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RESEARCH ARTICLE

Service quality assessment in IT projects based on aggregate indicators

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Abstract

Objectives. Due to the need for prompt and rational assessment of service quality within the framework of complex IT projects, including infrastructure servicing and maintenance, which often involve a large number of identical or similar iterations, it becomes necessary to develop novel analysis methods based on nonlinear aggregation of indicators. As a result of changes in the structure of the process, territorial remoteness, automation, informatization, and the emergence of big data, the use of existing assessment methods often becomes impossible or labor-intensive. The purpose of the present work is to develop an approach to assessing the quality of work (services) in the framework of IT projects based on nonlinear aggregation of indicators.

Methods. The proposed approach to assessing service quality within IT projects is based on nonlinear aggregation of a number of indicators involving a preliminary decomposition of the system into private indicators. In order to meet the requirements of the decomposition process, service quality indicators must fully characterize the properties of the service as a whole at the different stages of its life cycle.

Results. The application of the proposed nonlinear aggregation methodology to quality indicators obtained by decomposing the system is described with the further calculation of a single indicator that takes all the essential initial parametric indicators into account. The decomposition of complex systems to the level of elementary relationship subsystems more adequately reflects interrelated phenomena in a complex system.

Conclusions. The practical application of the neural network parametric data aggregation model for assessing the quality of IT services is demonstrated. The use of an aggregated information and analytical indicator for assessing service quality increases the availability of analytical information for decision makers, reduces the dimension of analytical data, and improves the objectivity of the obtained generalized information.

Keywords: aggregation, assessment, quality, indicator, IT project, analytics

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НАУЧНАЯ СТАТЬЯ

Оценка качества услуг в рамках ИТ-проектов на основе агрегирования показателей

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Резюме
Цели. Необходимость оперативного и обоснованного оценивания качества услуг в рамках сложных ИТ-проектов, таких как сервисное, техническое обслуживание ИТ-инфраструктуры, включающей выполнение большого числа схожих или аналогичных итераций, предопределяет необходимость разработки новых методов оценки качества, основанных на нелинейном агрегировании показателей. Применение прежних методов контроля становится невозможным либо трудозатратным ввиду изменения структуры процесса, территориальной удаленности, автоматизации, информатизации и появления больших данных. Цель работы – разработка подхода к оцениванию качества работ (услуг) в рамках ИТ-проектов на основе нелинейного агрегирования показателей.
Методы. Предлагается подход к оцениванию качества работ (услуг) в рамках ИТ-проектов на основе нелинейного агрегирования ряда показателей с предварительной декомпозицией системы на частные индикаторы. Показатели качества услуги должны соответствовать требованиям процесса декомпозиции, т.е. полностью характеризовать свойства услуги как единого целого на стадиях ее жизненного цикла.
Результаты. Описано применение предложенной методологии нелинейного агрегирования к индикаторам качества, полученным путем декомпозиции системы, с дальнейшим расчетом единого показателя, учитывающего все существенные изначальные параметрические показатели индикаторов. Предложено производить декомпозицию сложных систем до уровня элементарных подсистем соотношений, описываемых этими индикаторами, которые изначально более адекватно отражают взаимосвязанные явления в сложной системе, нежели абсолютные показатели.
Выводы. Показано преимущество практического применения модели параметрического нелинейного агрегирования данных для оценки качества ИТ-услуг. Использование агрегированного информационно-аналитического показателя оценки качества услуг улучшает доступность аналитической информации для лиц, принимающих решения, снижает размерность аналитических данных, повышает объективность получаемой обобщенной информации.

Ключевые слова: агрегирование, оценка, качество, индикатор, ИТ-проект, аналитика

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INTRODUCTION

An important element in the management of a company's processes consists in assessing the quality of the services provided. Such an assessment provides a basis for feedback to support management decisions. However, a unified methodology for assessing all aspects of service quality is yet to be developed.

