Expert System for Information Technology Services Management

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Abstract*: In the company it was identified that the level of maturity in relation to the implementation of the systems is inconclusive, there is little confidence, low level of efficiency, and the times exceed what is stipulated. The objective was to demonstrate that the expert system significantly improves the average time, reliability levels, and efficiency in evaluations of maturity levels in the management of IT services of the Sions Company. Likewise, the CommonKADS methodology was used to build the knowledge of the expert system and SCRUM for the active monitoring of the project. Regarding the methodology of scientific research, it was based on the quantitative approach, pre-experimental design; the study population was made up of 16 evaluations of technology companies in Peru. The results showed that the expert system improved the average time in the evaluation of maturity levels by 85%, compared to the traditional system. In this way, the levels of reliability and efficiency improved by approximately 49% compared to the traditional system. In this way, the levels of reliability and efficiency improve in 49% the capacity of response, the quality of the service and the functional availability in the evaluations of the technological management. Therefore, the processes of the service management phases such as design, strategy, transition, operation and continuous improvement benefit by reducing time, costs and increasing its functionality for companies that have technological services as part of the business strategy. Therefore, the expert system would be applied in companies of different areas that have technological services, whose purpose allows to identify the current state of the service and its possible improvement over time.

***Keywords*: Keywords: IT service management, CommonKADS, Scrum, ITIL and Expert system.**

I. INTRODUCTION

Nowadays, technological advances have expanded and diversified worldwide, being the axis of the multiple opportunities that benefit people and companies in general, although our participation as indirect actors are not enough. The technologies are changing, extensive and diverse, which is why the effort, analysis, understanding, and evaluation of the population is required, because they are transforming realities (economics, customs, businesses, students, entrepreneurs, specialists and processes) that allow improving the labor aspect and the near future of the population. In this sense, the management of IT services is an essential axis as part of the control, monitoring and use of best practices for the benefit of digital transformation. According to Axelos, he says that 70% of professionals in this area argue that organizations have drawn their strategies aligned to technological changes, but without a sincere sense of their evolution. That is to say, when implementing the new technologies, the level of maturity of the companies is not precise and they do not know the way forward to achieve sustainable growth, in this sense according to the data obtained in a study, 61% of professionals recognize the importance of aligning the strategic objectives of the companies with the technological services of the business [1,2,27].

On the other hand, it is essential to use the information technology infrastructure library as a reference framework that promotes the good practices of IT service management, as it is based on standards, rules, procedures, policies, processes, control and continuous improvement for the integration of different technological areas in organizations; in addition to strengthening communication, experience and efficiency in the response time of operational activities [3]. Likewise, all systems development requires the integration of specialized knowledge with the areas involved in the business. It also needs the use of technological tools that improve the quality, availability, usability and reliability of operational services in the shortest possible time. Consequently, technological processes must be combined with the knowledge of people, applications and business strategies.

The importance of using the control mechanisms and the experience of the ITIL reference framework for proper technological management is highlighted since they improve the quality, efficiency and reliability of the services. Likewise, companies have various technological services, within which the use of an ISO or reference framework in IT is suggested to control the management of their services [4].

In Peru, Sions is one of the largest companies in IT services consulting, which has specialists in the areas of technological governance, methodologies of the GSTI and digital transformation for government areas through outsourcing service.

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Therefore, an analysis GAP was performed to determine the critical points of the business processes and evaluate the maturity levels, which is why the following problems were identified: (a) the maturity evaluations are incomplete, due to time of effort in its realization; (b) low level of reliability and efficiency in maturity assessments for the operational phases such as design, transition and operation of the IT service; and (c) delays in the analytical determination of maturity levels in operational processes. Therefore, the following general problem was raised: To what extent an expert system will improve maturity levels in the design, transition and operation phase in IT service management?

II. STUDIES RELATED TO IT SERVICES MANAGEMENT

Reviewing international sources; the importance of using reference frameworks such as ITIL and ISO / IEC 20000 was verified to diagnose the behavior of IT processes and provide the steps to follow to achieve a high level of maturity of services. It is also argued that the correct application of ITIL in the management of IT services, leads to improved levels of quality, efficiency and reliability in services, coupled with the use of an expert or intelligent system that automates the functions, allowing the reduction of the average times, which is why it will increase the levels of reliability, availability and efficiency in the determination as well as in the evaluation of the maturity levels of the IT services management [26,31].

