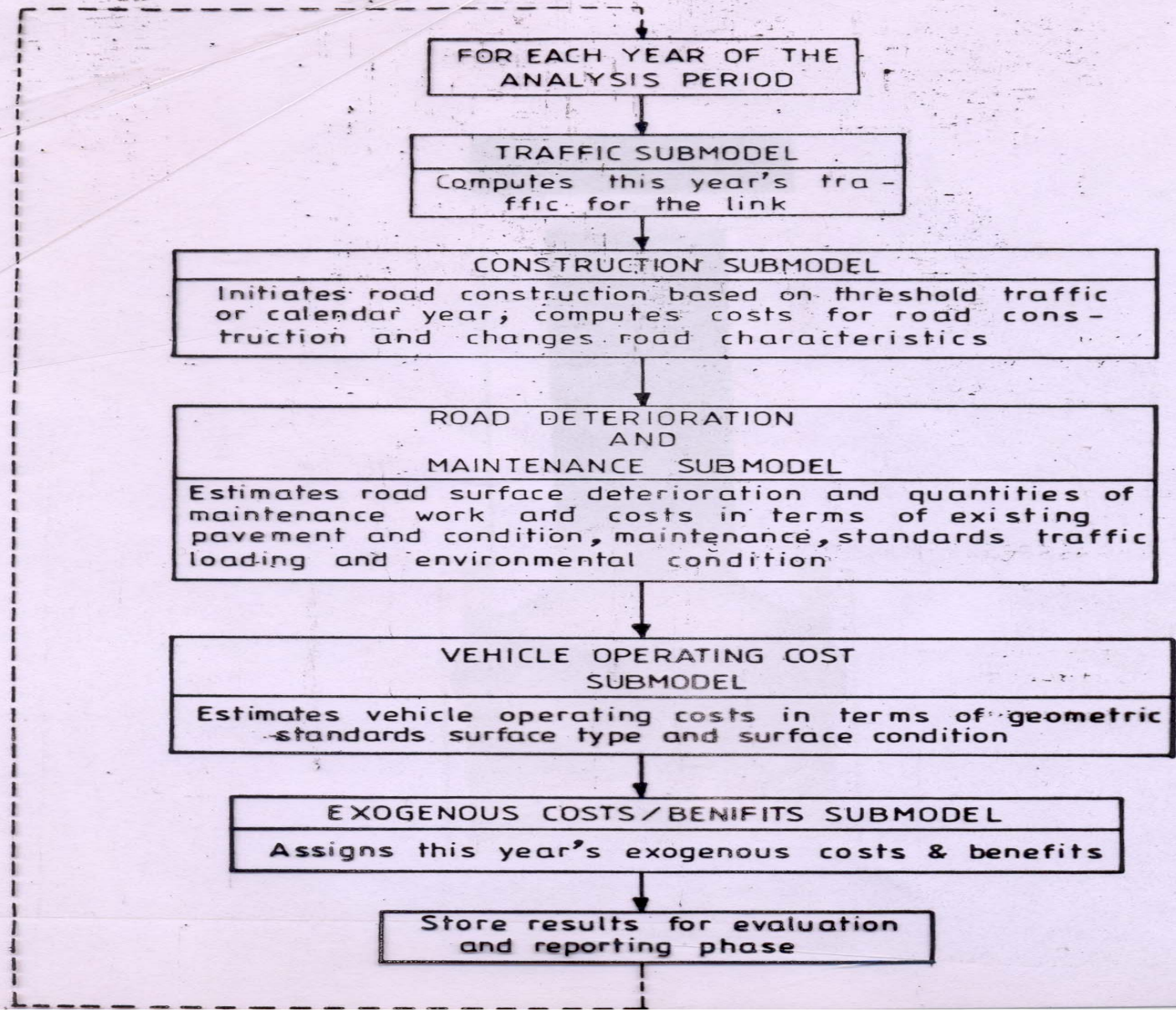
HDM-3

- **The Highway Design and Maintenance Standards Model is a computer program for analyzing the total transport cost of alternative road improvement and maintenance strategies.**

