Research and concepts

The integrated evaluation model for administration quality based on service time

Jann-Pygn Chen
Chi-Kuang N. Chen and
K.S. Chen

The authors

Jann-Pygn Chen is Associate Professor, Department of Industrial Engineering and Management,
Chi-Kuang N. Chen is Associate Professor, Department of Business Administration, and **K.S. Chen** is Professor, all at the National Chin-Yi Institute of Technology, Tapin, Taiwan, ROC.

Keywords

Service, Efficiency, Customer satisfaction, Service quality

Abstract

Increasing the service quality in administrative areas is a critical factor facing the service industry today. This is supported by the latest version of the international quality standard ISO 9001, which emphasizes that customer satisfaction should have a complete and objective evaluation method and index. Uses the service quality defect concept in the PZB model to measure the time characteristic of service quality in processing an administrative job. At the same time, establishes the best estimates of service efficiency for each service unit and the whole department. Establishes a non-center *t* distribution and a test procedure by *p*-value to evaluate if the service process fits the customer-defined service efficiency index. The result can then be used to judge the service efficiency of both individual service units and the whole department. According to the test procedures presented here, provides an objective evaluation criterion for administration and service industry.

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Introduction

As the global economy becomes ever more prosperous, the productivity of the service sector gains in importance. Accordingly, researchers increasingly devote themselves to the characteristics of this sector, with the constant aim of capturing and increasing customer satisfaction. But since a service offering is intangible, the measurement of its quality is so much more difficult than measuring quality in a tangible product. However, as customers' disposable income increases, so too does their level of discernment; they expect and require higher levels of service delivery – and to meet this, organisations have to look at their internal processes which contribute to the total service experience – not least the quality and efficiency of their administrative systems.

When aiming to increase service quality, the contribution of the administration department cannot be ignored. Issues such as streamlining the processing of documents to improve the service attitude of the administrative staff can have a major impact on the perceived and actual levels of service quality recognised by the customer.

Regardless what business is considered, the service element comprises a series of operations, each of which influences the total working hours to finish a job. Therefore, a single operation can influence total efficiency. It is important therefore to investigate the service efficiency for each individual operation, and to seek out and resolve any bottlenecks in the process, in order to improve the service advantage and to optimise customer satisfaction.

The research described in this article focuses on establishing a service efficiency index for each operation, and on creating a total service efficiency index for the organization, by which it may calculate the efficiency of its entire service operation. The article aims to reach the following goals:

- To define the operation processes, and the characteristics of each operation activity, to evaluate service quality.
- To define a service efficiency index for each operation activity to evaluate the administration capability of each service person, and find the relationship between

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the respective service efficiency index and the rate of service accomplishment.
- To calculate the total service efficiency index, and analyze the relationship between that total service efficiency index and the customer satisfaction rate.
- To calculate the best estimates of the total service efficiency index and the respective service efficiency index.
- To analyze the characteristic of the sample distribution of the best estimates of the total service efficiency index, and the respective service efficiency index.
- To utilize statistical hypothesis methods to judge whether or not the service process fits the preset standard of administrators or customers.

Literature review

The concept of service originates from a Latin word *Servitum* which means "served by slaves", and also means diligent (Kotler, 1991). Over time, and with changes of environment, the concept of service has also changed. The following are some of the definitions of service by scholars.
- According to Juran (1986), service is "work performed for someone else".
- According to Kotler (1991), service means an activity or a performance which is offered by one to another. It is invisible in substance and does not necessarily come with the real products.
- According to Buell (1984), service is used to sell things, or offered through a variety of activities, benefits or satisfactions, in order to sell products.

To sum up, the characteristics of service are (Kotler, 1991):
- intangibility;
- inseparability;
- variability;
- perishability.

Some scholars, including Murdick *et al.* (1990), also mentioned some characteristics of service: it is difficult to standardize; in its process, it cannot be mass-produced; its quality and measurement is often a subjective judgement; its quality is mainly focused on the control of service process, etc. These characteristics are totally different from those in manufacturing industry.

In contrast, however, most of the definitions of quality came from manufacturing industry, but these definitions do not dovetail neatly into the service sector. The concepts of service quality among scholars differ, because the surveys they made are in different businesses.

