Increasing the satisfaction with the Integrated System for Academic Activity Management: prioritizing improvements with a structural equations model

Aumentando a satisfação com o Sistema Integrado de Gestão de Atividades Acadêmicas: priorizando melhorias com um modelo de equações estruturais

Salém Miranda Alves¹
Ari Melo Mariano²
Maristela Holanda³
Maíra Rocha Santos⁴

Abstract
This research aims to identify improvements for the Integrated System for Academic Activity Management (SIGAA) based on the main factors that affect user satisfaction with academic information systems. The study presents the structural equations model and importance-performance analysis as a basis for improving system requirements. This research is exploratory and quantitative through the modeling of structural equations. A questionnaire was used to collect data, and the total sample size was 153 people. The results revealed that the most important variables to explain user satisfaction were information quality (30.33%), system quality (21.77%), and perceived benefits (21.61%). Thus, user satisfaction was explained 72.5% by the proposed structural model. The results achieved help improve the university information system. The importance of performance analysis pointed out indicated

¹Graduated in Production Engineering, Universidade de Brasília, Asa Norte, Brasília - DF, CEP: 70910-900. E-mail: salembledley@gmail.com Orcid: https://orcid.org/0000-0002-9758-9688
²Postdoctoral in Data Science, Quantitative Methods and Methodology, Universidade de Brasília, Asa Norte, Brasília - DF, CEP: 70910-900. E-mail: arimariano@unb.br Orcid: https://orcid.org/0000-0002-7987-5015
³Postdoctoral in Computer Science, Universidade de Brasília, Asa Norte, Brasília - DF, CEP: 70910-900. E-mail: mholanda@unb.br Orcid: https://orcid.org/0000-0002-0883-2579
⁴Doctor Student in Public Policy Development, Universidade de Brasília, Asa Norte, Brasília - DF, CEP: 70910-900. E-mail: mairarocha@unb.br Orcid: https://orcid.org/0000-0002-9880-6082
the priority of actions to be taken, and the mapping of processes presented possibilities of increasing requirements to increase the satisfaction of the system's users.

**Keywords**: Academic Information System. Structural Equations Model. PLS-SEM. SIGAA. IPMA.

**Introduction**

Concepts such as smart campus or smart university, which represent entities that use information technologies and infrastructure to improve their internal processes, are not new in several places worldwide (Sánchez-Torres et al., 2018). These technologies on university campuses are responsible for improving the quality of academic services and reducing consumption and resource costs (Bandara et al., 2016).

Seeking to modernize, integrate and improve the quality of its academic information systems, the university adopted, in 2020, the Integrated Management System (SIG), a system composed of four integrated management systems, among them the Integrated System for Academic Activity Management (SIGAA). The new system was implemented in more than 40 Brazilian universities and was used by more than 700,000 students. Among its main
features were the academic services of enrollment in subjects by students, the issue of academic documents, and monitoring of the course by the student (Portal SIG, 2021).

Academic information systems are management software used to improve the productivity of educational services. For these systems to be effective, universities need to provide an adequate technological infrastructure, which meets the needs of the service users (Palilingan & Batmetan, 2018). Furthermore, for a system to work as developed, it is necessary to have continuous quality monitoring (Aasi; Rusu & Han, 2014). According to Pressman (2009), software quality is measured through system conformance to explicitly stated functional and performance requirements.

Consolidating a system's requirements, on the other hand, is frequently challenging due to the numerous parties involved and the emergence of new requirements during use.

As a result, systems must be constantly monitored to ensure that the user's and developer's expectations are aligned. Thus, this study seeks to answer the following question: what are the main factors that impact the satisfaction of users of Integrated System for Academic Activity Management (SIGAA) regarding the undergraduate teaching module for students?

Answering this question is essential in order to improve the provision of academic information systems in educational institutions in the country, and to collaborate for modernization and greater efficiency in the use of scarce educational resources. In this way, the following article aims to present steps to improve the Integrated System for Academic Activity Management (SIGAA), based on the main factors that affect users’ satisfaction with academic information systems.

The research was divided into seven sections. The theoretical framework presents topics on academic information systems and their implementation, success factors, and measurement of information system satisfaction. Third, the model and hypotheses present the model that will be calculated in the study and the hypotheses that will be tested. Finally, material and methods (4), results (5), discussions, implications (6), conclusions (7) are presented.

**Background**

2.1 Academic Information Systems

Introducing technologies in the educational area has become a fundamental need instituted by a highly competitive educational and professional market.
Increasing the satisfaction with the Integrated System for Academic Activity Management: prioritizing improvements with a structural equations model

Communication technologies have renewed the reality of several contexts, giving rise to teaching and learning environments surrounded by technologies (Costa, Sousa, & Cusin, 2019).

The academic information system can have different uses. E-learning is an electronic format that supports learning and teaching. In addition to supporting learning and teaching, the academic information system also contributes to the business management of the educational institution, so its application is broader than that of E-learning (Yuhana, Raharjo & Rochimah, 2014).

