

# The Study on Behavioral Intention of Use Towards Clinical Decision Support Systems: A Case in CNS La Paz - Bolivia

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## Abstract

*This study discusses the role of behavioral intentions towards a Clinical Decision Support System in Caja Nacional de la Salud (CNS), La Paz – Bolivia. Specific Research on clinical decision support systems (CDSS) is limited in the area of computer science, which rarely seen in behavioral intention analysis. This study identified the interrelationships among the research variables by testing the model developed through survey research. A 47-item questionnaire survey targeted at the CNS doctors and specialist in the area of Aneurysms. Performance Expectancy, Effort Expectancy was found to exert a significant influence on Attitudes Towards Use. Behavioral Intentions was found to be positively influenced by Attitude Towards Use. However, Social Influence does not have a positive impact on Behavioral Intentions, also it does not have a positive impact on Attitudes Towards Behavior. Understanding Behavioral Intentions, then, is important to the successful implementation of the CDSS.*

*Keywords: Clinical Decision Support Systems, Technology Acceptance Model, Intentions of Use.*

## 1. Introduction

Computers with programmed syntax can already provide answers that before only human beings could accomplish. AI has been focused on problem solving and processing capabilities that support problem solving [9].

CDSSs, a specialized Expert Systems (ES), have different interpretations but the same purpose. According to Subramanian et al. (1997), ES is a computer program that performs decision making or problem solving functions in a very specialized and narrowed problem area. Wong and Monaco [48] stated that ESs have become a practical tool that is widely used by business, as well as in the medical area for its decision making capabilities. CDSS is a computer system that utilized for clinical use in patient care, which mimic the decision making behavior of a human expert and allow computer power to be applied to tasks which require the processing of human knowledge.

This study focuses on a specific case: In 2005, the national health care in Bolivia (CNS), branch Materno-Infantil Hospital introduced a CDSS for the primary prevention of Aneurysms on elderly people. The system was developed by some students from the Bolivian Catholic University with the supervision of a

team of doctor and specialist using a graphic interface that helped the system to be user friendly. Also, it has a database that contains previous historical findings on symptoms in the area of aneurysms. The system was programmed by artificial neural networks with multilayer perceptron and tested for its accuracy before introducing to clinical practice. It is used for Aneurysm expertise to help them have a preliminary diagnosis for the aneurysm that need to be treated beforehand in order to prevent major tragedies like death or stroke. Most of the CDSSs introduced around the world are more focused on pharmacy and billing sectors [21], but this particular CDSS is focused on patient's diagnosis. According to Newman-Toker and Pronovost [31], the diagnostic based CDSS will prevent human errors while diagnosing health the problem to the patients. Therefore, in line with the purpose of the CDSS, this research will focus on the behavioral intentions of use of these specialists toward CDSSs in their professional career.

According to statistics from the CNS "La Paz" and a group of medical experts specializing in aneurysms in La Paz, more than 40% of La Paz citizens over 60 years old die because of an aneurysm. As mentioned above, one of the main causes of an aneurysm is high blood pressure. This is mostly the case in La Paz, mainly because of its geographical location (3,800 meters above sea level). Thus, people tend to have high blood pressure often. In line with this, La Paz citizens are said to be more susceptible and prone to having an aneurysm.

Researches in the area of CDSSs are limited in the area of computer science and engineering and rarely seen in the behavioral intention analysis. Technology acceptance by users in the area of medicine has received less attention in the past years and therefore new to study and not too much models currently exist to predict factors influencing their technology adoption. A literature study yielded a set of acceptance factors that could influence and predict behavioral intentions of doctors towards a CDSS.

This study therefore incorporated relevant literature and developed a comprehensive model based on the Technology Acceptance Model (TAM) to identify the relationship and influence among several research constructs. The study also empirically tested the research model by conducting research survey in the area of medicine. The primary objective of this study is to analyze the behavioral intentions of use from medical doctors towards the CDSSs.