Parasuraman *et al.* (1985, 1991) have aroused attention with the concept that customers use their knowledge and expectations to measure service quality. Customer expectation brings much influence to bear on service quality. This concept found there were two levels of customer expectation: desired and adequate. "Desire" means customers hope to receive the service that sellers need to – and ought to – provide: "adequate" means customers find acceptable the service that they think and predict the seller will provide. Between the desired and adequate levels are the so-called zones of tolerance, and the amount of tolerance will differ from person to person, and will also change through experience of other sellers' service standards. When the service experience falls in zone 1 (at the "adequate" end of the continuum), they will never come to visit again unless there are some special reasons; when it falls in zone 2, customers will feel the service is acceptable; when it falls in zone 3, they will feel the service is outstanding and beyond their expectation. They will become loyal customers and only go to this store from that moment.

Scholars, including Parasuraman (1991), investigated customer behaviors and found ten factors involved in the measurement of service quality:
(1) reliability;
(2) responsibility;
(3) competence;
(4) access;
(5) courtesy;
(6) communication;
(7) creditability;
(8) security;
(9) understanding/knowing customers; and
(10) tangibles.

Parasuraman also introduced the concept of a service quality conscious continuity zone (Berry *et al.*, 1985), suggesting that the quality standard which customers expect is defined as the sum of three factors: (expectation before buying) × (quality in the service delivery process) × (the appraisal of quality received after the service delivery). Service quality, then, is influenced by expectation, process quality and output quality; in other words, the standard of service quality is defined by customers who have experienced that service, and used their experience and feelings to form a judgement. If the service offered by the seller is better than the customer expects, it is called "ideal quality standard", while if the service is worse than the customer expects, it is called "unacceptable quality standard".

In this way, in can be seen that customer satisfaction of service quality can be measured by the difference between customer expectations prior to delivery, and how he or she feels after the service experience (Parasuraman *et al.*, 1985; Cronin *et al.*, 1992, 1994). The model that is used most in measuring service quality is the P2B model (Parasuraman *et al.*, 1985), where good service quality must eliminate five possible defect areas:

(1) management cognition;
(2) service quality specifications;
(3) service transmission;
(4) outside communication; and
(5) service perception.

In this model, the last defect is the service quality agreed by customers, and the other four defects are the reasons for producing defect (5). Parasuraman *et al.* (1988) extended the original model to discuss the factors such as communication problems and role conflicts which influence defects (1) to (4). They analyzed those factors and found five elements which contained: tangible, reliability, responsiveness, assurance; and empathy and 22 problems of SERVQUAL used to measure service quality.

From the research above, while it is clear that there are many factors which can influence service quality, they can be combined into two groups: quantity and quality. Quantity factors are those which can be measured by exact value, such as the processing time used from the beginning to the end of the service delivery, and the quantity of service delivered in a specific period of time.

Quality factors are those which do not lend themselves easily to be measured by exact value, such as the attitude of service workers and their professional capability. The vice president of Boston Consulting Group, Chang (1994) claimed that time has become a new fatal strategic weapon by which to conquer the enemy. In today's environment, Japan has spent a lot of money on "decreasing the development of products and manufacturing time" in order to maintain its leading role in the global competitive market.

In manufacturing industries, the productivity index is an effective tool to estimate the efficiency of products and manufacturing processes. Many statisticians and QC engineers have undertaken much work in this field (Kane, 1986; Chan *et al.*, 1988; Boyles, 1991, 1994; Pearn *et al.*, 1992; Chen, 1998; Chen, 2000). Although the methods used in product estimation and manufacturing process quality efficiency are well tested, the quality efficiency guide for use in the service industry can still be improved. This research used the service quality specification defect together with the service transmission defect in the completion time of administration processes, to measure the efficiency of the total administration process. This research also considered individual process efficiencies, for comparison, to establish where bottlenecks lie, and to identify any department or departments which fail to reach the expected quality, and to provide the means of grading the service provision, so that priorities can more easily be set, and the competitive advantages of the service industry be accomplished.

Service efficiency index

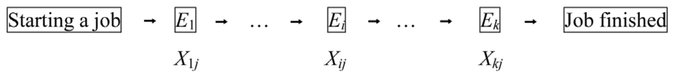
Establish the service efficiency index in service process

In order to construct the service process, we have to make the following definitions:

E_i : the operation or service unit i for a job;
X_{ij} : the service time for the job j to pass E_i;
T_j : the total service time for job j;
U_{ij} : the service deliverer- or specifier-defined maximum service time for job j to pass process E_i;
U_j : the manager- or customer-tolerated maximum service time for job j.

