Chapter 4
The Thought Process-A Theoretical Outline

[The core work attempted in the thesis is presented here. Recognizing the weak position of a patient in a medical treatment context in India, the chapter proposes a few classifications of service deficiencies, development of some quality indices and concepts of positive and negative attributes and of de jure and de facto quality levels. Suggestions are made for measuring these aspects. The gap between the two said levels and its assessment is vital for knowing the quality deficit and every attempt is to be made to reduce/eliminate this gap. A hybrid model containing binary as well as rated variables is developed to work out a service quality score. This model has two-level flexibility for the choice of weights. A multivariate model accommodating responses from a sample of size n on p questions is outlined.]

4.1.1 The Disadvantaged Patient

A patient is generally highly disadvantaged due to his/her being sandwiched between medical ignorance and an emergency. This calls for the qualities of empathy and compassion (e.g. as shown by Florence Nightingale and Mother Teresa) to be displayed by the healthcare providers. Mother Teresa was canonized and elevated to sainthood on Sept. 4, 2016—she was stated to have full compassion and was an artisan of mercy. In view of the hidden point mentioned above, the play of compassion and empathy is severely curtailed. Thus, in general, the patient is almost entirely at the receiving end. The host of hospitals accessible to the patient poses just variations of this problem. But the result is the same. One may mention in this context, Government hospitals (general or specialized), Private hospitals (general, special or super-specialty), Nursing homes, Primary health centers and so on. Unnecessary diagnostic tests, as perceived by a patient as duplication or superfluous, usually at centers specified by the hospitals impose extra financial burden on the patient. The “prescription culture”, whereby expensive drugs are prescribed in lieu of cheaper generic drugs, is rampant. There are hospitals where the

Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka
drugs are to be bought only at their pharmacy counters and there is a differential pricing within the pharmacy for different categories of patients; of course, all the time being highly expensive. This arbitrariness coupled with lack of empathy and compassion makes the patient highly vulnerable. There is need for hospitals with hospitality.

4.1.2 A Categorization of Quality Factors

It is convenient for understanding and evaluating (and attaching weights) the factors involved to have a broad categorization. The weights may be by choice (e.g. Sixteen each for factors (a) to (e), eight each for factors (f) and (g) and four for the last factor (listed below), the weights adding up to a total of hundred. Alternatively, the choice of weights may be based on an optimal design centered on a chosen objective function. The factors are outlined next.

a) Diagnostic Analysis and Interpretation: The factors identified are: Appropriateness, adequacy (neither excess nor deficit), accuracy of interpretation, communication with the patient/guardian and cost burden on the patient.

b) Medical Service: The sub-factors involved are suitability, adequacy, and simple registration/admission procedure, standard of critical care, access to efficient medical care, timeliness and cost effectiveness. Alternative choices to a common man, quality and cost balancing, working of special schemes for the poor, PPP models (like Yeshasvini Scheme of the Karnataka Government), cases of pediatric, normal and geriatric care, follow up after discharge (when necessary), empathy and compassion, the power of positive thinking, problem of medical negligence, medical ethics and doctors’ commitment for the same are the aspects relevant here.

c) Nursing Care: Skill, communication with patient, soft and soothing mode- this aspect is often overlooked or under stated. The skill and human aspect of nursing staff, humane and loving care, patience and positive attitude which should get translated to the patients.

d) Cost Factors: Cost of diagnosis, medicine, charges of hospitalization (when applicable), doctor's fees and absence of corruption (Baksheesh).

Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka
e) **Human Factors**: The human factors are: Empathy, compassion-humane behavior by doctors and administrative staff.

f) **Hospital Administration**: The factors are: Easy access, quick and timely registration, simple procedures, priority in emergencies, good institutional culture and environment.

g) **Government’s Role**: The framework is: Rules and regulations, health policy and its implementation, the possible gap due to laxity, control of corruption and steps in this regard.

h) **Other Factors**: The other peripheral factors are: Hospital environment, after treatment (discharge of patient) follow up, ancillary facilities like canteen, parking lot for vehicles and adequate signboards.

### 4.1.3 Construction of Service Quality Index

The construction aspects for obtaining quality indices are detailed here:

**Assessing the Qualitative Attributes**

The attributes like safety and security measures are somewhat easier to evaluate as they are resultants of hospital policy decisions. But the negative attributes which manifest as events like patient deaths due to medical negligence are difficult to assess. Sometimes these are stray occurrences. One way to assess these will be to go by such recorded cases during a period, *say* one year. The relevant data are to be gathered meticulously with caution and care. These data generally result from two sources of causes:

1) Administrative laxity and

2) Negligence and lack of work ethics of individual staff members

The two sources may work *in tandem* and result in recurring serious lapses. This directly contributes to the misery of the patients and hence, a steep fall in quality of healthcare.

**Country Level Index**

Quality assessment is complex. It involves several factors with differing importance (weights). For a country, one has to make the following choices to build such an index:

---

**Total Service Quality in Healthcare**: With Special Reference to Yeshasvini Project in Karnataka
1) The factor groups to be included 2) The items in each of the groups and 3) The weight for each group.

The first step is to construct group level indices, which are appropriately combined as outlined below:

A close parallel may be drawn with construction of the Human Development Index (HDI) of the United Nations which considers the Geometric mean of normalized indices of GDP, level of literacy and longevity of life. A similar index could be constructed for the Quality of Life. A practical aspect to consider here will be the data requirement for the proposed index, its availability and reliability. A kind of truncated index may be developed for an institution like a hospital or a drugs manufacturing company. The data availability may again be a constraint.

4.2.1 Healthcare Indices

A healthcare index $I$ is a theoretical construct. It amalgamates the relevant component factors (mentioned as (a) to (h) above) with assigned weights, into a single summary number. One may work out this index for a standard situation (Institution) as a benchmark. Then for a given case (e.g. hospital X) compute the index (say $I'$) with appropriate input data. Indices $I$ and $I'$ have the same structure, the difference being in data contents, some of which may be missing in the latter. Technically, $I'$ may exceed $I$, but generally it is the other way around, reflecting the quality deficiencies in the case under focus. While constructing $I'$ it is necessary to give weightage to periodical reviews by concerned health officials and consumers (patients and their guardians). The pair of Indices ($I$, $I'$) are comparable between them and are to be compared for different cases. It is well known that making the input base for the indices wider makes them more stable and their standard error (variability) decreases. If $I'$ is computed over time as $I'(t)$, the time variations in quality level can be identified to note the trend.
Institution Level Indices

At a hospital level, some other specific aspects could be included in the evaluation of quality of service. For example, the National Accreditation Board for Hospitals (NABH) considers the following chief parameters:

1. Access, Assessment and Continuity of Care (AAC)
2. Care of Patients (COP)
3. Management of Medication (MOM)
4. Patient Rights and Education (PRE)
5. Hospital Infection Control (HIC)
6. Continuous Quality Improvement (CQI)
7. Responsibilities of Management (ROM)
8. Facility Management and Safety (FMS)
9. Human Resource Management (HRM)
10. Information Management System (IMS)

A composite service quality index for a hospital may consider the eight component factors (a) to (h) listed above and the ten additional factors mentioned as (1 to 10) here.

