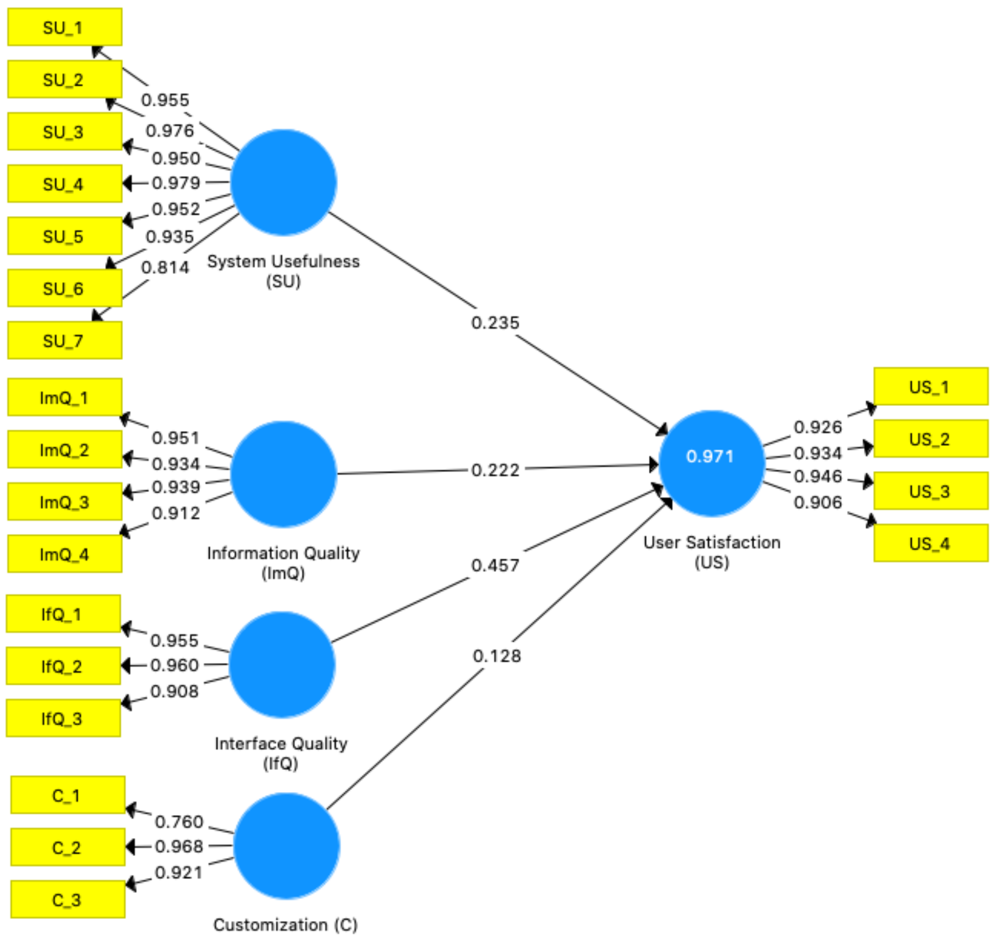


Figure 10: SEM Measurement Model

**Path Coefficients**

A path coefficient calculation is a data analysis measurement used to determine the relations between variables in a multivariate system. This research used the path coefficient to determine the direct effects of the independent variables (design principles) on the dependent variable (user satisfaction). The figures below show each of the path coefficients and the effects each principle has on user satisfaction (Figure 11, Figure 12, Figure 13, Figure 14). If the path coefficient indicators have a positive value, a positive relationship between the independent variables and the dependent variable is shown. A value of +1.0 implies a design principle has a perfect positive influence on user satisfaction. A path coefficient of zero would indicate the design principle and no influence on user satisfaction (Hair, 2017). A path coefficient for each design principle is shown in the figures below.