Dos Santos, Santoso, and Setyohadi (2017) further argue that the use of academic information systems to support the operational processes of universities provides benefits for the productivity of learning processes. Thus, both public and private universities should know the quality of each academic information system to become more innovative and well-structured.

Seventy-two records were found in search of the Web of Science database using the keyword "Academic information system" and 2000 to 2021. The records read show that academic information systems have many features in universities.

The main functionalities found were a repository of the institution's products, providing records of past, present, and future student management, processing major academic events, scheduling courses, planning classes, recording student progression and completion in the course, generating management reports, and allowing the feeding of various other specialized systems with student data (Ali et al., 2013).

Thus, the academic information system must provide a reliable, real-time system to handle academic results securely. In a review by the string "information system", between 2020 and 2021, on the Web of Science, different studies were found covered in three approaches i. implementation, ii. performance, and iii. user satisfaction (Figure 1).

---

**Fig. 1 Main approaches found in the 2000-2021 studies.**
Source: own

---

Revista Gestão e Secretariado (GeSec), São Paulo, SP, v. 14, n. 6, 2023, p. 9895-9921.
2.2 Information Systems Implementation

Several papers in the literature have sought to study the implementation of academic information systems in higher education institutions worldwide. For example, Indrayani (2013) studied the implementation, monitoring, effectiveness, and quality of academic information systems in Bandung, Indonesia. A descriptive analysis of the responses was prepared based on questionnaires distributed to faculty and students from 18 higher education institutions in the city. As a result, the author found that the quality and effectiveness of the systems were adequate, but the monitoring and evaluation of these systems were still unsatisfactory.

In another study, the Islamic State University Syarif Hidayatullah Jakarta has implemented a web-based academic information system accessible to the academic community via the Internet. However, other system versions have limitations in terms of display and interaction with the system. Therefore, the research focuses on the development of mobile-based academic information systems. There will be two types of users for this version: students and faculty, the latter, will probably use the system the most. This study shows that the mobile version of the academic system has made it a more user-friendly application for the proposed users (Sukmana et al., 2016). After implementation, one usually seeks to follow up on the information systems to find out their level of performance.

2.3 Information Systems Performance

Over time, the representation of performance has been altered numerous times by different authors and based on several variables. As a result, several models were developed and tested, and a variety of quantitative instruments were employed to determine the dimensions that best reflected these variables (Choe, 1996).

First, the performance of information systems was evaluated by engineering-related technical parameters such as processing speed, time savings, and output quality (Ferreira & Bufoni, 2006). The following models were then created to assess how well the system met the users' needs. As a result, satisfaction has become synonymous with superior system performance.

In the literature studied, different models were used to measure the high performance of an information system, such as the "Technology Acceptance Model" (TAM), "Theory of Planned Behavior" (TPB), "Information System Success Model" (IS Success model). (Kassim et al., 2012). Although there are other models for measuring the success and satisfaction of...
Increasing the satisfaction with the Integrated System for Academic Activity Management: prioritizing improvements with a structural equations model

One of the fundamental criteria in information system success has become user satisfaction. Therefore, the proper evaluation of user satisfaction and its determinants is essential in assessing the value and effectiveness of an information system (Kassim et al., 2012).

2.4 Information Systems User Satisfaction

However, in the models, this satisfaction is associated with two different groups of factors: a. from the technical perspective of systems delivery and support, and b. from behavioral factors. In table 1, one can see the main contributions of each of the models in the study of success and satisfaction of information systems.

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude</td>
<td></td>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Subjective norm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived behavioral control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intention to use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavioral intention</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>User satisfaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td></td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 variables of information systems models

The TPB (Theory of planned behavior) models by Fishbein and Ajzen (1977) and the TAM (Technology Acceptance Model) models by (2) Davis (1989) focus their models on behavioral characteristics such as attitude, ease of use, and subjective norms, while the models by DeLone and McLean (2003) and (4) Wu and Wang (2006), focus their variables on benefits, quality of information, and the system itself.

However, when it comes to a university information system, which is mandatory for students to access their grades and enrollments, it is believed that a model with system-related variables would be more helpful.

Bento, Costa, and Aparicio (2017) show in a literature review of the last 25 years that the model most used to measure the success of information systems is the model focused on

Revista Gestão e Secretariado (GeSec), São Paulo, SP, v. 14, n. 6, 2023, p. 9895-9921.
user satisfaction, developed by DeLone and McLean (1992). This model has six variables to
determine the success of information systems: information quality, service quality, system
quality, usage, user satisfaction, and net benefits.