In Figure 1, k represents the number of processes, X_{ij} includes idle time and transportation time. The relationship between T_j and X_{ij} can be represented by $T_j = \sum_{ij=1}^{k} X_{ij}$. Normally, the elapsed service

Figure 1 Processing procedure



time of E_i for X_{ij} is unfixed; and we can assume X_{ij} as a random variable in units of minutes, hours, or days. All other things being equal, the shorter X_{ij} is, the better the level of service quality. From the viewpoint of quality management, the shorter the period of elapsed time for the service to be delivered, the better. However, there is always a time limit U_{ij} for every process E_i. The limit could be set by service personnel or their manager, in what would be defined as the latest finish time. When X_{ij} is equal to or less than U_{ij}, there is no delay in the process of E_i, but when X_{ij} is greater than U_{ij} , then there is a delay.

Because every operation has a different service time, it is not appropriate to use X_{ij} as the absolute time to represent service efficiency. Instead, the time difference between U_{ij} and X_{ij} is a better value to represent service efficiency. This research uses $Y_{ij} = (U_{ij} - X_{ij})/U_{ij}$ as the relative service time, and uses the signal-to-noise ratio as the service efficiency index to evaluate service quality. The service efficiency index is as follows:

$$\mathrm{Ie}_i = \frac{\mu_{Y_{ij}}}{\sigma_{Y_{ij}}}, i = 1, 2, \ldots, k$$

where $\mu_{Y_{ij}}$ is the average of Y_{ij}, and $\sigma_{Y_{ij}}$ is the standard deviation of Y_{ij}. When $\mu_{Y_{ij}}$ is large, the processing time relative to the service maximum time U_{ij} is also large, which means the service efficiency is good. As to $\sigma_{Y_{ij}}$, when it is smaller, the processing time is stable and the efficiency is better. On the above basis, the larger the service efficiency index Ie_i , the greater the level of objective service efficiency indicated. If Ie_i is 0, the job is finished on time. If it is a negative number, the job cannot be finished on time. If it is a positive number, the job has a higher level of service efficiency.

The total service efficiency index

In order to evaluate the service efficiency of total service time T , we can derive the total service efficiency index I_T from the equation $T_j = \sum_{i=1}^{k} X_{ij}$. Similar to T_j , we can define $U_j = \sum_{i=1}^{k} U_{ij}$ and use the concept of relative total service time $W_j = (U_j - T_j)/U_j$ to define the total service efficiency index as follows:

$$I_T = \frac{\mu_{W_j}}{\sigma_{W_j}}$$

where μ_{W_j} is the average of W_j , and σ_{W_j} is the standard deviation of W_j .

Service efficiency index and service accomplish rate

When Y_{ij} is a positive figure or 0, and U_{ij} is greater than or equal to X_{ij}, then the service personnel finished job E_i on time. If the accomplish rate is defined as p, then $p = P(Y_{ij} \geq 0)$. Let $Z = (Y_{ij} - \mu_{Y_i}/\sigma_{Y_i}$, then under normal assumptions, the relationships between accomplish rate p and index Ie_i becomes:

$$p = P(Y_{ij} \geq 0) - P(Z \geq -\frac{\mu_{Y_{ij}}}{\sigma_{Y_{ij}}})$$
$$= P(Z \leq \frac{\mu_{Y_{ij}}}{\sigma_{Y_{ij}}}) = \Phi(\mathrm{Ie}_i),$$

where $\Phi(\cdot)$ is the accumulated standard normal distribution.

According to this equation, when the index is larger the accomplish rate becomes higher. At the same time, when the index is smaller, the accomplish rate also becomes lower. Therefore, every completed service efficiency index can fully represent the accomplish rate. In fact, index Ie_i and the on-time accomplish rate p has a one-to-one relationship. Table I shows the relationship of the service efficiency index, Ie_i, to on-time accomplish rate p, for the values of 1.0, 2.0, 3.0, 4.0, 5.0, and 6.0. Where Ie_i fails to show on Table I, the on-time accomplish rate $p = \Phi$ (Ie_i) can be easily calculated from the accumulated standard normal distribution table of statistics or quality control books.