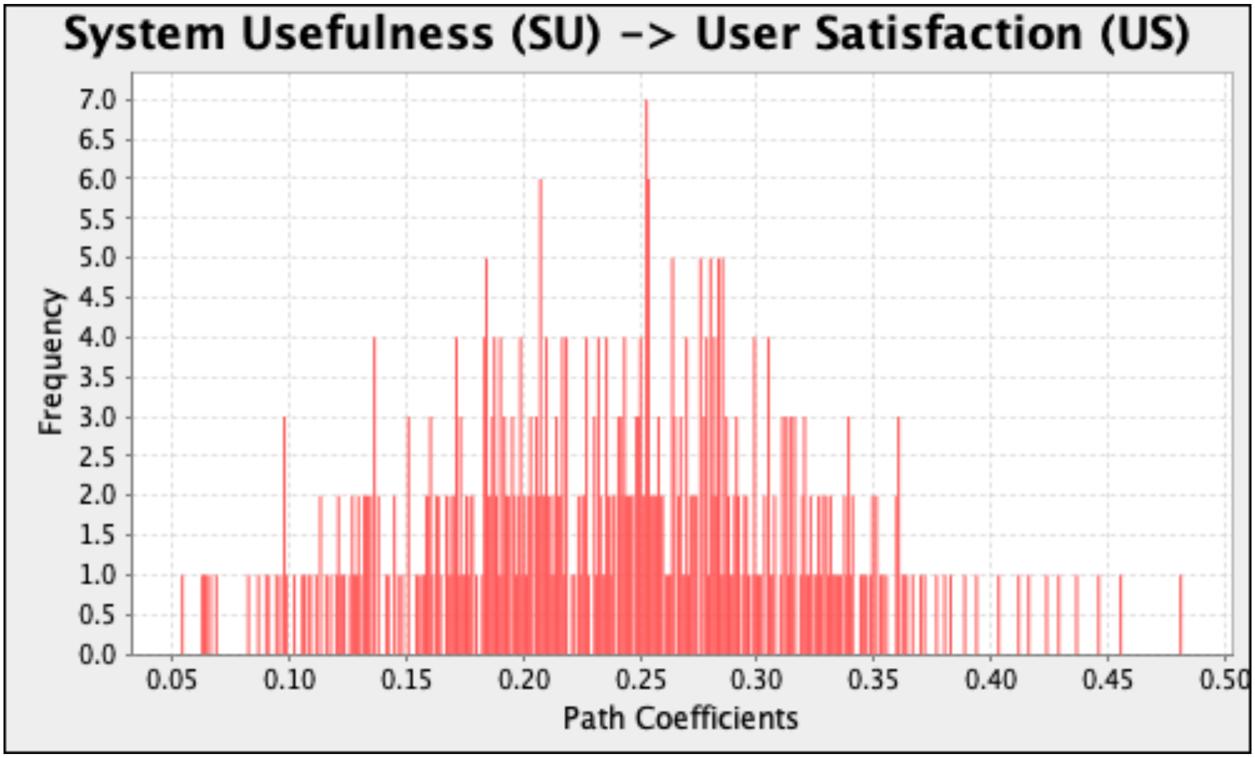


Figure 11: Path Coefficient of System Usefulness and User Satisfaction

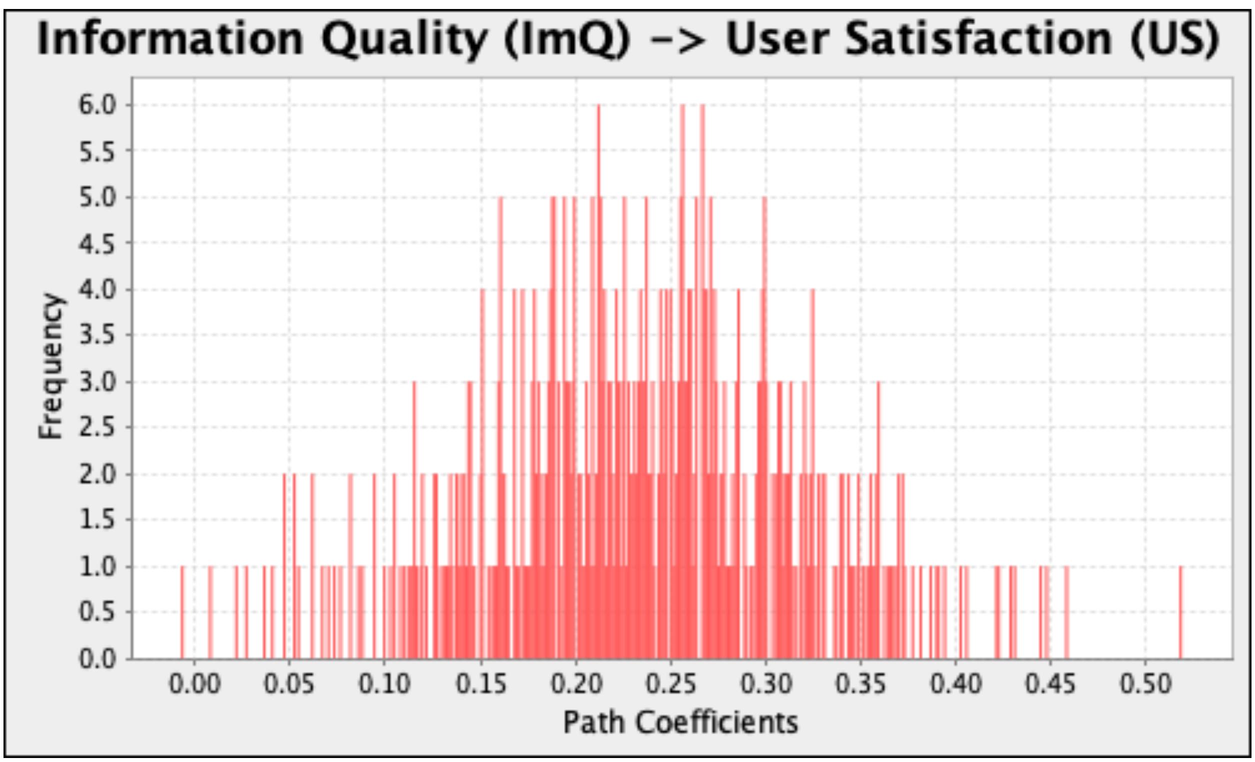


Figure 12: Path Coefficient for Information Quality and User Satisfaction

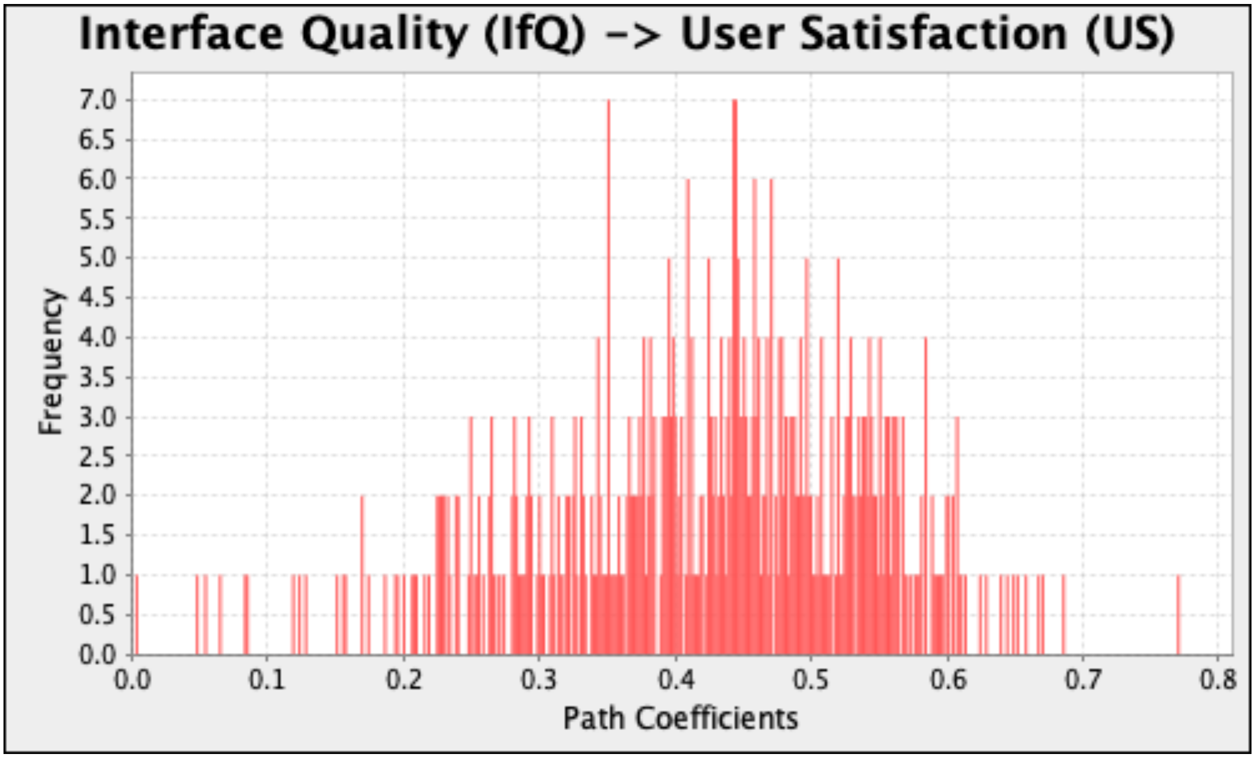

Figure 13: Path Coefficient of Interface Quality and User Satisfaction

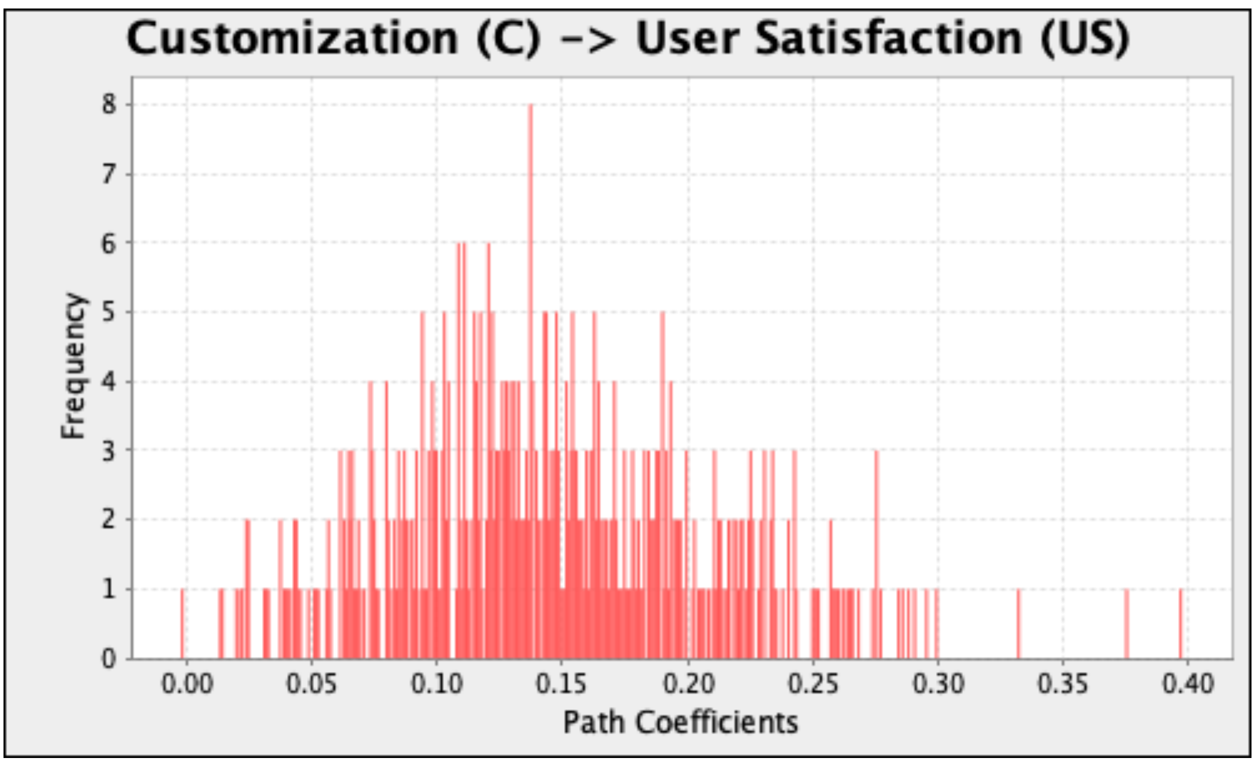

Figure 14: Path Coefficient of Customization and User Satisfaction

**Influence of Design Principles**

Over 97% of user satisfaction is explained by the four constructs used in the measurement model. To determine if the hypotheses were significant (95% confidence level), p values were calculated for each path (Table 12). All p-values below the .05 confidence level are considered to have a significant influence on the dependent variable.