During the period of rendering services within the framework of complex IT projects, including service and maintenance works, it is necessary to ensure proper definitions that underly the information-analytical parameters of work performance. Such information-analytical parameters can be used in analytical reporting to support organizational and technical decisions as a means of improving work performance (service provision).

Quality assessment indicators reflecting parameters used for quality management can be measured in different ways. In any case, the result of the measurement comprises a set of numerical values for the parameters. However, it may not be sufficient to indicate that the quality of a project depends on the timing of its implementation. Thus, decisions must also be taken concerning whether all operations must necessarily begin and end at a certain time or only after a certain deadline. In addition, it should be stated which outcomes are to be monitored. The results of quality assessment are used in service delivery, monitoring and processes management.

The purpose of the present work is to propose a methodology for the nonlinear aggregation of heterogeneous quality indicators. In this connection, the main task is to apply the proposed methodology of nonlinear aggregation to the quality indicators obtained by decomposition of the system, with further calculation of a single indicator that takes into account all the significant initial parametric indicators.

PROBLEM STATEMENT

Depending on the specifics of a project, various indicators can be used for nonlinear calculation of a single quality indicator. These include defect density, failure probability, availability of service, reliability, etc. At present, many methods of service quality assessment have been developed, including critical-case methods such as INDSER, Kano, SERVQUAL, SERVPERF [1–4]. Various weighted average ranking methods are also applied, many of which are based on the ranking of essential attributes of the provided service quality, e.g., tangibility, reliability, assurance, trust, security, attention, communication, and customer understanding. However, traditional quality assessment schemes are often not adapted to the changed information realities. Often it becomes impossible to operate with big data; moreover, there are no methods of online monitoring in the process of service provision or there are no reliable mathematical methods for calculating the proposed characteristics due to their being based on expert assessments, whose results can be difficult to formalize. In [4], it is noted that "there is no single best method for assessing the state [...] since the state is a multidimensional characteristic, and different methods [...] reflect different aspects of its state […] so there is a need for research into methods […] that enable objectivizing the assessment of the subject's state on the basis of available heterogeneous data."

For example, the commonly used SERVQUAL model is based on the concept of customer service, which is based on the expectation-perception principle. The questionnaire used in the SERVQUAL model consists of five blocks of user questions, each of which responds to a specific request. 22 pairs of questions in each block are distinguished using the Likert scale, where each parameter has its own value. This methodology is based on the assessment of consumer attitudes towards the product or service provided to the customer. Despite the fact that SERVQUAL models are based on quantitative and qualitative indicators of customer satisfaction, they lack universality. Some of the shortcomings noted by researchers were taken into account in the development and supplementation of evaluation methodology concepts. At the same time, the majority of works do not contain conceptually new approaches to the methodology of service quality assessment [5–8].

Since the evaluation of services "has a qualitative character and is an object of nonnumerical nature," the essential evaluation of services cannot be correctly performed within a deterministic framework but becomes possible only within the context of a linguistic scale [9].

The widespread practice of service quality assessment focused on customer satisfaction cannot be recognized as successful due to the risk of substituting subjective feelings for objective concepts; moreover, there is a danger of manipulating consumer opinions. At the same time, when assessing the quality of services, it is impossible to completely abandon the evaluation of consumer opinion, i.e., it becomes necessary to achieve a balance between consumer opinion and objective evaluation [10].

Along with methods of comparative analysis based on approaches to solving problems of multi-criteria and multi-objective decision making in fuzzy conditions, clustering methods [11] attract attention due to the possibility of using the mathematical and conceptual apparatus formed on their basis for ranking research objects in quality assessment. Fuzzy multi-criteria optimization methods include ELECTRE, PROMETHEE, VIKOR, TOPSIS, AHP, ANP, and DEMATEL approaches [12]. At the same time, the algorithms used in construction of decision matrices only achieve the goal of ranking within the group under consideration based on the available criteria. These are of little use in practical evaluation since they consider situational and relative rather than objective location problems. Such ranking algorithms evaluate an alternative solely within the presence of other alternatives. Clustering, on the other hand, represents a visualization method according to which the presence of relationships can be shown on a two- or three-dimensional projection. Meanwhile, the still-popular average value method can be supplemented with a number of weighting coefficients within the framework of metrics understandable to the researcher [13].