Healthcare and ISO 9001

The twenty elements identified by the above system are cataloged next. This awareness is necessary for the applicants of ISO 9001 certification.

Management responsibility, quality system, contract review, design control, document and data control, purchasing, control of customer supplied product, product identification and traceability, process control, inspection and testing, control of inspection, measuring and testing equipment, inspection and test status, control of non-conforming product, corrective and preventive action, handling, storage, packaging, preservation and delivery, control of quality records, internal quality audits, training, servicing and statistical techniques.

These aspects may be suitably fused together with the earlier mentioned factors to provide an exhaustive list of considerations.

Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka
4.2.2 Positive and Negative Attributes

In the setup of a hospital, it is meaningful to classify service quality as positive and negative attributes and consider them separately in index construction. The former ones are desirable, while the latter are not. Positive attributes are expected to have a positive impact on service quality. Negative attributes have an adverse impact and are hence undesirable. More of positive attributes and less of negative ones is to be the motto. In other words, positive attributes work on the positive axis and add to the quality level, while the negative attributes operate on the negative axis and hence lower the service quality level. This bifurcation helps in policy decisions regarding improving/ preventing the desirable/ undesirable attributes, as the case maybe. Some examples and relevant discussion is provided below including a proposal of a demerit index $I$.

a) Positive Service Qualities

Compassion for patients, uniform treatment protocol, vibrant institutional culture, reasonable and justified cost component, rapport with patient and attendant & transparency.

b) Negative Service Qualities

Absence of fire safety measures, cases of medical negligence exposing the patient to risk of losing life (e.g. overdose of anesthesia, non-testing for allergy to penicillin drug before administering), instances of surgical negligence (e.g. operating on the wrong foot or even patient switching, leaving surgical instruments like pair of scissors in the patient’s body after surgery), inefficient system for bio-medical waste disposal, inadequate radiation protection for the staff and the patient & compulsive corruption.

The negative attributes directly or indirectly affect patient security and welfare. Such cases are frequently noticed and reported in the media including cases of litigation. It is never known as how and when such cases ended. Instead of constructing a composite index for all the aspects, it is worthwhile to work out a separate index for the negative qualities by assigning scores (as demerits). The demerits assigned must reflect the seriousness of the cause. It may be relevant to classify the attributes according to their
seriousness as reflected by their adverse consequences. This classification will be handy to assign and weight the various types of deficiencies in some reasonable manner. One possible demerit scheme is discussed next.

Classification of Negative Attributes

1) **Class A Defects: Very Serious**

   Will cause severe health damage to the patient which will be irreversible or will even cause death. Non-testing for allergy or overdose of anesthesia are cases in point. Compatibility of blood groups before transfusion is another instance.

2) **Class B Defects: Serious**

   The patient may possibly suffer a Class A damage or somewhat less serious health consequences, may end up with reduced balance life span. Absence of fire and radiation safety measures provides examples.

3) **Class C Defects: Moderately Serious**

   Will cause trouble that is less serious than permanent health damage, but not insignificant in its impact. Certain cases of medical negligence are examples.

4) **Class D Defects: Minor**

   No impact on health status or longevity. Has minor effect on service quality level. Absence of a pharmacy in hospital premises is an example.

<table>
<thead>
<tr>
<th><strong>Class A defects: Very Serious</strong></th>
<th><strong>Class B defects: Serious</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cause severe health damage</td>
<td>Reduced balance life span.</td>
</tr>
<tr>
<td>(Even death).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Class C defects: Moderately Serious</strong></th>
<th><strong>Class D: Minor</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Less serious than permanent health damage.</td>
<td>No impact on health status or longevity.</td>
</tr>
</tbody>
</table>

*Source: Author*

**Figure 4.1: Defect Classification for Negative Attributes**

**Total Service Quality in Healthcare:** *With Special Reference to Yeshasvini Project in Karnataka*
A System of Weights

A suggested method of weighting to arrive at a composite demerit index for the hospital is the following:

Let $X_A, X_B, X_C, X_D$ be respectively the number of Class $A$, Class $B$, Class $C$ and Class $D$ defects in an inspection unit. Assuming each Class of defect to be independent and occurrence of defects in each Class to be well modeled, one may define the overall number of demerits in the inspection unit as

$$X = 100X_A + 50X_B + 10X_C + X_D \quad \ldots (4.1)$$

The demerit weights $(100, 50, 10, 1)$, though arbitrary, have been widely used in manufacturing industries. Other system of weights may be designed.

The expression $(4.1)$ has a form $\sum W_i X_i$, which may be converted to a weighted average as

$$I = \frac{X}{\sum W_i} \quad \ldots (4.2)$$

or

$$I = \frac{X}{161}$$

for the choice $(100, 50, 10, 1)$ of weights.

The evaluation parameters may be varied according to the type of healthcare provided by the hospital: What is expected in a maternity home significantly differs from that in an old-age care center.

Illustration

An inspection of a popular children hospital in Kolkata City by a Medical Team revealed that there was a serious shortage of incubators (Class $A$ defect), cleanliness and hygiene were substandard, and the bio-medical waste disposal system was arbitrary (Class $B$). The nurses and support staff demanded baksheesh (Class $C$). Also, the hospital had neither an in-house canteen nor a dispensary (Class $D$). No other deficiencies were noted.