Over time, the representation of performance has been altered numerous times by
different authors and based on several variables. As a result, several models were developed
and tested, and a variety of quantitative instruments were employed to determine the
dimensions that best reflected these variables (Choe, 1996). First, the performance of
information systems was evaluated by engineering-related technical parameters such as
processing speed, time savings, and output quality (Ferreira & Bufoni, 2006). The following
models were then created to assess how well the system met the users' needs. As a result,
satisfaction has become synonymous with superior system performance. In the literature
studied, different models measure the better performance of an information system, such as
work was an adaptation in the sense of cause and effect between the use and perceived benefits
in information systems. Thus, this study chose to use the adapted model of DeLone and

Model and Hypotheses

3.1 System Quality

One of the ways to measure the quality of an information system is the ease of use,
system flexibility, ease of learning, intuitiveness, technological sophistication, and system
reliability. (Petter, Delone, & Mclean, 2008).

Similarly, Seddon (1997) argues that the quality of a system is related to the frequency
of errors in the system, the consistency of its interface, the response times, and the
maintainability of the program code.

As Wu and Wang (2006) point out, system quality is expected to impact users' perceived benefits and satisfaction when using these systems. Thus, the following hypothesis
is proposed:

- H1: Academic information system quality positively impacts users' perceived benefits.
- H2: The quality of the academic information system positively impacts user satisfaction.
3.2 Information Quality

According to DeLone and McLean (1992), information quality refers to the usefulness of the information that an information system produces as outputs. The information provided by these outputs should be accurate, chronological, reliable, consistent, and complete (Benmoussa et al., 2018).

The quality of information applies to education since academic information systems must provide information about courses, schedules, subjects, and personal academic information of the users. As a result, the perceived benefits of the system and user satisfaction are expected to be influenced by information quality (Wu & Wang, 2006). Thus, the following hypothesis is proposed:

- H₃: The information quality of an academic information system positively impacts users' perceived benefits.
- H₄: The information quality of an academic information system positively impacts user satisfaction.

3.3 Service Quality

First added to DeLone and McLean's (1992) model by Pitt, Watson, and Kavan (1995), service quality is based on the expectation that a user expects to be offered the service that was provided. It reflects the quality of the support provided to users by information system departments and information technology technical teams, considering aspects such as the reliability, responsiveness, empathy, assurance, and technical competence of the services provided. Thus, service quality is expected to impact both the benefits perceived by users and their satisfaction with services. Thus, the following hypotheses were specified:

- H₅: The quality of service provided by support staff positively impacts the benefits perceived by users.
- H₆: The quality of service provided by support staff positively impacts user satisfaction.

3.4 Perceived Benefits

Staples, Wong, and Seddon (2002) define the perceived benefits of an information system as the degree to which a user believes that using an information system will bring benefits to him or her or his or her organization, usually linked to increased productivity.
Furthermore, this dimension measures the user's feelings and the effectiveness of the information system.

In proposing this new dimension, Wu and Wang (2006) hypothesized that the attitude of perceived benefit could positively affect system usage behavior and user satisfaction. As a result, the following hypotheses were developed:

- \( H_7 \): Benefits perceived by users positively impact system use.
- \( H_8 \): Benefits perceived by users positively impact user satisfaction.

### 3.5 User Satisfaction

User satisfaction is nothing more than the satisfaction perceived by users when using the information system, presenting the users' approval and sympathy towards the system (Benmoussa et al., 2018). Similarly, Gelderman (1998) defines user satisfaction as the extent to which a person believes that an information system meets his or her needs.

User satisfaction is expected to influence the effective use of an information system (Wu & Wang, 2006). Given this, the hypothesis was raised:

- \( H_9 \): User satisfaction positively impacts system use.

### 3.6 Use

The degree and manner in which its determined users use a system's functionalities is defined as system use. This usage involves criteria such as the amount of use, frequency of use, nature of use, the scope of use, purpose of use, and appropriate use (Petter, Delone, & McLean, 2008). As a result, a research model that can be proven was established (fig 2).

![Research model](source: adapted from DeLone and McLean (2003) and Wu and Wang (2006))

**Fig. 2 Research model.**

Revista Gestão e Secretariado (GeSec), São Paulo, SP, v. 14, n. 6, 2023, p. 9895-9921.
Material and Methods

This study is defined as exploratory research with a quantitative and qualitative approach. The site of this research was the public university. A public institution that is in Brasilia, in the Federal District. The university has four campuses, and according to the Census of Higher Education from 2014 to 2018 conducted by the Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (2018), it has 39,610 undergraduate students and 8,435 graduate students.

The data collection instrument used was a questionnaire translated and adapted from the survey instrument developed by DeLone and McLean (2003) and Wu and Wang (2006).

There were 28 questions, 26 of which were closed-ended. The first four questions were to understand the respondent's profile, asking about gender, age, monthly income, and whether the respondent had already used SIGAA. The other 24 questions were divided into six dimensions: system quality, information quality, service quality, perceived benefits, user satisfaction, and system use.