Therefore, if we can calculate Ie_i for every job, it is easy to calculate the on-time accomplish rate p – even though that accomplish rate can be derived from the calculation of the rate of on-time finished job.

Table I The on-time accomplish rate p when Ie_i = 1.0 (1.0) 6.0

Index Ie_i	On-time accomplish rate p
1.0	0.841344746
2.0	0.977249868
3.0	0.998650102
4.0	0.999968329
5.0	0.999999713
6.0	0.999999999

However, according to Montgomery (1991), we need a large sample size to accurately calculate p: but Ie_i does not require a large sample size to provide reliable results. Based on the one-to-one relationship between Ie_i and p, it is easy to estimate the on-time accomplish rate. In any event, the ability – through employing the index Ie_i – to easily establish the on-time service rate for service personnel is only one of the benefits. The most important is the ability to estimate the service efficiency and ability of an administration job accurately and reliably. The service efficiency index Ie_i is a very good tool to evaluate the service efficiency of an administration unit.

But customers focus on total service efficiency. When W_j is a positive number or 0, and U_j is greater than or equal to T_j, the total service time T_j is smaller than the customer's expectation service time U_j . In this situation, the service can meet the customer's requirement. If the customer satisfaction rate is p, then $p = P(W_j \geq 0)$. Under the assumption of normal distribution, $Z = (W_j - \mu_{W_j})/\sigma_{W_j}$, then Z is also a normal distribution. The relationship between the customer satisfaction rate p and the index I_T can be represented as follows:

$$p = P(W_j \geq 0) = P(Z \geq -\frac{\mu_{W_i}}{\sigma_{W_j}}) = P(Z \leq \frac{\mu_{W_j}}{\sigma_{W_j}}) = \Phi(I_T).$$

From the above equation, the customer satisfaction rate p and index I_T is similar to the relationship between index Ie_i and the on-time accomplish rate; the one-to-one relationship. The result is the same as shown in Table I. For example, if total service efficiency index $I_T = 2$, the customer satisfaction rate p becomes 0.977249868.

The estimation of service efficiency index

In general, the average service time (μ_i) and standard deviation (σ_i) for job E_i is unknown. Therefore, we have to randomly pick n samples from regular jobs to estimate the service efficiency index (Ie_i) and total service efficiency index (I_T). Those randomly picked n samples and their maximum service time are demonstrated in Table II.

Table II n samples and their maximum processing time

E_1	...	E_i	...	E_k	Total
(X_{11}, U_{11})	~	(X_{i1}, U_{i1})	...	(X_{k1}, U_{k1})	(T_1, U_1)
⋮	⋮	⋮		⋮	⋮
(X_{1j}, U_{1j})	~	(X_{ij}, U_{ij})	...	(X_{kj}, U_{kj})	(T_j, U_j)
⋮	⋮	⋮		⋮	⋮
(X_{1n}, U_{1n})	~	(X_{in}, U_{in})	...	(X_{kn}, U_{kn})	(T_n, U_n)

According to Table II, Y_{ij} can be derived easily. Then, we can use $\hat{\mu}_{Y_{ij}}$ and $\hat{\sigma}_{Y_{ij}}$ to estimate $\mu_{Y_{ij}}$ and $\sigma_{Y_{ij}}$, use $\hat{\mu}_{W_j}$ and $\hat{\sigma}_{w_j}$ to estimate μ_{W_j} and σ_{W_j}. Furthermore, if we adjust the bias, the unbiased estimator of Ie_i and I_T indices can be shown as follows:

$$\hat{I}e_i = (b_n) \times \left(\frac{\hat{\mu}_{Y_{ij}}}{\hat{\sigma}_{Y_{ij}}}\right),\ \hat{I}_t = (b_n \times \left(\frac{\hat{\mu}_{W_i}}{\hat{\sigma}_{W_i}}\right)$$

where

$$\hat{\mu}_{Y_ij} = \frac{1}{n}\sum_{j=1}^{n} Y_{ij},\ \hat{\sigma}_{Y_{ij}}\sqrt{\frac{1}{n-1}\sum_{j=1}^{n}(Y_{ij} - \hat{\mu}_{Y_{ij}})^2},$$
$$i = 1, 2, 3, \ldots, k.$$

$$\hat{\mu}_{W_j} = \frac{1}{n}\sum_{j=1}^{n} W_j,\ \hat{\sigma}_{W_j} = \sqrt{\frac{1}{n-1}\sum_{j=1}^{n}(W_j - \hat{\mu}_{W_j})^2}\circ$$

$$b_n = \sqrt{\frac{2}{n-1}} \times \left(\frac{\Gamma[(n-1)/2]}{\Gamma[(n-2)/2]}\right), n > 2\circ$$

Obviously, b_n is a function of sample size n. Table III shows the respective values (b_n) for n.