A direct counting of the demerits shows one in Class $A$, two in Class $B$, one in Class $C$ and two in Class $D$. Using the weights $(100, 50, 10 & 1)$, the demerit index is:

$$I = \frac{[100(1) + 50(2) + 10(1) + 1(2)]}{161} = \frac{212}{161} = 1.31$$

Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka
The Assumption of Independence

In expression (4.1) for $X$ it was stated that the occurrence of defects in each Class is well modeled (e.g. follows a Poisson distribution- refer Annexure VI) and that the four classes of defects are statistically independent. In the setup of a hospital, where the defects are basically due to policy decisions of the administration, (rather than due to chance) both these assumptions are unlikely to hold. However, this will not affect expression (4.1). Only when it is required to compute variance of $X$ or to evaluate its probability distribution, these assumptions come into play. Short of this, not holding of the twin assumptions will not cause any problem.

Demerit Index: Illustration

In a quality inspection of a specialty hospital in Jalandhar City the following points are noted.

The hospital has a hundred-bed capacity, distributed over a four-level building. It has an on-campus pharmacy, but no fire security measure is in place. The vehicle parking facility is severely limited. An in-house canteen facility is missing. The bio-medical disposing system is arbitrary. But there is adequate protection from radiation from the instruments for the patients and the staff. The patients are invariably tested for allergies before medication and for matching of blood groups before blood transfusion. Two cases of medical negligence in surgical treatment are on record, for which court litigation is on. No other demerits are discovered.

The hospital plays soothing music in all the occupied rooms between 6.00 am and 9.00 am. It has an efficient lift system for the floors and air conditioning in all the rooms. The bed occupancy rate in the hospital is quite high.

a) Compute the demerit index $I$.

b) If, after some probing, it is revealed that life saving drugs and oxygen cylinders are often in short supply and four of the doctors, including two surgeons, are under-qualified.

How will the demerit index be modified?
Analysis of the Case: Solution (a)

In the light of the demerit system described earlier, one may analyze the question in (a) as compactly shown in a table form below:

<table>
<thead>
<tr>
<th>Demerit Class</th>
<th>Description</th>
<th>No of Demerits</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>Nil</td>
<td>0 (X_A)</td>
<td>100</td>
</tr>
<tr>
<td>(Very Serious)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>Lack of fire safety and biomedical waste disposal systems</td>
<td>2 (X_B)</td>
<td>50</td>
</tr>
<tr>
<td>(Serious)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>Medical negligence</td>
<td>1 (X_C)</td>
<td>10</td>
</tr>
<tr>
<td>(Moderately Serious)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>Absence of canteen and parking facilities</td>
<td>2 (X_D)</td>
<td>1</td>
</tr>
<tr>
<td>(Minor)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Author

Then demerit index \( I = \frac{\sum W_i X_i}{\sum X_i} \)

\[
= \frac{(1/161) (150 \times 0 + 50 \times 2 + 10 \times 1 + 1 \times 2)}{112/161} = 0.69
\]

This represents a moderately serious situation.

Solution (b): Modification of I under additional facts

Under-qualification of four Doctors may be taken as very serious class (Class A) and short supply of life saving drugs and oxygen cylinders may be grouped under Class B. Thus, now \( X_A = 1 \) and \( X_B = 3 \). The reworked demerit index works out to be 312/161 or 1.93, representing a very serious lacuna, needing urgent rectification. It may be noted how a Class A demerit rapidly increases the value of the index due to higher weight for such a demerit.

Rate of Change of I

It is easy to note that the rate of increase of \( I \) with respect to Class A demerits is
150/161 (being \( \frac{d}{dX} I \)), while it is just 1/161 for minor demerits. In general, with respect to Class A demerits, \( I \) increase at the rate of \( W_1 / \sum W_i \). This is directly proportional to \( W_1 \). The weights \( W_i \) are at the disposal of the researcher.

**4.3.1 Generalization of \( I \)**

The generalization of \( I \) to \( k \) Classes is straightforward. This is given by the weighted average

\[
I(k) = \sum_{1}^{k} \frac{W_i X_i}{\sum W_i} \quad \ldots (4.3)
\]

where the \( W_i \) are weights and \( X_i \) is the number of demerits in Class \( i \). The choice of \( k \) is to be decided by the researcher and can be based on type of hospital as children hospital, maternity home, cardiac center, neurological center etc. The weights \( W_i \) for a given \( k \) may be decided using discretion and taking cognizance of the type of hospital.

The rate of change (differential co-efficient) of \( I(k) \) with respect to \( X_i \) is clearly \( W_i / \sum W_i \), which is proportional to \( W_i \), as earlier. These are the coefficients (weights) in the defining equation for \( I \). In the unlikely case of equal seriousness for all Classes of demerits, the weights reduce to \( 1/k \), which now becomes the rate of change of \( I(k) \). If \( I(k) \) is computed over several points of time as \( I(k, t) \), it may be plotted against \( t \) to know the trend over time.

**Use of Geometric Weights**

A choice of weights in (4.3) can be the geometric series 1, \( w \), \( w^2 \), ..., \( w^{k-1} \) with \( w < 1 \) (The choice \( w = 1 \) produces equal weights). Then

\[
\sum W_i = \frac{(1 + w + \ldots + w^{k-1})}{\sum W_i} = \frac{(1 - w^k)}{(1 - w)} \quad \ldots (4.4)
\]

For large \( k \), this reduces to \( 1/(1-w) \) since \( w^k \) becomes negligible. The choice \( w > 1 \) is ruled out since it produces an increasing series of weights for the Classes, which are assumed to be in decreasing order of seriousness. A typical weight system can take \( w = \frac{1}{2} \), the weights now being 1, \( \frac{1}{2} \), \( \frac{1}{4} \), 1/8, 1/16, ..., \( \frac{1}{2}^{k-1} \).

**Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka**
This gives unit weight for the first demerit Class and the other weights are in geometrically decreasing manner, with common ratio $\frac{1}{2}$. Generally, a choice of $k$ up to six seems justified, since further classifications are difficult to implement.

### 4.3.2 The Index $I$ and $g$ Ratio

The index $I$ focuses on the negative qualities or deficiencies in a hospital. It is the weighted mean of the number of defects in the four Classes $A$, $B$, $C$, and $D$. Clearly, larger values of $I$ put the hospital in bad light. This negative indicator of quality is helpful in accreditation processes and points to the scope for quality up-gradation.

A similar index $I'$ may be worked out for the positive qualities after a suitable classification into Classes $A'$, $B'$, $C'$, and $D'$. Finally, the balance of positive and negative qualities may be judged through a comparison of $I'$ and $I$.

For example, compute the ratio

$$g = \left( \frac{I'}{I} \right) \times 100 \quad \ldots \ (4.5)$$

which shows the percentage dominance or otherwise of negative attributes over positive attributes.

