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From the Editor

As rightly pointed out in the following article on technology transfer, foreign investment rarely comes to a place without any exploitable resources. That is why a poor country like Nepal is not a likely target for technology transfer. What we have is a dearth of industries and an excess of retail trade. Quite a few industries are, in fact, engaged in packaging near finished products brought from outside to circumvent import duties and gain easy access to the market.

A large pool of skilled manpower is one of the prime incentives for investors. A good example is the horde of IT companies flocking to India because of its plentiful IT engineers and scientists. This, however, is a chicken and egg conundrum. A company will not come in unless the quality of manpower is of relatively high standard and the labor pool is large enough to create competition to drive down prices and ensure a steady supply of manpower. On the other hand, without adequate employment opportunities, there is no incentive for people to take up the required skills and create the large pool of labor which is so crucial in attracting investors.

This brings us to the question of IT colleges mushrooming all over the country even though there appears to be very little prospect of the graduates finding gainful employment. At this juncture no large IT companies are going to establish here. This interim period is painful and trying. Nevertheless, continuous efforts have to be made to improve both the quality and quantity of IT engineers till the threshold limit for foreign and domestic investment is reached. India had to wait a couple of decades to overcome this inertia. With any luck we can cut the time by half.

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DESIGN CURVES FOR TUBULAR PURLINS

Kanhaiya Bhagat*

ABSTRACT

In the present work, curves are developed for the efficient design of tubular purlin sections. Design curves are applicable in the design of purlins for the pitched roof of rectangular clad buildings of height up to 10m, maximum horizontal dimension up to 50m, with building height ratio $h/w \leq 1/2$ and $1/2 < h/w \leq 3/2$ lying in the plane region of Nepal. All the design curves indicate that for a given truss spacing, and purlin spacing roof slope of 20° gives the most economical section. The present work emphasizes the need to develop a design handbook for the quick and efficient design of purlin sections.

Introduction

Steel roof trusses are one of the cheapest and most convenient roofing systems for various types of buildings such as industrial buildings, warehouses, workshop buildings, and storage godowns. It may also be used in residential buildings, office buildings, and school buildings, if the construction is to be done at low cost. These types of roofing systems are suitable for both large and short span. Fig. 1 shows various elements of typical steel truss roofing system of a rectangular clad building with pitched roof.

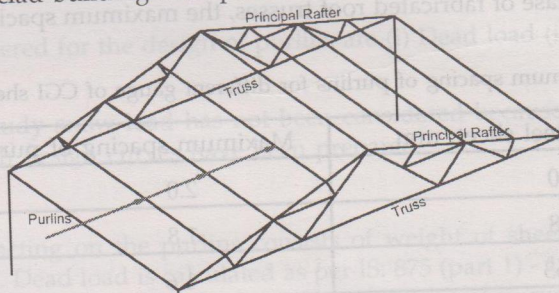


Fig. 1: Typical Roofing System

Purlins are the structural members of a roofing system to support the roof covering. They are placed basically on the principal rafters of the truss at their panel points or nodes. Roof covering directly rests either on the purlins or on common rafters, sometimes battens may be used between the purlins and covering. Purlins are flexural members and are subjected to vertical load due to dead and live load, and load normal to roof due to wind pressure. Generally channels, angles, tubes, cold-formed Zed and Cee, light gauge steel purlins, wire girders, warren or N-type truss, and triangular truss are used as purlins.

Among these tubular purlins are widely used in our country. Fig. 2 shows some typical purlin sections.

In the present study, an attempt has been made to develop design curves for tubular purlins, which may be useful in selecting an optimum section for a given purlin spacing, truss spacing

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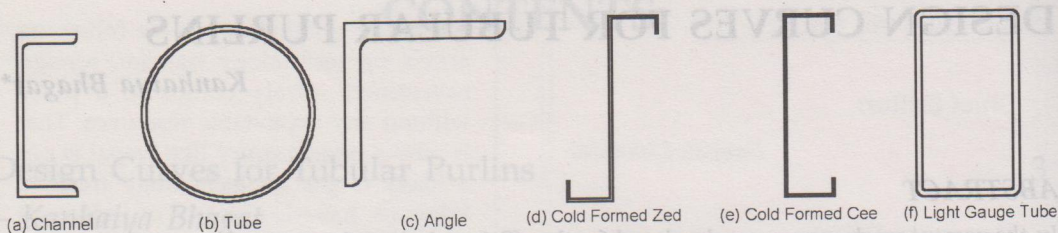


Fig. 2. Some typical purlin sections

and roof slope. The design curves have been developed for the plain region of Nepal with ground slope less than 3° . These curves are applicable in the design of purlins for the pitched roof of rectangular clad buildings of height up to 10m, maximum horizontal dimension up to 50m, with building height ratio $h/w \leq 1/2$ and $1/2 < h/w \leq 3/2$ lying in terrain category 2.¹

In the present study the wind load assessment has been done as per NBC 104: 1994, in conjunction with IS: 875 (part III) - 1987, and the analysis and design have been done on the basis of relevant Indian standards.

Spacing of purlins

The maximum spacing of purlins depends upon the safe span of covering material sheets. Mostly C.G.I. sheets conforming to IS: 277 - 1985 are used as roof covering in Nepal. Allowable bending stress or limiting deflections for sheeting governs the maximum spacing of purlins. As per IS: 12093 - 1987, in case of fabricated roof trusses, the maximum spacing of purlins are as given in table 1.

Table 1: Maximum spacing of purlins for different gauge of CGI sheets

Gauge	Thickness of steel sheet, mm	Maximum spacing of purlins C/C, m
20	1.0	2.0
22	0.8	1.8
24	0.63	1.6

Mostly 24 gauge and 26 gauge sheets are used as roof covering in our country. From Table 1 the maximum spacing of purlins for 26-gauge sheet comes out to be 1.4 m after extrapolation. Also, SP 38, Handbook of Typified Designs for Structures with Steel Roof Trusses, mentions that maximum purlin spacing should be restricted to 1.4 m. The number of purlins required per sheet and their spacing depends on the length of the sheet used. The standard sheet length available are 6 feet, 7 feet, 8 feet, 9 feet, 10 feet and 12 feet. Generally, in practice, 9 feet and 12 feet sheets, are most preferred in comparison to other sizes. Six feet and 7 feet sizes are least preferred and are used only under unavoidable circumstances. In practice, for 12 feet long sheet four number of purlins are used at equal spacing; similarly three purlins are used for sheet length of 7 to 10 feet, and for 6 feet only two purlins are provided despite recommendation of the clause 4.1 of IS: 12093 - 1987 to use at least three purlins. Centerlines of purlins at top

¹ According to IS: 875 (Part 3) Terrain category 2 represents an open terrain with well scattered obstructions having heights generally between 1.5 to 10 m, and includes airfields, open parklands and undeveloped sparsely built-up outskirts of towns and suburbs.

and bottom edge of the sheet are kept at a distance of 75 mm from the edge so that the end lap of 150 mm is achieved. With these arrangements the purlin spacing worked out for different sheet length are as given in table 2.

Table 2: Purlin spacing according to sheet length

Sheet Length in feet	Number of purlins	Purlin spacing in meter
12	4	1.169
10	3	1.449
9	3	1.296
8	3	1.144
7	3	0.994
6	2	1.679

From table 2 it is clear that purlin spacing for 10 feet and 6 feet size sheets exceed the provisions in the Code of maximum spacing of 1.4m. However, in case of 10 feet long sheet we can place purlins at the spacing of 1.4 m, if edge distance is increased to 100 mm. But, in case of 6 feet long sheet, as per provisions in the Code three purlins must be provided. However, this will decrease the purlin spacing to 0.8395 m that causes total cost of purlins to increase. Since the purlins are placed on the panel points of principal rafters to avoid bending in rafter, the positions of nodal points on the rafter are governed by purlin spacing.

Design Loads

The loads considered for the design of purlins are (i) Dead load (ii) Live load (iii) Wind load (iv) Snow load

In the present study snow load has not been considered because no snowfall occurs in the regions for which design curves have been prepared.

Dead Load

The dead load acting on the purlins consists of weight of sheeting and fixtures, and self-weight of purlin. Dead load is calculated as per IS: 875 (part 1) - 1987. Weight of sheeting and fixtures has been taken as 6 kg/m². Initially self-weight of purlin is calculated by assuming suitable section on the basis of preliminary design, and later rechecked and revised, if necessary.

Live Load

Live load is taken as per clause 4.1 of IS: 875 (part II) - 1987. Assuming inaccessible roof, a live load of 750 N/m² has been taken for roof slope up to 10°, and for roofs with slope greater than 10, a reduction of 20 N/m² has been made for every degree increase in slope, subject to a minimum of 400 N/m² of the plan area.

Wind Load

Wind load assessment has been done as per Nepal National Building Code, NBC 104: 1994, in conjunction with IS: 875 (part 2) - 1987. As per NBC 104: 1994 the country is broadly classified into two different wind zones. In the Zone I, which includes the southern plains of Terai, Kathmandu valley and those regions of country, which are below an elevation of 3000 m, a basic wind speed of 47 m/s has been adopted, whereas, a basic wind speed of 55 m/s has been adopted in the higher hills. In the present study the basic wind speed of 47 m/s has been taken for the wind load assessment.

The design wind pressure P_z is given by

$$P_z = 0.6 V_z^2$$

Where

V_z is design wind velocity at height z in m/s, and is expressed as

$$V_z = V_b k_1 k_2 k_3$$

Where

V_b = Basic wind speed in m/s at 10 m height

k_1 = Probably factor or risk coefficient

k_2 = Terrain, height and structure size factor

k_3 = Topography factor

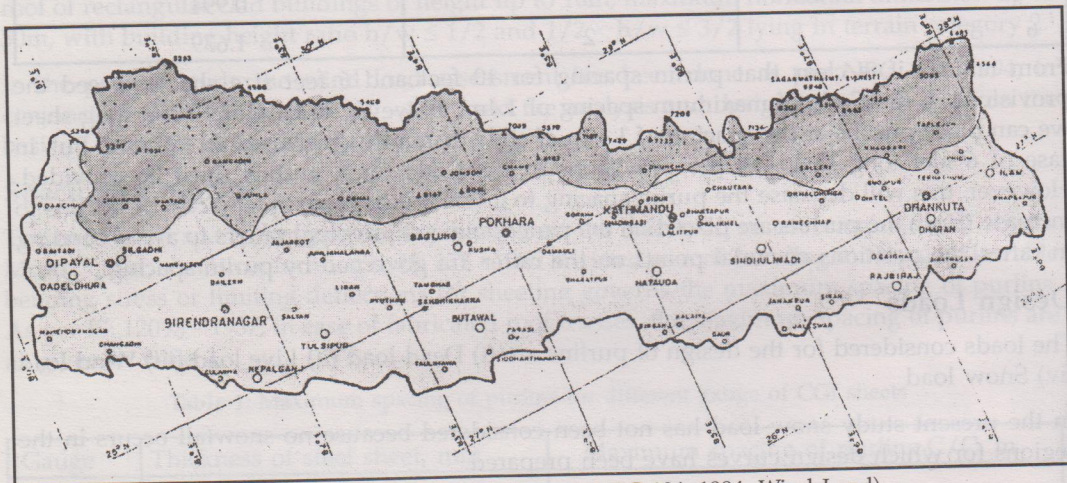


Fig. 3: Wind map of Nepal (Source: NBC 104: 1994, Wind Load)

The factor k_1 has been taken as 1.0 because for all general structures with mean probable design life of 50 years the value is 1.0. Similarly for plain region the factor k_3 is 1.0. In most of the design situations, the buildings for which design curves have been prepared are either of the class type A or class type B which are located in terrain category 2. The maximum value of k_2 for these conditions is 1.0 and minimum value is 0.98. In the present study the value of k_2 has been conservatively taken as 1.0.

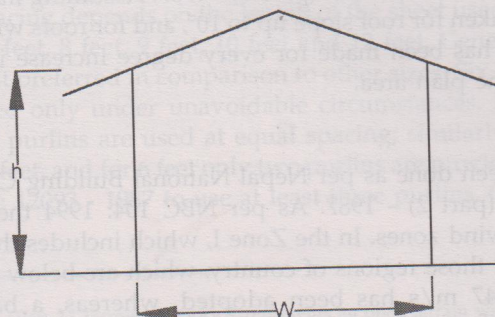


Fig. 4: Front elevation of a rectangular clad building with pitched roof

$$q_w = (C_{pe} - C_{pi}) \times P_z \times S \quad \text{N/m}$$

The wind force per unit length of purlin is calculated as below

where

C_{pe} = external pressure coefficient as given in Table 5 of IS: 875 (Part III) – 1987

C_{pi} = internal pressure coefficient as per clause 6.2.3 of IS: 875 (Part III) – 1987

S = purlin spacing in meter

Table 3: External Pressure Coefficient for Pitched Roof of Rectangular Clad Building

Roof Slope in Degree	$h/w \leq 1/2$				$1/2 < h/w \leq 3/2$			
	Wind Angle $\theta = 0^\circ$		Wind Angle $\theta = 90^\circ$		Wind Angle $\theta = 0^\circ$		Wind Angle $\theta = 90^\circ$	
	Windward	Leeward	Windward	Leeward	Windward	Leeward	Windward	Leeward
0	-0.800	-0.400	-0.8	-0.4	-0.800	-0.600	-1	-0.6
5	-0.900	-0.400	-0.8	-0.4	-0.900	-0.600	-0.9	-0.6
10	-1.200	-0.400	-0.8	-0.6	-1.100	-0.600	-0.8	-0.6
15	-0.800	-0.400	-0.75	-0.6	-0.900	-0.550	-0.8	-0.6
20	-0.400	-0.400	-0.7	-0.6	-0.700	-0.500	-0.8	-0.6
25	-0.200	-0.400	-0.7	-0.6	-0.450	-0.500	-0.8	-0.7
30	0.000	-0.400	-0.7	-0.6	-0.200	-0.500	-0.8	-0.8
35	0.100	-0.433	-0.7	-0.6	-0.067	-0.500	-0.8	-0.8
40	0.200	-0.467	-0.7	-0.6	0.067	-0.500	-0.8	-0.8
45	0.300	-0.500	-0.7	-0.6	0.200	-0.500	-0.8	-0.8
50	0.433	-0.533	-0.7	-0.6	0.333	-0.500	-0.8	-0.8
55	0.567	-0.567	-0.7	-0.6	0.467	-0.500	-0.8	-0.8
60	0.700	-0.600	-0.7	-0.6	0.600	-0.500	-0.8	-0.8

The external pressure coefficients C_{pe} for two different building height ratios as per Table 5 of IS: 875 (part III) are given in table 3. The values of C_{pe} for other roof slopes not given in code are calculated by interpolation. In the present study the internal pressure/suction as applicable for building with normal permeability has been considered. Therefore, the value of C_{pi} taken is ± 0.5 .

Load Combinations and Permissible Stresses for Design

The purlins have been designed to carry the following combinations of load allowing for appropriate permissible stresses:

- Dead load + Live load – permissible stress = 162.35 N/mm^2 (IS: 1161 Grade Y_{st} 250)
- Dead load + Wind load – permissible stress = $1.33 \times 162.35 \text{ N/mm}^2$

Limiting Deflection Requirements

As per IS: 806 – 1968, the limiting deflection criteria for purlins conforming to IS: 1161 – 1979 Grade Y_{st} 250 will be met if the following requirements are satisfied

Table 4: Limiting deflection criteria for tubular purlin

Nature of End Fixing	Minimum value of Section Modulus in cm^3	Minimum Outside Diameter in cm
Simply supported	$WL/13230$	$L/40$
Effectively Continuous	$\bullet \text{ } WL/19840$	$L/70$

Where

W = the total distributed load in kg on the purlins arising from dead load and snow but excluding wind, and

L = the distance in cm between the centers of the steel principals or other supports.

A purlin is considered as effectively continuous at any intermediate point of support if it is actually continuous over that point or it has a joint there able to provide a fixing moment of not less than $WL/12$, W and L are as defined above.

Analysis and Design

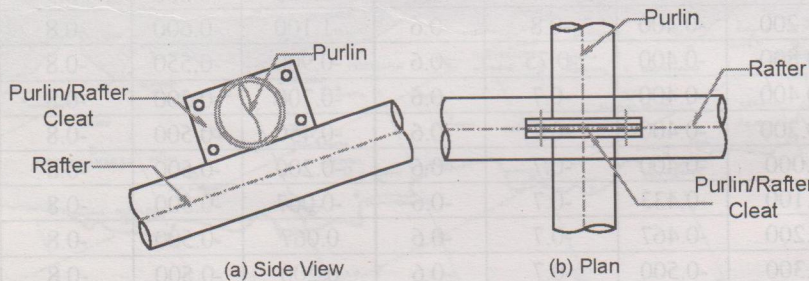


Fig. 5: Purlin connection with rafter

Tubular purlins are supported on principal rafters through a connection between its end plate and the cleat attached to rafters as shown in Fig. 5. These types of joints can neither be considered as simple support nor fully fixed. If we neglect the possible very small relative rotation of end plate with respect to purlin cleat attached to the rafter, it may be assumed to be effectively continuous over the rafters, and maximum bending moment in the purlin can be taken as $qL^2/10$.