The issue of IT service quality assessment, which remains a priority for any organization, implies decision making with the help of one model or another [14, 15]. In this case, service quality can be defined as "a set of service characteristics that determine its ability to meet the established or anticipated needs of the consumer."[1]

The proposed use of a parametric nonlinear data aggregation model to assess the quality of IT services offers a number of advantages over traditional methods [16–19]. According to this methodology, the process of IT service quality assessment requires identification of the necessary quality indicators to inform the further assessment of the service quality level. Service quality indicators should meet the requirements of the decomposition process, i.e., fully characterize the properties of the service as a whole at the stages of its life cycle, which determine its ability to meet certain customer needs.

Thus, the identification and establishment of quality indicators in an IT project, especially in such works as service and maintenance of IT infrastructure, is a complex and fundamental procedure for the subsequent quality assessment according to the parametric data aggregation model, because it implies decomposition of the service delivery process in terms of quality into the corresponding aggregates. Since the process of decomposition has its own peculiarities and limitations, it should be performed according to the developed methodology rationally, expediently, and in accordance with the set goals [20, 21].

To this end, it is necessary to establish which initially qualitative characteristics are important in controlling the realization of the IT project, representing them in the form of vectors of values with criterion indicators.

[1] GOST R 50646-94. State Standard of the Russian Federation. *Service for people. Terms and definitions*. Moscow: Izdatelstvo standartov; 1994 (in Russ.).

RESULTS

It is proposed to use the following indicators for IT projects:

1. Inquiry Processing Timeliness Indicator (IPTI).

This indicator expresses the probability that a request sent to the IT service will be processed within the agreed timeframe:

$$\mathrm{IPTI} = \frac{D1}{D1 + D2}, \tag{1}$$

where $D1$ is the total number of processed requests for the reporting period, $D2$ is the total number of overdue requests for the reporting period.

2. Operational Readiness Indicator (ORI).

This indicator expresses the probability that the IT service is in an operational state at a given point in time:

$$\mathrm{ORI} = \frac{T1}{T1 + T2}, \tag{2}$$

where $T1$ is the time period of service operation (in hours) for the reporting period, $T2$ is the time of IT service unavailability for the reporting period.

3. Consumer Satisfaction Indicator (CSI).

This indicator expresses the probability that the IT service will meet the consumer's needs:

$$\mathrm{CSI} = \frac{Y1}{Y1 + Y2}, \tag{3}$$

where $Y1$ is the total number of users for the reporting period, $Y2$ is the total number of complaints for the reporting period.

As well as being methodologically justified by a single dimension and concept, the use of the introduced indicators having numerical values from 0 to 1 has practical significance, convenience of application, and visualizability.

It is proposed to decompose complex systems only to the level of elementary subsystems described by these indicators, which initially reflect interrelated phenomena in a complex system more adequately than absolute indicators.

Since a complex system is composed solely only inherent relations, representing interconnected and interdependent processes that reflect an internal balance, the description of elementary subsystems using absolute values will significantly complicate the calculation of aggregate indicators.

The next step in the parametric nonlinear aggregation model comprises the calculation of the aggregated indicator of the service quality assessment. A simpler interpretation of the methodological approach given in [17, 18] is proposed as an aggregation technique:

$$\text{AIAI} = \frac{1}{1+\sum_{n=1}^{N}\alpha_n\frac{(i_n-1)^2}{h^2}},\quad 0 \le \text{AIAI} \le 1, \tag{4}$$

where AIAI is the aggregated information-analytical indicator; α_n are weighting coefficients that verify the individual importance of the indicators of elementary aggregates; i_n are the values of the indicators of elementary aggregates, i.e., i_1 = IPTI, i_2 = ORI, i_3 = CSI, … Here N is the number of indicators which can be of any value; h^2 are the expert estimations of unknown interference intensities of the elementary aggregate indicators.