Table 12: Calculation of Significance for Hypotheses

| | ORIGINAL SAMPLE | SAMPLE MEAN | STANDARD DEVIATION | T STATISTICS | P VALUES |
|---|---|---|---|---|---|
| **CUSTOMIZATION (C) -> USER SATISFACTION (US)** | 0.132 | 0.146 | 0.06 | 2.19 | **0.029** |
| **INFORMATION QUALITY (IMQ) -> USER SATISFACTION (US)** | 0.219 | 0.23 | 0.086 | 2.537 | **0.011** |
| **INTERFACE QUALITY (IFQ) -> USER SATISFACTION (US)** | 0.452 | 0.431 | 0.115 | 3.913 | **0.000** |
| **SYSTEM USEFULNESS (SU) -> USER SATISFACTION (US)** | 0.239 | 0.238 | 0.078 | 3.087 | **0.002** |

The average response for "Agree" included those who responded to questions with "Strongly Agree," "Agree," or "Somewhat Agree." The average responses for "Disagree" included those who responded to questions with "Strongly Disagree," "Disagree," or "Somewhat Disagree." School counselors had the option to select "Neither Agree or Disagree" for each question.

# CHAPTER 8

## DISCUSSION

According to Hevner (2004), a design artifact is complete and adequate when it satisfies the requirements and constraints of the problem it was meant to solve. Almost all counselors agreed that they were overall satisfied with each of the design principles: the usefulness of the system, the quality of the information, the quality of the interface, and the customization of the information (Table 8).