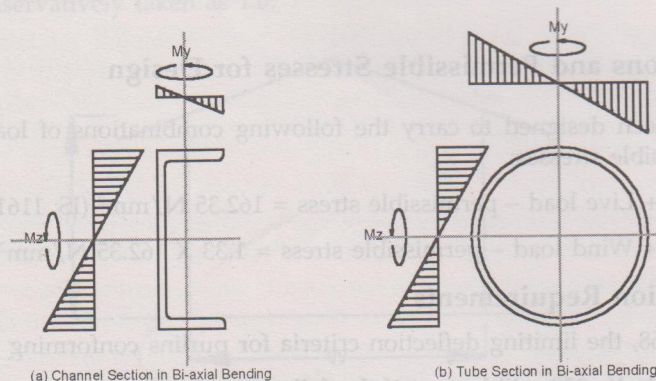


Fig 6: Purlin sections under biaxial bending

Purlins are subjected to gravity load in vertical plane and wind load in a plane normal to the roof. If I sections, channels, zed sections are used, they will be subjected to unsymmetrical bending. In that case the purlins are designed for biaxial bending about two principal centroidal axes as shown in Fig.6. But, in case of tubular sections the effects of biaxial bending are not cumulative because the maximum stress due to bending about one axis happens to occur on the neutral axis for the bending about the other orthogonal axis. Circular sections being symmetrical about any axis passing through its center, every axis through its center is a principal centroidal axis. Therefore, bending of tubular purlin occurs in a plane in which the resultant force lies, and maximum bending stress can be calculated considering uniaxial bending in this plane. Fig. 7 shows the orientations of resultant force and plane of bending for two different types of wind loading.

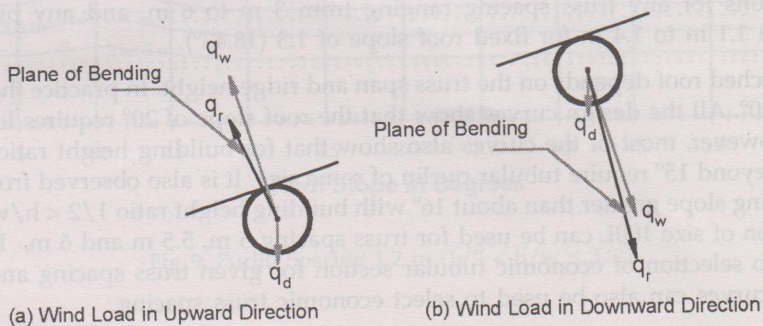


Fig. 7: Resultant of dead load and wind load

If q_{r1} and q_{r2} are the resultant intensities of uniformly distributed load acting on the purlin for load combination 1(DL + LL) and load combination 2(DL + WL) respectively, the maximum bending moments are given as

$$M_{1,\max} = \frac{q_{r1} L^2}{10} \quad \text{for load combination 1}$$

$$M_{2,\max} = \frac{q_{r2} L^2}{10} \quad \text{for load combination 2}$$

and, if b is the allowable bending stress, required section modulus will be greater of Z_1 and Z_2 given as below

$$Z_1 = \frac{M_{1,\max}}{\sigma_b}, \quad Z_2 = \frac{M_{2,\max}}{1.33\sigma_b}$$

The section modulus so calculated is compared with that required as per limiting deflection criteria, and suitable tubular section satisfying all criteria is selected as the required purlin.

Design Curves and their usage

For given purlin spacing, tubular purlins have been designed for truss spacing of 3m, 3.5 m, 4 m, 4.5 m, 5 m, 5.5 m and 6 m varying the roof slope from 0° to 60° at intervals of 5° . Required section moduli for a given truss spacing are plotted against the corresponding roof slopes to obtain a design curve for that truss spacing. Similar curves are obtained for other truss spacing. Fig. 8 and 9 show design curves for purlin spacing of 1.2 m for building height ratios

$h/w \leq 1/2$ and $1/2 < h/w \leq 3/2$ respectively. Fig. 10 and 11 show similar design curves for purlin spacing of 1.4m. From these figures it is seen that all the design curves have their peaks at a roof slope of 10° because for both the building height ratios the external pressure coefficients are maximum at a roof slope of 10° . It is also seen that the greater the truss spacing, the more prominent are the peaks, and as the truss spacing decreases, the curves become flat. However, all the curves show large variation in required section modulus up to roof slope of 15° . From 15° to 20° there is gradual decrease in required section modulus, and beyond 20° the curves are almost flat.

Fig.12 and 13 show another type of design curves in which required section moduli are plotted against truss spacings. Different curves have been plotted for purlin spacing of 1.1 m, 1.2 m, 1.3 m and 1.4 m for fixed roof slope of $1:3$. These curves can be used to select optimum tubular sections for any truss spacing ranging from 3 m to 6 m, and any purlin spacing ranging from 1.1 m to 1.4 m for fixed roof slope of $1:3$ (18.43°).

Slope of a pitched roof depends on the truss span and ridge height. In practice the slopes vary from 10° to 20° . All the design curves show that the roof slope of 20° requires lowest section modulus. However, most of the curves also show that for building height ratio $h/w \leq 1/2$, roof slopes beyond 15° require tubular purlin of same size. It is also observed from Fig. 9 that for roofs having slope greater than about 16° with building height ratio $1/2 < h/w \leq 3/2$ same tubular section of size 100L can be used for truss spacing 5 m, 5.5 m and 6 m. It means that in addition to selection of economic tubular section for given truss spacing and given roof slope, these curves can also be used to select economic truss spacing.

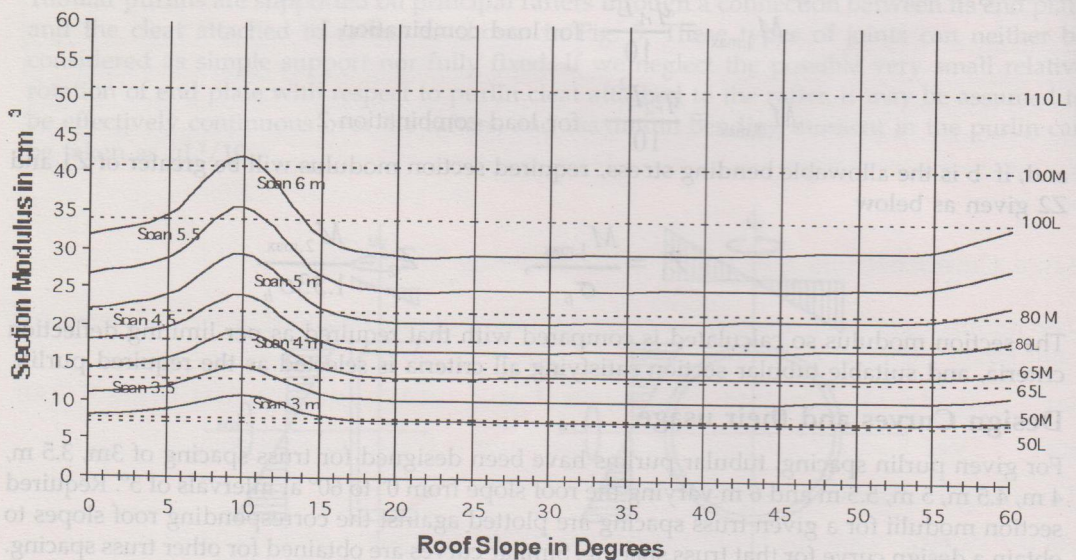


Fig 8: Purlin spacing 1.2 m ($h/w \leq 1/2$)

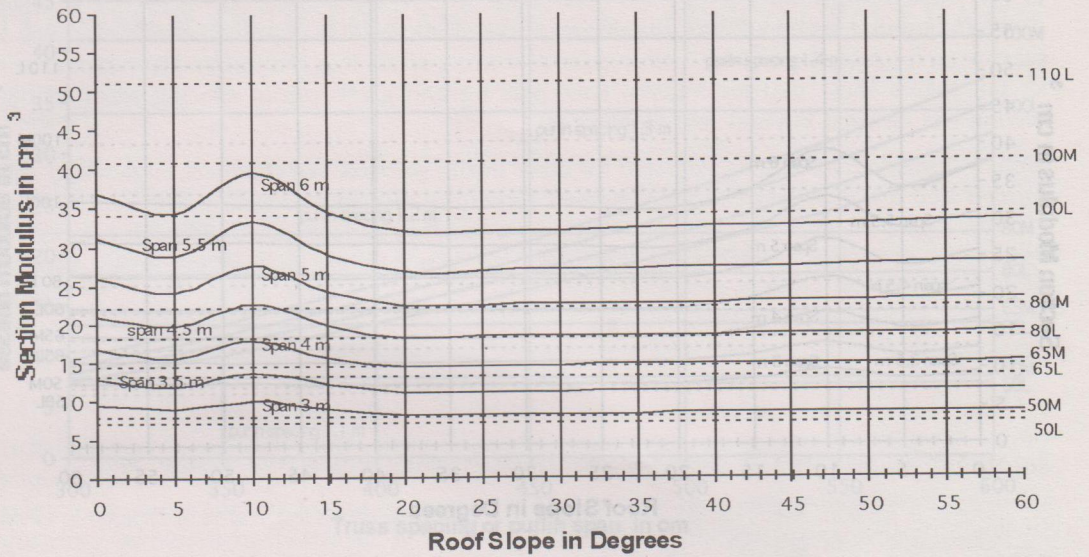


Fig 9: Purlin Spacing 1.2 m ($1/2 < h/w \leq 3/2$)

Illustrative example on the use of design curves

The use of design curves of Fig. 8-11 can be illustrated by the following example. Let us suppose that a workshop building is to be designed with the following data:

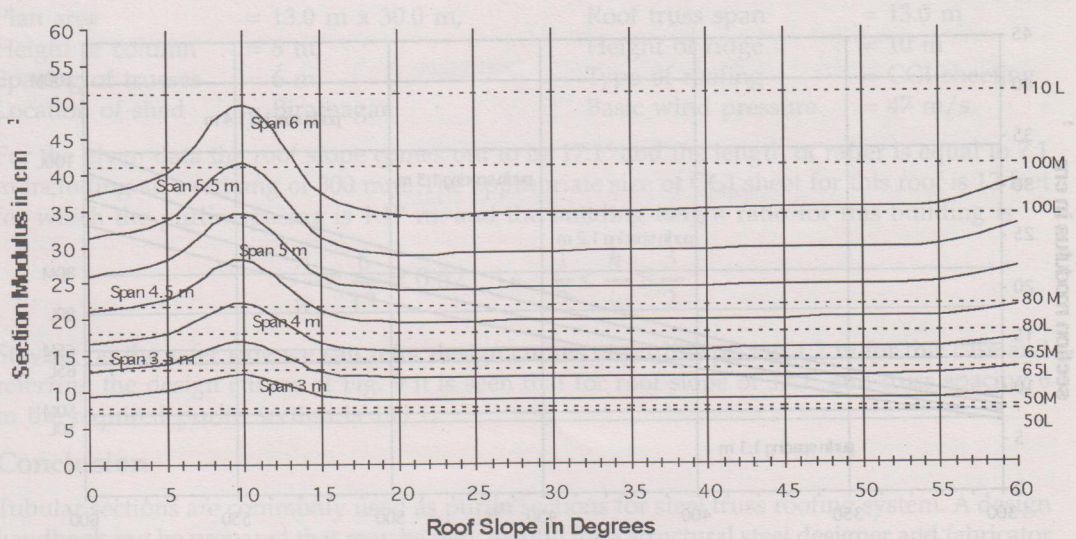


Fig 10: Purlin spacing 1.4 m ($h/w \leq 1/2$)

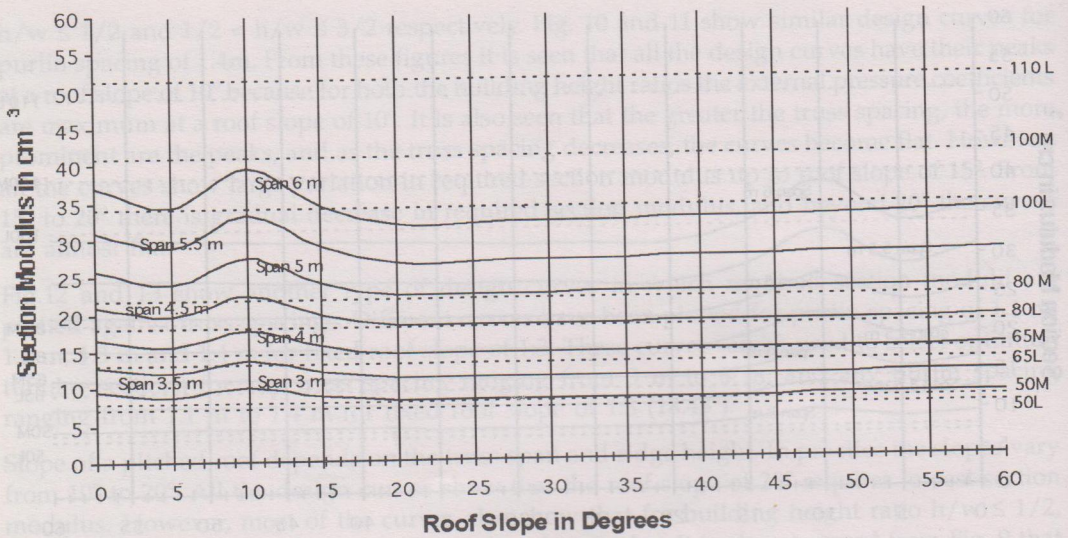


Fig 11: Purlin spacing 1.4 m ($1/2 < h/w \leq 3/2$)

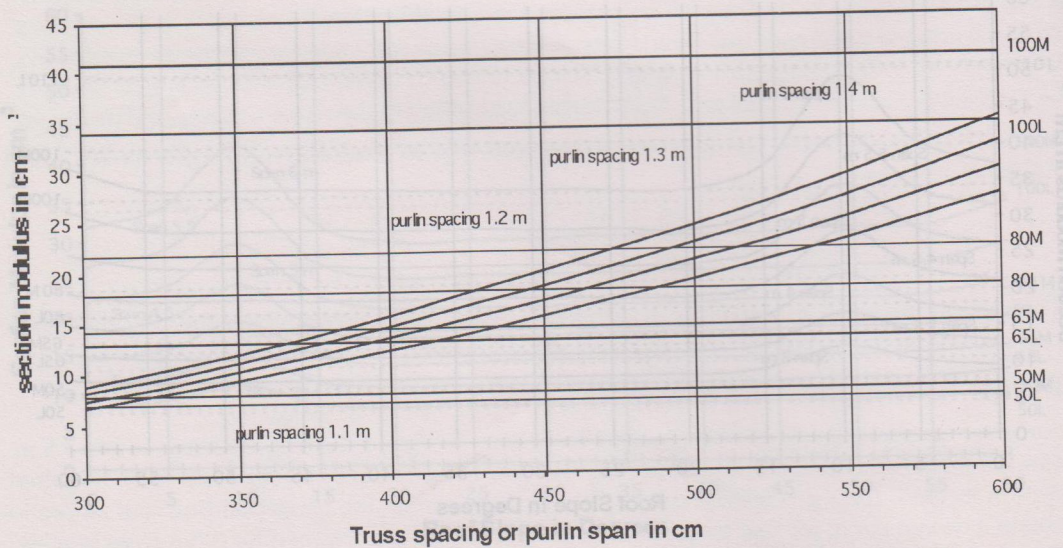


Fig 12: Design Curves for building height ratio $h/w \leq 1/2$ with roof slope of 1:3

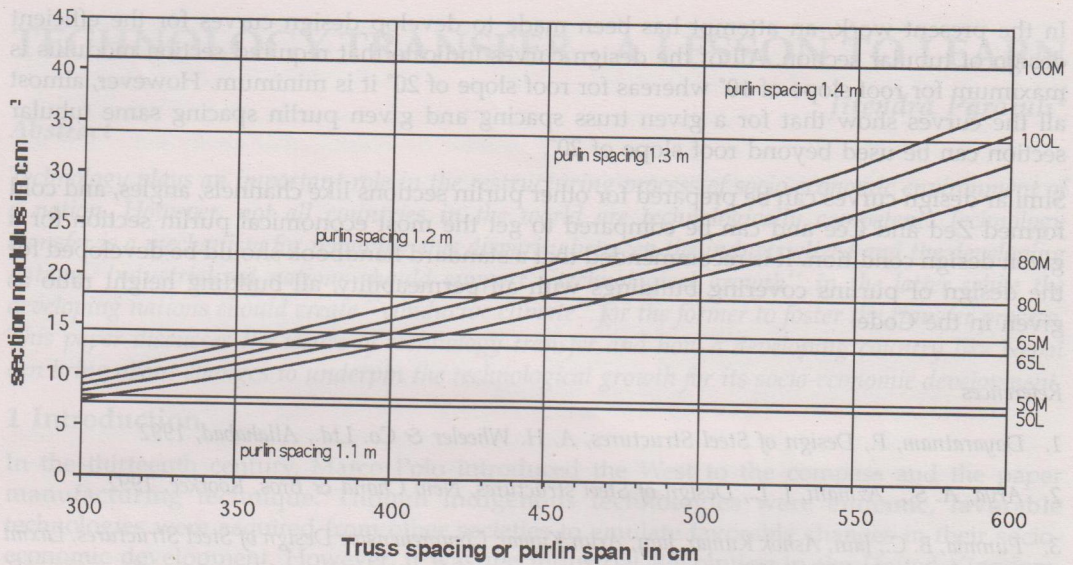


Fig 13: Design curves for building height ratio $1/2 < h/w < 3/2$ with roof slope of 1:3

Illustrative example on the use of design curves

The use of design curves of fig. 8 -11 can be illustrated by the following example. Let us suppose that a workshop building is to be designed with the following data

Plan area	= 13.0 m x 30.0 m,	Roof truss span	= 13.0 m
Height of column	= 8 m,	Height of ridge	= 10 m
Spacing of trusses	= 6 m,	Type of roofing	= CGI sheeting
Location of shed	= Biratnagar,	Basic wind pressure	= 47 m/s

For the given data the roof slope comes out to be 17.1° and the length of rafter is equal to 7.1 m including an overhang of 300 mm. The appropriate size of CGI sheet for this roof is 12 feet for which the purlin spacing is 1.17 m. and the building height ratio for this building is

$$\frac{h}{w} = \frac{8}{13} = 0.62 \quad \text{i.e.} \quad \frac{1}{2} < \frac{h}{w} \leq \frac{3}{2}$$

Staying on the safer side we can refer design curves of purlin spacing 1.2 m for this case and referring the design curves of Fig. 9 it is seen that for roof slope of 17.1° and truss spacing 6 m the required purlin section is 100 L.