In fact, the unbiased estimator $\hat{\mathrm{Ie}}_i$ is then a function of the complete, sufficient statistics of $(\hat{\mu}_{Y_{ij}}, \hat{\sigma}_{Y_{ij}})$ alone. For the same reason, $\hat{I}_T$ is also a function of the complete, sufficient statistics of $(\hat{\mu}_{W_j}, \hat{\sigma}_{W_j})$ alone. Therefore, $\hat{\mathrm{Ie}}_i$ and $\hat{I}_T$ are the minimum variance unbiased estimators (*UMVUE*) for Ie_i and I_T respectively. The variance can be shown as

$$\mathrm{Var}(\hat{I}) = \left(\frac{\Gamma[(n-1)/2]\Gamma[(n-3)/2]}{n \times \Gamma^2[(n-2)/2]}\right)(1 + n(I)^2) - (I)^2$$

where $I = \mathrm{Ie}_i$ or I_T , and $\hat{I} = \hat{\mathrm{Ie}}_i$ or $\hat{I}_T$. Let $t'_{n-1}(\delta) = \sqrt{n} \times (b_n)^{-1} \times \hat{I}$, then t' follows the non-centralized t distribution with degree of freedom $n - 1$, and the non-centralized parameter $\delta = \sqrt{n} \times I$. Therefore, we can derive the probability density function for the optimal estimator $\hat{I}$ as the following equation:

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Table III Respective values b_n for n

n	b_n	n	b_n	n	b_n	n	b_n	n	b_n	n	b_n	n	b_n
3	0.564	10	0.914	17	0.952	24	0.967	31	0.975	38	0.980	45	0.983
4	0.724	11	0.923	18	0.955	25	0.968	32	0.976	39	0.980	46	0.983
5	0.798	12	0.930	19	0.958	26	0.970	33	0.976	40	0.981	47	0.984
6	0.841	13	0.936	20	0.960	27	0.971	34	0.977	41	0.981	48	0.984
7	0.869	14	0.941	21	0.962	28	0.972	35	0.978	42	0.982	49	0.984
8	0.888	15	0.945	22	0.964	29	0.973	36	0.978	43	0.982	50	0.985
9	0.903	16	0.949	23	0.965	30	0.974	37	0.979	44	0.982	51	0.985

$$f_{\hat{I}}(y) = \left(\frac{b_n^{-1} \times \sqrt{n} \times 2^{-(n/2)}}{\Gamma[(n-1)/2]}\right) \int_0^\infty t^{\left(\frac{n-2}{2}\right)} exp\{-0.5[t + \left(\frac{\sqrt{nt}}{(n-1)b_n} y - \delta\right)^2]\}dt,$$

where $x \in R$ (R is a real number).

The evaluation of service efficiency

The statistical hypothesis of service efficiency

According to Cheng (1994-95), due to sampling errors, one cannot directly judge if service efficiency has reached the desired standard by the point estimate of service efficiency index. To achieve this, we have to employ statistical methods to establish whether the service efficiency meets customer requirements, under the requested confidence coefficient ($1 - \alpha$) or level of significance (α). If the requested service efficiency for every service unit is set up at Ie_0(equivalent to accomplish rate $p = \Phi(\mathrm{Ie}_0)$). If we then employ a statistical hypothesis method, the test of hypothesis for service efficiency can be represented as follows:

H0. $\mathrm{Ie}_i \geq \mathrm{Ie}_0$ (i-th service unit has good efficiency).

Ha. $\mathrm{Ie}_i < \mathrm{Ie}_0$ (i-th service unit does not have good efficiency).