The distribution of responses in the data is not a normal distribution but instead, positively skewed. While this may not be ideal for some methods of analysis, in this case, it establishes the usefulness of the system. School counselors agreed the DSS was an easy way to help them identify evidence-based interventions (92%), were satisfied with the quality of the interventions (89%), were satisfied with the interface of the report (86%), and felt the interventions were customized to their school (91%).

Using Cronbach's Alpha, Composite Reliability, and AVE, the reliability, validity, and internal consistency of the constructs were demonstrated. Satisfying these requirements implies the design principles in this research were measured accurately by the indicators.

The measurement model revealed the four constructs explained 97.1 % of the user satisfaction. This model also confirmed all the hypotheses in this research and demonstrated which design principle had the most substantial effect on user satisfaction. Hypothesis three states interface quality is positively related to user satisfaction, which was confirmed with a path coefficient of .457. This design principle had the strongest influence on user satisfaction. The first hypothesis states system usefulness is positively related to user satisfaction, which had the second highest influence on user satisfaction and was confirmed with a path coefficient of .235. Hypothesis two states information quality is positively related to user satisfaction, which had the third strongest influence on user satisfaction and was confirmed with a path coefficient of .222. Finally, hypothesis four states customization is positively related to user satisfaction, which had the lowest influence on user satisfaction and was confirmed with a path coefficient of .128.

The weakest path coefficient was customization (.128). Although it was above the .10 threshold of significance, the limited number or quality of the indicators may have contributed to this outcome.

Counselors who participated in this study had over 588 years of collective experience. This demonstrates the expertise of those evaluating the system. Because the results show that each design principle has a positive influence on user satisfaction, future designs of DSS in school counseling should include these principles.

# CHAPTER 9

# CONTRIBUTIONS

## Contributions to Secondary School Counselors

One significant contribution of this research is the actual development and implementation of the proposed IT artifact and its implementation in a real-life setting. The interface of this system was developed using a similar technology counselors were familiar with, which perhaps helped them overcome any resistance to learning new technology. Understanding systems counselors currently use and then create technology using a similar design, saves counselors time learning new technology.

The results of the evaluation also demonstrate the system was a useful technology for solving the problems facing school counselors and provided a way for them to identify interventions and prioritize information for decision-making. In addition to improving school counselors' daily tasks, the results from this research may also indirectly help students, parents and staff. For example, if school counselors have an information system that helps them identify specific evidence-based intervention plans that address specific student, parent and staff needs, more effective programs can be implemented in the schools to meet those needs. Each evidence-based intervention that is implemented in a school, can address the real and relevant problems facing parents, students, and staff. When school counselors are unable to identify evidence-based or research based-interventions, the strategies they employ may not solve the identified problems of their stakeholders.

It is well known that the demands and responsibilities of school counselors have increased significantly in recent years. Therefore, using a system following the design principles in this research may decrease the time school counselors spend identifying evidence-based interventions, enabling them to dedicate themselves more fully to serving students and other stakeholders.

## Contributions to Information Systems Research

This research also contributes significantly to the field of Information Systems by providing evidence on how design principles correlate to DSSs and how they influence the user-satisfaction in non-technical fields. Furthermore, this research offers a logical and practical approach to building a DSS following design science principles where the IT artifact, in the form of an instantiation, is an effective way to develop and evaluate a solution to a problem. This research is the first to state that these are the principles that directly correlate to components of a DSS. Designers of DSS should incorporate these design principles into their systems. The steps to build a DSS include:

1. Understand the user
2. Collect data for the knowledge base
3. Build logic for the inference engine
4. Build user interface (using designs familiar to the users)

This research also demonstrates the efficacy of DSR to solve problems and build theory. Developing systems following a DSR approach and using theories of design, can positively influence user satisfaction of technology in non-technical fields. The research further validates the IBM tool and SERVQUAL as effective tools to measure constructs relating to user satisfaction.

## Contributions to Theory and Model Development

As previously stated, technology can and should be utilized in all phases of DDDM. For this reason, I propose a new eight-stage model, the Technology-Enhanced DDDM Lifecycle Model (Figure 15). This model allows researcher a new look at how technology can improve each aspect of the decision-making process in school counseling and hopefully in other non-technical decision-making models and processes.

## Technology-Enhanced Model for DDDM

The proposed decision-making model, as shown in Figure 15, integrates previous models of DDDM in IS and school counseling (Dimmitt et al., 2007; Young & Kaffenberger, 2013; Zyromski & Mariani, 2019), pays explicit attention to the role of technology and has eight cyclical stages. An overview of the model is provided below.