## 2. Interrelationship among Research Constructs.

### 2.1 Interrelationship between Attitude Towards Use and Performance Expectancy.

In the theory of TAM, perceived usefulness is a basic driver of usage intentions, where it is essential to recognize the determinants of the constructs and how their powers adjust over time with using the system [45]. From Davis et al. [12], perceived usefulness has a direct effect on attitude and is parallel to the results of other researches. The correlation between perceived usefulness and attitude is such that the individuals form a certain attitude which consequently leads to a belief that it will enhance their performance [47].

According to the previous studies of Agarwal and Prasad [1], Compeau and Higgins [10], Davis et al. [13], Taylor and Todd [41], and Thompson et al. [42], the performance expectancy construct within each individual model is the strongest predictor of attitudes towards the system and remains significant in all points to be analyzed. Performance of the expert system appeared in the literature a number of times. Some authors like Changchit et al. [7] mentioned that the effectiveness of performance in the result of expert system plays an important role in decision making. If the system does not produce an effective result, it will decrease user-confidence in using it as a tool for their professional work. Payne [34] mentioned that a system, which considers historical and examination findings, laboratory and test results and a list of diagnoses with corresponding explanation, have a higher effectiveness, creating a better performance for the overall system. For that particular reason the system needs to be trusted and tested. McCaffrey [27] and Subramanian et al. [40] mentioned that performance effectiveness is the result of a good outcome derived from the expert system and an enhanced attitude toward the system. Balas et al. [2], Hunt et al. [20], and Johnston et al. [22] performed a trial about systems and the interrelationship between performance expectancy and attitude towards use. Findings from these trials conclude that a positive relationship exists between the two.

H1: *Performance expectancy will have a positive influence on attitude towards use of the CDSS.*

### 2.2 Interrelationship between Attitude Towards Use and Effort Expectancy.

A Positive relationship between perceived ease of use with attitude and intentions of use is revealed in a number of recent studies using TAM [32]. It was found that with a higher level of perceived ease of use, the willingness of consumer to adopt the system was also greater. Davis [11], Davis et al. [12], Moore and Benbasat [28], Plouffe et al. [35], and Thompson et al. [42] mentioned that the effort expectancy construct within each model is significant to attitudes towards use. Prior research conducted by Davis et al. [12] and Thompson et al. [42] pointed out that effort-oriented constructs are expected to be more salient in the behavior. Results from previous research affirm that there are substantial similarities among the construct definitions and measure scales. The importance of effort expectancy is critical in the introduction of a new technology. In fact, the adoption

process of a new technology can be constrained and even fail when factors related to ease of use are not taken into account by technology designers [33]. Therefore, developers should take into account in a simultaneous fashion both the instrumental and the effortless side of the technology. Moreover, Venkatesh [44] and Venkatesh et al. [46] support the notion that the construct effort expectancy will be a positive determinant of individuals attitudes.

H2: *Effort expectancy will have a positive influence on attitude towards use of the CDSS.*

### 2.3 Interrelationship between Attitude Towards Use and Performance Expectancy and Effort Expectancy.

According to TAM, the intentions to accept or use new technologies are determined by its perceived usefulness and perceived ease of use of the technology. TAM2 retains perceived usefulness and perceived ease of use from TAM as a direct determinant of perceived usefulness. All else being equal, the less complicated a system is in terms of usability, the more it can enhance job performance [11]. Over decades worth of accumulated, empirical evidence show that perceived ease of use is significantly linked to attitude and intention, both directly and indirectly via its impact on perceived usefulness [11]. The goal of direct users is to perceive the system as being easy to use so they can easily and more efficiently obtain the desired performance. In the context of this study, the aforementioned would relate to the extent to which ease of use could be integrated into the user's daily routine. Thus, in line with the TAM model, the following hypothesis was created:

H3: *Effort expectancy will have a positive influence on performance expectancy.*

### 2.4 Interrelationship between Attitude Towards Use of the CDSS, Behavioral intentions of use the CDSS and Social Influence.

Based on prior research there is a significant body of theoretical and empirical evidence regarding the importance of the role of subjective norm, image on technology use through perceived usefulness in the workplace [19,25,41]. The TAM suggests that social influences like subjective norm have directly impacted behavioral intentions regarding use of information technology. It can show the idea that within organizational settings, people form attitudes and feelings toward behaviors of use if they consider that the system will enhance their job performance [6]. The higher the individual's outcome expectations are, the higher his/her affect (or liking) for the behavior is going to be [10].