Assume the optimal estimate $\hat{\mathrm{I}}\mathrm{e}_i$ of Ie_i is used as a test statistic, while calculating $\hat{\mathrm{I}}\mathrm{e}_i = V_e$, p-value can be calculated as follows:

$$\begin{aligned} p\text{-value} &= \mathrm{P}(\hat{\mathrm{I}}\mathrm{e}_i \leq V_e | \mathrm{Ie}_i \geq \mathrm{I}_{e0}) \\ &= \mathrm{P}(\sqrt{n} \times (b_n)^{-1} \times \hat{\mathrm{I}}\mathrm{e}_i \leq \sqrt{n} \times (b_n)^{-1} \times V_e | \mathrm{Ie}_i \geq \mathrm{I}_{e0}) \\ &= P(t'_{n-1}(\delta) \leq \sqrt{n} \times (b_n)^{-1} \times V_e), \delta = \sqrt{n} \times (\mathrm{I}_{e0}) \end{aligned}$$

For the same reason, if we require the total service efficiency index to at least I_0 (equivalent to customer satisfaction rate of at least $p = \Phi(I_0)$). The test of hypothesis for the total service efficiency is as follows:

Ha. $I_T < I_0$ (poor total service efficiency).

Similar to the test of Ie_i, if the optimal estimate of $\hat{I}_T$ of I_T is used as a test statistic, when given $\hat{I}_T$, p-value is derived as

$$p\text{-value} = \mathrm{P}(t'_{n-1}(\delta) \leq \sqrt{n} \times (b_n)^{-1} \times \hat{I}_T), \quad \delta = \sqrt{n} \times (I_0)$$

The evaluating procedure of service efficiency

We can then, in fact, use p-value as the evaluation standard. However, when the total service efficiency cannot meet the demand, there must still be some service units that are performing badly. Even when the total service efficiency is good, it does not necessarily follow that each individual unit is good. There might be some outstanding units that more than compensate for the poorly-performing ones. From the viewpoint of management, we should make sure every unit meets the requirement, and seek to improve those performing less well. When every unit meets the requirement, the total service efficiency is naturally reached. In order to establish a simple method to evaluate if administration efficiency meets customer requirements, the following evaluation procedure can be applied:

(1) Decide the sample size n and level of significance (α) for service efficiency index Ie_0 I_0.
(2) Based on n samples, calculate the average and standard deviation for each unit and individual jobs (including total units):

$$\hat{\mu}_{Y_{ij}} = \frac{1}{n}\sum_{j=1}^{n} Y_{ij},\ \hat{\sigma}_{Y_{ij}} = \sqrt{\frac{1}{n-1}\sum_{j=1}^{n}(Y_{ij}-\hat{\mu}_{Y_{ij}})^2},\quad i = 1, 2, 3, \ldots, k.$$

$$\hat{\mu}_{W_j} = \frac{1}{n}\sum_{j=1}^{n} W_j, \hat{\sigma}_{w_j} = \sqrt{\frac{1}{n-1}\sum_{j=1}^{n}(W_j-\hat{\mu}_{W_j})^2}$$

(3) Find out b_n from Table II and calculate the test statistics $\hat{I}e_i$ and $\hat{I}_T$.
(4) Follow the calculation of p-value for every unit and individual jobs.
(5) The rules below will help make decisions based on the p-value calculated on Step 4:
- When the p-value is equal to or less than α/k for i-th unit, the unit fails to meet the service efficiency requirement and should be improved.
- When total p-value is equal to or less than α for jobs, total service efficiency fails to meet customer requirements. Obviously, when total p-value is greater than α, the total service efficiency has already met customer requirements, but further evaluation should still be performed to find out whether any individual department is still disqualified.

An illustrated example

In order to illustrate the algorithm above, this research randomly selected ten co-op cases from the co-operation office of Chin-yi Institute of Technology (NCIT), Taiwan. The process flow is as shown in Figure 2. First of all, for these cases, the teaching units have to propose a consulting proposal. After related departments confirm it, the proposal has to go back to the original department to complete the job. From the information supplied by teaching units and discussion of the administration units, ten cases are listed in Table IV.

This assumes that the service efficiency index for every service and teaching unit is at least 1 (which means that, with reference to Table I, the customer satisfaction is at least 0.85). Under 0.05 significance level, the results can be derived as shown in Table V.

Because the p-value of each job is greater than 0.05, and the p-values of every service unit is greater than 0.01, the integrated service efficiency is outstanding.