The purpose of the research is to build an expert system based on rules for the determination and evaluation of the maturity levels of IT service management. The construction of the expert system will be carried out through a hybrid development methodology, that is, it will use the CommonKADS methodology for the construction of expert knowledge, and the agile SCRUM methodology for project monitoring and control. Also, the PHP programming language was used because it is a dynamic and agile framework in the construction of systems in a web environment and MySQL for database management. The expert system called "GSTI Evaluator" is in a cloud environment in the company Sions, which meets the necessary conditions for its application and achieve the planned results [23,24].

The research was carried out using two study variables, which are represented as follows: (a) expert system referring to the independent variable; (b) the management of IT services as the dependent variable. For the conceptualization of the first variable, it is validated that expert systems turn out to be a vital part of artificial intelligence because it allows the reduction of operational tasks, saving time and cost. It should be noted that technological tools seek to emulate the experience and behavior of the human specialist in some specific subject, making the expert system make decisions according to the previously programmed logic, aligned with the objectives of the organization [5, 6]. That is, the expert system will determine and evaluate the current state of the processes of IT service management in various areas of the company, to improve the duration of the evaluations and in determining the tasks be performed to grow in maturity levels.

Expert systems are related to intelligent systems that are part of artificial intelligence and cognitive systems, which, in turn, are designed from the experience of a specialist in a subject. The purpose of expert systems is to simulate certain activities of an area or the automation of unconventional tasks, this logic includes some of its characteristics such as (a) flexibility; (b) reliability; (c) availability; (d) efficiency; (e) performance; (f) cost and time reduction; and (g) quality [32, 25, 29].

Therefore, expert systems are structured as follows: (a) knowledge base, which contains the logic of the human expert; (b) factual basis, charged with guarding the events of the problems; (c) inference engine, models and processes the logic to show the results; and (d) interface, which comprises the interrelation between the user and the expert system [25]. In this sense, expert systems have different types, which can be applied and aligned according to the problem. The types of systems are: (a) based on cases, these types of systems focus on reusing predefined cases as part of the solution and learning; (b) based on neural networks, consists in applying rules accompanied by fuzzy logic; (c) based on rules, is to use conditional rules to determine the results.

The purpose of managing IT services is to apply the correct planning, organization, execution and control of technological services in an organization. These services are made up of processes from different areas of the business, which are accompanied by a correct management imposed by the IT government; their application will generate value in the organization, because it will improve the standards of quality, reliability, efficiency and control, for the use of management indicators around the IT operational processes. In the same context, the importance of using the ITIL methodology in the management of IT services is sustained because they manage to generate trust and experience for the business services, which is carried out in most cases by suppliers through outsourcing [22, 26].

The management of IT services corresponds to the set of strategies aligned to the delivery of technological services. That uses an approach that relates to the client, the business and the quality of the service [7]. The most used methodologies in the world of technology services are ITIL, ISO / IEC 20000 and Cobit.

In this sense, the ITIL methodology proposes the improvement of quality, working times and the optimization of resources in the different phases of the technological processes of the services. In the same context, the ISO / IEC 20000 standard is fundamental because it seeks to guarantee the quality, effectiveness and efficiency of agreements to the regulations and guidelines for the operation of the services.

The management of IT services includes the following elements as part of the business management: (a) people; (b) processes; (c) technical operations; and (d) operational businesses. All these must be combined for a correct management of the services, where the interaction of the people with the technology and its processes, coexists, generating the added value at the time of providing the various services [8].

In this sense, companies have the power to use some of the IT service management methodologies.

They try to make an alignment with the business strategies; therefore, if the business is considered a small business, it is recommended to use the underlying processes, in order to contribute to the correct management of services. Unlike large companies that have evolved in providing quality services, they try to acquire a correct evaluation of their services, considering that technologies are changing over time. To determine the evaluation of their maturity levels, they choose to recruit expert specialists to design, transform and lead the technological services, to reach the desired maturity level for all the processes implemented. In this way, a significant contribution is generated for the new technological challenges associated with IT services [30]. The proposal of the expert system will help to integrate the knowledge of the specialists in a single source, in such a way that it is possible to reduce the problems identified in the study, considering that the scope of the solution is subject to the operational phases of the life cycle of ITIL.