The $g$ ratio is positive, but as such no upper limit can be worked out as it is just the ratio of two non-negative weighted arithmetic means. In any case, larger values of $g$ put the hospital in favorable light. Value of $g$ exceeding hundred shows the predominance of positive attributes over the negative ones.

**Computation Base of Demerit Index**

A demerit index can be elegantly computed for compact units like a hospital or a nursing home. Here the premises are well defined and the defects can be enumerated through observation or questioning (inquiry). For larger units like a geographical area the compilation is tricky and aggregation over the different units will have an averaging effect which can confound the demerit scenario. Also, the interpretation of the resultant index of such an exercise is difficult.

Another feasible evaluation is to group the institutions by their focus: For example, cancer hospitals, TB hospitals, general hospitals and so on. Within each group the quality
requirements will be the same, so that enumeration of demerits runs parallel and on similar grounds. The resultant demerit index would indicate the service quality or its shortcoming in the context of the ailment.

4.4 Cause and Effect Analysis of Demerits

Using the seriousness as a criterion for demerits, classification leads to a Weighted Index (as outlined above) for the institution concerned, showing an evaluated quality level. Alternatively, one may classify the demerits by source, leading to a cause and effect analysis. This may be shown pictorially to pin-point the source, akin to cause and effect diagram (Ishikawa diagram, Montgomery, p. 149), popular for process control in manufacturing. In the healthcare sector, taking a hospital as a unit, the following sources causing demerits are listed:

1) Administration, 2) Infrastructure, 3) Medical treatment, 4) Nursing, 5) Diagnostic analysis and 6) Others.

The identified demerits may be displayed in a table form, showing one-to-one correspondence between the source and the non-conformity. Alternatively, the situation may be shown in diagrammatic form (fish-bone diagram), for a clearer display, providing a simple picture in a form that is easily understood by all. It is known, by its author, as Ishikawa diagram. A typical example is given below:

Table 4.2: Example of Demerit Classification by Source

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Source</th>
<th>Demerits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Administration</td>
<td>Messy administration process</td>
</tr>
<tr>
<td>2</td>
<td>Infrastructure</td>
<td>No fire safety measure</td>
</tr>
<tr>
<td>3</td>
<td>Medical treatment</td>
<td>Duplication of tests, Expensive drugs instead of generic ones</td>
</tr>
<tr>
<td>4</td>
<td>Nursing</td>
<td>Skill below par</td>
</tr>
<tr>
<td>5</td>
<td>Diagnostic analysis</td>
<td>Delayed results</td>
</tr>
<tr>
<td>6</td>
<td>Others</td>
<td>No in-house canteen, Inadequate parking</td>
</tr>
</tbody>
</table>

Source: Author

**Total Service Quality in Healthcare:** With Special Reference to Yeshasvini Project in Karnataka
The above classification is handy for fixing responsibility for demerits and initiating corrective actions. This is particularly useful for internal quality audits, which may be conducted periodically. The direction of the arrow in the diagram is indicative of the deficiencies all combine to result in a dissatisfied patient.

A cause and effect analysis may be made of positive attributes (merits) too, like excellence in performance, lifesaving acts or promptness of service. However, this does not call for any corrective action, except for appreciating the concerned persons or departments and rewarding them through incentives. This will promote service quality improvement and innovation.

Source: Author

Figure 4.2: Ishikawa Diagram for Data in Table 4.1

Where Does Ishikawa Diagram Lead to?

This cause and effect representation helps in three ways:

1) Provides a compact visual display of the deficiencies by their source.
2) Serves as an internal audit-tool for fixing responsibility for the shortcomings and

**Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka**
initiating corrective actions.

3) Allows targeted design correction to arrive at a desired solution.

**4.5.1 Morbidity versus Productivity**

Morbidity refers to sickness of individuals in a society. The impact of morbidity can be easily expressed in three different ways, each having its own significance and giving a specific insight into the case.

*Loss of productivity due to morbidity*

Let $p$ denote the annual productivity of a typical individual and take that it starts at the age of eighteen years and goes up to the retirement age of seventy years. Then the total productivity during his/her service time is $(70-18)p$, which is $52p$.

Assume a 50% efficiency of a sick, but not bedridden person and 0% efficiency of a bedridden person. Thus, the efficiency is further reduced by $(0.5x+y)$ due to morbidity, where $x$ denotes the number of years of sick life (Stage I, not bedridden or confined to home) and $y$ denotes number of years of sick life: bedridden or in coma state and vegetative cases or confined to the premises of the home (Stage II). This reasoning puts the total individual productivity level at $52p-(x/2)p-y p$ or $p(52-(x/2)-y)$. Clearly a reduction in $x$ and $y$ through better quality health service increases the total number of productivity years. The average of these quantities is a natural indicator of individual productivity level in the presence of morbidity.

The life cycle recognizes four vital events, *nativity (birth), nuptiality (marriage), morbidity (sickness) and mortality (death)*. Assessing the period of morbidity in an individual’s life is of sufficient interest and it indicates his/her health status during the entire span of life. With minimal basic data, one may construct the following ratio:

$$h = (x + y)/l \quad \ldots (4.6)$$

where $l$ denotes total length of working life in years from birth to death.

The $h$ ratio reflects the proportion of morbid life in the life history of an individual. Infants less than five years may be excluded since their health status indicator is amply reflected by infant mortality as traditionally used. Alternatively, $(1-h)$ denoted
by \( h' \) is the proportion of disease free life. Mathematically, \( h + h' = 1 \). In this evaluation, common complaints like cough/cold/headache/minor stomach ailments etc. are ignored. Also, cases where life is terminated by accidents/suicides are not to be considered. The computation of \( h \) or \( h' \) will necessarily need the complete history of individual's life until death. This needs follow-up and data building. Averaging of \( h \) values for many persons in a community will give a mean life proportion \( h^* = \frac{\Sigma h}{n} \), where \( n \) is the number of persons involved. Larger the value of \( n \), more stable will be the value of \( h \) and hence more reliable. Such indicators \( h^* \) may be computed for men and women separately and separately for certain major diseases like cancer/heart problems needing surgery/diabetes/paralysis.

Another simple and quick comparison will be that of the expected longevity of life at birth \( l^* \) (about sixty-five years in India) with average \( l' = \frac{\Sigma l}{n} \), average life span of morbid persons. The difference \( (l^* - l') \) may be looked upon as the average reduced life (ARL) span of individuals due to morbidity.