FIGURE - I

SIMULATION OF A LINK-ALTERNATIVE (HDM) 8

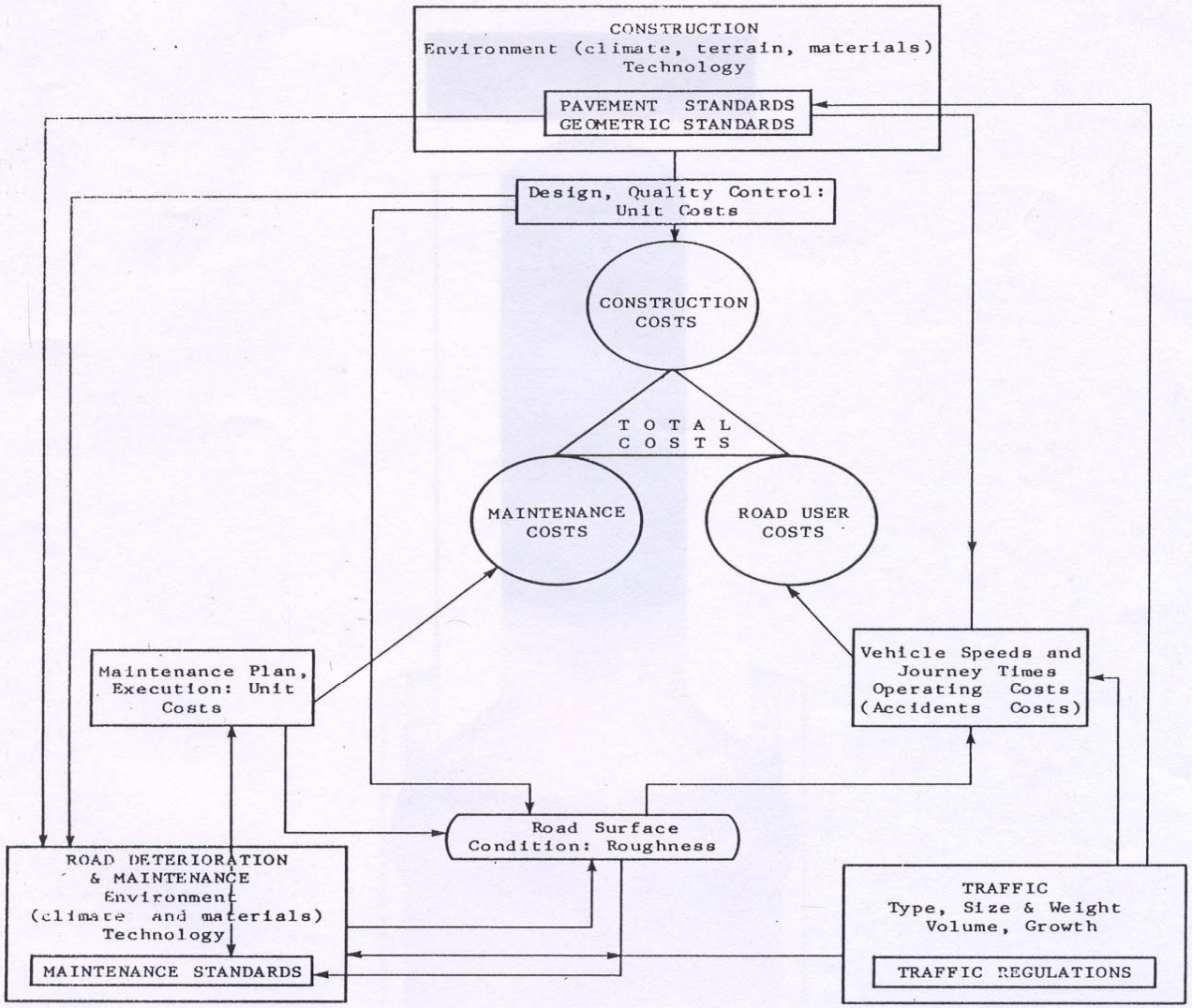


Limitations of the Model

- The sub model for the vehicle operating costs does not include the effects of congested traffic conditions, but the congestion costs may be entered as an exogenous input in the model.
- The road deterioration sub model does not include freezing climates but facility to adjust the sub model for most effects of freezing conditions is provided and has been validated.