III. REVIEW CRITERIA

A. Research approach

All scientific research is divided into three approaches: (a) quantitative approach: because it is objective and allows the hypothesis to be tested; (b) qualitative: for being analytical, subjective and descriptive; (c) mixed: by having a little of the first 2 approaches and focusing the analysis on the triangulation of the sources [9, 21]. They also have the peculiarity of immersing themselves in the quantitative approach, due to their easy application and adaptation in the scientific world with social reality. In this investigation, we chose to use the approach mentioned above to have pure numbers, be quantifiable and focus on a cause and effect according to the research variables [10].

B. Type of investigation

All scientific research that has as its characteristic the resolution of problems, the practical analysis of the results and the revision of different theories; an investigation of the applied type is considered. Besides, it has the particularity that the problem to be reviewed is known by researchers, which is why they efficiently transfer various theories in order to determine the solution [28].

C. Research design

The study corresponded to the pre-experimental design, where the independent variable called an expert system was manipulated to achieve the modification of the dependent variable that was the management of IT services [11, 10].

The steps for the application of the pre-experimental design consisted of (a) identifying the test scope: That is, the 12 IT service management processes that would be impacted with the application of the expert system were identified. (b) Identify the measurement indicators: it consists of selecting the three indicators such as time, reliability and efficiency. (c) Run the pre-test: the measurements are executed and recorded in the dependent variable (IT service management) without using the expert system; (d) run the post-test test: this activity is executed using the expert system in IT service management; and finally (e) the consolidation of the data, to then proceed with the validation and check its consistency. As part of the technology, the construction of the rules was applied using the CommonKADS methodology. These conditional rules allowed to identify the individual cases for each process, so the maturity level for each of the 12 IT service management processes can be determined.

D. Population

The study population consists of the formation of a set of objects, artifacts, elements, components, records, or evaluations that have characteristics such as place, time, quantity and form. In this sense, the study was made up of 16 evaluations of companies in the technology sector; there was no sample due to the small number of companies [12].

E. Method of data analysis

Descriptive and inferential statistics will be used as the basis for contrasting research hypotheses. Descriptive statistics allow the interpretation and analysis of the calculation of statisticians such as variance, mean, sum, minimum and maximum values for pre and post-test [13]. On the other hand, inferential statistics allow deductions to be made on the results that add value in the hypothesis test [14, 15]. For this, the following steps have to be applied: (a) perform the consistency of the data: double mass analysis was applied to determine its consistency; (b) normality test: the Shapiro-Wilk test was used, due to the quantity of the sample, being equal to or less than 30, the Kolmogorov-Smirnov test being discarded; (c) level of significance: a level of 95% reliability and 5% will be used as a margin of error, with the aim of identifying whether the distribution of the data is parametric or non-parametric. If the test provides a parametric result, it will be decided to use the T-student test. Otherwise, the Wilcoxon test will be used, and (d) identify the sig value: this point is to test the research hypothesis.

IV. RESULTS AND DISCUSSIONS

All research with a quantitative approach should conduct a prior review of the data to determine consistency. These data were processed through the support of a statistical tool to determine the normality test then and thus continue with the hypothesis test.

A. Consistency analysis

The second mass method was applied for consistency analysis, which consisted of entering the data cumulatively and sequential order. The data was then presented in a Cartesian graph, where the formation of a line was evidenced, which is an indication of data consistency. In the case that the Cartesian graph presented a line with deviation, then there are errors or deviations in the consistency. In the study, the double mass method was used, both in the pre and post-test, based on the 3 IT management indicators and: (a) the evaluation time of maturity levels for all technological processes; (b) the level of reliability in the evaluation of the level of maturity over the technological processes; and (c) the level of efficiency in the

evaluation of IT managed services, as shown in the consolidated table I [16].

Table- I: Consolidated indicators of IT service management.

Item	Time (minutes)		Reliability (percentage)		Efficiency (percentage)	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
1	731	105	54.55%	100%	47.38%	94.29%
2	725	106	45.45%	100%	39.50%	94.34%
3	725	106	54.55%	100%	47.40%	93.40%
4	736	106	54.55%	100%	47.43%	93.40%
5	731	106	45.45%	100%	39.49%	94.34%
6	731	106	54.55%	100%	47.38%	93.40%
7	707	107	45.45%	100%	39.54%	93.46%
8	725	105	45.45%	100%	39.50%	94.29%
9	731	106	54.55%	100%	47.38%	93.40%
10	731	107	45.45%	100%	39.49%	93.46%
11	725	106	54.55%	100%	47.40%	94.34%
12	731	106	54.55%	100%	47.38%	93.40%
13	731	105	45.45%	100%	39.49%	94.29%
14	731	106	54.55%	100%	47.38%	93.40%
15	719	105	45.45%	100%	39.51%	94.29%
16	719	106	54.55%	100%	47.41%	93.40%