According to Burnkrant and Cousineau [5], Hartwick and Barki [18], the relative influence of the social influence construct on behavioral intentions is expected to be stronger for potential users with no prior experience since they are more likely to rely on the reactions of others in forming their intentions. Hartwick and Barki [18] also mentioned that an individual who is motivated to enhance or support his concept of himself would be expected to accept a referent's influence by associating himself with positive referents and/or disassociating

himself from negative referents.

Thus, a person would identify himself with either positive or negative referents by taking on the behaviors and opinions, which he perceives as reflective of his positive or negative reference groups. Here the individual adopts the behavior or the belief due to its enhancing or supporting effect on his self-concept and the reward inherent in this enhancement or support. In contrast to the process of compliance, the visibility of his performance would be unrelated to the occurrence of identification. What is crucial here, however, is that the positive and negative referents provide information about the behaviors or expectations of others who are significant referents for the individual.

H4: *Social influence will have a positive influence on attitude towards use of CDSS.*

H6: *Social influence will have a positive influence on users behavioral intentions of use the CDSS.*

### 2.5 Interrelationship between Attitude Towards Use and Behavioral Intention of Use.

Eagly and Chaiken [14] stated that beliefs and attitudes correlate positively with behavior for people who have had direct experience with an object. Fishbein and Ajzen [15] stated that the direct experience will result in a positive, more stable behavioral intention on attitude towards use. Also, Keen [24] and Morton [29] stated that the significance of the similarity between the attitudes towards use of an user with behavioral intentions should be positive. Goodhue and Thompson [17] mentioned that the technology used for the purpose has to fit to and be compatible to the result that the user expects, and if this is the case, users attitudes will have a positive influence on behavioral intentions. Bueno and Salmeron [4] also mentioned in one of their studies that attitude towards use had a positive relationship to behavioral intention. Therefore, the investigation of attitude toward using the clinical decision support system and identification of its relationship with behavioral intention to use is valuable for predicting usage behavior.

H5: *Attitude towards use of CDSS will have a positive influence on users behavioral intentions of use the CDSS.*

## 3. Research Design and Methodology

### Conceptual Model.

The overall conceptual framework of this study is illustrated in Figure 1.

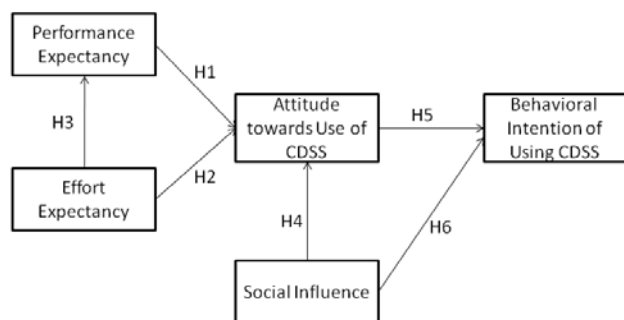


Figure 1. The conceptual framework

### Questionnaire Design.

A 47-item questionnaire was designed to obtain an appropriate amount of data for analysis. The questionnaire was consisted of the 5 main areas that constructed: Performance Expectancy (18 items), Effort Expectancy (13 items), Social Influence (5 items), Attitude Towards Use (7 items), and Behavioral Intentions of Use (4 items).

The questionnaire used a seven-point Likert scale with levels of agreement between 1=Strongly Disagree and 7=Strongly Agree.

### Sampling Plan.

The questionnaire was developed to include Aneurisms Expertise from CNS La Paz - Bolivia. Therefore, the surveys were sent directly to the hospital for answering and were also posted online for easy access. This study aimed to receive 120 respondents and succeeded with 100% response rate due to the personal connection.

### Data Analysis Procedure.

In order to achieve the research objectives and test the hypotheses, the program SPSS 16.0 and Amos 5 for Mac were employed to analyze the data. The following analysis was conducted when all the data was collected:

#### A. Purification and Reliability of the Measurement Variables.

In order to purify the measurement scales and to identify their dimensionality, factor analysis with varimax rotation was applied to condense the collected data into certain factors. Once the analysis was done, item to total correlation and internal consistency analysis (Cronbach's alpha) were done to confirm the reliability of each research factor.