- **The model does not explicitly account for the account of varying base routine maintenance on pavement performance, but this can be handled indirectly by adjusting pavement strength parameter.**
- **The model endogenously predicts neither road accidents nor their costs, nor the indirect costs incurred during road construction or maintenance. Facility is provided however, to incorporate accident costs, delays and environmental impacts where exogenous estimates are available.**

Figure 1.1: The HDM Model: Interaction of Costs of Road Construction Maintenance and Use



Pavement Deterioration Models

- Cracking models
- Patching Models
- Ravelling Models
- Pothole Models
- Rutting models
- Roughness Models

Cracking Model

- **Cracking Initiation Models**
- **The initiation of cracking is defined as the stage when a crack is observed on the pavement surface.**
- **It is mainly caused due to traffic repetition and the bituminous mix properties.**
- **The age of cracking initiation has been taken as the time between the pavement age since the last renewal or strengthening and the appearance of the cracks up to 2 percent of the pavement age.**

- **MSN :Modified structural number**
- **CSALYR :Cumulative standard axles per year (msa)-million standard axles**
- **AGECRIN :Age of pavement at the time of cracking initiation (years)**
- **PC :Premix carpet surfacing**
- **SDC :Semi-dense carpet (Semi-dense bituminous concrete) surfacing**
- **AC : Asphaltic concrete (Bituminous concrete) surfacing**
- **CRi :Initial cracking (%)**

Crack Initiation Models

Eqn No.	Surface type	Model form
Eqn. 1	PC	AGECRIN = 2.74*EXP*- 2.57(CSALYR/MSN^2)
Eqn. 2	SDC	AGECRIN = 3.29*EXP*-2.40(CSALYR/ MSN^2)
Eqn. 3	AC	AGECRIN = 4.00*EXP*-1.09(CSALYR/ MSN^2)

Cracking Progression Models:

Eq No.	Surface type	Model form
Eqn. 4	PC	$(CR_t/ti) = 5.41(CSALYR/MSN)* 0.54*SCR_i^{0.28}$
Eqn. 5	SDC	$(CR_t/ti) = 5.67(CSALYR/MSN)*0.34*SCR_i^{0.20}$
Eqn. 6	AC	$(CR_t/ti) = 4.26(CSALYR/MSN)*0.56*SCR_i^{0.32}$

Ravelling Models

- Raveling occurs either due to loss of fines or stone particles from the surfacing and due to the loss of adhesion or bonding between binder and aggregates.
- It affects both the structural and functional performance of the pavement. Thin binder film tends to oxidize rapidly, and thus the affect of aging on raveling is much higher on thin films than on thick films.
- Raveling when developed beyond a certain extent, leads to potholing

- **AGERVIN = Age of pavement at the time of ravelling initiation**
- **AXLEYR = No. of vehicle axle per year (million)**
- **CQ = Construction quality**

- **Ravelling Initiation Models:**

$$AGERVIN = 3.18\ AXLEYR^{-0.138*}(CQ+1)^{-0.38}$$

Ravelling Progression Models:

- $(RVt/ti) = 3.94\ AXLEYR^{0.32*}SRVi^{0.46}$

Pothole Models

- Potholes are the cavities in the raod surface and are generally bowl-shaped. Potholes are the most severe form of pavement distress which is caused due to spalling of wide cracks and disintegration of surfacing and subsequently the base material.
- THBM = Thickness of bituminous layer (mm)

Pothole Initiation Models

Eqn. No.	Surface type	Model form
Eqn. 9	PC	$AGEPHIN = 0.21THBM^{0.23}EXP[-0.18AXLEYR]$
Eqn. 10	SDC	$AGEPHIN = 0.29THBM^{0.35}EXP[-0.22AXLEYR]$
Eqn. 11	AC	$AGEPHIN = 0.13THBM^{0.47}EXP[-0.12AXLEYR]$