The quality of healthcare services will have the effect of reducing \( h \) and hence increasing \( h^* \), which is equivalent to increasing disease-free living in the society. This, in turn, increases labor productivity. In fact, the longevity itself is only a crude measure and it is to be corrected for serious life constraints like morbidity. Every life that is born has to end. The cause of death can be broadly grouped into two:

1) Unnatural causes (like accidents, murders, suicides) and

2) Natural causes (old age, killer diseases, infant and maternal mortality etc.).

The first type is due to chance (random) and hence cannot be meaningfully controlled except through effective counseling. The role of the healthcare sector really comes into play in the second category: higher the quality of health service, lower will be the chance of premature death. It is in this scenario that the government and hospitals (both private and public) should display national commitment to make and execute it. One must tackle not the symptoms but the melodies. The rural areas need more attention. In fact, access to health facilities is noted to have greatest inequality (about 50%), while
the commonly accepted upper limit for the same is 30 %. This implies that the 50 % level of inequality is to be progressively reduced to below 30 %, through sustained and committed work.

A Hypothetical Example

A small-scale hypothetical example for computing loss of productivity years is given below. For simplicity, it is assumed that productivity $p$ is uniform across the working life (eighteen-seventy) years of a person and across the community members. To be realistic, a stage II of sickness, productivity is taken to be -1.25 $p$, the extra 0.25 $p$ accounting for the loss due to an attendant helping the patient daily for substantial duration of time.

Table 4.3: A Hypothetical Example

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>II (Yrs)</th>
<th>Total Productivity (II -18) $p$</th>
<th>Loss due to Stage I</th>
<th>Loss due to Stage II</th>
<th>Total Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70</td>
<td>52 $p$</td>
<td>0</td>
<td>0</td>
<td>52 $p$</td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>52 $p$</td>
<td>0</td>
<td>0</td>
<td>52 $p$</td>
</tr>
<tr>
<td>3</td>
<td>69</td>
<td>51 $p$</td>
<td>0</td>
<td>0</td>
<td>51 $p$</td>
</tr>
<tr>
<td>4</td>
<td>69</td>
<td>51 $p$</td>
<td>0</td>
<td>0</td>
<td>51 $p$</td>
</tr>
<tr>
<td>5</td>
<td>68</td>
<td>50 $p$</td>
<td>0</td>
<td>0</td>
<td>50 $p$</td>
</tr>
<tr>
<td>6</td>
<td>68</td>
<td>50 $p$</td>
<td>0</td>
<td>0</td>
<td>50 $p$</td>
</tr>
<tr>
<td>7</td>
<td>67</td>
<td>49 $p$</td>
<td>0</td>
<td>0</td>
<td>49 $p$</td>
</tr>
<tr>
<td>8</td>
<td>67</td>
<td>49 $p$</td>
<td>0</td>
<td>0</td>
<td>49 $p$</td>
</tr>
<tr>
<td>9</td>
<td>66</td>
<td>48 $p$</td>
<td>0</td>
<td>0</td>
<td>48 $p$</td>
</tr>
<tr>
<td>10</td>
<td>66</td>
<td>48 $p$</td>
<td>0</td>
<td>0</td>
<td>48 $p$</td>
</tr>
<tr>
<td>11</td>
<td>65</td>
<td>47 $p$</td>
<td>0</td>
<td>0</td>
<td>47 $p$</td>
</tr>
<tr>
<td>12</td>
<td>65</td>
<td>47 $p$</td>
<td>0</td>
<td>0</td>
<td>47 $p$</td>
</tr>
<tr>
<td>13</td>
<td>64</td>
<td>46 $p$</td>
<td>0</td>
<td>0</td>
<td>46 $p$</td>
</tr>
<tr>
<td>14</td>
<td>60</td>
<td>42 $p$</td>
<td>0</td>
<td>0</td>
<td>42 $p$</td>
</tr>
<tr>
<td>15</td>
<td>58</td>
<td>40 $p$</td>
<td>0</td>
<td>0</td>
<td>40 $p$</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>722 $p$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>48.13 $p$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Author

Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka
An illustrative hypothetical example is given above for a group of thirty persons, out of the survivors in a cohort.

Average % loss in productivity = \[100 \times \frac{\text{Avg. Productivity of disease free cases} \text{ - Avg. Productivity diseased cases}}{\text{Avg. Prod of disease free cases}}\]

= \[100 \times \frac{46.13 - 36.02}{46.13}\]

= 21.91 %

Thus, about 22p % of productivity is lost due to morbidity of the individuals in the cohort.

4.5.2 Disease-Free Longevity and Human Health Development

In a country, a reliable data base may be built using modern network facilities (the point will be taken again in the Annexure III), which show the duration of affliction by major diseases to the people. Using this, appropriate totals can be worked out. These are to be corrected for the overlap of individuals in different disease categories (corrected Total $B$). On the other hand, one can easily workout the total longevity - total life period of the members of the community (Total $A$). Clearly, Total $A$ exceeds Total $B$. Now, one can compute the health adjusted longevity as

\[l_A = \frac{A - B}{n}, \quad \ldots (4.6a)\]

$n$ being the total population, the unit of measurement being a year. The three parameters: Infant mortality/maternal mortality and disease adjusted longevity as a composite can reflect the health status of a community. The first two are desired to be low, while the third one is desired to be high. Such triplets can be computed separately for rural and urban areas to examine the likely differentials between the two. Longevity may be computed for men and women separately to gauge the difference.

4.6.1 De jure and De facto Quality Levels

For manufactured products, quality is a characteristic that can be ascertained (since it is observable) through process or product control methods. Unlike this, when it comes to quality of service, it is subtler and often not clearly visible. In manufacturing, an
unintended exception occurs in inspection fatigue or inspection error. In service quality ascertainment, there are human processes involved in the quality cycle. Thus, for instance, in the health sector the doctors, nurses and hospital administration are all involved. A human component easily allows for de jure and de facto quality levels to be different. The latter reflects the ground realities with all its harsh aspects. De facto situation is what matters to the patients, as it corresponds to the attained level of service quality. A hospital may satisfy the norms as per the book (guidelines). But when it comes to practice, there may be a significant gap between what is 'claimed' (de jure), say L, and what is actually 'delivered' (de facto), say L'.

Non-functioning of medical equipment (even though available), unethical practices (though disclaimed), poor quality of drugs (including spurious drugs), ineffective fixed dose combinations (FDC), all contribute to the gap between de jure and the de facto levels L and L' of service quality. The latter is often substantially lower than the former.