B. Normality test

As part of the inferential statistics, the normality test was performed for the three research indicators. The indicators are (a) evaluation time of IT service management; (b) level of reliability of the evaluation of IT service management; and (c) level of efficiency of the evaluation of IT service management [17]. Likewise, the results of the Shapiro-Wilk test (n <30 evaluations) applied to the three indicators of IT service management; table II shows values below 0.05, a fact that allows us to accept that the data has no distribution normal, fundamental reason to apply the non-parametric Wilcoxon Ranges test.

Table- II: Shapiro-Wilk test

	Shapiro-Wilk test		
	Statistical	gl	Sig.
Time (Pre-Test)	,806	16	,003
Time (Post-Test)	,778	16	,001
Reliability (Pre-Test)	,638	16	,000
Reliability (Post-Test)	,273	16	,000
Efficiency (Pre-Test)	,642	16	,000
Efficiency (Post-Test)	,676	16	,000

C. Hypothesis test

The hypothesis test is a tentative and not necessarily definitive answer to the solution of the problems under study [18, 14]. In the hypothesis tests, the interrelation of the study variables is evidenced, such as independent and dependent variables, which are subject to verification, verification, contrast and based on the data obtained from the population, to determine the acceptance or rejection of the theories

In this sense, the hypothesis test was carried out for the 3 indicators of IT service management, which are made up of: (a) an expert system improves the evaluation time of the design, transition and design services phase operation of IT service management in Sions; (b) an expert system improves the level of reliability in the evaluation of the design, transition and operation services phase of IT services management at Sions; and (c) an expert system improves the level of efficiency in the evaluation of the design, transition and operation services phase of IT services management at Sions. The null hypothesis is the denial of each of the indicators.

In this way, descriptive statistics were calculated where it is evidenced that the minimum, maximum, range, average, standard deviation and variance values for both pre-test and post-test. Thus, for the time indicator, it was verified that the average in pre and post-test, there is a considerable difference of approximately 620 minutes (Pre721; Post106), as can be seen in Fig. 1; unlike levels of reliability with a margin of difference of 49% (Pre721; Post106) as set out in Fig. 2 and for levels of efficiency with a margin of difference of 40% (Pre721; Post106), see Fig. 3.

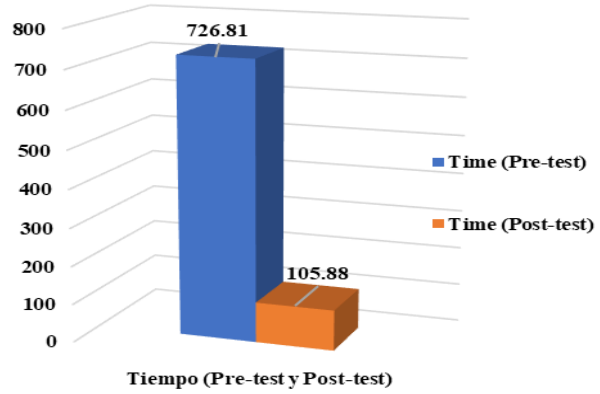

Fig. 1. Evaluation time of IT service management in minutes.

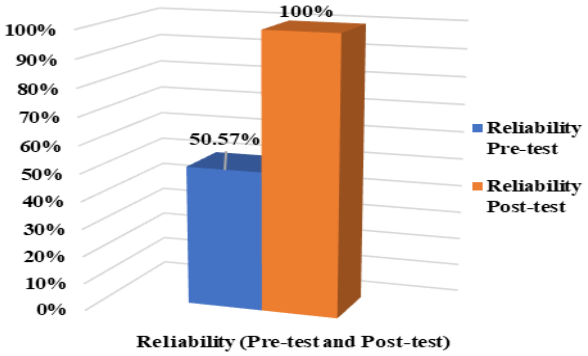

Fig. 2. Reliability in the evaluation of IT service management in percentages.