Pothole Progression Models

Eqn. No.	Surface type	Model form
Eqn. 12	PC	$(PH_t/ti) = 1.49CR_i * \frac{AXLEYR(1+CQ)}{THBM*MSN} + 3.60Ph_i * \frac{AXLEYR(1+CQ)}{THBM*MSN} + 3.47\ RV_i * \frac{AXLEYR(1+CQ)}{THBM*MSN}$
Eqn. 13	SDC	$(PHt/ti) = 5.24CRi * \frac{AXLEYR(1+CQ)}{THBM*MSN} + 0.78Phi * \frac{AXLEYR(1+CQ)}{THBM*MSN} + 0.84\ RV_i * \frac{AXLEYR(1+CQ)}{THBM*MSN}$
Eqn. 14	AC	$(PH_t/ti) = 1.23CR_i * \frac{AXLEYR(1+CQ)}{THBM*MSN} + 2.50Ph_i * \frac{AXLEYR(1+CQ)}{THBM*MSN}$

Roughness Progression Models

- **Roughness is distortion in the road profile. The rate of distortion is accelerated, on weakening of the pavement due to surface defects like cracking, ravelling, potholing etc. roughness affects the dynamics of moving vehicles, vehicles wear and tear, and therefore, has an appreciable influence on vehicle operating costs.**
- **It also imposes dynamic loading on the road surface, thus accelerating the deterioration process further. Empirical statistical models of incremental form have been developed for prediction of roughness progression.**

- $RG_t = a_1(CSAL/SNCK)*e^{mPAGE} + a_2\ m.RG_t*ti + a_3\ CR_t + a_4\ PH_t + a_5\ PT_t + a_6\ RV_t$

- Where,
- SNCK = Modified pavement strength = (1+MSNR)
- MSNR = Reduced modified structural number due to cracking
- m = Environmental factor
- MSNR = MSR – (0.0000758*THBM*CRi)
- CR_j =Initial cracking (%)
- RV_j =Initial ravelling (%)
- PH_j =Initial pothole (%)

Modified structural no.

$$SN = \sum_{i=1}^{N} a_i D_i + 3.51 \log_{10} CBR - 0.85 (\log_{10} CBR)^2 - 1.43$$

Where a_i = the strength coefficient of layer i

D_i = the thickness of layer i in inches

CBR = California Bearing Ratio of the subgrade.

Roughness is computed as

$$R \doteq R_o + mN$$

Where,

R_o = Initial Roughness

N = No. of millions of standard axles.

$m = 1250/\text{anti}\log_{10} (a^{1/3} - b^{1/3} - 1.3841)$

$a = 0.20209 + 23.1318\, C^2 - 4.809\, C$

$b = 0.20209 + 23.1318\, C^2 + 4.809\, C$

$C = 2.1989 - SN$

HUMANS NOT TO BLAME FOR NEANDERTHA

It was believed that Europe was populated by a stable Neanderthal popul of years up until humans arrived. Now, a team has shown that most Nea died off around 50,000 years ago, after they carried out an analysis of anci

Tobacco goes from villain to biofuel hero

The plant may soon find a new role in society, thanks to research that will genetically engineer it to directly create fuel, in a form that can be used with little processing in almost any vehicle

Mumbai Mirror Bureau
mirrorfeedback@indiatimes.com

Mention biofuels and most people think of ethanol. Some may think of advanced biofuels from switchgrass. But tobacco? Not likely. That could change.

A team of scientists led by a researcher Christer Jansson of Berkley University is exploring a way to produce gasoline, diesel, and jet fuel from the plant. Their goal is to engineer tobacco plants that use energy from sunlight to produce fuel molecules directly in their leaves. The leaves would then be crushed, and the fuel extracted and separated. The scientists estimate that about 1000 acres of tobacco could yield about one million gallons of fuel.

Why tobacco? It's grown in large tracts in more than 100 countries. It generates multiple harvests per year, its large leaves could store a lot of fuel, and it's amenable to genetic engineering.

For the tobacco-to-fuels project, Jansson and his collaborators want to create a shortcut in the way in which solar energy is converted to biofuel. Today, one approach to biofuel production requires deconstructing biomass and then using microbes to ferment them into fuel. In contrast, the team hopes to create a plant that grabs CO_2 from the air and converts the carbon into a fuel that's almost ready for the tank.

Christer Jansson with some tobacco-based fuel

"We want to bypass downstream processes like fermentation and produce fuels directly in the crop," says Jansson. "After the biomass is crushed, we could extract the hydrocarbon molecules, and crack them into shorter molecules, creating gasoline, diesel, or jet fuel."