A pre-test of the instrument was performed after it went through the translation stage (cross-cultural) and subsequent semantic and psychometric validation. For the psychometric test, the instrument achieved an average Cronbach's alpha of 0.81. Although Cronbach's alpha is a recognized index of quality of research instruments, Hair et al. (2019) state that Cronbach's alpha can vary according to the number of variables involved in the model, and the use of composite reliability is recommended. Therefore, the composite reliability test was also performed, and the instrument achieved an average value of 0.90.

According to the classification, the survey instrument used a 5-point Likert scale: disagree; partially disagree; neither disagree nor agree (neutral); partially agree; and finally, totally agree. In addition, a space was provided for the student to respond in text format to the open questions. Information was gathered from a questionnaire that was opened in Google Forms format online and disseminated via social media for data collection. The questionnaire was then available from 09/06/2021 to 09/13/2021.

The survey sample was calculated via G-power from the effect size. For an average effect size (0.15), with the predictive power of 0.80 and alpha of 0.05 and with five predictors, generating a sample requirement of 92 respondents. There was a total of 155 records obtained. Removing those who did not answer and those who did not use SIGAA, the final sample was 152.
The sample of this work was composed of undergraduate students and former undergraduate students of UnB who have used SIGAA at some point. The sample is 50% women, 48% men, and 2% who did not want to identify themselves.

Regarding age, 66% of those who responded were 21 - 25 years old, 16% were 18 – 20 years old, and 18% were of varied ages.

4.1 Data Analysis Procedure

Data analysis was performed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The analysis is divided into two steps, the valuation of the measurement model and the valuation of the structural model.

Step 1 (valuation of the measurement model) established that the variables would be calculated reflexively, based on Henseler’s assumptions (2015). PLS-SEM was used because it was necessary to calculate a complex model with multiple variables, with the possibility of data normality issues, and effective in exploratory type research (Hair et al., 2019). Additionally, in the search conducted in the Web of Science database from 2000 until 2021, the method appears with the highest frequency in research with measurement models in information systems.

Tests were also performed for multicollinearity and on possible excess non-normality of the data, and no violations were found in this respect. Therefore, after collecting the responses, the information was entered into an Excel spreadsheet where the data from the closed questions were processed to be compatible with the SmartPLS 3.3.3 software.

Results

5.1 Measurement Model Valuation

Two groups of tests were run to determine the measurement model. The first two were about the model’s dependability, and the second two were about the model’s validity. Because of the high correlations between indicators in each construct, we estimated our composite variables in Mode A (Rigdon, 2016).

The first test to be performed to validate the model's reliability is the item reliability test. This test calculates the indicators’ correlation with their respective variables. According to Chin (1998), items with values less than 0.707 should be purged for model correlations to be considered satisfactory.
Increasing the satisfaction with the Integrated System for Academic Activity Management: prioritizing improvements with a structural equations model

When performing this test, the indicators "System Quality 3", "System Quality 4", and "System Usage 3" were found to have values below the acceptable limit, so they were removed from the model. Next, item reliability was tested again with the debugged items, and all values were found to be within acceptable limits. Table 2 shows the values after Chin's (1998) debugging, ensuring item reliability.

Internal reliability is the second test of reliability, and it takes into account the degree to which each set of indicators explains its respective latent variable, thus indicating whether the questions are sufficient to measure the variable.

According to Ramirez, Mariano, and Salazar (2014), for composite reliability to be accepted, each variable in the model presenting composite reliability must have a value greater than 0.7. Thus, Table 1 shows that the model met these requirements, indicating a reliable model.

Table 2 also depicts the first validity test, the Average Variance Extracted - AVE, which is used to confirm the model's internal consistency whether the indicators are related to the variables assigned to them (Ramirez, Mariano & Salazar, 2014). According to Hair et al. (2019), for the model to be considered valid, it must present AVE equal to or greater than 0.5 for all variables. Thus, as shown in Table 2, all AVE values were above the proposed acceptance limit.

<table>
<thead>
<tr>
<th>Item description (construct/indicator)</th>
<th>Loading</th>
<th>Composite reliability</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP1 Using SIGAA helps me achieve my academic goals</td>
<td>0.874</td>
<td>0.939</td>
<td>0.838</td>
</tr>
<tr>
<td>BP2 Using SIGAA speeds up my tasks</td>
<td>0.923</td>
<td>0.946</td>
<td>0.827</td>
</tr>
<tr>
<td>BP3 SIGAA facilitates my tasks.</td>
<td>0.946</td>
<td>0.768</td>
<td>0.812</td>
</tr>
<tr>
<td>QI1 The information available in SIGAA is sufficient for what I need</td>
<td>0.827</td>
<td>0.871</td>
<td>0.629</td>
</tr>
<tr>
<td>QI2 I can access SIGAA information at an acceptable time</td>
<td>0.871</td>
<td>0.812</td>
<td>0.629</td>
</tr>
<tr>
<td>QI3 The information available on SIGAA is helpful for my activities</td>
<td>0.812</td>
<td>0.765</td>
<td>0.825</td>
</tr>
<tr>
<td>QI4 The information available in SIGAA is easy to understand</td>
<td>0.871</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>QS1 SIGAA is easy to use</td>
<td>0.891</td>
<td>0.895</td>
<td>0.813</td>
</tr>
<tr>
<td>QS2 SIGAA is intuitive to use</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>QSV1 The technical support team is helpful</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>QSV2 The technical support team responds within the established deadline</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>QSV3 The technical support team has enough knowledge to do their job in the best possible way</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>SU1 SIGAA meets my needs as a student</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>SU2 SIGAA delivers what it promises</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>SU3 SIGAA fulfills its promises in the best possible way</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>SU4 Overall, I am satisfied with SIGAA</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>US1 I use SIGAA to assist in decision making regarding my academic trajectory</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
<tr>
<td>US2 I use SIGAA to access information about my course</td>
<td>0.895</td>
<td>0.812</td>
<td>0.751</td>
</tr>
</tbody>
</table>