##### (1) Factor Analysis.

The primary purpose of factor analysis is to define the underlying structure among the variables in the analysis. Factor analysis works by reducing the number of variables into factors. It assumes that a small number of unobserved variables are correlated to a larger number of observed variables. Even more specifically, factor analysis assumes that the variance of each observed variable comes from two parts: a common part shared with other variables that cause correlation among them and a unique part that is different from other variables.

##### (2) Item to total Correlation.

Item to total correlation measures the correlation of each item to the sum of the remaining items. This approach assumes that the total score is valid and thus the extent to which the item correlates with the total score is indicative of convergent validity for the item. Items with a low correlation will be deleted.

##### (3) Internal Consistency Analysis (Cronbach's alpha).

Coefficient alpha ( $\alpha$ ) is a measure of squared correlation between observed scores and true scores. In other words, reliability will be measured in terms of the ratio of true score variance to observed score variance. It can test the internal consistency of each factor. According to Robinson and Shaver (1973), if  $\alpha$  is greater than 0.7, it means that it has a high reliability and if  $\alpha$  is smaller than 0.3, them implies that there are no reliability.

### B. Structural Equation Model (SEM)

SEM is a statistical technique for testing and estimating causal relationships using a combination of statistical data and qualitative causal assumptions. SEM was used to find the relationship in the whole research model, which it examines the fitness of overall model. SEM encompasses an entire family of model known by names, among the covariance structure analysis, latent variables analysis. It includes one or more linear regression equations that describe how the endogenous construct depends upon the exogenous construct.

### 4. Data Analysis

#### Data Collection.

The data was collected using survey questionnaires sent back to La Paz- Bolivia; also a database was created with the electronic copies of the questionnaire in order to have an efficient widespread data collection. The survey was filled by 120 specialists that are also the 100% of the population who utilizes the system.

#### Characteristic of Respondents.

Table 1 shows the basic attributes of the respondents only for reference. The table indicates that there are more male respondents (59.17%) than female respondents (40.83). More than 50% of the respondents are more than 35 years old (55%). It can be said that more the results are more significant because more than 50% of the respondents have more experience in the area.

Table 1 Characteristic of the Respondents

Demographic	Frequency (people)	Percentage (%)
<b>Gender</b>		
Male	71	59.17
Female	49	40.83
<b>Age (years old)</b>		
25 and less	1	0.83
26 to 35	53	44.17
36 to 45	40	33.33
46 to 55	25	20.83
56 and over	1	0.83

#### Reliability Test.

To verify the dimensionality and reliability of the research constructs, purification processes such as factor analysis, item-to-total correlation, and internal consistency analysis (Cronbach's  $\alpha$ ) were conducted. For each research construct, factor analysis was first accomplished to identify the dimensionality of the construct, to single out and select questionnaire items with high factor loadings. Item-to-total correlation and cronbach's  $\alpha$  were then assessed to identify the internal consistency and reliability of the constructs.

#### Structure Equation Model (SEM).

The structure equation model is employed to test the interrelationship of all variables with each other and the entire model. The result is presented in Figure 2. The evaluation of this research model can be carried out in two steps. First, the standardized path coefficients and their statistical significance for the hypotheses and

constructs in this model were estimated. Secondly, fit indexes were examined to measure the model fit.

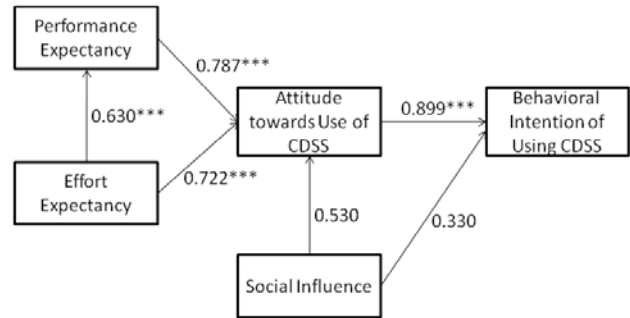


Figure 2. The result of SEM in path diagram; the coefficients are standardized value; the number of stars (\*) shows its significance.