Conclusion

Tubular sections are commonly used as purlin sections for steel truss roofing system. A design handbook can be prepared that may be very helpful for a structural steel designer and fabricator to select an optimum section as well as optimum span to achieve economy in the cost of roofing system.

In the present work, an attempt has been made to develop design curves for the efficient design of tubular section. All of the design curves indicate that required section modulus is maximum for roof slope of 10° whereas for roof slope of 20° it is minimum. However, almost all the curves show that for a given truss spacing and given purlin spacing same tubular section can be used beyond roof slope of 20° .

Similar design curves can be prepared for other purlin sections like channels, angles, and cold formed Zed and Cee and can be compared to get the most economical purlin section for a given design condition. It is recommended that a standard handbook should be developed for the design of purlins covering buildings with all permeability, all building height ratio as given in the Code.

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TECHNOLOGY TRANSFER - A LESSON TO LEARN

Jitendra Parajuli*

Abstract

Technology plays an important role in the restructuring process of socio-economic environment of a nation. However, not all countries in the world are technologically competent. Technology transfer is a mechanism for removing this disparity between the industrialized and the developing nations. Industrialized nations should support "technological growth" in the latter while the developing nations should create "conducive climate" for the former to foster the transfer process. This paper discusses the issues of technology transfer and how a developing country like Nepal can bring about changes to underpin the technological growth for its socio-economic development.

1 Introduction

In the thirteenth century, Marco Polo introduced the West to the compass and the paper manufacturing technique. Though indigenous technologies were endemic, favorable technologies were acquired from other societies to emulate favorable changes in their socio-economic development. However, it was the Industrial Revolution in the United Kingdom, from about 1760, which brought about a gradual change in the socio-economic changes arising out of the use of technology - the power-driven machines. This impact of the Industrial Revolution gradually percolated in other parts of the world. Some countries in the West, like Germany, and the US, were fast in utilizing and adapting new technologies. This, in fact, provided the impetus for their economic growth and they ultimately became major industrial and economic powers.

Those countries that dawdled to embrace the use of technologies for industrial and economic development succumbed to the advanced technological and military might of powerful nations. The resources in those areas of the world were exploited and the people were kept politically and economically dependent. Even after overcoming the military and political leverage of the ruling powers, they had to formulate century-leaping development plans. With the limited resources - economic and technical, it was a difficult race to compete together. Further, the situation was aggravated by factors like population growth, lack of effective government policies, proper technology and skilled manpower.

While the population growth of the industrialized nations was very stable and low, the population growth of the developing countries is still stupendous. So most of the countries' output is still being used simply to feed the people. Efficient banking systems and financial institutions were developed in the West. Lower interest rate was a key determinant for technological growth. This was, however, not the case in regions like South Asia and Africa. There were no resolute government policies in investment and hence impeded the economic growth. Not only policies but also the allocation of investment were not at the right places. The market was guided by import of variety of goods from textiles to food which in turn affected the balance of payment of the developing countries. There was an absence of regional and multilateral cooperation among developing countries which also hindered in the flow of knowledge and information required for development. Lack of technology and skilled manpower also made developing countries rely on less-productive means of production and had to rely on imports for fundamental needs [1].

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The technological advancement in the fields of biotechnology, cybernetics, space technology and telecommunications, hitherto, are still centrifuging in those countries which had the earlier advantage of being industrialized. This has led to a bipolar world - economically and technologically. One of the efficacious means to remove this schism is the transfer of technology and its absorption and assimilation; the socio-economic development of newly industrialized nations like South Korea and Singapore corroborates this fact.

2 Technology transfer

The acquisition of technology from external sources is termed as technology transfer. Recognizing the potential economic opportunities, economists, policy-makers, and organizations advocated for the need of technology transfer. This was based on a simple economic theory - technology which has already been produced, and hence paid for by someone else, could be used and exploited by others to generate revenue.¹

In the most recent years, the technology transfer has been separated into vertical and horizontal modes. The vertical technology transfer in its simplest form refers to concept development, that is, the transformation of ideas or findings from basic research into a technology or a product. The horizontal transfer of technology refers to the dissemination of research findings, concepts, methods and technologies between research and development (R&D) organizations and/or industrial units [2].

For a technology transfer to be effective, multifarious processes are necessary. These interrelated processes are crucial to the acceptance of the new technology. The adoption-absorption-assimilation process must work in close tandem with the process of technology transfer in order to achieve the desired results. This process is a series of complex stages and has a specified order - namely, awareness, interest, evaluation, trial and adoption [3].

1. **Awareness:** This is the initial stage of technology transfer. The probable transferee has heard or read about the technology but lacks specific information.
2. **Interest:** In this stage, further information is sought about the new technology that is to be transferred.
3. **Evaluation:** Based upon the evaluation of information gathered, there is a decision-making process.
4. **Trial:** If the decision at the evaluation stage was positive, usually, a pilot study, a trial run, or some small portion of the overall situation is "sacrificed" to study the effects of the new or transferred technology in a real-life situation.
5. **Adoption:** A positive trial will usually result in a large-scale use of the new or transferred technology.

Absorption-assimilation is crucial after adoption; the adopted technology must be absorbed by various sectors for their economic gain and the absorbed technology must be made better through a continuous process of innovation.

¹ When the technology owners demurred at scrounging of their technologies, different national, regional and international treaties were ratified to protect them. For example, the General Agreement on Tariffs and Trade (GATT) is a multilateral treaty subscribed by many governments around the world and it protects the intellectual properties like the copyrights, trademarks, patents, designs, and confidential information.

2.1 Mechanisms of technology transfer

Depending upon the capability of the recipient, the technology can be transferred in the following ways:

- Foreign direct investment: Direct investment of multinational companies in the form of a fully owned subsidiary or a joint-venture with a local enterprise can bring in the technology as well as skills needed to implement the new technology. Though, turnkey projects can also involve foreign investment, the transfer may be limited to transplantation of technology.
- Technology transfer units: Many universities including research-based organizations have industrial liaison units and technology transfer units to bring in technology from outside and/or to find partners to help exploit in-house developments. Sometimes intermediary agencies act between companies seeking and companies offering technology. This has also led to the growth of science parks.²
- Licensing of patents/trademarks: Patents/trademarks are the prerogative of the technology owners. A licensing agreement between the transferor and the transferee is necessary before the technology can be accessed. Lots of business communities and universities grant the licenses of their technologies to the third parties and generate income. However, the transferee should carefully evaluate the licensing agreement because technology can be superseded by new development.
- R&D operations: Without innovation, transferring technology is merely transplantation of technology from one area to the other. So in the context of technology transfer innovation is one of the critical areas that needs to be thoroughly examined. If there are no R&D efforts, technology will be stagnant and there will not be any meaning of technology transfer.
- Skilled personnel: Hiring skilled personnel with necessary skills and knowledge can bring the technology in an organization. Probably, this is one of the oldest methods of technology transfer. Personnel exchanges, regular trainings, and foreign employment can also enhance as well as bring in new technologies.

Other mechanisms of technology transfer could be through acquisition of companies, government to government agreements, consultancy and so forth [4] [5].

2.2 Areas of technology transfer

Usually developing countries have to "purchase" technologies from the industrialized countries. Since it involves a huge capital investment, it is up to the transferee to identify the areas where there is need of technology. The following could be some of the areas in which new technologies can be applied:

- Farming and irrigation techniques
- Energy sector
- Transportation
- Electronics, informatics, and telecommunications

² The idea is to develop an industrial area close to an established university. The underlying rationale is that academic scientists will have the opportunity to take laboratory ideas and develop them into real products. The science-based companies can, hence, utilize the knowledge base.

- Manufacturing industries
- Biotechnology
- Natural calamities
- Land use
- Housing
- Environment
- Human resource development

3 Technology transfer policy issues

Policy provides guidelines to achieve goals. Because of the monopolistic and capital-sensitive nature of technology transfer, any country planning to acquire technologies from various sources must have a well-formulated technology transfer policy. Political elites, bureaucrats, technocrats, academicians and business houses must resolve the differences and set a common goal before the policy is rubricated.

However, since the success in technology transfer is pursuant to the success of economic growth, the foremost goal of any country is to bring about a favorable environment for internal as well as external economic growth. Singapore, for example, came up with several determinants that were critical for her growth and they are as follows [6]:

- A stable, good, and development-oriented administration
- Adequate accumulation of human capital
- Adequate accumulation of physical capital
- Adequate savings functions
- Market-driven economic system
- Outward-looking economic policy
- Conducive private investment climate

Other countries like South Korea, Malaysia, and Thailand also contrived radical and competitive policies to bring about favorable changes in their economic conditions.

3.1 Determinants of technology transfer

Technology must be taken as a primary factor needed for production and growth, in both macro- and micro-levels, to make technology transfer a success. Policy-makers must take this into account while formulating technology transfer policy. Determinants affecting the technology transfer policy are as follows:

3.1.1 Appropriateness of the technology

It is difficult as well as expensive to develop every technology from its nascent state. So every transferee needs to recognize the technologies that are to be transferred. Whether the transfer involves some basic know-how or entirety, it must be economically viable, technically feasible and socially palatable. The egregious blunder of Nigeria, in the Seventies, to establish automobile industry with the help of world-famous companies like Volkswagen and Peugeot is an example of selecting inappropriate technology for import-substitution. The industry merely siphoned

the foreign exchange and could not meet the expectations of the government, the investors and the multinational companies. This selection also became one of the key factors in the economic crisis of Nigeria in the Eighties. On the other hand, the Brazilian informatics industry still attracts the attention of policy-makers and development theorists around the world. Brazil showed adeptness while selecting the technology that was to be transferred. In 1986, the Brazilian computer industry was able to generate revenue of \$2.7 billion.

3.1.2 Procedure of transfer

When any kind of technology is about to be transferred, there must be mutual understanding between buyer and seller.³ All the relevant information pertaining to the technology must be accessible to the buyer before the purchase. Both the parties can reach an understanding of the level of transfer process - in parts or in totality, before the contracts are signed.

3.1.3 Availability of trained manpower

The success stories of Singapore and South Korea in technology transfer can be attributed to the availability of trained manpower having skills to handle technologies. The trained manpower not just includes engineers or technicians, but also managers, scientists, academicians, and instructors. Developing a human resource plan by every transferee is very crucial. This plan must focus on educating and training from the elementary education level. Developing analytic ability, learning new languages and communication skills, and developing interpersonal skills and discipline should be some of the areas that the education and training programs should concentrate on. Identifying the type of skilled personnel required, the number to be trained and skills the manpower should possess must be integrated in the human resource plan. Upgrading curriculum in educational and vocational sectors should be a continuous process otherwise the trained manpower will not be able to handle sophisticated technologies.

3.1.4 Availability of raw material

While importing new technologies, the transferee must have raw materials required for the use of technologies. One of the factors attributed to the failure of Nigeria's automobile industry is lack of raw material. The import of different components required to manufacture cars guzzled a large amount of foreign currency. Not all the countries have abundance of raw material. Some initial investment can be done in acquiring raw material, processing it and exporting the finished product. This can generate income to acquire more raw materials. A classic example of this is the steel industry of Japan. Japan imports iron ore, processes it and exports high-quality steel, and the profit generated by the value addition is used for importing more iron ore.

3.1.5 Infrastructure facilities

Good infrastructure facilities are critical to technology transfer. Availability of electricity, road, water, drainage, telecommunications networks, airports, seaports, industrial estates and banking systems play an important role in inviting foreign investments. India focused on rural development by providing various incentives to foreign companies to bring technologies in the rural parts of the country. But, since, there was lack of rudimentary facilities for the companies to establish, and to manufacture, and it was a gargantuan task for the investors to invest in infrastructure facilities, the investors shied away from investing in India. On the contrary, the Singapore government established Jurong Town Corporation which is responsible

³ Buyers and sellers can be governments, manufacturers, R&D institutes, multinational companies and so forth.

for the development and management of industrial estates. The Port of Singapore Authority was created to handle cargo via sea, while The Changi Airport earned its reputation for being the most preferred airport in the world both in terms of passenger traffic and cargo handling. The telecommunications infrastructure is rated among the best in the world. Hence, the foreign investors were not reluctant to bring in the technologies to Singapore.

3.1.6 Availability of R&D facilities

R&D plays a key role in the absorbing, assimilating and upgrading the transferred technologies. The other areas that R&D is critical are innovation and improving production processes. So the policy-makers should separate some of the country's spending in R&D and invest in organizations where prototypes are designed, products are manufactured and innovated, and production processes are developed. These organizations can be government-owned subsidiaries solely involved in R&D, labs in the universities and colleges, and manufacturing industries. The government must also support individuals like scientists and entrepreneurs to become involved in R&D. It is also important to raise the expenditure on R&D gradually and to devote aid in technology. In developed countries, the mutual collaboration between the universities and the science parks in the vicinity of the universities have been playing a supportive role in R&D while the amount of R&D in the developing countries is minimal [5] [7].

4 Nepal's perspective

The present socio-economic condition of Nepal reflects the need of technology for rapid development. Though traditional industries like carpets and handicrafts are generating revenues from the international arena, they are not enough for leaping into a self-sufficient society. Nepal needs modern technologies to increase production and revenue, and to uplift the present socio-economic condition of the country.

4.1 Status of technology

It was in 1936, with the establishment of Biratnagar Jute Mills, that modern technology entered Nepal. Since then, technical assistance from donors, use of sophisticated equipment and machines in telecommunications, information technology (IT)-based industries and health sectors, and a couple of global enterprises like Colgate Palmolive and Tuborg have been instrumental in transferring technologies. Figure 1 shows the number of joint venture industries in Nepal.

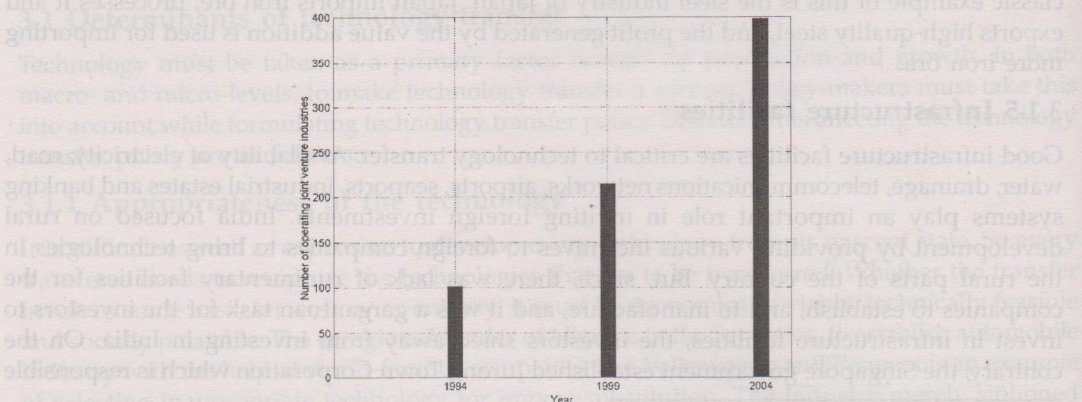


Fig 1: Joint venture industries in Nepal [8]

The commitment and desire of both the government and private sectors toward attaining autarky through technology are reflected from the establishment of Royal Nepal Academy for Science and Technology (RONAST), Ministry of Science and Technology, research centers, and universities and colleges.

The enactment of the Foreign Investment and Technology Investment Act 1992 was a major step towards attracting foreign investment in the form of technology transfer. The Tenth Five-Year Plan, which came into effect from the fiscal year 2002/2003, also heeds the need of incorporating and utilizing available technologies for development and poverty alleviation. On the contrary, the status of foreign investment and the utilization of technology in development is less than the expectations and contravenes the aspirations of the government as well as the private sectors.

The factors that have severely affected this process are as follows:

- **Lack of political/bureaucratic commitment:** Lack of commitment of the main political forces has been a major setback in the investment in technology. Frequent strikes, unstable governments, tinkering with bureaucracy and unstable situation of the country have "dithered" foreign investment. Inefficiency, unnecessary hassle and red-tapism, and malfeasance within the bureaucracy have further eroded the environment for foreign investment.
- **Ineffective technology institutions:** Institutions with adequate R&D facilities play a critical role in inviting technologies. Government, private enterprises, and universities and technical institutions lack well-equipped and well-funded research laboratories. Though some institutions have R&D facilities, they function in isolation and lack coordination and cooperation among themselves. The research findings also remain confined to laboratories and their impacts on reducing poverty have been minimal. Establishment of technology transfer units within an organization, and establishment of science parks on a larger scale is not common.
- **Poor availability of technical human resources:** Dearth of technical manpower in the country has adversely affected the technical development. Lack of adequate facilities and funds, production of manpower without considering the market demand, lack of career opportunities, and brain drain have severely hurt human resource development.
- **Lack of infrastructure facilities:** One of the critical problems in technology transfer has been the lack of various rudimentary infrastructure facilities. Efficient electricity and water supply, effective road and telecommunications networks, and adequate airports are not present. Likewise, the existence of some countable industrial estates and the non-existence of science parks have also limited the technology transfer.
- **Rapid pace of technological change:** Nepal has not been able to keep up with the pace of technological advancement. Due to high cost in acquiring new technologies, the government as well as the private sectors is reluctant to make investment in high-tech industries [9].