**Assessment of the Two Levels**

Assessment of the gap between L and L' is a necessary step for a realistic quality evaluation of health service that is provided to the public. This is a tricky step, as human respondents are involved, many with vested interests. A recent example is that of a sub-committee which recommended only a 50% warning area on tobacco product packs as against a standard norm of (80-85)% in many countries. The Chairman of the Committee has gone on record as saying that there is no conclusive evidence for the association between consumption of tobacco and cancer! Every study in any part of the world has established this association!!

An investigative indirect survey will be needed to throw light on the situation.

i) Two methods are proposed:

1) A survey of patients with a few probing questions may be conducted, as a fact-finding exercise,
2) As a better alternative, one may plan a Delphi method (refer Annexure VI) based evaluation. The focus may be made more pointed by a suitable stratification of the frame. For instance, the health service providers may be pre-stratified for a specified geographical area/state as:
   a) Government hospitals,
   b) Public private partnerships (PPP models),
   c) Private hospitals/nursing homes and
   d) Super - specialty hospitals
The Delphi group should include health experts, policy makers, journalists and social workers concerned with the area. The survey results may be analyzed separately for four strata mentioned above. Then a summarizing compilation may be undertaken. This analysis would provide a de facto level $L'$ of realized health service quality,
ii) The de jure health service quality level $L$ may be assessed through a direct survey of hospital administration and medical personnel, employing the very same stratification.
The gap between the two assessments will measure the gulf between de jure and de facto health service quality levels. This may be expressed as a ratio for ease of interpretation. The ratio is defined by:

\[ H = \frac{L'}{L} \]  

The non-negative ratio $H$ is generally less than one, since $L'$ tends to be much less than $L$. The value of $H$ closer to one points to a highly desirable situation with de jure and de facto levels of quality being quite close, while values of $H$ nearer to zero show a poor condition of delivered healthcare service.

The topics covered in Delphi method may include service quality factors (medical and nursing), cost aspect, nexus involving over testing, over medication, cost of drugs, empathy, follow-up, procedural steps for hospitalization etc., quality and integrity, kickbacks for referrals from doctors and revenue targets at corporate hospitals.

4.6.2 A General Hybrid Model

The development of a Service Quality Score (SQS) in a generalized framework is
attempted here. In the setup of a hospital, the service quality variables can be conveniently bifurcated as follows:

a) **Binary Variables:**

These are *present/ absent* or *yes/no* type characteristics. Availability of a lift system, fire safety measures and an in-house pharmacy are three such examples. When there are *p* such desirable variables, define

\[ X_i = 1 \text{ if variable } i \text{ is present; 0 otherwise} \]

for \( i = 1, 2, \ldots, p \).

Then, in a vector form, one may write

\[ X = (X_1, X_2, \ldots, X_p) \]

which will consist entirely of ones and zeros, depending on availability or otherwise of the factors. These are in fact *indicator variables*.

b) **Rated Variables:**

These are not amenable for direct measurement but can be *rated* in an interval, say 0 to 10. Nursing skill, medical care and simplicity of patient admission are three good examples. In the presence of *q* such variables, the vector \( Y \) is defined as

\[ Y = (Y_1, Y_2, \ldots, Y_q) \]

where \( Y_j \) is the *rating* for characteristic \( j \), \( j = 1, 2, \ldots, q \).

With the above notation, a general service quality score model can be formulated as

\[ SQS = f(X, Y) \quad \ldots \quad (4.8) \]

where \( X \) and \( Y \) are vector variables. This is a *hybrid model* in the sense that it has both binary and rated variables as *independent* factors. \( SQS \) is the *dependent variable* to be evaluated.

If the two components in (4.8) are segregated, possibly with different functional forms, one may write the service score as

\[ SQS = f_1(X) + f_2(Y) \quad \ldots \quad (4.9) \]

assuming an *additive structure* for the components, where \( f_1 \) and \( f_2 \) stand for the two...
Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka

**Linear Structure for \( f_1 \) and \( f_2 \)**

When \( f_1 \) and \( f_2 \) are both linear in the variables, which is the simplest form to consider, the model (4.9) can be rewritten as

\[
\begin{align*}
   f_1 (X) &= a_1 X_1 + a_2 X_2 + \ldots + a_p X_p = \sum a_i X_i \quad \ldots \quad (4.10 \text{a}) \\
   f_2 (Y) &= b_1 Y_1 + b_2 Y_2 + \ldots + b_q Y_q = \sum b_j Y_j \quad \ldots \quad (4.10 \text{b})
\end{align*}
\]

so that

\[
SQS = \sum a_i X_i + \sum b_j Y_j \quad \ldots \quad (4.11)
\]

where the coefficients \( a_i \) and \( b_j \) are to be estimated using empirical evidence. In (4.10 a, b), no provision is made for the intercept term since when all binary variables are zero, the component \( f_1 (X) \equiv 0 \). Similar is the case with \( f_2 (Y) \) when all the rated variables are rated zero.

**Interpretation of the Coefficients**

From a calculus viewpoint, \( a_i \) and \( b_j \) are partial derivatives of \( SQS \), with respect to the variables. In fact, \( a_i \) are the slopes of a \((p + 1)\) dimensional plane and \( b_j \) are the slopes of a \((q + 1)\) dimensional plane (direction cosines), which are represented by (4.10 a) and (4.10 b) respectively. From a practical viewpoint, \( a_i \) is the quantity by which \( SQS \) increases when binary variable \( i \) is present. Likewise, \( b_j \) is the rate with which \( SQS \) increases when rating of characteristic \( j \) goes up by one point. Assuming a direct relation between \( SQS \) and each of the independent variables, one can take \( a_i \geq 0 \) for all \( i \) and \( j \). This is a direct consequence of the manner in which \( X_i \) and \( Y_j \) are defined. \( \sum a_i \) is the total contribution by the binary variables to \( SQS \) which occurs when each \( X_i = 1 \), the best possible position. Likewise, \( \sum b_i \) is the total increment to \( SQS \) when each rated variable goes up by unity. The score \( SQS \) may be computed periodically as \( SQS (t) \) for any institution to assess the changes of the service quality level over a span of time.

**The Relative Score**

Under model ((4.10 a) and (4.10 b)), the maximum score occurs when each \( X_i = 1 \)
and $Y_j = 10$ (assuming rating between zero and ten). This works out to be

$$SQS_{\text{Max}} = [\sum a_i + 10 \sum b_j]$$  ... (4.12)

Thus, the relative score, relative to the maximum, is

$$SQS_{\text{Rel}} = \frac{SQS}{SQS_{\text{Max}}}$$  ... (4.13)

The relative score lies between zero and one, and a value closer to one points to a good service quality level.