## Model Overview

The Webster dictionary defines a lifecycle as "a series of stages through which something (such as an individual, culture, or manufactured product) passes during its lifetime" (Merriam-Webster, 2019). The proposed Technology-Enhanced DDDM Lifecycle Model follows a series of stages that are revisited until a positive outcome is achieved. Central to the proposed model is technology, which influences every step in the model. The human component of this this model is essential as experience, emotion, and collaboration are crucial elements of the decision-making process. Thus, the cloud symbols of the model represent choices made by the decision-maker (human): setting a goal and determining the logistics of the intervention.

### *Step 1. Collect and Organize Data*

Collecting data is the first step in a data-driven inquiry process. At the data level, decision-makers collect and organize data that may indicate an area of growth for a particular problem. These data then must be organized in some way in order to make sense of them.

*Role of Technology:* Data is accessed using an organization's information system (such as student information system (SIS) for attendance records and achievement scores) or online databases (i.e. the National Clearinghouse, High School Feedback Reports, etc.). New data is collected in the form of online surveys. Services such as SurveyMonkey, Qualtrics, Google Forms, and SurveyGizmo allow for the collection of new data.

### *Step 2. Analyze and Transform Information*

At the information level, decision-makers analyze and summarize data to narrow the focus of the investigation. They use context in which to ground the data and transform them into information. Through analysis and summarization, the raw numbers have been transformed into statements. These statements can then be used to identify goals for improving the area in need.

*Role of Technology:* Many applications can be used to analyze and disaggregate data such as spreadsheet applications, and statistical analysis software (i.e. Excel, Google Sheets with Fusion Tables, Infographics, Tableau Public). Custom analytical software may also be developed to assist in statistical analysis.

*Step 3. Synthesize Information / Determine a Course of Action (Knowledge)*

At the knowledge level, the decision-maker synthesizes and prioritizes the information and transforms it into knowledge. This knowledge is then used for determining which course of action should be implemented. Once the decision-maker has selected a course of action, the logistics of the intervention are then determined.

*Role of Technology:* Online forums occur when a group of experts or individuals in the field collaborate in an online setting to share experiences. Questions are asked, and through collaboration, questions are answered. Knowledgebase systems are information systems that have stored data that is already related to the subject under investigation. More advanced systems, such as recommender systems, allow a system to suggest specific, applicable content. This type of system uses historical data built from a collaboration system to recommend interventions (Sangwan & Dahiya, 2013).

*Step 4: Evaluate the Intervention*

The purpose of evaluating the intervention is to see if a change occurred in the group with whom the intervention was applied. If interventions met the focused needs, the data would likely show this change. If the requirements are not met, then the gap will likely stay the same (Zyromski & Mariani, 2019).

*Role of Technology:* Same as step 1.

*Step 5: Collect and Organize Data*

Step 5 follows the same process as Step 1. This step requires new data to be collected or accessed to compare against baseline data.

*Role of Technology:* Same as step 1

*Step 6: Analyze and Transform Information*

Data needs to be transformed into information to determine if the data from the evaluation indicated a change occurred. If there was no positive impact, the decision-maker would re-examine goals and move back to Step 3 to identify a different intervention. If a change did occur, a user would then proceed to Step 7.

*Role of Technology:* Same as step 2.

*Step 7: Report Positive Outcomes*

Reporting outcomes demonstrate an intervention’s effectiveness and should be shared with stakeholders. Furthermore, the results should feed information into recommender systems to improve the system's ability to suggest interventions to other counselors facing similar issues more accurately.

*Role of Technology:* Reporting software should be used to report positive outcomes. This technology comes in two different forms: collaborative filtering to build more accurate recommender systems, and software for sharing results, specifically presentation software (i.e. Google Slides, PowerPoint, PowToon, Prezi).

For an evaluation of available, free online software available for data collection, management and analysis, and presentations, see Sink et al. (2019).