According to the conditions of formula (4), the AIAI monotonically increases to 1 when the values of all elementary aggregates approach to their upper values, i.e., to 1. Thus, the AIAI objectively reflects the qualitative characteristics of the process of rendering services (works performed). The AIAI can also be used to identify processes that require additional controls.

The presented methodology resolves many problems "associated with the use of indices, such as the choice of a base for calculation, the quality of source data and data aggregation" [22, 23].

The following table presents the calculation of AIAI for five organizations that are part of the group of companies providing IT support services (authors' data based on the materials of Digital Service[2]).

Calculated AIAI are presented in the diagrams (Figs. 1 and 2).

Table. Calculated data of indicators and AIAI

Pos. No.	IPTI	ORI	CSI	AIAI
1	0.85	0.75	0.88	0.66
2	0.79	0.76	0.74	0.58
3	0.93	0.95	0.98	0.88
4	0.65	0.55	0.64	0.46
5	0.58	0.5	0.45	0.40

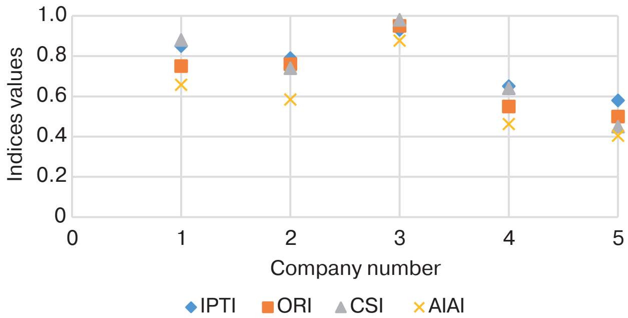

Fig. 1. AIAI visualization (dot diagram)

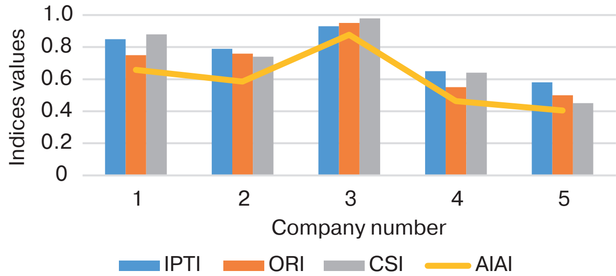

Fig. 2. AIAI visualization (combined diagram)

DISCUSSION OF RESULTS

As shown in the diagrams, the AIAI obtained by the model of parametric nonlinear aggregation correlates with the set of initial data represented by elementary aggregate indicators, as well as adequately summarizing the set of initial indicators within the framework of relations between them.

In the process of pilot application and operation taking into account expert opinion, the AIAI may be supplemented with the following conditions for best practical application:

- threshold value;
- target value;
- actual value.

The target direction of AIAI changes for all works over time: positive – increasing; negative – decreasing.

Target and threshold values can be used to set the AIAI scale of the work, including for comparison over time. The AIAI scale can also be divided into the following areas:

- works (services) do not require additional control,
- additional control of works (services) is required),
- preventive measures are required.

If the actual value of AIAI is not less than the target value, it corresponds to the wording "works (services) do not require additional control." If the actual value of AIAI is greater than or equal to the threshold value and less than the target value, this corresponds to the wording "additional control is required." In cases where the actual value of AIAI is less than the threshold value, it can be concluded that "preventive measures are required."

CONCLUSIONS

The parametric nonlinear data aggregation model for IT service quality assessment offers a number of advantages in terms of practical application. As well

[2] http://digitservice.ru (in Russ.). Accessed December 05, 2023.

as reducing the dimensionality of analytical data and increasing the objectivity of the obtained generalized information, the use of the aggregated information-analytical indicator for assessing the quality of services improves the availability of analytical information for decision makers.

Authors' contribution

The authors' contribution to the writing of the article, including the development of the concept (idea formation, formulation and development of key goals and objectives), conducting research, preparing and editing the text, and approval of the final version of the article is joint, balanced, and equivalent.

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