4.2 Areas for technology transfer

A nation's competitiveness depends on the capacity of its industry to innovate and upgrade. No nation can or will be competitive in every or even most industries. By analyzing internationally successful industries we can deduce what works and why. Then we need to apply it. German high-performance autos, Japanese semi-conductors and Swiss banking are

well-known international success stories [10]. Nepal also needs to identify areas that are favorable for its socio-economic development and meticulously open avenues for technology transfer.

4.2.1 Agriculture and biotechnology

A major portion of country's gross domestic product (GDP) is still dependent on agriculture and agro-based industry. Due to excessive dependency on the Monsoon, and lack of seed and fertilizers, the optimum production has not been achieved. Though, proper irrigation facilities and availability of seed and fertilizers can play a prominent role in increasing productivity, biotechnological techniques for plant breeding and genetic manipulation can play a dominant role in increasing the agricultural output. Diseases-resistant and highly productive seeds of vegetables, cereals and other food grains can be produced for increasing productivity.

Likewise, the application of biotechnology in the areas of floriculture and forestry should also be considered. For the production of milk products, meat and hide, stock breeding is another area that has to be explored thoroughly. Animal cell culture can be aimed at pharmaceutical industry and fragrances. Traditional herbs and medicines can be analyzed to find out the ones that can be exploited in the international market.

4.2.2 Energy sector

Nepal is heavily dependent on the import of fossil fuel. Therefore, inviting foreign companies and supporting domestic companies to invest in alternate sources of energy like solar, geothermal and wind energy can also bring in technologies as well as alleviate the massive consumption of fossil fuel. Alternate energy source like biomass can also help in reducing the problem of haphazard deforestation.

The exploitation of Nepal's abundant hydroelectric resource potential, which are estimated at around 25,000 megawatts, remains an important element in development strategy [11]. Other areas related to hydropower like irrigation, and fishery can also be exploited.

4.2.3 IT industry

IT industry, which is a knowledge-based industry, has revolutionized the world. The economic leverage of industrialized nations in the areas of E-commerce, E-learning and E-health can be perceived around the world. Though, the IT policy of Nepal was enacted in 2000 with the vision of putting Nepal on the global map by 2005, due to lack of substantial IT-related industries, the present status of Nepal's IT industry and its impact on the global commerce is minuscule. However, Nepal can make IT industry as one of the key ingredients in generating revenue. The technical manpower produced by educational institutions can play a prominent role in increasing economic productivity if an opportunity exists to advance career within the nation. So it is crucial that Nepal starts exploiting its IT professionals by inviting foreign investors and technologies as well as supporting local IT-based companies.

4.2.4 Human resource development

Human resource plays a pivotal role in inviting technologies in any country. Highly qualified and trained managers, engineers, technicians, and researchers are needed for technology transfer to become successful. Inviting foreign professionals and experts to train and to educate domestic manpower, and sending the local personnel abroad to acquire skills and trainings must be an important area of technology transfer. Otherwise their skills, trainings, and education will be obsolete. So expedient reforms in the area of education - from elementary to university level, trainings, and skills development must be governed by the international standards and technology transfer is critical in these areas.

Other sectors like manufacturing industries, environment-related issues must be encompassed in the areas of technology transfer.

5 Conclusion

The global dimension of economy is changing rapidly and is being facilitated by the revolution in information communication technologies (ICTs), decrease in manufacturing and transportation costs, and role of international and regional institutions. Except for the industrialized and newly industrialized nations, only a handful of nations have been able to capitalize these changes; China and India are emerging as major economic powers. This change is attributed to the radical reforms in their overall policies. Inviting participation of private/foreign investors, allocating investment in right places, improving efficiency in the use of capital, increasing levels of domestic savings and investment, lowering trade barriers and managing with responsibility have been crucial in "importing" technologies in those countries and have been supportive in the socio-economic development.

Nepal also needs to comprehend the changes around the world. The country should play a supportive role and contribute significantly to reforms and development. Infrastructure, R&D facilities, free flow of foreign capital, human resource development, better production, marketing and financial policies, and political commitments are key ingredients in the technology transfer process. Finally, as Former Prime Minister of Malaysia, Dr. M. B. Mohammad in his working paper "Malaysia: The Way Forward (Vision 2020)", points out the need of establishing a fully moral and ethical Malaysian society, Nepal should also heed the importance of moral and ethics to establish a prosperous and dynamic society.

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GENESIS OF WTO AND GLOBALIZATION PROCESS

*Bharat Sharma**

Background of WTO

During the nineteen-thirties, the world experienced a very big recession. The global economic situation was really very bad. It was further aggravated by World War Two. At this critical juncture the developed countries decided to hold an international meeting to alleviate the situation by formulating a strategy to restructure the global economy in order to come out of the recession. In 1944 a meeting of the representatives of various concerned governments was held in Bretton Wood, New Hampshire USA.

The meeting decided to create three international bodies, which would take care of the vital concerns namely: (1) Economic Reform (2) Financial Stability and (3) Promotion of Free Trade through international trade organizations.

The two mega institutes, namely the World Bank and the International Monetary Fund, were consequential creations. Meanwhile, big companies of developed countries started to put pressure on their governments to liberalize the global economy so that they could conveniently reap the fruits unhindered.

Bretton Wood Institutes obliged them by pushing for liberalization of the economies of developing countries. As a result, big companies operating multinationally expanded their markets very rapidly as the environment was properly tailored for them. The Transnational Corporations (TNC) were further helped in their relentless effort of globalization by the creation of the World Trade Organization (WTO) in early 1995.

The handy tool in the name of structural adjustment programme (SAP) was designed by Bretton Wood Institutes to curtail governmental expenditure to enable them to service and repay debts. However, this became a concern for the developing and least developed countries (LDC) as curtailing governmental functions (Public Sector) helped to usher in privatization. This is how privatization of public sector enterprises came into being.

Under structural adjustment programme (SAP), the privatization policy had to be formulated by each developing country in a way that would provide foreign investors the right environment to invest. Investment in social sectors such as health and education was branded as unproductive and governments were advised to involve the private sector to run the above stated social sectors.

WTO

The World Trade Organization was established in 1995. It took over from GATT (General Agreement on Tariffs and Trade) which was founded in 1948. The Bretton Wood Institutes' conception of SAP included maintaining fiscal discipline, public expenditure priorities, tax reform, deregulation, removing barriers for foreign direct investment, financial liberalization, rationalizing exchange rates, trade liberalization, privatization and ensuring security of property rights under law without excessive costs. Obviously WTO carried a strong base of an unimpeded free trade.

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Nepal initiated membership process of WTO in 1995 and eventually during the Cancun round of talks, 8 negotiating countries signed Nepal's accession to the WTO in September 2003 as the 148th member country subject to some procedural conditions of approval by the Nepalese Parliament. Due to the absence of the Parliament, it has now been endorsed through an ordinance promulgated recently. But this is only just a ritual of getting membership and not a test of strength to face the flak. Since 23 April 2004, Nepal has been enlisted a full member of WTO. But there are many hurdles to be crossed over. To reap the maximum benefits from WTO membership Nepal has to reform over 40 laws and Acts. This is urgently needed to upgrade stakeholders' capacities in order to minimize adverse impacts.

Though GATT was applicable to only **"Visible Trades"** in merchandise goods, WTO encompasses both visible and invisible goods, **meaning Trades in goods and services and Trades in ideas and intellectual properties.**

WTO is supposed to be governed by four guiding principles namely

- (i) Non discrimination status to all
- (ii) Trade liberalization with tariff barriers removed
- (iii) Trade barriers would not be raised arbitrarily
- (iv) Preferential treatment to developing and poor countries

Trade in Services

A framework has been established to govern international trade in commercial services which covers four modes of supply.

- (i) Cross border movement of service product i.e. from the territory of one member country into another e.g. banking, architectural services.
- (ii) Movement of consumers to the country of importation e.g. users consuming in territory of supplier e.g. aircraft maintenance, tourism.
- (iii) Establishment of commercial presence in the country where service is to be provided e.g. presence of supplier in users' territory e.g. hotel chain, consultants.
- (iv) Temporary movements of natural persons to another country to provide services e.g. doctors, lawyers, accountants, managers, engineers, architects.

Further, the service sector has been classified into 12 sectors and 155 sub-sectors. The sectors designated are:

- Business service
- Communication service
- Construction and related engineering services
- Distribution service
- Education service
- Environment service
- Financial service
- Health related service

- Tourism and Travel related service
- Recreational, cultural, sporting service
- Transport service
- Other services

Service Sector Commitments

Due to the inherent characteristics of the agreement, Nepal is compelled to extend the commitments for opening of the service sector. Under WTO, the General Agreement on Trade in Services (GATS) governs the service sector. This sector is a strong tradable area, covering business, communication, construction, engineering, education, environmental finance, health, tourism and travel, transport, culture and sports, recreation etc.

The fundamental principles of WTO are as follows

- (1) While providing trade facility to any member country, the facility should not be less than one enjoyed by most favored nation. (MFN)
 - (2) A member state must treat the goods produced in another country at par with its own goods. This is referred to as "National Treatment".
 - (3) Any dispute arising between member countries should be submitted to a "dispute settlement body" under WTO.
 - (4) Disputes should be settled by consensus.
 - (5) Developing countries and LDCs should be given special and preferential treatment.
- However "best endeavor value of WTO" is creating somewhat of a hurdle.**

Out of the numerous service sectors and sub-sectors, everywhere it is a very challenging task for Nepal in general and the engineering community in particular to remain competitive in engineering service which falls into one of the sub-sectors under construction and related engineering service category of the Trade in Services. Lots of homework has to be done in which the legal capacity build up and right environment propagation are prerequisites to harvest the fruits out of the competitive WTO markets. The problem is that Nepal is not at all prepared for that. So just getting membership is not good enough. If we do not prepare ourselves, the result could be really shocking as instead of enjoying the fruits we might land up in hot soup and be the losers. Let us not have self-created nightmares. If we want to use the service sector, which forms the major share of GDP even in developed countries, to create a foundation for national development, then we should prepare ourselves to explore the market and to grab it by our competence. But the irony is that to date nothing concrete has been done to prepare us to face the challenges. If this is the situation, then instead of reaping dream bumper harvest, we will be at the receiving end and be like sitting ducks without any cover. Mercy solicitation on our part will only result in loss of our self-esteem. Even if we are granted some rebate and sympathetic consideration, it will be definitely restricted to some temporal frame beyond which we will have to prove our competence on the global scale. For this an all-out effort and systematic endeavor will be required on our part. The government has hardly initiated its spadework in the context of preparedness. Perhaps it is high time that Nepal Engineering Council [NEC] should take up the Herculean task at least in the sectoral context to protect the interest and well-being of the engineering community of Nepal. The protectionist policy of the developed countries is likely to create hurdles in the context of

access to open market. It is prerequisite to build-up capacity and competence at various levels. Restructuring institutional set-up as well as allied activities and legal frame is the call of the hour. In the national context there are many key actors who should provide their meaningful inputs to prepare ourselves. Let the government come out with clear-cut workable policies and strategies to further our cause. Till then we have to brace ourselves for the worst.

It will be very pertinent to mention about a breaking news [BBC Aug 1, 2004] that 'a draft deal to cut agricultural subsidies and open up global trade was finally agreed in Geneva'. WTO members have agreed to a revised draft deal which aims to activate stalled talks on freeing up trade between the rich and the poor nations. The latest deal should reduce the barrier on international trades and it is hoped that this will lift millions out of poverty. The draft deal agreed on 31 July 2004 in Geneva puts the Doha Round of trade talks back on track, after a similar talk in Cancun last September fizzled out in a deadlock. According to the World Bank a successful final deal could add 520 billion dollars to the world economy by 2015 if rich and poor countries cut their tariffs.

In September 2003 in Cancun Mexico, a summit was held to work a deal on the Doha (Qatar) round and it concentrated on four principal areas - Industrial Goods, Trade in Services, Customs Code and Agriculture. The talks failed because rich and poor countries could not reach agreement on the above stated areas in general and agriculture in particular. Poor nations felt, and rightly so, that rich nations were protecting their interests through subsidies and then dumping their goods on poor countries at knock down prices, thus undermining local farmers. The subsidies, funded through taxpayers via governments or trade associations, have made production costs for western farmers cheaper. This has created an unequal race, which is unfair.

Now as the Geneva round of talks has been successfully concluded, the key nations have agreed to eliminate export subsidies at a date to be set later, to limit subsidies and to lower tariff barriers. Developing countries have also won the right to protect special products which are crucial to their economy. Hence it could be concluded that just being a member of WTO is not good enough and we have to do lots of ground work to prepare ourselves in various areas to take up the challenge. Reaping the benefits of membership to WTO would not be that easy as lots of strategic works, policy formulation, legal ground works and institutional strengthening have to be done. Use of modern technologies, quality management and hardcore professionalism could help to usher in a compatible climate. Issues of intellectual property rights are quite knotty problems. The creation of a conducive environment is the call of the hour.

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SOLID WASTE MANAGEMENT IN KATHMANDU: A HOLISTIC APPROACH

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ABSTRACT

Kathmandu shares similar problems in solid waste management as other cities in the developing countries. However, there are some unique features also: Kathmandu is a valley and transportation costs become high; the increase in population is very rapid; the land has high agricultural value; and, waste management is considered to be the responsibility of only the so called lower caste people. The problem of solid waste in Kathmandu can be solved only by paying special attention to these unique features. The paper discusses the need for a holistic approach in order to solve the problems of solid waste management in Kathmandu valley and recommends some measures to be taken at different levels.

Introduction

Managing solid waste has become one of the most challenging problems for Kathmandu valley. In fact, effective management of solid waste in urban centers has become a challenge not only for underdeveloped countries like Nepal, but also for developed countries. The problem demands special attention in developing countries as it is further worsened by the lack of access to advanced technology, by poor infrastructure and by allocation of insufficient resources.

Kathmandu is a culturally important city, and many parts of the city are listed in UNESCO's world heritage site. Throughout history, Kathmandu has remained a holy city, drawing pilgrimage not only from Hindus but also from Buddhists, and is a tourist hub for people from all over the world because of its traditional importance and panoramic beauty. As has been the trend in urban cities worldwide, Kathmandu also experienced mass migration from other parts of the country in the last half century. In the last decade, two factors provided a further boost to this migration trend: first, increasing unrest and armed revolution in remote areas; second, increasing purchasing power of people working abroad. The surge in population in a short span of time, haphazard urbanization and unplanned growth of the city, pace of development of facilities and infrastructures not matching with increase in population, crumbling infrastructures because of need to allocate resources in new projects rather than maintaining completed ones, exhausted resources, and lack of innovative approach have contributed in the past to make solid waste unmanageable in Kathmandu.

Kathmandu valley, covering an area of 667 sq. km., is divided politically into three districts - Kathmandu, Lalitpur and Bhaktapur, 3 municipalities - Bhaktapur, Thimi and Kirtipur, one sub-metropolitan city - Lalitpur and one metropolitan city - Kathmandu. The total population is estimated to be around 1.5 million, out of which 750 thousand are in Kathmandu city alone. The volume of waste generated in Kathmandu City equals to about 1000 m³/day - 30% of which is generated from the daytime population, waste from neighboring cities & villages and, commercial districts - and that of neighboring Lalitpur is 130m³/day (Manandhar, 2002). Although the quality of the solid waste is changing with time, a large share of the solid waste

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in Kathmandu valley consists of household waste and the volume can be decreased significantly before taking it to the dumping site. Reports suggest that about 21 percent of total generated waste in Kathmandu Valley can be recycled and 62 % can be composted (as quoted in Timilsina, 2001)

Kathmandu is not alone in facing the growing challenge of solid waste management (SWM). By the end of 1998, "Municipal SW in China was about 440 kg [per capita] (about 1.16 times China's annual per capita grain production by weight), and the recorded annual production of Municipal Solid Waste has expanded at a 9.3 percent compound annual growth rate over the past decade" (Suocheng et al., 2001). However, because of the features unique to Kathmandu that other cities may or may not share, the SWM in Kathmandu demands special attention. Kathmandu is a valley surrounded by hills on all sides. Because of its valley nature transportation becomes costly - in some cases not feasible at all. The land has high agriculture production value and hence there is competition between land for agriculture and landfill sites, and as the city can not grow beyond certain limit, there is fierce competition between land for residence and landfill sites. Many industries are located in the valley, which not only increase volume of waste but also are a source of conflict with the general public because they share the resources and cause environmental nuisance. Location of industries inside or near the city has also been the major reason for increase in population in Kathmandu. Another unique feature that may not be common in urban cities of other countries is the prevalent caste system throughout the country - only the so called lower castes are considered responsible to collect and dispose the waste.