Table 2. Measurement Model Indicators
Source: author. Extracted from Smartpls 4.0

Revista Gestão e Secretariado (GeSec), São Paulo, SP, v. 14, n. 6, 2023, p. 9895-9921.
Finally, to confirm the model's validity, the Discriminant Validity test was applied. This analysis tells whether the latent variables differ from each other; that is, these variables have autonomy in the model. Here the heterotrait-monotrait (HTMT) method, proposed by Henseler, Ringle, and Sarstedt (2015), can be used to avoid a strong correlation between indicators that do not belong to a variable and those that do. To ensure discriminant validity, values less than 0.9 are adequate.

<table>
<thead>
<tr>
<th>System quality</th>
<th>n.a.</th>
<th>Information quality</th>
<th>0.710</th>
<th>Service quality</th>
<th>0.314</th>
<th>0.360</th>
<th>Perceived benefits</th>
<th>0.636</th>
<th>0.771</th>
<th>0.208</th>
<th>User satisfaction</th>
<th>0.826</th>
<th>0.898</th>
<th>0.289</th>
<th>0.794</th>
<th>Use</th>
<th>0.446</th>
<th>0.679</th>
<th>0.152</th>
<th>0.681</th>
<th>0.604</th>
<th>n.a.</th>
</tr>
</thead>
</table>


Table 3. heterotrait-monotrait (HTMT) test
Source: author. Extracted from Smartpls 4.0

From the data in Table 3, all the values fall within the proposed limit. Therefore, after passing all reliability and validity tests, the structural model is found to be valid and reliable for the subject under consideration.

5.2 Measuring the Structural Model

The valuation step was performed following the model validation and reliability steps to analyze the model result and explain the critical factors for SIGAA user satisfaction.

As seen in Figure 3, "User Satisfaction (SU)" achieved an R2 of 72.5%. This is considered substantial (Chin. et al. 1998). On the other hand, "Perceived Benefits (BP)" achieved an R2 of 47.3%. This is considered moderate. "Use (US)" achieved 29% which is regarded as weak. As a result, it is suggested that in the case of using the SIGAA system. There are still other essential variables to be tested that help to better explain the reasons for this use.

In Figure 3 and table 4. the results showed a positive and significant (p-value <0.05) effect on the relationships between "System Quality (SQ)" and "Information Quality (IQ)" with "Perceived Benefits (BP)."

As for "User Satisfaction (US)" a positive and significant effect on the variables "System Quality (SQ), " "Information Quality (IQ)" and "Perceived Benefits (BP)" can be observed. Finally, there is the variable "Use (US)," where only "Perceived Benefits (BP)"
showed a direct and significant relationship with the variable. Significance tests were performed via bootstrapping with a 10,000 re-sample, two-tailed procedure.

Thus, hypotheses 1, 2, 3, 4, 7, and 8 (table 4) were supported by presenting a beta greater than 0.2, t-value greater than 1.96 and a p-value less than 0.05. Furthermore, in the R2 decomposition, it is observed that "System Quality" has a direct relationship with "Perceived Benefits" (13.42%) and with "User Satisfaction" (21.77%).

The "Information Quality" presents a direct effect on "Perceived Benefits" of 34.5% and with "User Satisfaction" of 30.32%. On the other hand, the "Service Quality" did not show relevant effects in this study. One of the factors is the lack of institutional disclosure of the possibility of using support services.

"Perceived Benefits" also showed a direct relationship with "User Satisfaction" (20.5%) and with "Use", at 21.6%. On the other hand, "User Satisfaction" showed no significant relationship with "Use".