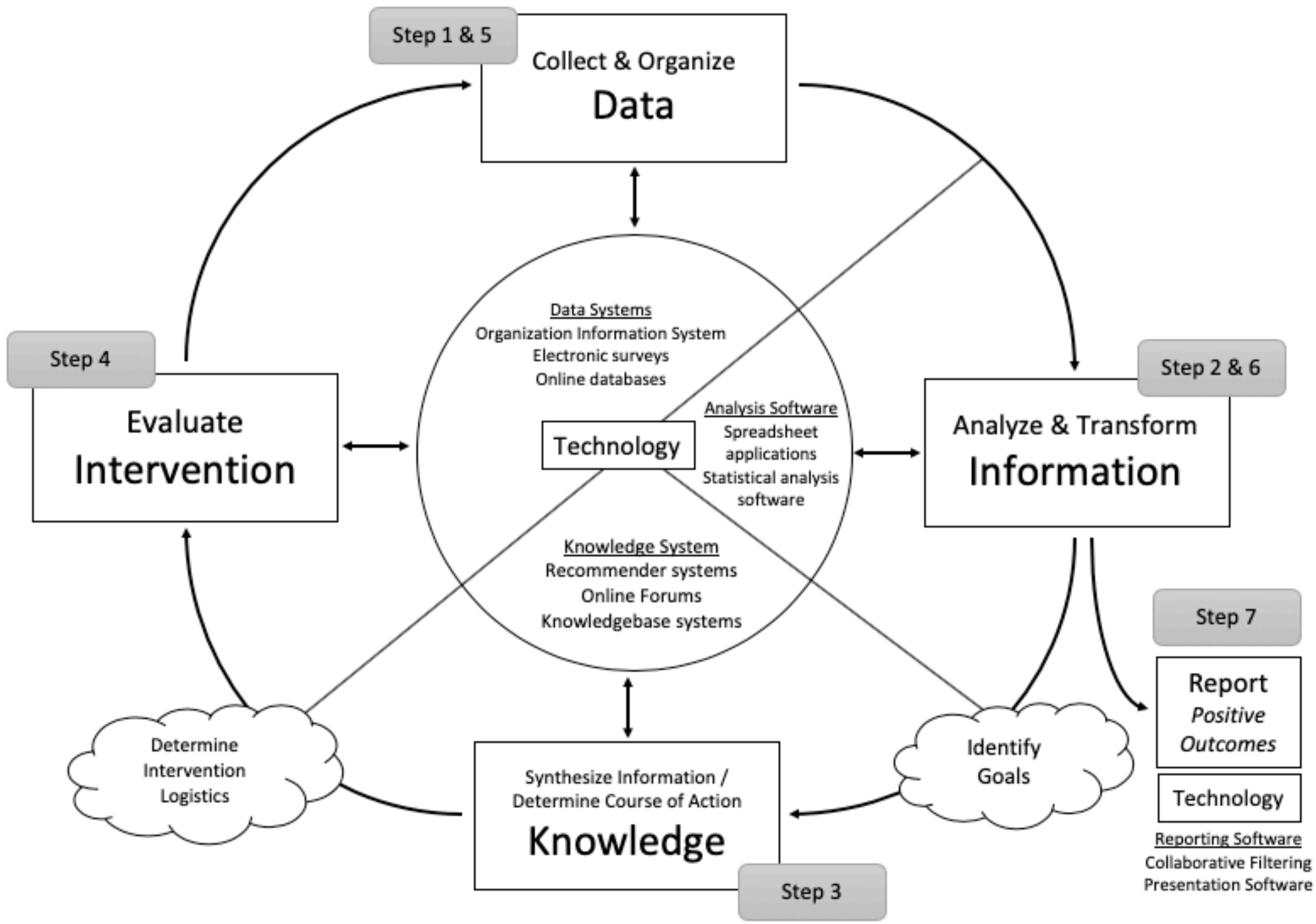


Figure 15: Technology-Enhanced DDDM Lifecycle

# CHAPTER 10

# COMMUNICATION, LIMITATIONS & FUTURE RESEARCH

## Communication

The final step of DSR is communicating the results and findings. The results of this research will be published as part of this dissertation. Furthermore, the results will be communicated to school counselors and educational leaders to demonstrate the utility of technology in the profession as well as in their decision-making processes. Education and other non-technical fields lack the emerging technologies that can result in improved data-driven decision-making processes. Therefore, information system specialists, developers, and researchers will drive the digital transformation in these fields.

While there are many data-driven decision-making models in school counseling, *all* undermine the integral role technology can have in each phase of the process. The results of this study will be shared with leaders in the field of school counseling to demonstrate the role technology can play in helping counselors perform their duties. Additionally, The Technology-Enhanced DDDM will be communicated to school counselors as a new approach to ease DDDM and demonstrate how this process can be improved using technology.

While it is important to communicate the findings and contributions of this research, it is also important to discuss the assumptions and limitation for those wanting to replicate the study. Furthermore, acknowledging these elements improves the credibility of the research.

## Limitations and Future Research

This study incorporated design principles into each component of a DSS and then used SEM to determine their influence on user satisfaction. One general assumption is that participants have a general understanding of the technology being studied. If participants have this initial understanding, the underlying barrier of learning a new technology is reduced as well as external factors influencing user's satisfaction.