To get there, the scientists will work to create tobacco plants that are optimised to take in CO_2, harvest sunlight, and produce hydrocarbon molecules. For the latter, Jansson will start with cyanobacteria genes that encode for enzymes which produce alkane, a type of hydrocarbon. He'll then make synthetic versions of these genesfor the tobacco. In another approach, Tasios Melis, a biologist, will conduct a similar exercise with green algae genes that produce isoprenoids, a type of hydrocarbon.

The scientists also want to get as much carbon into the tobacco plant as possible to maximise hydrocarbon production. Ordinary tobacco "fills up" with CO_2 very quickly. To increase the plant's carbon uptake, the team will again turn to cyanobacteria, which are very efficient at grabbing carbonate from the surrounding water and transporting it into the cell. Jansson hopes to insert cyanobacteria genes that facilitate carbon transport into the tobacco plants.

The team hopes to grow their first plant in about 18 months. Their ultimate goal is a plant in which between 20 and 30 per cent of its dry weight is hydrocarbon.

TOI
5.3.96

GDP/GNP
HDI = Human Development Index
GPI = Genuine Progress Indicator

Is GDP a true measure of progress?

By J.B. D'Souza

MUMBAI, March 4.

Between the early fifties and the early nineties, India's per capita income almost doubled from a low of Rs 1,127 to a low of Rs 2,240 (in 1980 prices). By contrast, in the last 20 years South Korea quadrupled its per capita GDP. India's doubling over 40 years was the glorious achievement of the policies our governments imposed on us when we shook off the British yoke. Could this mean that most of us are twice as well off as our parents were when we won freedom?

In recent times, social scientists have been less and less comfortable with the wide acceptance of Gross National Income (GNI) or Gross Domestic Product (GDP) as an infallible index of a nation's condition, and the consequent concentration on income growth as a policy goal. The GNI/GDP concept is largely indifferent to the people's health, to their literacy levels, to disparities in income distribution. It is essentially little more than "a measure of market activity, of money changing heads. It makes no distinction whatsoever between the desirable and the undesirable, or costs and gains. On top of that, it looks only at the portion of reality that economists choose to acknowledge – the part involved in monetary transactions. The crucial economic functions performed in the household and volunteer sectors go entirely unreckoned." So wrote a group of public policy analysts at a San Francisco think tank in a perceptive report last year.

In a 1993 ranking done by the United Nations of 173 countries on a Human Development Scale, there were only 39 that fared worse than India did. A 1970 list of 108 countries showed 28 below India. Apart from national income, the human development concept involves life expectancy and educational attainment, specially the literacy level – useful indicators of the quality of life in a society. The UN began to measure human development about six years ago, recognising the importance of "investing in human capabilities, whether in education or health or skills, so that they can work productively and creatively... ensuring that economic growth is distributed widely and fairly... giving everyone a chance to participate."

Such good thoughts notwithstanding, the Human Development Index (HDI) takes very little account of disparities in income distribution or of people's participation, though it does improve on GNI/GDP as a measure of people's welfare and quality of living.

The failings of GNI/GDP (and of course of the HDI too) prompted the San Francisco analysts to devise a Genuine Progress Indicator (GPI) as a closer approximation of a nation's true condition. Dealing chiefly with America, they write:

"The GDP would tell us that life has gotten progressively better since the early 1950s – that young adults are entering a better economic world than their parents did. GDP per American has more than doubled over that time. The GPI shows a very different picture: an upward curve from the early fifties until about 1970, but a gradual decline of roughly 45 per cent since then. This strongly suggests that the costs of increased economic activity – at least the kind we are locked into now – have begun to outweigh the benefits, resulting in growth that is actually uneconomic. Specifically, the GPI reveals that much of what we now call growth or GDP is really one of three things in disguise: fixing blunders and social decay from the past, borrowing resources from the future, or shifting functions from the traditional realm of household and community to the realm of the monetised economy."

The GDP has some basic deficiencies. They stem from the restriction of economics to concepts that can be properly measured. This means that if something is hard to count, then it doesn't count. That rules out the economic contribution of households and communities – the sphere of life where homes are run and children and older people cared for. In contrast, the earnings of pimps and commercial sex workers are currently included in the GDP count. The GPI attempts to evaluate activities in money terms and includes the vital work that housewives do and the household economy in general.