![Fig. 3 Research model.](image)


<table>
<thead>
<tr>
<th>Hipótese</th>
<th>$R^2$</th>
<th>Path coefficient</th>
<th>%</th>
<th>t-value</th>
<th>p-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>QS-&gt; BP</td>
<td>0.473</td>
<td>0.250</td>
<td>13.425%</td>
<td>3.534</td>
<td>0.000***</td>
<td>Sim</td>
</tr>
<tr>
<td>QS-&gt; SU</td>
<td>0.725</td>
<td>0.315</td>
<td>21.767%</td>
<td>5.218</td>
<td>0.000***</td>
<td>Sim</td>
</tr>
<tr>
<td>QI-&gt; BP</td>
<td>0.473</td>
<td>0.526</td>
<td>34.506%</td>
<td>6.882</td>
<td>0.000***</td>
<td>Sim</td>
</tr>
<tr>
<td>QI-&gt; SU</td>
<td>0.725</td>
<td>0.398</td>
<td>30.328%</td>
<td>5.492</td>
<td>0.000***</td>
<td>Sim</td>
</tr>
<tr>
<td>QSV-&gt; BP</td>
<td>0.473</td>
<td>-0.034</td>
<td>-0.670%</td>
<td>0.568</td>
<td>0.285</td>
<td>Não</td>
</tr>
<tr>
<td>QSV-&gt; SU</td>
<td>0.725</td>
<td>-0.003</td>
<td>-0.078%</td>
<td>0.062</td>
<td>0.475</td>
<td>Não</td>
</tr>
</tbody>
</table>
Increasing the satisfaction with the Integrated System for Academic Activity Management: prioritizing improvements with a structural equations model

Table 4 Path. R² and Hypothesis Test
Source: author. Extracted from Smartpls 4.0
1. System Quality (QS). 2. Quality of Information (QI). 3. Quality of Service (QSV). 4. Perceived Benefits (BP). 5. User Satisfaction (SU). 6. Use (US); *** p<0.001; ** p<0.01; * p<0.05.

<table>
<thead>
<tr>
<th>Path</th>
<th>R²</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP -&gt; SU</td>
<td>0.725</td>
<td>0.287</td>
<td>20.549%</td>
</tr>
<tr>
<td>BP -&gt; US</td>
<td>0.290</td>
<td>0.410</td>
<td>21.607%</td>
</tr>
<tr>
<td>SU -&gt; US</td>
<td>0.290</td>
<td>0.163</td>
<td>7.433%</td>
</tr>
</tbody>
</table>

**Discussion and Implications**

The results obtained in this research support most of the hypotheses proposed.

**H1: Academic information system quality positively impacts users' perceived benefits.**

A 13.42% positive relationship was discovered between the quality of the information system and the benefits perceived by users, thereby supporting the first hypothesis of this research. Aspects related to usability and system use intuitiveness were addressed to measure quality.

This result differs from that found by Wu and Wang (2006), who found that the system's quality would have no significant influence on the perceived benefits. According to the authors, quality would have a more significant impact in the early stages of implementation of a system but would decrease over time, becoming a minimum mandatory requirement. As SIGAA was recently implemented at university, it is suggested that the positive result in this hypothesis is due to this factor.

**H2: The quality of the academic information system positively impacts user satisfaction.**

The statistical tests supported the assumption that the quality of an academic information system positively impacts user satisfaction with an index of 21.77%. This reflects the expectation that users have those systems that should have high quality, corroborating with that found by Wu and Wang's (2006) study.

Therefore, you should expect the system to have a modern and easy-to-use design so that users can find the desired information with a minimum of effort.

**H3: The information quality of an academic information system positively impacts users' perceived benefits.**
Another hypothesis that had a positive impact on the benefits perceived by system users was this one. In conclusion, the hypothesis with the most positive impact was related to the information quality in a system, which influenced perceived benefits by 34.51%.

This result found by Wu and Wang (2006) because they argue that in an information system, the quality of the content ends up being more critical for the perception of benefits than the operation of the system itself. Thus, the system is expected to provide enough valuable information to help students in their decision-making so that they perceive more significant benefits in using SIGAA.

\[ H4: \text{The information quality of an academic information system positively impacts user satisfaction.} \]

The quality of information of SIGAA stood out as having a solid positive relationship with undergraduate students' satisfaction with the system, with an index of 30.33%. Thus, it is confirmed that an improvement in the quality of information of a system can be associated with higher user satisfaction (Wu and Wang, 2006).

Thus, one should expect SIGAA to supply helpful information that is easy to understand and provided in an acceptable timeframe to increase user satisfaction with the system.

\[ H5: \text{The quality of service provided by support staff positively impacts the benefits perceived by users.} \]

Although it is expected that the quality of service provided has a positive impact on users' perceptions of benefits (Delone & Mclean, 2003), neither the beta test nor bootstrapping found any significant influence with regard to this assumption.

It is suggested that this difference in results is due to a cultural issue of students, who often prefer to ask colleagues or friends before seeking technical support. Thus, the technical support teams could launch more effective outreach campaigns to show that they can help students with any difficulty related to SIGAA.

\[ H6: \text{The quality of service provided by support staff positively impacts user satisfaction.} \]
The assumption was that the service provided by the support team did not impact the satisfaction of the system users.