The problem of solid waste in Kathmandu can be solved only by paying special attention to these unique features. It's not that efforts are not being made to solve this critical problem that is devouring the scenic and culturally and historically important city. But the solutions are limited to rectify and improve the disposal method only, whereas the problem starts from the very basic nature of lifestyle of the people. What is needed is a holistic approach that comprises of social, cultural, technological, economical, political and administrative dimension and focuses on different levels of decision making entities i.e. household, community, municipality and the state.

SWM System in Kathmandu

Current management of solid waste in Kathmandu can be broadly divided into three categories - managed at household level, managed at municipality/state level, managed at community/ NGO level. Details of all these categories and the steps involved in the movement of waste from source to the final dumping site are shown in Fig. 1.

First category is the waste managed at household or individual level. Majority of the waste managed at this level is either dumped haphazardly or composted. An insignificant amount of waste is separated into reusable viz. papers, recyclable viz. metals, polythene etc. and rest of the waste is either burned or composted or landfilled. The remains of burn and final product after composting are used as fertilizer in agriculture. This is still a common practice in households active in agriculture especially in the outskirts of the city. Some industries and hospitals are also practicing self management of waste generated by themselves. But the process is limited and is done without adopting proper technology as pointed out by Pokharel (2002) that two hospitals incinerating their waste run their plant at around 300 to 400° C temperature only. Since most of these processes are carried out at individual level without technical know-how and without proper hygienic measures, this contributes very little to the overall SWM of the city.

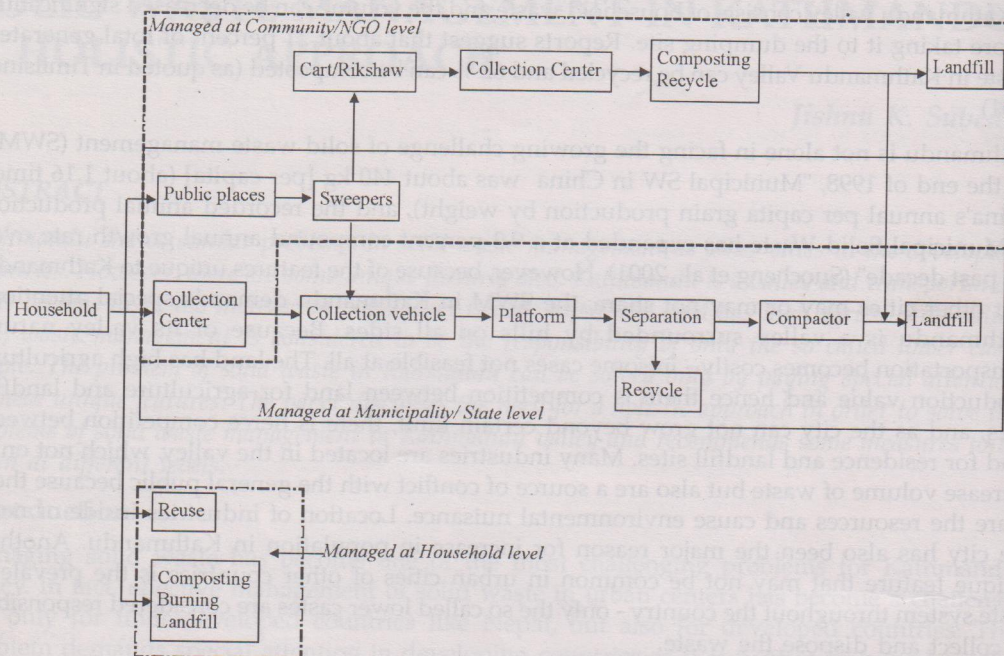


Fig. 1. Different waste management system in practice in Kathmandu valley.

Second category is the waste management system of municipality. Out of about 1000 m³/day waste generated in Kathmandu city, about 70 percent of the waste is collected by the municipality (Manandhar, 2002). Containers are placed at different nodes of the city where waste generated in the households are supposed to be dumped. Because of inadequacy of the containers, their location point and lack of awareness in the users, waste being dumped in public places is common in Kathmandu. The municipality assigns sweepers to clean the streets and public places, collect the dumped garbage and load it onto the collection vehicles. The collected garbage is taken to an unloading platform where separation of the recyclable waste takes place. However, currently only an insignificant amount of waste is recycled. Rest of the waste is compacted and taken to the dumping site for landfill.

Third category is that managed by NGOs/communities: One of the emerging trend in Kathmandu is the waste management with economic return - "waste is wealth" concept translated into action. With the main goal to "establish an integrated solid waste management system, which is efficient, cost effective, and environmentally sound by the year 2002 with maximum involvement of local communities as well as the private sector," (Manandhar, 2002) Kathmandu Municipality is encouraging participation of the private sector to manage the solid waste. As a pilot project, two contractors were awarded the contract to manage two different wards in the Municipality. Although the plan earlier was to include 6 wards, the contract was limited to two wards only because of pressure from sweeper unions against lending the SWM to private parties. The program turned out to be successful and Manandhar (2000) has reported that "private sector participation program launched by KMC is partially successful and heading towards the right direction but KMC must continuously build confidence among stakeholders."

Another successful and exemplary work from the private sector is that carried out by WEPCO (Women Environment Preservation Committee) - an NGO led by local women of Lalitpur with the central aim of urban solid waste management and helping people with healthy environment and related awareness training. Since its inception in 1992, WEPCO has been involved in solid waste management and conservation education program independently. Major activities carried out by WEPCO include organic composting, waste recycling, environment awareness training, and environment education program. They are now collecting rubbish from more than 700 households and recycling almost all of it. Through their extensive and innovative approach they have been able to show that involving the community can be one sustainable alternative to effectively manage solid waste of Kathmandu.

Issues in SWM

Kathmandu is a typical example of very rudimentary level of SWM in developing countries as reflected "in the unknown quantity and types of solid waste collected, the amount recovered and recycled, the inadequate selection of final disposal sites, as well as inefficient reutilization and recycling programs (Buenrostro et al. 2003)." On top of the general problems in developing countries, SWM in Kathmandu is further complicated by inter alia limited availability of landfill sites, prevalent division of caste systems with only the so called lower castes entitled to take care of garbage, and difficulty in expanding infrastructures because of the geography.

Volume of waste generated: Quantity of waste generated is one of the key issue to be confronted while talking about SWM. Because of the increase in population, and activities thereafter, because of the increasing trend of use-and-throw types of items, and because of increasing consumption culture with growing industrialization of the country, the volume of waste generated is increasing in urban centers. As the quantity is increasing, the cost of managing waste is also increasing, for waste so far is not treated as revenue generating commodity. The transportation cost is high in Kathmandu as it is surrounded by hills on all sides and exit routes from Kathmandu are limited. Because of agricultural productivity of the land, and because of limited possibility of expansion of the city beyond a certain limit, landfill sites are difficult to acquire.

Change in quality or make-up of waste generated: Along with development process, not only the quantity but also the content of the waste changes. So far hazardous wastes are being disposed in an ad-hoc basis. But because of increasing amount of medical and other hazardous wastes, there is an immediate need for proper disposal technique. Reports suggest that the major share of the medical waste is in Kathmandu: "A total of 799 tons of hazardous waste is generated from the hospitals of Nepal (ENPHO 2000, based on 0.48 kg/bed/day) and a majority of this is from the hospitals and nursing homes in Kathmandu Valley" (as cited in Pokharel, 2002). Besides medical waste, increasing use of batteries in SAFA-TEMPOS and other devices and obsolete pesticides are also major contributors to the hazardous waste.

Private sector participation/ Management at community level: To materialize the concept of "waste is wealth", participation of the private sector is indispensable. However, earlier attempts by Kathmandu Municipality did not proceed in expected ways because of pressure from sweeper union, and relatively less experience of private sector in waste management. The cost incurred in SWM by Kathmandu municipality in 2000 and 2001 was US\$ 200,000 each year, whereas the collected revenue was US\$ 72,000 each year (Manandhar, 2002). Involvement of the private sector and NGOs lessens the economic burden of the municipality and increases the quality of service to the public.

Disposal method: Notwithstanding the make-up of waste generated, most of the waste is disposed in landfill sites. This is not only costing resources of the municipality, but also is not recommended from the view point of environment and hygiene. A large part of the waste is recyclable, and is potential source for generating income. Because of increasing content of hazardous waste, proper disposal practice by incinerating the waste has to be adopted. Developed countries utilize the energy generated in incineration plant via Waste-to-Energy concept (Hong, 1999). Proper disposal method is indispensable not only from the economic and environmental view point, but also from the view point of scarcity of landfill site.

Landfill sites: Currently the majority of the waste is being dumped into either some ill-conditioned and already exhausted landfill sites, or in river sides, road sides and open spaces. Proposed landfill sites at Syuchatar and Chovar could not be used because of immense public protest. Another very potential landfill site in Okharpauwa, Nuwakot has not been used although the government has already invested money in building access roads and developing the site. As it's relatively far from Kathmandu city, about 27 Km, the municipality is reluctant to accept the site as a viable alternate. Besides, as the city is expanding towards the south and has already reached its limit towards the north, a dumping site located towards the north is not practical. Kathmandu, already facing problem with traffic congestion, can not tolerate vehicles carrying waste to bisect the city frequently. The prospect is not economical also.

Socio-cultural issues: SWM can not be effective if only the issue of dumping is addressed. Dumping is the final and less controllable option in the whole consumption-generation-processing-disposal chain of waste management. "It (SWM) is particularly an urban issue that is closely related, directly or indirectly, to a number of issues such as urban lifestyles, resource consumption patterns, jobs and income levels, and other socio-economic and cultural issues. All these issues have to be brought together on a common platform in order to ensure a long-term solution to urban waste" (Srinivas, 1998). The issues of reducing volume of waste, creating awareness among the people about safe and sound waste disposal method and making it the responsibility of all consumers rather than one particular caste or creed are important factors in successful implementation of any SWM system. Moreover, the people involved in managing garbage require to have proper training and facilities required for hygienic practice.

Recommended actions

Taxing the waste: In Kathmandu, although it's the responsibility of the municipality to provide free service of SWM to the public, people are ready to pay a modest sum for an effective solution to the problem. Even now, people in different localities are combined in a group and have arranged some contractors on their own to collect the garbage and take it to the collection center. The contractors usually carry the waste in Rikshaw/Carts and charge some amount on monthly basis from each household. Another example of the effectiveness making users responsible for managing waste is asking them to return the items in certain places after use. Costumers of potential polluting items that can be re-used or recycled are charged a certain amount which will be refunded after returning the item - one example is bottles of cold-drinks and beer. This practice can be extended to batteries, tires and many other electrical appliances.

Unit pricing of waste generated can be another effective solution in reducing volume of the garbage. In this system, the users are required to throw their garbage only in trash-bags to be sold by municipality/authority which will essentially force the users to reduce volume. This is a more practical approach also, as those who generate large volumes are liable to pay higher charges. Although the trash bags can be replaced by stickers, the former are more effective as volume is also controlled. As recyclable and reusable material is generally not charged in this

system of taxing the waste, it can be effective in separation of the waste at the source itself. From the experience of adopting such a system in Korea, Hong (1998) has concluded that: "The performance of a volume-based per-bag unit pricing system adopted in Korea seemed to be successful. Total amount of solid waste generated was reduced by 17.8 percent and the household recycling was increased by 26.8 percent".

Education/training program and increasing social awareness: The peoples should be encouraged and educated to separate the recyclable waste at the source, reuse the items and reduce the volume - i.e. implementation of the concept of 3-Rs: reduce, reuse and recycle. It has been observed in many other issues in Kathmandu, e.g. no-smoking movement and traffic safety programs, that spreading the message through the children is a very effective tool. Efforts to educate children and make them aware about waste management is an essential and indispensable step towards attaining the goal.

The prevalent concept in Kathmandu - in Nepal for that matter - that dealing with garbage is the responsibility of certain castes needs to be changed. Although the caste system is legally prohibited, the norm is that only the so called lower castes are responsible to take care of the garbage. Statutory measures coupled with strong political will are required to overcome this traditional burden for effective SWM.

Involvement of all stakeholders: SWM can be effective and efficient by making clear the role and responsibility of all the stakeholders and involving them directly in the process. The role of different levels of decision making in SWM is explained in Fig. 2. At the household level, the issues to be addressed are reducing volume of the waste, separating the waste at the source and properly disposing it in collection centers. At the community level, the issues to be addressed are to increase awareness among users through different medium, monitor

behavior of individual household, encourage them and involve them in various other activities to keep the community clean. Although the role of the municipality is to assign and monitor the private sector, its role is manifold. It should act in coordination with communities to increase awareness, encourage interaction among communities, monitor the performance of private parties and other individuals or organizations involved in SWM, and take the waste to the disposal center. The government should help the municipality in education training program, give more authority to the municipality through bills and regulations and support them. Only through collective effort can the SW be managed effectively and efficiently.

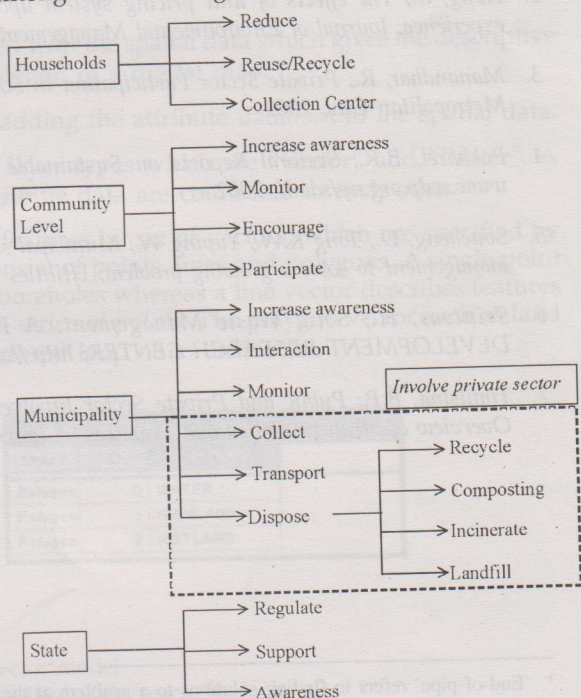


Fig. 2. Role of different levels of decision making in SWM

Conclusions

Kathmandu is not alone in facing the task of managing the ever-growing amount of solid waste. But building upon the experience of the past and learning from the experiences of other cities, it is time to adopt a holistic approach to counter this difficult task. The range of actions expands from increasing social awareness to adopting more scientific and efficient approach in disposing the solid waste. There is immediate need to improve the working conditions of those involved physically in collecting, transporting and managing the waste, and there is need to train, educate and facilitate them to protect them from the damaging effects of waste on their health.

As space available for landfill site is limited and transporting cost is high, the volume of waste finally taken to the site has to be reduced. Reduction of volume starts from the source and proper arrangement from taxing the waste to educating users is necessary. Recyclable materials need to be separated, hazardous waste should be incinerated and organic materials should be composted to make fertilizers. Dumping at landfill site is the final destination of the garbage and more attention has been given to dumping. Necessary measures to improve management of solid waste in previous stages of generation of waste have been sidelined in the past. This end-of-pipe approach¹ is detrimental to 'Waste is Wealth' concept. Furthermore, involving the private sector and encouraging community and NGOs can be effective in lessening the financial burden to the municipality.

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¹ 'End-of-pipe' refers to finding solutions to a problem at the final stage of its cycle of causes and effects. In the case of urban waste, it means focusing on waste disposal rather than waste recycling or waste minimization: Srinivas (1998)

"APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM (GIS) IN IDENTIFYING URBAN SPRAWL: A CASE STUDY OF HONG KONG"

*Amit Bhattarai**

1.1 Geographical Information System (GIS)

"A GIS is best defined as a system which uses a spatial data base to provide answers to queries of a geographic nature.....The generic GIS that can be viewed as a number of specialized spatial routines laid over a standard relational data base management system." (Goodchild quoted in Huxhold 1991:28)

In simpler terms Geographic Information System (GIS) is a computer based information system where a map with the spatial data and information of a particular area is stored in data base platform. These data when needed, can be retrieved, analyzed, queried and displayed for land related information. The data structure can be divided into 2 different types, which are:

a. Spatial Data

The spatial data is generally in the form of maps which shows the topography, geology, soil types, slopes, forest, land use etc. and which is stored as individual layers in a digital format. These data are stored according to their exact geographic position on earth with X and Y co-ordinates. The data base can be used to produce map for plotting or displaying purpose when needed.

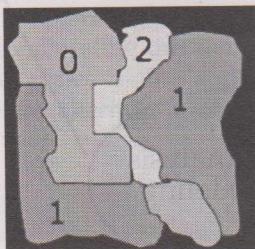
b. Attribute Data

These are the non-graphics data associated with the spatial data which gives the descriptive information about the line, point or polygon of a digital map.

A data layer of an area can be created adding the attribute database to the spatial data.

GIS fundamentally works on two different layer types which are "Vector" and "Raster". A layer type refers to how the spatial and attribute data are connected to each other.

The Vector data structure organizes spatial features by set of vectors, which are specified by starting point co-ordinates. These vectors consist of points, lines and polygons. A single point describes location of point features such as boreholes whereas a line vector describes features such as roads and canals which is stored as a series of points. The polygon vector such as land parcel and river catchments is stored as a closed loop of co-ordinates.



Attributes of Theme2.shp		
Shape	ID	LANDUSE
Polygon	0	WATER
Polygon	1	HIGHLAND
Polygon	2	WETLAND

A Vector model

(Source: <http://libraries.mit.edu/gis/teach/basics.html>)

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The Raster data structure organizes the spatial feature in regular space of grid of pixels. A row and column matrix of X and Y space with attribute information associated with each pixel is used for this type of data structure. Because of this, the data structure requires large storage space compared to vector layer type.