**Illustration**

Consider a hospital where the six characteristics referred to at the start of this subsection are checked. Three of these are binary, while the other three are rated. The respective scores are displayed below

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Status</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lift system</td>
<td>Available</td>
<td>1</td>
</tr>
<tr>
<td>Fire safety</td>
<td>Available</td>
<td>1</td>
</tr>
<tr>
<td>In-house pharmacy</td>
<td>Not available</td>
<td>0</td>
</tr>
<tr>
<td>Nursing skill</td>
<td>Rated</td>
<td>6</td>
</tr>
<tr>
<td>Medical care</td>
<td>Rated</td>
<td>5</td>
</tr>
<tr>
<td>Admission process</td>
<td>Rated</td>
<td>7</td>
</tr>
</tbody>
</table>

*Source: Author*

Let us choose $a_1 = 1, a_2 = 2, a_3 = 1; b_1 = 2, b_2 = 3, b_3 = 1$ as the coefficients. Then the service quality score works out to be

$$SQS = 1 \times 1 + 2 \times 1 + 1 \times 0 + 2 \times 6 + 3 \times 5 + 1 \times 7 = 1 + 2 + 12 + 15 + 7 = 37$$

For the given set of $(a_i), (b_j)$ viz $(1, 2, 1)$ and $(2, 3, 1)$ respectively.

$$SQS_{\text{Max}} = 4 + 10 \times 6 = 64$$

For the illustration on hand, the relative quality score is

$$SQS_{\text{Rel}} = \frac{37}{64} = 0.58 \text{ (approx.)}$$

This is a reasonably satisfactory quality level, being it is close to 60%.

---

**Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka**
Effect of Change of Scale

It is easily verified that if both \( f_1 \) and \( f_2 \) are multiplied by a scalar \( k \), then \( SQS \) is multiplied by \( k \), while the relative score remains unchanged. This makes the relative score eminently suitable for comparisons. As already stated, this score lies between 0 & 1.

Remarks

With many binary and rated variables, the relative quality score is expected to stabilize. The two extreme cases of only binary and only rated variables are obtained respectively by taking \( f_2 (Y) = 0 \) and \( f_1 (X) = 0 \) in model (4.9).

In practice, the intermediate situations are of interest. However, an important issue is that of choice of \( a_i \) and \( b_j \). This may be done using empirical data or expert judgment. Development of other objective methods is called for.

Choice of Weights

Since \( SQS \) is a computed statistic and not an observed variable, standard statistical techniques like multiple regressions are not an option here. However, to negate arbitrariness, some guidelines for the choice of weights may be developed. One may use expert opinion, experience or practice elsewhere to arrive at a set of weights, keeping in view the role of binary and rated factors in service quality for the patients.

The coefficients \( a_i, b_j \) are non-negative. The \( a_i \) are the intra-set weights reflecting the relative importance of the binary variables, likewise are the \( b_j \) for rated variables. Parity between the two sets of weights may be ensured by making their averages mutually proportional. Thus take

\[
\sum b_j/q = \alpha \sum a_i/p
\]

where \( \alpha \) is the constant of proportionality. A choice \( \alpha = 1 \) keeps the two sets of variables on par; \( \alpha > 1 \) implies greater role for the rated variables and \( \alpha < 1 \) is for the reverse situation. A choice of \( \alpha \) in (1.5, 2.0) appears to be a good one, since the rated variables are generally more important for the patients. One word about the range for rated variables is in order here. As the \( X_i \) are confined to (0, 1), the range for \( Y_j \) may be zero to five or zero to ten rather than being wider.
The researcher has another lever in the choice of $W$, to account for the relative contributions of $f_1(X)$ and $f_2(Y)$ in the SQS. One may make weights proportional to the number of variables in the sets. Thus use

$$ W = 2 \frac{p}{p + q}; $$
$$ (2-W) = 2 \frac{q}{p + q}; $$

where the sum of weights is two and not one, since the sum $(f_1 + f_2)$ is being estimated and not the average $(f_1 + f_2)/2$. This two-level choice of weights imbibes near proportionality between as well as consideration for the number of factors in each set.

In practice, the relative score $\text{SQS}_{\text{Rel}}$, which is scale-invariant with respect to the variables and has its value pegged to the interval $(0, 1)$, may be used for evaluating a medical institution and comparing institutions.

**Variations of the Model**

The model (4.9) can be modified in several ways. For example, one may consider a multiplicative structure as in

$$ \text{SQS}_M = f_1(X) * f_2(Y) $$

as often done in *time series* models. The model (4.14) is additive in logarithms of the factors. Thus,

$$ \log \text{SQS}_M = \log f_1(X) + \log f_2(Y) $$

However, this has the effects of binary and rated variables inter-twine, which makes the score rather unstable and sensitive to variations. Also, it does not accommodate the cases $f_1(X) = 0$ and/or $f_2(Y) = 0$.

Alternatively, one may consider a weighted combination of $f_1(X)$ and $f_2(Y)$ as in

$$ \text{SQS}_W = W f_1(X) + (2-W) f_2(Y), \quad 0 \leq W \leq 2 $$

The weights $W$ and $(2-W)$ represent the relative importance of binary and rated factors in the aggregated score. Thus $W < 1$ gives lower weight for the former; $W > 1$ reflects the opposite.

**Illustration** (continued)

Consider the choice $W = 0.8$, so that $(2 - W) = 1.2$. Then for the illustration discussed above

**Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka**
Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka

SQS_w = (0.8) (3) + (1.2) (34) = 43.2

The maximum score now turns out to be

SQS_{Max} = (0.8) (4) + (1.2) (60) = 75.2

and the relative score becomes

SQS_{Rel} = \frac{43.2}{75.2} = 0.57 \text{ (approx.) or, as a percentage, } \sim 57\%.

Remark

It may be noted that SQS_{Rel} is again scale invariant both in the weights and the components f_1(X) and f_2(Y).

4.7 Complementary Roles of Demerit Index and SQS

While constructing a demerit index I (discussed earlier), the possible deficiencies in an institution are first classified into a specified number k of Classes to reflect their seriousness in the quality evaluation. The number of deficiencies in each group is counted; then these counts are converted into a weighted average, the weights reflecting the impact of the Classes on quality level. The focus here is entirely on deficiencies (and not on positive aspects) and as a result a lower value of the demerit index I is desirable.