### 5. Result and Discussion

The principal purpose of this study was to contribute to the understanding of the key factors influencing users' behavioral intentions towards a clinical decision support system. The result is shown in Table 2.

Table 2 Hypotheses and Results of the Empirical Tests

Hypothesis	Result
<b>H1</b> There will be a positive relationship between performance expectancy and attitude towards use of the CDSS.	Supported
<b>H2</b> There will be a positive relationship between effort expectancy and attitude towards use of the CDSS.	Supported
<b>H3</b> Effort expectancy will significantly influence performance expectancy.	Supported
<b>H4</b> There will be a positive relationship between social influence and attitude towards use of the CDSS.	Not Supported
<b>H5</b> There will be a positive relationship between social influence and behavioral intentions of use the CDSS.	Not Supported
<b>H6</b> There will be a positive relationship between attitude towards use of the CDSS and behavioral intentions of use the CDSS.	Supported

Based on the results of the study, several conclusions can be made or drawn. Firstly, there was significant positive relationship between performance expectancy and attitudes towards use. To support this statement, Davis [11] mentioned that perceived usefulness has a direct effect towards attitudes. Thus it can be concluded that performance expectancy, including perceived usefulness, had a positive impact towards attitude towards use. The statement from Wei [47] was believed and affirmed, and it can be concluded that the correlation between performance expectations and attitude towards use was defined such that the individuals have certain attitude and belief on the system, making the system have a better performance while using it. The users of the CDSS were aware about the system performance, which enabled them to have a better attitude toward use and intention of use towards the CDSS. This conclusion correlated with previous studies made by Garg et al. [16] that mentioned that the performance of the CDSS have a relationship with the attitude towards the use of it. If the

practitioners realized that the CDSS performs well, the attitude of using it will be better and higher. Previous researches from CDSS have similar results. Stacey et al. [39] demonstrated that the performance of the CDSS plays an important role to the users specifically when they felt comfortable using the decision support system, they intended to use it again within the next months. Many of these users felt that their job performance had improved since they started to use the CDSS. Kawamoto et al. [23] mentioned that CDSS significantly improved clinical practice according to the systematic review of the trials that he had conducted. The findings in this research can also be supported by the study of Dreisetl et al. (2007) which concluded that the CDSS significantly improved its performance in terms of accuracy and efficiency in diagnosis, making doctors have a higher attitude towards the use of the CDSS. Bergman and Fors [3] also have a similar conclusion to this study and found out that physicians had a higher attitude towards the use of the CDSS when they realized that the performance of the CDSS was acceptable.

Secondly, there was a significant positive relationship between Effort Expectancy and Attitude Towards Use of the CDSS. This supported the statement from authors Davis [11], Davis et al. [12], Moore and Benbasat [28], Plouffe et al. [35], and Thompson et al. [42] that asserted that the higher level of perceived ease of use is, the greater the willingness of consumer to adopt the system is. It can be concluded that the users had a higher ease of use expectation, and the system was easy for them to employ so they adopted and integrated the system more easily into their daily work. It can also be concluded that there was a positive attitude towards the system regarding the effort expectation from the users of the CDSS. Stacey et al. [39] found that the users had more attitude towards the use of the system when they felt that the system does not take too much effort from themselves and it was easy to learn how to use it. The study of Liu et al. [26] supported his conclusion, which mentioned the success of clinicians to use the CDSS is because of the following cases: They understood what it was for, the prevailing clinical culture patronized it; their patients or peer group supported it, it was fast, or it was linked to the electronic patient record (EPR).

Thirdly, there was a significant positive relationship between Effort Expectancy and Performance Expectancy. According to TAM, the intention to accept or use new technologies is determined by its perceived usefulness and perceived ease of use of the technology. The aforementioned relationship was supported and proven by a study from Davis [11] which stated that there is an empirical evidence that perceived ease of use is significantly linked to attitude towards use and both directly or indirectly have an impact on perceived usefulness. In this study, it can be concluded that effort expectancy has a positive impact towards performance expectancy, and also, both have a positive impact on attitude towards use, supporting the statement from Davis [11].