0	0	0	2	1	1
1	0	2	1	1	1
1	0	0	2	1	1
1	1	1	1	0	1

0: WATER
1: HIGHLAND
2: WETLAND

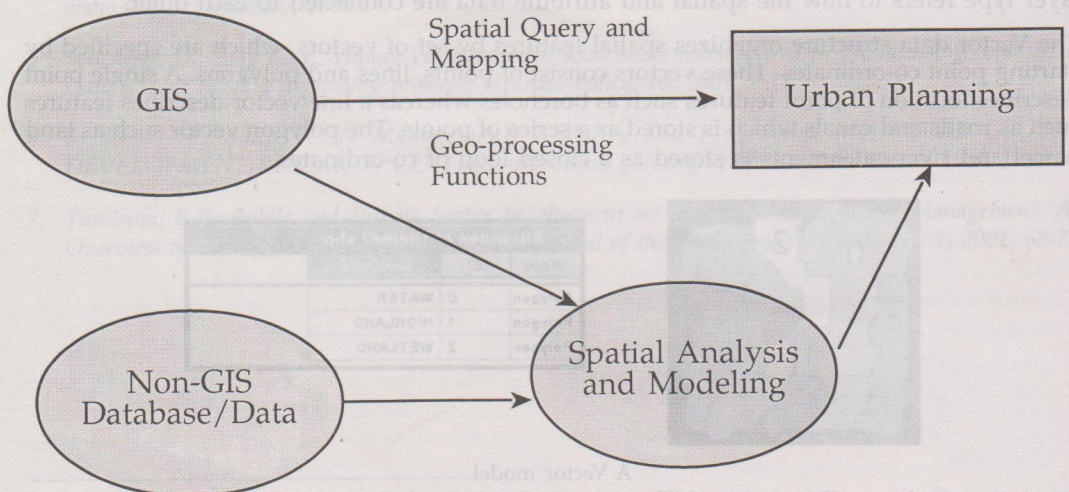
A Raster model

(Source: <http://libraries.mit.edu/gis/teach/basics.html>)

1.2 GIS and Urban Planning

Because of the advancement of technology and cheaper price, computer based systems are becoming more widely accepted and used. Compared to when it was developed in late 1960s, GIS undoubtedly has more wide spread use today than earlier, which includes the developing countries too. It has become an important tool for the Urban Planners for spatial analysis and modeling (Yeh 1999).

According to Yeh (1999), GIS can be used to make effective planning decisions when combined with different Spatial Analysis & Modeling and data from other non-GIS database using the geo-processing functions such as map overlay and buffering. GIS can also be used for retrieving maps and different queries useful for the planners for specific use such as; land suitability analysis or location of facilities and activities.



GIS and Urban Planning
(Source: Yeh 1999)

As planning basically involves general administration, development control and plan making, Yeh has furthermore elaborated the use of GIS into these three specific functions.

	General Administration	Development Control	Plan Making
Use of GIS in Urban Planning	● Office Automation-mapping, data retrieval ● Public Enquiry-internet map, 3-D map	● Office Automation ● Land Suitability Analysis ● 3-D Analysis	● Office Automation ● Land Suitability Analysis ● Location of Facilities and Activities ● Plan Generation ● Plan Evaluation

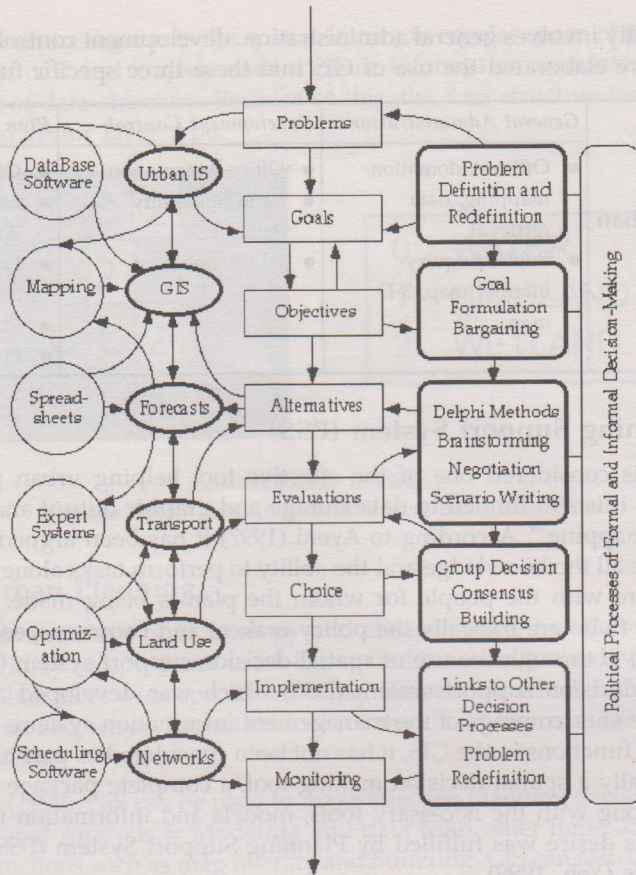
2.0 GIS as Planning Support System (PSS)

Even though GIS is considered one of the effective tool helping urban planners to make planning decisions, it is still limited to data storage and graphic output and still lot needs to be done "beyond mapping". According to Ayeni (1997) it has been argued that planners do not necessarily have all the knowledge and the ability to perform tasks alone and consequently should interact more with the people for whom the plan is being made. The only way to integrate the actors (who are basically the policy makers and common people for whom the plan is being made) is through the use of spatial decision support system (SDSS). This SDSS is an extension of decision support system (DSS) which was developed around 1960s and 1970s to counter the shortcomings of the management information systems (MIS). Because of the lack of Analysis functions in the GIS, it has not been considered as part of SDSS (Yeh 1999). As SDSS was basically a spatial decision making tool, a complete package of decision based support systems along with the necessary tools, models and information used was desired. And solution to this desire was fulfilled by Planning Support System (PSS) which was first advocated by Harris (Yeh, 1999).

"PSS comprise a whole suite of related information technologies (e.g. GIS, spreadsheets, models and databases) that have different planning applications in different stages of planning" (Batty and Klosterman quoted in Yeh 1999: 883).

The PSS not only consist of GIS but lots of other components like expert systems, different information systems, transport and land-use modeling, forecasting for a planner to make an effective planning decision at the end of the whole exercise. One of the examples of an effective PSS is the software named "What if?"¹ developed by Richard E. Klosterman. According to the website of "What if?" it is an interactive GIS-based system which supports all aspects of the land use planning process: conducting a land suitability analysis, projecting future land use demand, allocating this demand to suitable locations, and evaluating the likely impacts of alternative policy choices and assumptions. This software allows the planner or the user to create different alternate scenarios and to evaluate each scenario before taking or making decisions.

¹ Website of "What if ?" <http://www.what-if-pss.com/info.html> visited on 20 Dec. 2003



The Planning Process as a Sequence of Computable Methods Enabling Decision Support
Source: Batty and Densham, 1996

3.0 GIS Application: Identification of Urban Sprawl

3.1 Introduction

Due to the increase in population and economic activities, rapid urban development and change in land use has been witnessed in both developed and developing countries. Hong Kong is not untouched by this phenomenon and due to this urbanization the natural habitat and environment has been severely affected.

Planners and academicians have attempted to define the urban sprawl but there is a lack of consensus about the definitions. Urban Sprawl may be defined as the scattering of new development on isolated tracts, separated from other areas by vacant land (Ottensmann quoted in Lata, et al., 2001)

In simpler words, according to Ramchandra and Jagadish (2003), as population increases in an area or a city, the boundary of the city expands to accommodate the growth; this expression is considered as sprawl. Sprawl is generally associated with unplanned development along the fringe of urban areas but sprawl can exist even with planned development as new built up form is destroying the existing landscape and environment of that particular area but

sprawl may be of different type and kind. The sprawl according to form can be divided into three types² :

- Low density sprawl

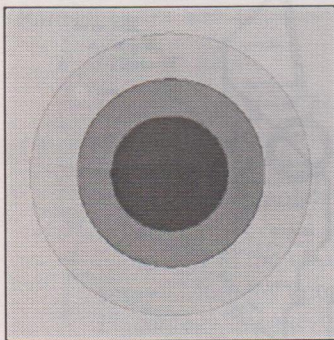
These sprawls are basically developed along the fringe of urban areas and are supported by piecemeal extension of infrastructures.

- Ribbon Sprawl

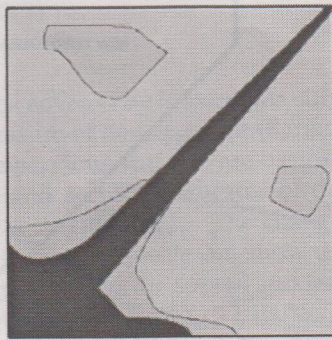
These types of development sprawls are along the transport corridors like railways or highways which are outward from the city core.

- Leap frog development

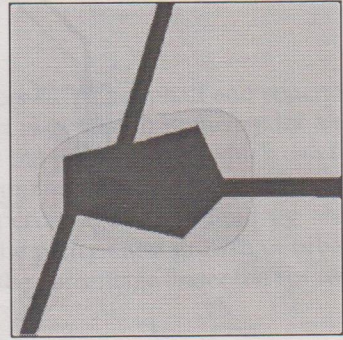
These are discontinuous type of development with patches of developed urban lands widely separated from each other and from the boundary of urban area.



Low density Sprawl



Ribbon Sprawl



Leap Frog development

3.2 Urban Sprawl and Hong Kong

Not all forms of urban sprawl are applicable to Hong Kong but ribbon form of sprawl is clearly visible with the development of new towns along the track of East Rail. After the modernization of KCR in early 1980s, the commuting time between the Lo Wu Station and Hung Hom Station has significantly decreased resulting in the rapid urbanization of new towns like Tai Po and Sha-Tin. Because of the urbanization of these new towns natural environment, habitat and ecology of surrounding areas are being disturbed and destroyed which might be regarded as a result of these sprawls.

As new railway lines, mainly the West Rail, Ma-O-Shan link and Lok Ma Chau Spur line are opening up in the near future, by using GIS and remote sensing, the growth pattern of new towns along these new lines can be predicted by analyzing the growth pattern along the east rail before and after the modernization.

3.3 Study Objectives

The main objectives of this study are:

- Identify the patterns of urban sprawl of the study area
- Analyze the sprawl pattern of the study area through remote sensing and GIS techniques
- Analyze the cause of urban sprawl
- Use the result for future prediction

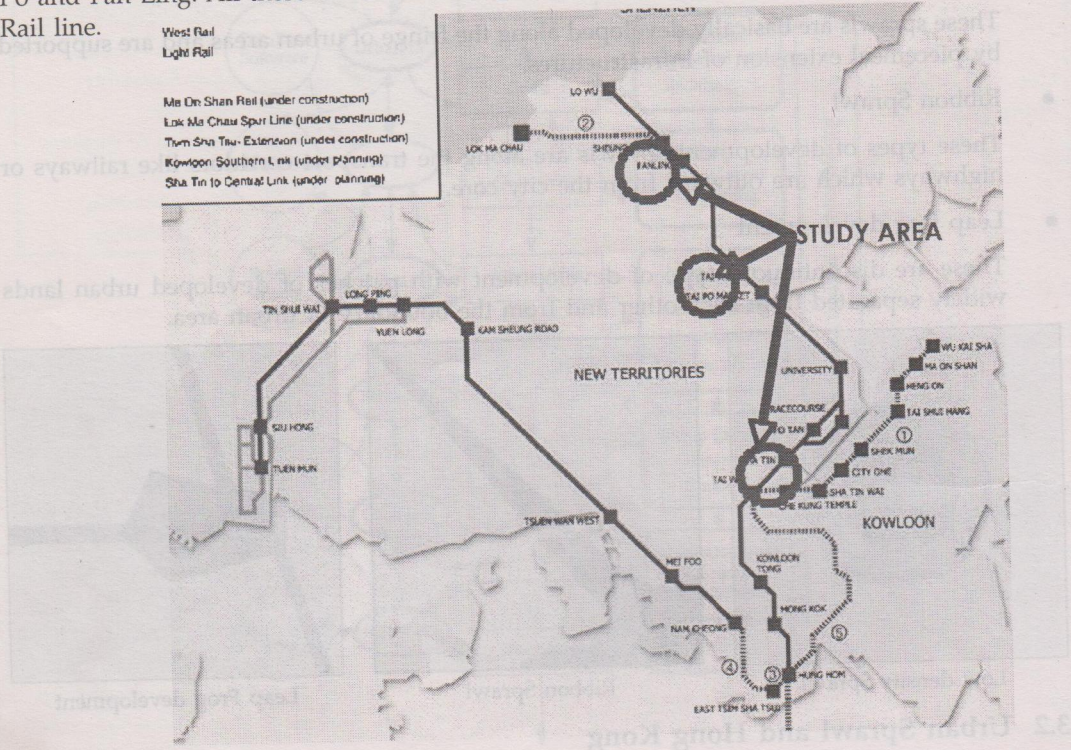
² Website, < <http://chesapeake.towson.edu/landscape/urbansprawl/forms.asp>>

3.4 Study Area

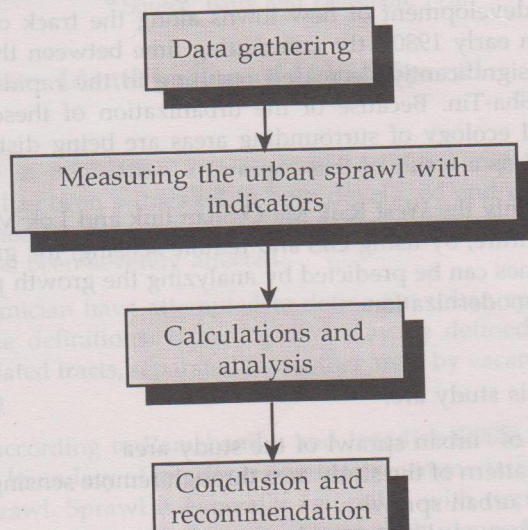
To identify the pattern of urban sprawl three sites have been selected which are Sha-Tin, Tai-Po and Fan-Ling. All these three sites are new town development and along the KCRC East Rail line.

West Rail
Light Rail

Ma On Shan Rail (under construction)
Lok Ma Chau Spur Line (under construction)
Tuen Sha Tiew Extension (under construction)
Kowloon Southern Link (under planning)
Sha Tin to Central Link (under planning)



3.5 Methodology



Methodology Chart

The methodology for this research has been divided into four parts. In the first part of the research all the necessary data will be gathered. These data will include the survey sheets and maps of the study areas, satellite images and demographics data through census abstracts.

The survey sheet should include the following features:

- Drainage, Water bodies, rivers;
- Contours and Slopes;
- Built-up area;
- Roads and rail network;
- Boundary

In the second stage the urban sprawl of these three study areas will be quantified using the three set of indicators which are Built-up area, Population and Shannon's Entropy (Sudhira, Ramachandra and Jagadish, 2003)

- Built-up area:

The percentage of an area covered by impervious surfaces such as asphalt and concrete is a straight forward measure of development (Barnes et al quoted in Ramchandra and Jagadish 2003). These impervious surfaces are basically the built up area which can be considered as potential and accurate indicator of urban sprawl as built up area and urban sprawl have a direct relationship. The change percentage in the built up area compared to the two different time scale can show us the pattern and growth of urban sprawl. More the percentage higher the sprawl and less the percentage lesser the sprawl. Percentage change in built-up area: $(Y-X/X)*100\%$

(where Y is current built up area and X is past built up area)

- Population

For this study the change in the population of the area of 1971 census to n population of the same area of 2001 census will be used as an indicator to quantify the urban sprawl as population is directly related to built-up area.