According to DeLone and McLean (2003), the service quality variable is greatly influenced by the research context, for example, it is expected that when an information system is measured on an individual basis, this variable will have less impact, as opposed to when measuring satisfaction concerning an information technology department.

\[ H7: \text{Benefits perceived by users positively impact system use.} \]

This hypothesis was verified by a positive relationship of 20.55\% between the benefits perceived by undergraduate students in using the system and the effective use of the system, ratifying what was found in the research of Wu and Wang (2006). As a result, it is expected that the system will provide a set of functions that will make it easier and faster for users to complete tasks to achieve their academic goals.

\[ H8: \text{Benefits perceived by users positively impact user satisfaction.} \]

This was another hypothesis supported by this study since the research showed that the perception of benefits by students in using the SIGAA impacts positively by 21.61\% the satisfaction of the students themselves. With this, the finding by Wu and Wang (2006) confirmed that perceived benefits strongly influence information system users’ satisfaction.

As a result, some system functionalities can be added to increase the benefits perceived by students and their satisfaction with SIGAA. Such features could be specific filters to find subjects, the option to prioritize classes, and the possibility to query the remaining free module hours.

\[ H9: \text{User satisfaction positively impacts system use.} \]

Finally, the assumption that student satisfaction positively influences system usage was not supported, as it presented a beta of 0.163. Furthermore, bootstrapping analysis rejected this hypothesis, presenting a t-student of 1.559 and a p-value of 0.060. Thus, this result differs from the literature (Wu & Wang, 2006; Delone & Mclean, 2003).

It is suggested that this result has occurred because undergraduate students at university are dependent on SIGAA to perform some activities and get information about the courses. Similar behaviors occur in monopolized services, where satisfaction, even if low,
leads to the use of the service for lack of another option. So even if users are not satisfied with SIGAA, they end up using the system anyway.

### 6.1 Practical Implications

To enrich the research and establish criteria for the practical implications, an importance-performance analysis (IPMA) was conducted. The IPMA analyzes the average value of the latent variables and their respective indicators. Thus, joining the importance analysis with the performance analysis makes it possible to reach additional conclusions and identify more essential areas to improve (Ringle & Sarstedt, 2016).

This analysis offers a graph that positions the variables according to each criterion's importance and the system's achieved performance in that item. The x-axis shows the importance of each factor, while the y-axis shows its performance. As a result, the points in the lower right quadrant should be addressed first because they have high importance but low performance, according to the numerical order shown in Figure 4.

![Importance-Performance Map](image)

**Fig. 4 Importance-Performance Map.**
Source: Author. Extracted from SmartPLS 3.3.3

The graph obtained shows that the indicators "System Quality 1" and "System Quality 2", which deal with the ease of use and intuitiveness of the SIGAA, respectively, presented a high level of importance and low degree of performance. Therefore, the system developers must prioritize creating a more modern and intuitive design.
Increasing the satisfaction with the Integrated System for Academic Activity Management: prioritizing improvements with a structural equations model

Other points that showed high importance and low performance were "Information Quality 1" and "Information Quality 4". These indicators address whether the information available in SIGAA is sufficient for users' needs and whether this information is easy to understand, respectively.

In this context, the concept of User Experience (UX) can be applied to improve the user's interaction with the system (Park et al., 2013), for knowing how users feel when using a system can improve their satisfaction and help them achieve their goals.

Therefore, using the information extracted from the IPMA, it was possible to identify which factors could be improved to increase students' satisfaction with it. Then, in possession of this information, functional requirements were listed according to the functionality of managing enrollment, aiming at the better functioning of SIGAA. The requirements raised can be seen in Table 5.

<table>
<thead>
<tr>
<th>Functionality 01</th>
<th>Manage enrollment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>This functionality aims to manage the enrollment process of courses for undergraduate students at university by implementing functional requirements in SIGAA.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Functional Requirement 01</th>
<th>Insert priorities in the forms of a subject.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The system should allow undergraduate students to assign priorities to different classes for each subject when selecting them in the registration application. Thus, first, the system should process the student's enrollment in the form with priority 1. Then, if this is not possible, it should try to enroll him in the form with priority 2, and so on.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Functional Requirement 02</th>
<th>Filter subjects and classes.</th>
</tr>
</thead>
</table>
| Description               | The system must allow undergraduate students to filter the subjects and classes according to class schedule, subject time, campus where the subject will be applied, and compulsory, optional, and free module subjects.  
**Note:** You can already filter forms by level, code, name, prerequisite, and co-requisite requirements, equivalence, responsible unit, component type, and subject modality in the current search. |

<table>
<thead>
<tr>
<th>Functional Requirement 03</th>
<th>See free module hours.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The system must allow undergraduate students to see how many hours of the free module they have completed and how many hours they have left to reach the maximum free module limit allowed by the student's course.</td>
</tr>
</tbody>
</table>

Table 5 Requirements  
Source: author.