Fourthly, there was no positive relationship between social influence and attitude towards use, and also between Social Influence and Behavioral Intentions. The measure of social influence used in this study was found

not to be significant. It did not appear to have any significant effect upon doctors' attitude towards use the CDSS and doctors' behavioral intention of use the CDSS. Medical doctors are trained and skillful professional who are not easy to be influenced by social norms in their professional field. The reason of this can possibly be that doctors want to find out for themselves the contributions and value of using the CDSS in their own medical practice and not being influenced by comments from other persons. Also, it could be that doctors are hesitant to put too much reliance on the CDSS for the diagnosis of patients only based on social influence. This conclusion was supported by Schepers and Wetzels [37] and stated that even there were findings that social influence has positive relationship on attitudes towards use the system and behavioral intention of use, there were cases that this relationships did not have a significant effect between each other. Roberts and Henderson [36] also proved in their study that social influence did not have a positive impact relationship in their study. Addressed to a similar failure of a subjective norm instrument, Davis et al. [12] observed "more sophisticated methods for assessing the specific types of social influence processes at work in a computer acceptance context are clearly needed". Also the conclusion of the study proved the opposite of TAM. TAM proved that social influences such as subjective norm have directly affected behavioral intentions regarding the use of the technology. This conclusion also diverge from Burnkrant and Cousineau [5], Hartwick and Barki [18] who stated that the relative influence of social influence on behavioral intentions is expected to be stronger for potential users with no prior experience since they are more likely to rely on their intentions.

Lastly, there was a significant positive relationship between Behavioral Intention and Attitudes Towards Use the CDSS. This statement can be proven with a study from Eagly and Chaiken [14], who wrote that beliefs and attitudes correlate positively with behavior for people who had a direct experience with an object. In this study, it was demonstrated that even the specialist does not have too much experience on the system, but their attitude towards the use was accepting, thus so the relationship became positive. Also this statement coincided with previous conclusions from Keen [24] and Morton [29] who stated that in decision support systems, the significance of the similarity between the behavioral intentions of use of a user's behavioral intentions should be positive. There was a good acceptance inside the hospital regarding the CDSS. Most of the users were more aware on the behavior than to the affect and emotions toward the use of the CDSS. Other like Chismar and Wiley-Patton [8] found same results applying the TAM in physicians concluding that the attitude towards the use of the CDSS related positively with the behavioral intentions of use the CDSS. A recent article from Trivedi et al. [43] reported on a survey of factors affecting clinicians' acceptance of clinical decision support and revealed that even though a majority of the clinicians were not explicitly following clinical support suggestions provided, they did feel that such systems were of benefit and reported that they would even be more so if they had more time to make use of them [38]. This finding was also supported by Murray et al. [30] who mentioned that

physicians tended to have a better attitude towards the clinical decision support when they knew that the performance of the system is acceptable, increasing the behavioral intention of use of the CDSS.

Also, some implications should be taken into consideration. For companies that develop the CDSS, there is a need to consider that the performance of the CDSS will influence users' behavioral intentions of using the CDSS and users' intention of use of the CDSS. Time, usefulness, job fit, and the outcome expectation need to be considered when developing the CDSS.

## 6. Concluding Remarks

In this study, we have examined the interrelationships on the proposed construct and understand the behavior intention of medical professional on CDSS usage. Some implications for the researchers can be derived from this study. The proposed model provides researchers with another way of looking at the relationship among Performance Expectancy, Effort Expectancy, and Social Influence to Attitude Towards Use. Also, this gives researchers a better way of looking at the relationship among Attitudes Towards Use, Social Influence, and Behavioral Intentions among the skilled professional community, and can be useful for future development of CDSS.

Although the results of this study were productive and useful and may contribute to the existing literature, there are still some suggestions that could be made for further academic and business practices. The research respondents of this study were only from one specific location (CNS-La Paz-Bolivia) and limited in an in-house built system. A suggestion for future research is to analyze other CDSS for verifying its validity.

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