- Shannon's Entropy

Shannon's Entropy indicator to quantify urban sprawl was developed by Yeh and Li (2001). The Shannon's Entropy, H_n is given by,

$$H_n = \sum P_i \log_e (P_i)$$

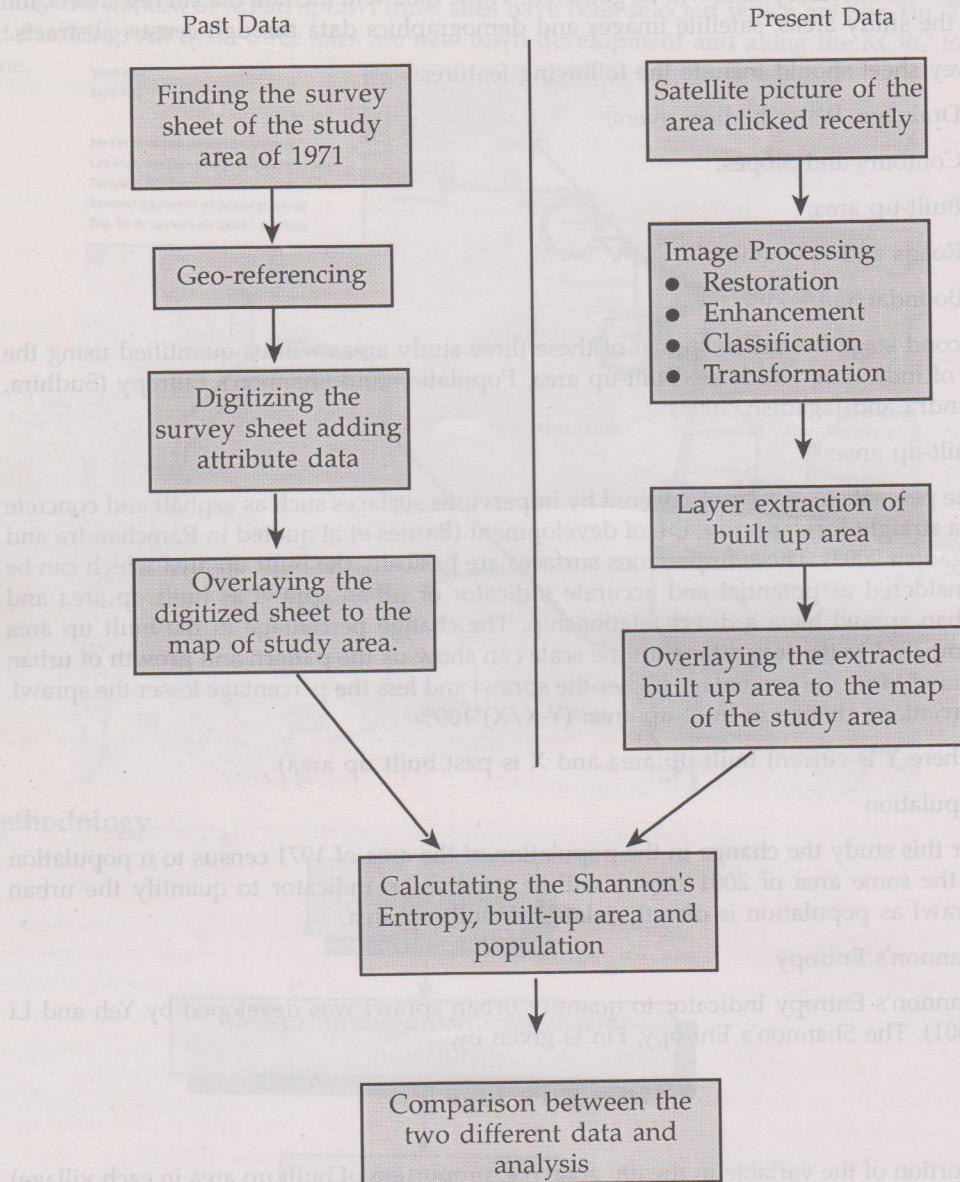
Where;

P_i = proportion of the variable in the i th zone (i.e. proportion of built up area in each village)

n = Total number of zones (i.e. number of villages in the region)

The value of entropy ranges from 0 to $\log n$. Value of 0 indicates that the distribution is very compact, while values closer to $\log n$ reveal that the distribution is much dispersed. Higher values of entropy indicate the occurrence of sprawl.

3.6 Flow chart



Flow Chart for the analysis of urban sprawl

3.7 Calculations and Analysis

To calculate the urban sprawl a comparison of the indicators of sprawl i.e. population, built-up area and Shannon's entropy between the year 1971 and 2001 is carried out. According to the preliminary investigation, our site areas of Sha-Tin, Tai Po and Fan-Ling had been rapidly developed after the modernization of KCRC which took place in early 1980s. So to identify the urban sprawl caused by the railway development census data of 1971 and survey sheet of around the same period is used. The calculation can be divided into two parts:

In the first part of the study, the survey sheet of 1971 is found out of all the study areas. These sheets are geo-referenced in the real world co-ordinate system. The maps are then digitized with the help of digitizer and each separate vector layer is created for land use, built-up area, roads and boundaries. An attribute table is added to the map with population, area and other relevant information. The current map of each of the different study area is overlaid into the digitized layers of the area to define the scope of the area. With the help of GIS, a buffer zone of 500M is created around the centre of each station. From this whole process, population, built up area and Shannon's Entropy value is calculated separately.

In the second part of the study a satellite picture of Sha-Tin, Tai Po and Fan Ling of 2001 is collected through LANDSAT. The initial image processing is carried out by band extraction and geo-correction. This image is later generated into False Color Correction (FCC). After this process a built up layer is extracted from the image and overlaid into map of study area where a buffer zone of 500M around all the three stations is marked. At the end of the process population, built-up area and Shannon's Entropy is calculated for comparison with the earlier values. The result from the above finding is entered into the following table



(Source: http://rst.gsfc.nasa.gov/Sect8/Sect8_7.html)

Year	Population		Built Up Area		% change in the built up area	Shannon's Entropy	
	1971	2001	1971	2001		1971	2001
Sha Tin	Xs1	Xs2	Ys1	Ys2	α	Ssa	Bsb
Tai Po	Xt1	Xt2	Yt1	Yt2	β	S _{ta}	S _{tb}
Fan Ling	Xf1	Xf2	Yf1	Yf2	χ	S _{fa}	S _{fb}

From the above value entered into the table, a distinct urban growth pattern can be found out for each new town with the help of three key indicators; population, percentage change in the built-up area and Shannon' Entropy. A model of urban growth pattern can be developed from the above findings to find out scale and pattern of future urban sprawl.

3.8 Conclusion

The recent publication of Hong Kong 2030 stage III booklet projects the population of Hong Kong growing from 6.8 million in 2002 to 9.2 million in 2030 which means that additional housing for 2.4 million people is required by 2030. The report also projects the GDP growth rate of 2.5% by 2030 which would bring more economic activities. Seeing these scenarios the urban sprawl in Hong Kong is inevitable. Even though the development is planned, the loss of open space, natural habitat and ecology will be affected by these new developments and thus can be regarded as sprawl. Seeing the current trend of development around the railway stations, the results from this study can be used to project or predict the future urbanization pattern of small towns like Yuen Long and Tin Shui Wai after the commencement of West Rail or Ma On Shan after the construction of Ma On Shan extension.

As GIS is becoming more widely accepted, planners now-a-days can make more accurate and effective planning decisions with these kinds of research and studies. Since, the urbanization and urban sprawl is a continuous process due to ever growing population and economy, the planner's job is to minimize the effect of these sprawls to the environment by making effective planning decisions facilitated by tools like GIS, remote sensing and planning support systems.

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Online Resources:

1. <http://www.gisdevelopment.net>
2. <http://wgbis.ces.iisc.ernet.in/energy/>
3. <http://www.what-if-pss.com/info.html>
4. <http://www.ccrs.nrcan.gc.ca>

HOW NOT TO DESIGN A NEIGHBOURHOOD

- Reviewing Different Residential Precincts of Kathmandu -

Bijaya K. Shrestha, Ph.D.*

Abstract

Both the government implemented residential settlements and private sector initiated housing projects in different parts of Kathmandu have failed to address the socio-cultural and psychological needs of the inhabitants and their linkage to the built environment including the building of community thereby converting the planned areas into 'placeless' and their inhabitants into 'homeless,' whereas the haphazard transformation of the traditional neighbourhood of the historic core area has resulted in reduction of socialisation opportunity, degradation of 'sense of place' and destruction of the legible urban setting. Residents of these neighbourhoods are little aware of these issues but are more concerned on the quality of physical infrastructure and services of daily needed items. As these problems cannot be solved through the existing inadequate and ineffective legal and institutional frameworks, formulation of residential planning and building design guidelines through urban design approach and their strict implementation as well as enhancement of socio-cultural events including social networking are recommended for future healthy residential neighbourhood development.

Key Words: Neighbourhood, Community, Culture, Socialisation, Sense of place, Legible urban environment, etc

Introduction and Overview

Neighbourhood - mainly comprised of housing as a single greatest urban land use - is the most singular important planning component of districts or cities. It guides the pattern (of fabric) of urban growth, provides places of socialisation and recreation, enhances economic sustainability and above all represents the socio-cultural identity of the communities. Moreover, it not only expresses the vernacular architecture but also affects the daily activities of inhabitants and is directly related to their quality of life. Hence, residential neighbourhood is considered as a major theoretical dimension in post-modern urban design. However, its multiple roles have been greatly ignored in the urban growth process of the Kathmandu Valley. Transformation of the traditional neighbourhood communities of the historic core area and formation of new residential settlements both planned and unplanned in the city peripheral areas are yet to be reviewed. Against this background, this paper aims to focus on the critical analysis of residential neighbourhood development in a threefold manner. First, it studies numerous theories of 'neighbourhood' from different aspects and then develops an analytical framework, which provides a basis for quantitative and qualitative comparison of the existing different residential precincts. Second, it identifies numerous weaknesses in their planning and development processes. Finally, it draws conclusions and proposes some key planning guidelines for future healthy residential developments.

Theories of Residential Neighbourhoods

From history, residential areas - grid layouts of Greek and Roman cities, organic towns of the Middle Ages, and radial and circular plans of European cities in the Renaissance period - are

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considered as valuable units in human settlements, (Colquhoun and Fauset, 1991). Though the pre-nineteenth century housing had compact urban form with community spaces (in the form of squares and plazas) and dwelling units acting as 'figure-ground' for each other, industrial revolution, on one hand, accelerated the construction of mass housing (with insufficient floor space and facilities, inadequate sanitary provision and poor light and ventilation with little or no communal space) to accommodate the huge flow of workers in the city centre and, on the other hand, caused the formation of 'urban sprawl' of low rise and low density new housing, mainly to cater to the affluent citizens in the suburban areas. In response to the poor living conditions of workers in mass housing, Ebenezer Howard (1850-1928) in his 'Garden City Concept,' in England and William E. Drummond's 'Neighbourhood Unit Concept'¹ in the United States had proposed a new housing environment with a new urban society that not only influenced the modern town planning but also sustained the socio-economy to a certain extent. Many new British towns and American cities in the subsequent years adopted this planning philosophy. Before World War II, 'builders' used to simply buy lots on already established city streets and constructed few houses at a time linking new settlement to the social and commercial fabric of the city. After the War, 'developers'² replacing the 'builders' started planning large tracts of 'virgin' land and constructing huge number of similar housing units - aiming at maximising rate of return and fulfilling the needs of local codes and municipal regulations rather than addressing community's diverse needs - over a brief period of time (Ford, 1999). The destruction of traditional street patterns and squares to accommodate the demands of the car, the rigid zoning of land uses segregating functional activities of working, living and entertainment, the demise of the notion of the 'public realm' in favour of the privatisation of development - all have combined to create neighbourhoods that are anti-social and anti-human.

With the emergence of urban design as a new profession in the 1960s with emphasis on cultural continuity, mixed land use, and priority on public realm design (Shrestha, 2003), the spirit, values and virtues of neighbourhood were rediscovered in the planning and development of cities. Incorporation of citizen's participation and introduction of advocacy planning during the 1980's has helped the formation of 'New Urbanism,'³ which advocates a balanced mix of human activities (dwelling, shopping, working, schooling, worshipping, recreating, etc.) within a walking distance (five minutes walk or radius of a quarter of mile) in neighbourhood planning with formation of public spaces and fine network of interconnecting streets (Duany and Zyberk, 1994). Others have sought for achievement of diverse, lively, safer and convenient public realm through mixed land use, high density and compact urban fabric including provisions of local employment and public transport system to gain local identity, community value and sense of place (Lennard and Lennard, 1995; Roseland, 1998). An effective neighbourhood comprising a clear, complete, and consistent political and administrative entity, therefore, should provide basic necessities of life and society - a small grocery shop, a local park and playground, a meeting place either in the elementary school or in a recreation centre that also houses community activities, a fire station and a post office including the police precinct. A good residential form should have vitality, accessibility, sense of community, fit and control (Lynch, 1981), which can be developed through the principles of community

¹ The term 'neighbourhood unit' was coined by William E. Drummond and later expanded by Clarence Perry in 1929.

² By the 1970's and 1980's, private developers were engaged even in constructing shopping and office complexes, community facilities such as parks and promenades, and so on thus playing ever-increasing role in designing of public places.

³ New Urbanism is described in the charter developed by the Congress for the New Urbanism, a group formed in 1992 comprising architects, urban designers, planners and landscape architects from across North America.

design - function (convenient and comfort to all the users), order (orientation to environment), identity (image, quality of environment) and appeal (pleasure to users) (Sherwin, 1992).

The socio-cultural perspective of theory of neighbourhood focuses on community building. As neighbourhood provides a place for inhabitants to raise children, to satisfy the socialising needs of people and to develop intimate friendships, it fosters community and civic pride (Von, 1978), enhances the 'sense of security and belonging' and finally connects the individual to the society through its support and facilities (Bartuska, 1994). Geographical proximity (locality), social completeness or cohesion (social criterion) (Davis, 1949) including sharing of the basic condition of a common life (community sentiment) are essential to form a community (MacIver and Page, 1955), which is influenced by size, density and heterogeneity (Wirth, 1964). Therefore, a community requires (a) a set of households, relatively concentrated in a delimited geographical area; (b) a substantial degree of integrated social interaction by the residents; and (iii) a sense of common membership, of belonging together. Finally, neighbourhood community can be perceived by characteristics and views of the inhabitants (micro-level approach) and formal organisation and institution that looks the community within a greater context (macro-level approach) (Downs, 1981).

Relationship in the community occurs in three different ways: *Gemeinschaft* by blood (kinship relation in the house), *Gemeinschaft* of locality (common habit of the community), and *Gemeinschaft* of mind (mental society in the form of friendships independent of kinship and neighbourhood) (Toennies, 1955). Other upgraded this relationship with family and close friends as 'primary' while casual associations with shopkeepers, bureaucrats, and so on as 'secondary' with 'quasi-primary' relationship in between (Gans, 1962). Individual experience, cultural background, social setting together with the physical condition determines the relationships between human experience and behaviour and built form (Proshansky, 1970) and shapes the residential life. The notion of 'culture' as – a system of shared meanings (Greetz, 1973; Hall, 1966) and public standardised values of a community (Douglas, 1966) – creates values and norms embedded into people behaviour, which shape the spaces and use them in everyday life (Coolen and Ozaki, 2004). The relationship between community activities and their built environment is better understood by 'lower level (manifest function) meaning'⁴ and non-fixed feature of the dwellings (Rapport, 1988, 1990).

After reviewing numerous literatures on different aspects of residential neighbourhood, a theoretical framework is developed which comprises of three components as (a) Physical Aspect: Size and shape of the neighbourhood, Street network and open space hierarchy, Architectural meaning, (b) Social Aspect: Social network and institution, and Opportunity for socialisation, and (c) Cultural Aspect: Sense of place (and community) and Community resources.

Selection of Residential Neighbourhoods for Case Study

Kathmandu Metropolitan City (KMC) comprises of diverse residential form. Their differences lie not only in site context, physical layout, population density and land use activities but also in neighbourhood community. Four different residential precincts of Kathmandu, planned and

⁴ Rapport (1988) distinguishes the meaning of the built environment as (a) High-level meaning (related to cosmologies, world view, philosophical system, etc.), (b) Middle level (identity, status, wealth, power, etc.) and (c) Lower level (everyday activities such as movement, accessibility, etc.), whereas Hall (1966) defines the features of dwellings as (a) fixed-features (structural elements such as walls, ceilings, etc.), (b) semi-fixed feature (contents of the physical setting such as sofa, curtain, plants, etc.), and (c) non-fixed feature (related to behaviour such as clothing, languages and other activities that communicate occupiers' social identity and status).

developed under different models in different circumstances, namely (i) Kuleswore Housing Project (KHP), Gongabu Land-pooling Project (GLP), Sunrise Home (SRH)⁵, and Manju Shree Tole (MST) were selected for comparative study (Table 1).

Table 1. Comparison of contextual parameters of neighbourhoods

Particular	KHP	GLP	SRH	MST
<i>Location</i>	Kuleswore - KMC, Ward No. 14 (Urban area)	Gongabu -KMC, Ward No 29 (Peripheral area)	Balkumari - Patan Ward No. 9 (Peripheral area)	Manju Shree Tole - KMC, Ward No. 21 (Core area)
<i>Project type</i>	Site and services	Land pooling	Private housing	Ancient settlement
<i>Planning area</i>	522 Ropani (26.5 ha.)	280 Ropani (14.2 ha)	45 Ropani (2.3 ha)	100 Ropani (5.1 ha) ⁶
<i>Development period</i>	1977 - 1987	1988 -1996	2002 - now	Lichchhavi time -now
<i>Development agency</i>	Government	Government	Private Sector	
Source: (DHUD, no date; DUDBC, 2003; KMC, 2001; OCD CPL, no date)				

Located on the urban area of KMC's ward no. 14, Kuleswore Housing Project was developed by the government in the late 1970s as a 'Site and Services Project' to house government service holders. Gongabu Land Pooling Site, situated on the northern peripheral area of KMC's ward no. 29 was also planned by the government though 'Land Pooling' technique in the late 1980s with objectives to control haphazard urban growth and to ensure basic services and social amenities in the developed area. Initiated by the private sector after the enactment of the 'Joint Apartment Ownership Act -2054' Sunrise Home is an ongoing housing project (targeted for upper middle and high economic status group) developed on a 45 Ropani of land located on the peripheral area of ward no. 9 of Lalitpur Sub-metropolitan City. Manju Shree Tole lies in the core area of KMC's ward no. 21 is an ancient Licchavi period residential settlement which still houses many historical monuments and cultural heritage.