Another assumption is that the design principles in this research measure all the different aspects of school counselor's satisfaction of a DSS. The design principles studied were only those correlating to components of a DSS. However, there may be additional design principles that influence user satisfaction of these systems. Future research should improve this narrow focus by asking qualitative questions to school counselors asking what they like or dislike about the system to discover new principles that may also influence their satisfaction, including those that relate to components of a DSS.

This research is limited by the sample population as it only represents school counselors who use CTESurveys.com. This sample population was chosen as the DSS functions by using specific school data collected and stored using this site. Therefore, the generalizability is limited, and future research should focus on testing the DSS and collecting survey responses from a random sample of all school counselors to ensure more diversity and to allow the findings of this study to be generalized to the population.

Future research could also focus on validating and testing the Technology-Enhanced Model for DDDM proposed in this research. This model may improve the decision-making processes of school counselors by incorporating technology in each phase, including identifying and prioritizing interventions, and allow counselors more time serving students in ways technology cannot.

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# APPENDIX A

## Survey Instrument

Demographic Questions

Q1 What is your gender?

○ Male (1)

○ Female (2)

Q2 What is your age?

________________________________________

Q3 How many years have you been a practicing school counselor?

________________________________________

Q4 What age group do you primarily work with?

○ Middle School (1)

○ Junior High School (2)

○ High School (3)

○ K-12 (4)

○ Other (please describe below) (5) ________________________________________

Construct: System Usefulness

| | Strongly Agree | Agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Disagree | Strongly disagree | N/A |
|---|---|---|---|---|---|---|---|---|
| It was simple to identify interventions using this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I could effectively identify interventions using this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I was able to identify interventions quickly using this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I was able to efficiently identify interventions using this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I felt comfortable identifying interventions using this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| It was easy to learn about interventions using this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I believe I could become productive quickly identifying interventions using this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Overall, I am satisfied with how easy it is to identify interventions on this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Construct: Information Quality

| | Strongly Agree | Agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Disagree | Strongly disagree | N/A |
|---|---|---|---|---|---|---|---|---|
| The intervention information included with this report was clear. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The interventions provided by the report were easy to understand. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The report was effective in helping me identify valuable interventions. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The organization of interventions on the report were clear. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Overall, I'm satisfied with how easy it was to find interventions. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Construct: Interface Quality

| | Strongly Agree | Agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Disagree | Strongly disagree | N/A |
|---|---|---|---|---|---|---|---|---|
| The interface of this report was pleasant. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| I liked the layout of interventions of this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| This report has all the functions and capabilities I expect it to have to be able to identify interventions. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Overall, I am satisfied with the interface of this report. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Construct: Customization

| | Strongly Agree | Agree | Somewhat agree | Neither agree nor disagree | Somewhat disagree | Disagree | Strongly disagree | N/A |
|---|---|---|---|---|---|---|---|---|
| The content displayed was individualized to my school. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The content displayed was customized my school's needs. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| The content presented was adapted to me as a counselor. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| Overall, I am satisfied with how the interventions were customized to me and my school | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

# APPENDIX B
## Institutional Review Board Letter

**Dakota State University Institutional Review Board**

DAKOTA STATE UNIVERSITY
605.256.5038 / dsu.edu

**To:** Kodey Crandall and Cherie Noteboom
**Date:** Feb 5, 2020
**Project Title:** Designing Decision-Support Systems for Secondary School Counselors
**Approval #:** 2019-20-2

Dear Investigator(s):
The Dakota State University IRB has reviewed the submission for your project noted above including: recruitment email, participant instructions, and survey tool. As a result, the IRB determined that your research project falls under exempt category 45 CFR 46.104(d)(2), in accordance with federal regulations that govern the protection of human subjects. Your plan to waive documentation of consent signatures was determined appropriate for your project as well. Your research activities are applicable to the "exempt" category conditions as stated below:

*Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording): (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context;*

While your project remains exempt from review, your research must be conducted according to the final (most recent) plan reviewed and determined exempt by the DSU IRB. You must notify the IRB of:

- Any changes to your research plan including any information provided in the application and/or other documents submitted;
- Any unexpected or adverse event that occurs in relation to your research project; and
- A **notice of closure once all project activities have concluded**, prior to 364 days from the date of approval.

If you have any questions regarding this determination or during the course of your study, please contact us at 605-256-5038 or irb@dsu.edu. We are happy to provide guidance as needed.

Yours truly,

Dorine Bennett, Vice-Chair
DSU Institutional Review Board