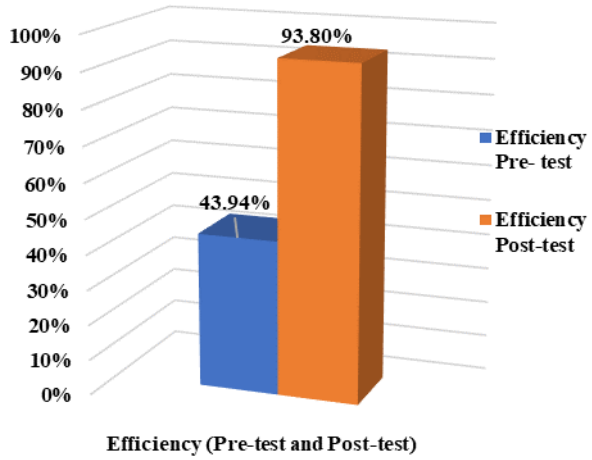

Fig. 3. Efficiency in the evaluation of IT service management in percentages.

Then the hypothesis was tested using the Wilcoxon Ranges test, as shown in Table III. It was applied to the three indicators: (a) Time indicator, Zc = -3,531, p = .000, reason why which, the null hypothesis is rejected, and it is affirmed that the expert system reduces the time of evaluation of the phase of design, transition and operation services of the management of technological services in the company Sion, 2019. The second one (b) Reliability indicator, Zc = 3,601, p = .000, a fact that makes it possible to reject the null hypothesis and affirm that an expert system improves the level of reliability in the evaluation of the design, transition and operation phase of service management of information technologies in the company Sion, 2019. The third one (c) Efficiency indicator, the distribution Zc = 3,522, p = .000, situation that generates the rejection of the null hypothesis, and demonstrate that an expert system improves the level of efficiency in the evaluation of the design, transition and operation phase of the management of information technology services in the company Sion, 2019. In summary, the comparisons of the results for the time, reliability and efficiency indicator for the management of IT services were consolidated and where it is stated that these results were for the implementation of the expert system.

Table-III: Contrast test statistic of the three indicators

Test statistics[a]			
	Time (Post-test) - Time (Pre-test)	Reliability (Post-test) - Reliability (Pre-test)	Efficiency (Post-test) - Efficiency (Pre-test)
Z	-3,531[b]	-3,601[c]	-3,522[c]
Sig. asymptotic (bilateral)	,000	,000	,000
a. Sign rank test of Wilcoxon.			
b. It is based on positive ranges.			
c. It is based on negative ranges.			

The expert system implemented improves the evaluation time of the maturity levels in the design, transition and operation phases of IT service management. It should be noted that the evaluation time of maturity levels has improved significantly, decreasing from 721 minutes to 106 minutes. That is, the application of the expert system obtained an average time reduction of 85%. Likewise, what is expressed by Tanovic and Mastorakis is shared where they refer, that by using a management system, service times are improved by 35.68%, so it is verified that an expert system allows improving the evaluation time of the levels of maturity of IT service management [20].

At the same time, the rule-based expert system improves reliability and efficiency, because they increased significantly by 49% overall. Consequently, what is expressed by Yandri, Nugeraha, & Zahra is shared, where they state that when using an expert system in fuzzy logic, the determination of maturity levels is improved, generating better levels of quality, efficiency and usability for its purpose. Consequently, it was proved that an expert system allows improving the determination, reliability and efficiency in the evaluation of the levels of maturity of the management of IT services [19].

V. CONCLUSIONS

An expert system for the evaluation of the maturity levels of IT technology management processes adds an average time of approximately 106 minutes compared to the traditional system used by IT managers, which represents an increase of 727 minutes in the Average time of evaluation of maturity levels, which meant a reduction of 621 minutes. That is a decrease of 85.43% of the overall average time as a comprehensive evaluation of the maturity levels of information technology services management. Therefore, the technology company increased its evaluations in the management of technological services, because before they made three evaluations for every 36 hours approximately, now it will be able to carry out 20 evaluations on average. Considering that these evaluations of maturity levels of IT service management will have an increase of approximately 85% of reliability and efficiency because before, it represented 50.57% of reliability in evaluations and 43% of efficiency using in a traditional system. Expert systems and various technologies are an essential part of R + D + I in organizations because it allows improving productivity, competitiveness and innovation, coupled with information technologies. Therefore, it should be noted that expert systems for the management of IT services turn out to be a disruptive and innovative solution that will allow the identification, evaluation and improvement of technological processes for all companies that are immersed in the world of information technologies. In summary, it is concluded that the implementation of an expert system improved the evaluation of the maturity levels for the management of IT services.

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