Conclusion

In the 2000 version of the international quality standard ISO 9001, it is emphasized that enterprises should be given the motive to investigate and understand service requirements and customer satisfaction. It is also required to define a reliable method to gather customer information. This research focuses on the service time of series service units and proposes service efficiency indices of every unit and the whole department. The theory of statistical hypothesis is used to evaluate service accomplishment and customer satisfaction.

Finally, a simplified implemental procedure of an administration management example

Table IV Ten samples from NCIT

E_1	E_2	E_3	E_4	E_5	Total
(0.5,1.0)	(2.5,3.0)	(1.0,1.5)	(1.5,1.5)	(0.5,1.0)	(6.0,8.0)
(1.0,1.0)	(2.0,2.5)	(1.0,1.5)	(1.0,1.5)	(2.0,1.0)	(7.0,7.0)
(2.0,1.0)	(3.0,2.5)	(1.0,1.5)	(4.0,1.5)	(0.5,1.0)	(10.5,8.0)
(0.5,1.0)	(1.5,2.0)	(1.0,1.5)	(2.0,2.0)	(1.0,1.0)	(6.0,7.0)
(1.0,1.0)	(2.0,3.0)	(1.0,1.5)	(1.5,1.5)	(0.5,1.0)	(6.0,8.0)
(3.0,1.0)	(3.0,3.0)	(2.0,1.5)	(1.0,1.5)	(0.5,1.0)	(9.5,7.0)
(0.5,1.0)	(2.0,2.0)	(2.0,1.5)	(3.0,2.5)	(2.0,1.0)	(9.5,10.0)
(1.5,2.0)	(1.0,2.0)	(1.5,1.5)	(1.5,1.5)	(2.0,2.0)	(7.5,8.0)
(1.0,1.0)	(2.0,3.0)	(1.0,1.5)	(1.5,2.0)	(2.0,1.0)	(7.5,5.0)
(0.5,1.0)	(2.0,3.0)	(1.0,1.5)	(1.5,1.5)	(0.5,1.0)	(5.5,7.0)

Figure 2 Process flow of the co-op cases in NCIT

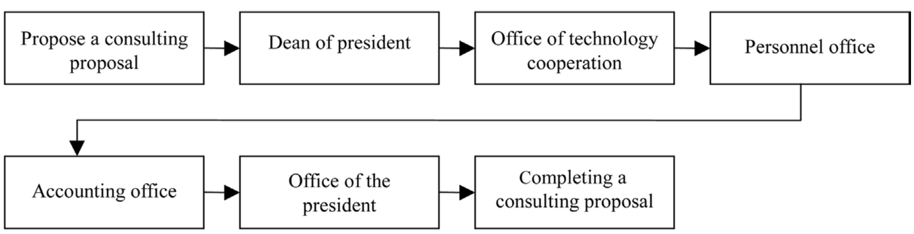

Table V The calculation for estimated service efficiency indices and *p*-value

	Service efficiency for every unit				Total service efficiency			
	$\hat{\mu}_{Y_{ij}}$	$\hat{\sigma}_{Y_{ij}}$	$\hat{I}e_i$	*p*-value	$\hat{\mu}_{W_j}$	$\hat{\sigma}_{W_j}$	$\hat{I}_T$	*p*-value
Service unit 1	–0.075	0.8169	–0.0839	0.39480				
Service unit 2	0.1917	0.2072	0.8456	0.97131				
Service unit 3	0.1667	0.2833	0.5378	0.92251	–0.02	0.2726	–0.0671	0.41532
Service unit 4	–0.095	0.5785	–0.1501	0.31885				
Service unit 5	–0.05	0.6852	–0.0667	0.41581				

from the co-operation office of Chin-yi Institute of Technology at Taiwan was presented to demonstrate the evaluation procedure of the service efficiency.

In summary, the research result of the integrated administration quality evaluation model can:

- provide an evaluation model on the service satisfaction between service provider and customer;
- can be applied in many different businesses;
- provide the administrator with a reliable index for efficiency and resource allocation.

It should be noted that this research assumes that the service time includes transportation and idle time that follows normal distribution. If the service time does not follow normal distribution, the theory presented cannot be reliably applied. In addition, it is also assumed that the U_{ij} and U_j for the service provider and customer are known. It is hoped that in future research, these constraints can be resolved.

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