On the other hand, while constructing a SQS, there is a bifurcation of quality factors as

a) Binary variable (with values 0 or 1) and

b) Rated variables which are rated in a specified range, e.g. 0 to 10.

A score is constructed for each group as f_1(X) and f_2(Y). There is a two-level flexibility for choosing weights.

Level I: The coefficients a_i and b_j for the groups (a) and (b) and with f_1 and f_2 having linear structures.

Level II: The weights W and (2 – W) are for combining the partial quality scores for groups (a) and (b) from Level I.

Thus, we have two-level options for the choice of weights: Intra-group as well as inter-group. While the demerit index has deficiencies in the institution on the center stage of evaluation, the quality score considers both negative and positive aspects, the former
noted in terms of absences and the latter rated individually. On the face of it, the score $SQS$ is more broad-based, with two-level decisions on choice of weights to be taken. Clearly, a larger $SQS$ is desirable (like a lower demerit index $I$). However, if rectification of deficiencies is the prime objective, then the use of $I$ and the Ishikawa diagram are handy in practical applications. This is particularly so for internal audit purposes. The score $SQS$ is apt for public display and soliciting financial support.

Structure-wise, the demerit index is the weighted average of scores from negative quality aspects while $SQS$ from positive quality aspects. The complementary nature of focuses (negative versus positive) accounts for the complementary nature of the two measures as outcomes.

4.8 A Multivariate Model

The hybrid model is eminently apt when a single vector of evaluations (observations) on several variables is on hand, as when an expert team evaluates a hospital. Alternatively, let us consider a situation where $n$ respondents give their assessment on these variables. This creates a multivariate set up. If the respondents are common people (e.g. patients), each patient may be allowed to opine on a short range of options, like a five or seven-point Likert scale (refer Annexure VI). For instance, ranging from 'very much dissatisfied' to 'very much satisfied'. This operational simplicity accounts for the popularity of such scales. Assume that there are $p$ variables, response on each being an integer between 1 and $k$ (being small like five or seven). This is not a restriction on the model but only a suggestion for practicability as non-integral evaluations may not be easy for laymen. The data collection process will now create an $n \times p$ data matrix:

$$X = \begin{bmatrix} X_{11} & X_{12} & \cdots & \cdots & X_{1p} \\ X_{21} & X_{22} & \cdots & \cdots & X_{2p} \\ \vdots & \vdots & \ddots & \cdots & \vdots \\ X_{n1} & X_{n2} & \cdots & \cdots & X_{np} \end{bmatrix}$$

where $X_{ij}$ is the response by unit $i$ for question $j$. This is a multivariate setting where...
responses are on a common \textit{multinomial} discrete scale one to \( k \).

Standard multivariate techniques of data analysis can be applied here, under suitable assumptions. A large number of respondents is supportive of such assumptions (\textit{Law of large numbers}). \textit{Individual-directed methods} like cluster analysis or classification can be used to examine variation among rows (Respondents) and \textit{variable-directed methods}, such as principal component analysis (to identify leading variable combination contributing to total variance) or Factor Analysis to identify key characters, to examine variations among columns (Variables). An application of such a Factor Analysis to empirical evidence is in Chap. 5.

\textbf{Total Score}

In order to derive a Total Score (TS), one may work on the column means (average responses)

\[
X_m = (X_{m1}, X_{m2}, \ldots, X_{mp}) \quad \ldots \quad (4.18)
\]

where

\[
X_{mj} = \frac{\sum_{i=1}^{n} X_{ij}}{n} \quad \ldots \quad (4.19)
\]

for \( j = 1, 2, \ldots, p \). thus take
\[
\text{TS} = f(X_m)
\]
\[
= f(X_{m1}, X_{m2}, \ldots, X_{mp}) \quad \ldots \quad (4.20)
\]

Under a \textit{linear structure} for \( f(X_m) \), one may write

\[
\text{TS} = \sum_{j=1}^{p} a_j X_{mj} \quad \ldots \quad (4.21)
\]

where the coefficients (weights) \( a_j \) reflect the relative importance of the factors in the determination of a Total (quality) score. For obvious reasons, a constant term is not provided in model (4.21). In fact, \( a_j \) may be interpreted as a derivative or the quantity by which \( \text{TS} \) goes up when \( X_{mj} \) moves one notch up.

The smallest and largest \( X_{mj} \) are respectively one and \( k \) occurring when all responses are at the extremes of the spectrum. Thus \( \text{TS} \) ranges between \( \sum a_j \) and \( k \sum a_j \); which reduces to \( p \) and \( kp \) with the constraint \( \sum a_j = p \), mentioned below. The actual values of \( a_j \) may be based on experience (in similar evaluations) or on expert opinion.

\textbf{Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka}
arrived through a Delphi approach. The factors of equal importance are to be attached equal weights, by bunching such factors together. For comparison and standardization, one may impose a restriction

\[ p \sum_{j=1}^{p} a_j = p \text{ (The Number of Factors)} \quad \ldots (4.22) \]

**Case of Missing Data**

In the case of *complete non-response* by a unit in the sample, the sample size may be taken as reduced by one (equivalent to deleting a row in the data matrix \( X \)). If there is partial missing of data in the sense that a few respondents did not answer some of the questions, one may accordingly alter (reduce) the divisors while computing the column means. With a large enough \( n \), this may not pose a serious handicap, in either of the cases. Alternatively, one may use *imputation* (substituting) for partially missing sample information, for instance replacing missing values in a column by the mean of the available values or one of neighboring values in the column used as proxy. This sets right the imbalance in the sample size.

### 4.9 In a Nutshell

This chapter made some theoretical contribution in terms of a few service quality concepts, classification of quality attributes from different angles and a few new quality indicators along with illustrations and implications. A hybrid quantitative model was developed and a quality score (\( SQS \)) was derived therefrom. There is adequate flexibility in the choice of weights while constructing the \( SQS \). This model merits further work, particularly, as applicable to medical services like pediatric centers, cardiac institutes and centers for neurological disorders. Also, a macro-level model (State or Country level) may be built as a further generalization, encompassing all the service quality aspects. Finally, a multivariate model accommodating the responses from a sample of \( n \) units on several factors was outlined and a Total Score function was derived.

---

**Total Service Quality in Healthcare: With Special Reference to Yeshasvini Project in Karnataka**