Both GDP figures and the HDI ignore disparities. Brazil's index of human development would fall 14 per cent if it were adjusted to reflect extreme disparities in income. So would that of India – which, of course is to be expected, given that even in relatively prosperous Maharashtra, nearly half the population struggles below the poverty line.

The San Francisco researchers also attack defensive expenditure. "Close to 50 per cent of Americans consider themselves overweight. When one considers the $32 billion diet industry, the GDP becomes truly bizarre. It counts the food that people wish they didn't eat, and then the billions they spend to lose the additional pounds that result."

Money spent on repairs after car accidents falls into a similar category. It is a curious contribution to the nation's progress.

An even more perverse inclusion in the GDP, and perhaps the largest distortion, is the income people earn from destroying the environment and using up resources that cannot be renewed. Today, the factories in Chembur (the fertiliser factory and the refineries) that emit harmful effluents contribute doubly to the GDP – once in the production process and again when the government spends crores to clean up the mess. The GDP calculation also includes the extra medical bills that result from the effects of pollution.

Quite as freakish is the component in GDP that arises from the depletion of our natural resources.

(The author is former chief secretary, Maharashtra government.)

CE-754 TOI 12/09/2005

HDI: Nation's report card

Q: What is the HDI?

A: The United Nations Human Development Index (HDI) is a summary composite index that measures a country's average achievements in three basic aspects of human development: longevity, knowledge, and a decent standard of living. Longevity is measured by life expectancy at birth; knowledge is measured by a combination of the adult literacy rate and the combined primary, secondary, and tertiary gross enrolment ratios; and standard of living by GDP per capita (in purchasing power parity US$). Each year, countries are ranked according to a composite index that captures all these measures. The index was developed in 1990 by the Pakistani economist Mahbub ul Haq, and has been used since 1993 by the United Nations Development Programme (UNDP) in its annual Human Development Report.

Q: What was the need for such an index?

A: Usually, countries were ranked in terms of well being on the basis of their per capita incomes alone. But it was felt that human development was much more than just economic growth, which is only a means, albeit a very important one, of improving the quality of life. In order to assess the level of people's long-term well being, it was necessary to look at other parameters which aided in human development. For instance, India has a higher per capita income than Vietnam, but the latter is far ahead on social indicators. Again, within India, Kerala is a middle-income state but it has social indicators that are close to world class and way ahead of any other Indian state.

A UN human development report has ranked India at a modest 58th place among 103 developing countries

Q: How is the HDI computed?

A: Before the HDI is computed, an index needs to be created for each dimension, the life expectancy index, education index (comprising literacy index and gross enrolment index) and income index. Performance in each dimension is expressed as a value between 0 and 1 by applying the general formula: dimension index = (actual value -minimum value)/ (maximum value -minimum value). Values (max, min) for each dimension, life expectancy (85, 25), literacy (100,0), gross enrolment ratio (100, 0) and per capita income in PPP US$ (40000, 100) are used in computing the HDI. The literacy index and gross enrolment index are given two-thirds and one-third weightage to arrive at the education index. Once the three indices have been computed, the HDI is calculated as a simple average of the three.

LEARNING WITH THE TIMES

Q: How are countries classified on the basis of HDI?

A: Countries are classified into three categories: high human development (HDI 0.800 and above), medium human development (HDI 0.799-0.500) and low human development (HDI below 0.500). Of the 177 countries, 57 countries fall in high, 88 in medium and 32 in low human development. Norway (0.963) is ranked first as per HDR 2005, while India (0.602) is ranked 127th and falls in the medium category. Of the 32 countries in the low development category, as many as 30 are from Africa.

Q: Is the HDI enough to measure a country's level of development?

A: Not really. The concept of human development is much broader than what can be captured in the HDI, or any other of the composite indices that have been developed. The HDI, for instance, does not reflect political participation or gender inequalities. The HDI only offers a broad proxy on some of the key issues of human development.

Q: Which other composite indices have been developed?

A: Since the first report, four additional indices have been incorporated in the HDR. These are the human poverty index for developing countries (HPI-1), human poverty index for selected OECD countries (HPI-2), gender-related development index (GDI) and gender empowerment measure (GEM).