Following that, a use case diagram was created to make the requirements for system improvement more visually appealing. A use case diagram is nothing more than the
presentation of user interaction with a system, using the Unified Modeling Language (UML) as a standard (Sabharwal, Sibal & Kaur, 2014). Figure 5 shows a diagram of this type.

![Fig. 5 Use Case Diagram](Source: author)

With the requirements elicited, the Enrollment Process and Additional Registration Process models are suggested, through modeling by the Business Process Model and Notation (BPMN) represented in Figure 6 and Figure 7, respectively. According to Chinosi and Trombetta (2012), BPMN is a standard notation used to graphically represent processes occurring in any type of organization so that anyone who knows the notation can understand modeling.

Requirement elicitation based on business processes brings benefits by standardizing a language for all stages of a project, improving the interface between the various activities, accuracy, and the suitability of the software for the organization's actual needs (Carvalho, Escovedo & Melo, 2009).

The process modeling can be used in conjunction with functional requirements to establish a good view of the process and ensure the correct implementation of these requirements in the system because poor process modeling leads to poor requirements elicitation.

The Enrollment Process, as shown in Figure 6, begins on the opening date of the enrollment period for students, when students must consult the stream courses offered to them,
and may decide between following the flow and confirming the courses or refusing the offered classes and seeking others in the enrollment. At this stage, students can consult SIGAA to check the number of hours pending for compulsory, optional, and free module subjects.

Next, if the student does not want to follow the flow or wants to follow the flow but adds new subjects, he/she will have to consult the available subjects and classes for that semester. For this, the student will have the option of filtering the classes by time, workload, campus, department, if it is a compulsory, optional or free module, by code, teacher, necessary prerequisites and co-requisites, equivalence, responsible unit, type of component and modality of the subjects.

After selecting the subjects, the students can numerically order the forms of the same subject according to the priority they want, and the system will process first the forms with priority "1", then those with priority "2", and so on.

After prioritizing the classes in the chosen subjects, the undergraduate student should confirm the enrollment request in SIGAA and wait for the initial enrollment processing.

If the student does not get some of the courses requested or wants to add some more courses after the registration period, he or she can request new courses in the re-registration and the extraordinary registration, as shown in the Additional Registration Process model in Figure 7.
Figure 6. Enrollment Process
Source: author.
Figure 7. Additional Registration Process
Source: author.
The process of additional enrollments begins with opening the re-enrollment period, when the student must verify if he/she needs to enroll in new courses. If he/she does not want to, he/she must wait for the beginning of classes, not further action in the system is necessary. If the student wants to add new courses, he/she must consult the offer of courses with vacancies remaining. At this time, he/she can use the same filters as for the enrollment process and consult the number of hours remaining for compulsory, optional, and free module courses.

Then, similarly to the registration process, the student will prioritize the classes, request the courses, and wait for the matriculation process. After checking the result of the re-enrollment, the student can also, in the period of special enrollment, check for remaining courses that still have vacancies and enroll directly through the system. This time, he will not need to wait for the processing period since the enrollment is automatically done in the request if the student meets the requirements and has time availability for that subject, thus closing the Additional Enrollment Process.

As a result, implementing the requirements raised by the proposed models may improve SIGAA users' perceptions of "System Quality" and "Information Quality". This is because students will have a more comprehensive set of information to assist in their decision-making at the time of enrollment of courses, and they will do this in a more intuitive and easier way. Consequently, the satisfaction of SIGAA users will also increase.

Conclusions

The research problem was to understand the main factors that impact user satisfaction of the SIGAA regarding the undergraduate teaching module for students. As a result, it was found that the main factors that positively influence user satisfaction were the quality of information (30.33%), the quality of the system (21.77%), and the perceived benefits (21.61%), and user satisfaction was explained in 72.5% by the proposed structural model.

Thus, the objective of this research to identify improvements for SIGAA, based on the main factors that affect the satisfaction of users of academic information systems, was achieved through the survey of functional requirements for the system and the proposal of Additional Registration and Enrollment Process models.

Given the size of the research instrument, one limitation of this study is the difficulty in obtaining respondents for the questionnaire.

It is suggested that studies be conducted on users' perceptions of the research modules, extension, scholarships, and internships as future lines of research. In addition, research could also be done on teachers’ perception of SIGAA. As a final suggestion, a study could be
Increasing the satisfaction with the Integrated System for Academic Activity Management: prioritizing improvements with a structural equations model

cased to improve the design and interface of the system in order to make SIGAA more intuitive and easier to use.

References


Increasing the satisfaction with the Integrated System for Academic Activity Management: prioritizing improvements with a structural equations model


Increasing the satisfaction with the Integrated System for Academic Activity Management: prioritizing improvements with a structural equations model


Submetido em: 09.05.2023
Aceito em: 14.06.2023