Comparative Study of Selected Residential Neighbourhoods

Physical Aspect of Neighbourhoods

Size, scale and integration with the surrounding areas

A population range of 500 to 10,000 inhabitants or minimum of 150 dwelling units considered as enough to sustain local retail outlets or an elementary school, can be taken as appropriate size and scale for an effective neighbourhood (Gans, 1962). Small urban blocks (no longer than 90 -135 M) increases physical and visual permeability (Bentley et. al., 1985), provides more street frontages and junctions, allows development of diverse land use and building types and hence are suitable for residential developments. Clear boundaries are necessary by which neighbourhoods establish and sustain identity. Integration in terms of street layout, urban blocks, population density and land use with the surrounding existing areas results in smooth transportation, orientation and views, ultimately reducing the contradiction between the old and new developments.

⁵ This housing estate located at Balkumari, Patan is easily accessible from many activity centres of Kathmandu.

⁶ For the purpose of comparative study, the area taken of Manju Shree Tole is one third of the whole ward area (approximately), as the demarcation of clear boundary is difficult in the core area.

On the basis of population and dwelling unit, SRH comprising 164 units with total population⁷ of 820 can be considered as the smallest neighbourhood while KHP and GLP are respectively five times and two and half times larger settlements, and MST is the largest community (Table 2). However, in terms of developed land area, MST is about two times bigger than SRH whereas KHP and GLP have respectively eleven and half times and more than six times larger lands. Again, both SRH and MST are respectively two and half times and roughly eight and half times denser than that of GLP (and KHP with population density of 159 ppha), which is the least populated neighbourhood with gross population density of 143 ppha (persons per hector of land). In spite of similar average block size of twenty five Ropani (five times bigger than block of SRH), MST comprises roughly one-ninth the houses of the MST, whereas urban blocks of GLP (two times bigger than that of SRH) and SRH posses similar number of houses or units. Both KHP and MST consist of diverse urban blocks with arbitrary orientation (Figure 1). Interestingly, urban blocks of GLP and SRH are generally slim and elongated but are oriented in opposite direction.

Table 2. Comparative study of physical aspect of different neighbourhoods

Particular	KHP	GLP	SRH	MST
Total developed area	522 Rop. (26.5 ha) (11.5 X SRH)	280 Rop. (14.2 ha) (6.2 X SRH)	45 Rop. (2.3 ha) (1X SRH)	100 Rop. (5.1 ha) (2.2 X SRH)
Total no. of urban blocks	21 ⁸	26	9	4
Average urban block size	24.85 Rop. (5 X SRH)	10.77 Rop. (2.1 X SRH)	5 Rop. (1X SRH)	25 Rop. (5X SRH)
Total no. of plots	842 (5.13 X SRH)	406 (2.5 X SRH)	164 units (1X SRH)	1376 houses (8.4 X SRH)
Plot nos. per urban block	40	16	18	344
Population density (person per hac.)	159 ppha (1.1 X GLP)	143 ppha (1 X GLP)	356 ppha (2.5 X GLP)	1185 ppha (8.3 X GLP)
Urban block orientation	Arbitrary (all direction))	East-West (mainly)	North-South (mainly)	All direction (due to courtyard)

Both KHP and GLP being planned have the urban blocks, plot shape including street network of geometrical shape juxtaposing forcefully with the surrounding haphazardly (and spontaneously) growth residential and commercial areas whereas SRH bounded by masonry wall acts as a 'black box' in the locality. Though none of these planned neighbourhoods has a clear centre and edges (except the boundary wall of SRH), nonetheless, mismatch of streets and urban blocks at the interfaces with the surrounding areas provides a clue of boundary of the neighbourhood. Moreover, major transportation routes such as Ring Road and Thamel – Shamakhushi Marg frames the location of GLP, whereas Kalimati-Kuleswore Road and Kalimati – Kalanki Road orients the locality of KHP. Only MST being part of an old settlement harmoniously coexists with the neighbouring areas with Manju Shree Temple and activity nodes of 'Lagan' and 'Jaishi Dewal' acting as centre and edges of the community.

⁷ An average size of 5 members per household is assumed.

⁸ Few blocks subdivided by pedestrian paths are not considered.

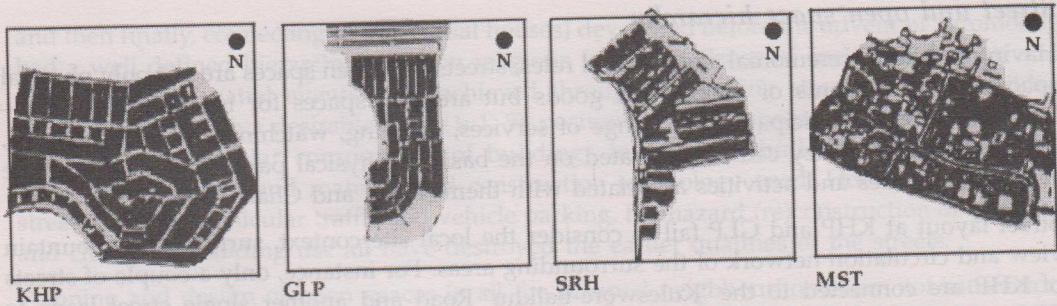


Fig. 1. Comparative study of urban fabrics of different neighbourhoods

A resident survey with a 29-item questionnaire⁹ focussing on different aspects of neighbourhoods (such as physical setting, sense of place, community amenity and physical infrastructure, etc.) is conducted at different locations in each study area¹⁰ to relate residents' responses with the theory of good neighbourhood design.

Regarding the size of neighbourhood, only majority of the respondents (62%) of KHP feel that they have big neighbourhood, while the similar percentage of residents of the remaining three cases think that their neighbourhoods are of appropriate size and scale (Figure 2). Surprisingly, none of the residents living at KHP and GLP and only insignificant percentage of inhabitants of the remaining neighbourhoods are in the opinion that their neighbourhoods are of small size. Similarly, except the case for SRH, only insignificant percentage of inhabitants of the remaining neighbourhoods mention that they have small urban blocks (Figure 2). Again, though a significant number of residents of KHP (100%) and SRH (85.8%) think of 'well integration' of their residential precincts with the surrounding areas, about half of the respondents of MST (40.1%) and GLP (52.7%) find that their community are 'not integrated' with the neighbouring areas (Figure 3).

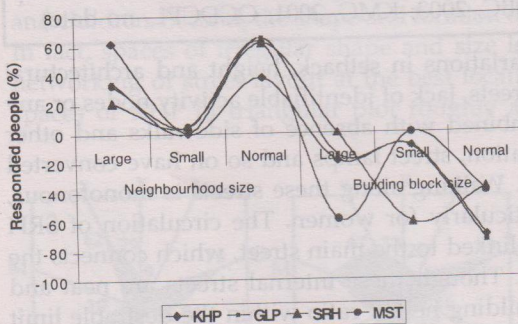


Fig. 2. Scale of neighbourhoods

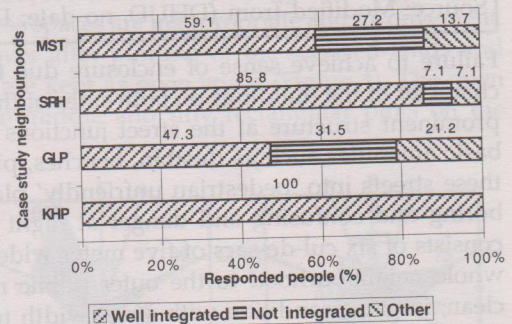


Fig. 3. Integration of neighbourhood with the surrounding areas

⁹ Though the number of interviewees (25 households in each study area with responses from ninety to hundred percent) seems to be low for such study, nonetheless, considering time and resource constrain, low public awareness and education and the prevailing situation where people are reluctant to share the information due to safety reason, the responded figure is sufficient to understand their feelings towards the neighbourhood. As all the interviewees did not fill up (or answer) all the questions, the percentage is calculated based on the total responded numbers.

¹⁰ The tedious works of interviewing and collecting data in all the neighbourhoods carried out by Ms. Reena D. Bajracharya are highly acknowledged.

Street and open space hierarchy

Having symbolic, ceremonial and political roles, streets and open spaces are not only physical spaces for movements of people and goods but are also spaces for multiple activities – socialisation and participation, exchange of services, enjoying, watching and so on (Jacobs, 1993; Gehl, 1987). They can be evaluated on the basis of physical parameter, micro-climate criteria, amenities and activities associated with them (Heng and Chan, 2000).

Street layout at KHP and GLP fail to consider the local site context, surrounding mountain view and circulation network of the surrounding areas. For instance, only a couple of streets of KHP are connected to the 'Kuleswore-Balkhu' Road and another single street leads to 'Kalimati-Kalanki' Road, where public transportation is available. Similarly, GLP is connected to the neighbouring areas through a single street leading to the Ring Road on the northern part and a couple of streets linking to 'Thamel-Shamakhushi' Road. Street networks in these developments consist of inadequate circulation area (14.3% at KHP and 17.5% at GLP-Table 3), lack hierarchy and well defined connection, have poor visual and physical permeability due to long elongated urban blocks without cross access and have poor street junction design, difficult to turn emergency vehicles.

Table 3. Comparative study of open spaces and streets of the case study neighbourhoods

Particular	KHP	GLP	SRH	MST
Area allocated for open space (%)	4.4	5.2	4	10 -12
Area occupied by street (%)	14.3	17.5	15.0	3 -5
Street width (M) ¹¹	2-3-4-5-7.5	4-6-8	5	4 – 6
No. of street junctions	40	51	7	8
Street width to building height ratio (approx.)	1: 1.3	1: 1.7	1: 2	1: 1.5
Source: Modified from (DHUD, no date; DUDBC, 2003; KMC, 2001; OCD CPL, no date)				

Failure to achieve sense of enclosure due to variations in setback, height and architectural character of the buildings on both sides of the streets, lack of identifiable activity nodes or any prominent structure at the street junctions combined with absence of sidewalks and other basic amenities such as dustbin, benches, plantation, street lamps and so on have converted these streets into 'pedestrian unfriendly' places. Walking along these streets is monotonous, boring and confusing and danger at night particularly for women. The circulation of SRH consists of six cul-de-sacs of five meter wide all linked to the main street, which connects the whole neighbourhood to the outer public road. Though these internal streets are neat and clean, in good condition with street width to building height ratio within the desirable limit ($H/W = 1:2$), they are hardly used for multiple functions other than for vehicle parking and connecting to each unit. The task of creating well connected streets with activity nodes at the junctions and landmark structure at the end is less relevant in private housing scheme. The street network of MST (narrow, non-axial street leading to courtyards and narrow alleyways,

¹¹ Caminos and Goethert (1978) recommended 20% as desirable and 30% as maximum proportion for circulation whereas the World Bank Project often use as 20-25% figure for circulation area in housing development projects. To allow emergency vehicle the main street should be 8, 6 and 4 M with corresponding right of way of 10, 7 and 5 M.

and then finally, connecting to individual houses) developed before the advent of automobiles had a well defined hierarchy based on religious functions. Sense of enclosure, human scale and sequential spatial events were achieved through controlling street width to building height ration within a desirable limit (1: 1.5), positioning a focal point at the end of the view corridor, and singular composition of buildings in terms of building height and bulk, architectural design and material and construction technology used. However, invasion of street spaces by vehicular traffic and vehicle parking, haphazard (re)construction of buildings and change of building use all have destroyed the earlier qualities of the streets.

Planning and design of open spaces in all the planned neighbourhoods are not satisfactory, whereas the multifunctional usages of community spaces of MST are under great threat due to numerous reasons. First, the amount of open spaces allocated in the planned areas is far less to fulfil the various needs of different age groups (Table 3). Urban open spaces of four and half percent of the total developed land at KHP and of four percent at SRH which are just one

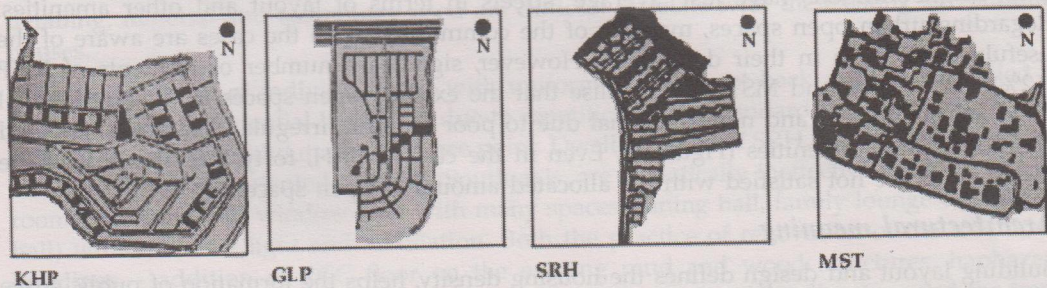


Fig. 4. Comparison of street layout and open space hierarchy in case study neighbourhoods

third of the existing open space of MST, cannot accommodate variety of functions - passive quiet area for adult, safe and privacy area for women, recreation and playing field for youngster and children. Second, the shape and location of these spaces are inappropriate and inconvenient. In fact, spaces of irregular shape and size left over after plotting of the serviced lands and networking of street layout at the best location, are kept as open space (Figure 4). The open spaces of KHP (a triangular plot roughly at the middle and tiny rectangular plots on the

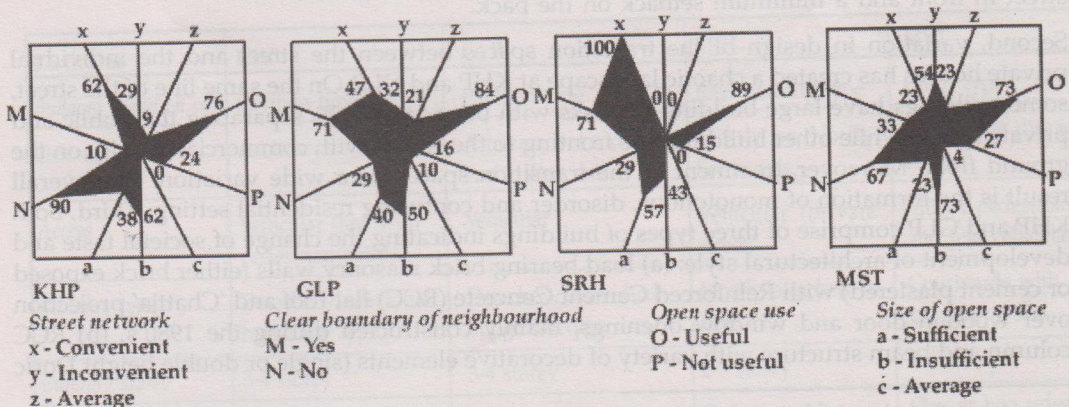


Fig. 5. Comparative study of residents' responses on street network and open space hierarchy

peripheral areas) and GLP (five different small rectangular plots along the hi-tension line) are of little use not only because of their fragmented nature but also due to vehicular streets encircling them. Similarly, the isolated corner plot below the hi-tension line, surrounded by parking plots allowed for Children Park can never be a meaningful place. It is only at MST where open space and houses complement each other. Open spaces in the form of Vihara, courtyards and street squares are part and parcel of residents' daily lives. However, changes in building typology and penetration of vehicular traffic has not only damaged the open space network but has also reduced the multiple usages of them.

Though fair condition of street with vehicular access to each house, low vehicular traffic and hence low air and noise pollution have made the streets 'convenient' for majority of residents of KHP (62%) and SRH (100%), significant number of people of GLP (32%) and MST (54%) find the streets of their neighbourhoods 'inconvenient' due to conflict of vehicular and pedestrian traffics, noise and air pollution and practice of disposing households and construction wastes on the streets. About one fifth of the residents of all the neighbourhoods think that their neighbourhoods have just 'average' streets in terms of layout and other amenities. Regarding urban open spaces, majority of the community in all the cases are aware of the usefulness of them in their daily lives. However, significant number of residents of KHP (62%), GLP (50%), and MST (73%) realise that the existing open spaces in their residential areas are insufficient and non-functional due to poor location, irregular size and shape and absence of basic amenities (Figure 5). Even in the case of SRH, forty three percent of the respondents are not satisfied with the allocated amount of open space.

Architectural meaning

Building layout and design defines the housing density, helps the formation of public space and expresses the socio-economic status of its inhabitants. Moreover, building typology should response to climatic condition and societal development. As building typology differs in each neighbourhood, its consequences are numerous. First, the layout of building on the plot with setback from all the sides – pavilion type – at KHP and GLP has resulted in lower density with formation of fragmented open spaces between the two buildings, which is hardly useful other than for lighting and ventilating building units, whereas the layout of building around the courtyard – court type¹² – at MST has allowed the achievement of higher density and formation of community space enclosed by building units (Figure 6). A moderate level of density has achieved at SRH due to the layout of building in row on the plot – row housing type – with street in front and a minimum setback on the back.

Second, variation in design of the transition spaces between the street and the individual private houses has created a chaotic landscape at KHP and GLP. On the same line of the street, some buildings have large building setbacks with boundary walls separating the public and private spaces while other buildings are fronting to the streets with commercial activity on the ground floor. Moreover, treatment of the transition space has a wide variation. The overall result is the formation of monotonous, disorder and confusing residential setting. Third, both KHP and GLP comprise of three types of buildings indicating the change of societal taste and development of architectural style: (a) load bearing brick masonry walls (either brick exposed or cement plastered) with Reinforced Cement Concrete (RCC) flat roof and 'Chattja' projection over wooden door and window openings, mainly constructed during the 1980's, (b) RCC column and beam structure with variety of decorative elements (single or double height Doric

¹² A hypothetical model demonstrated by Le Slie Martin and Lionel March revealed that the 'courtyard type' layout of building can achieve five times more accommodation than the 'pavilion type' and one and two third more accommodation than 'row housing type' layout.

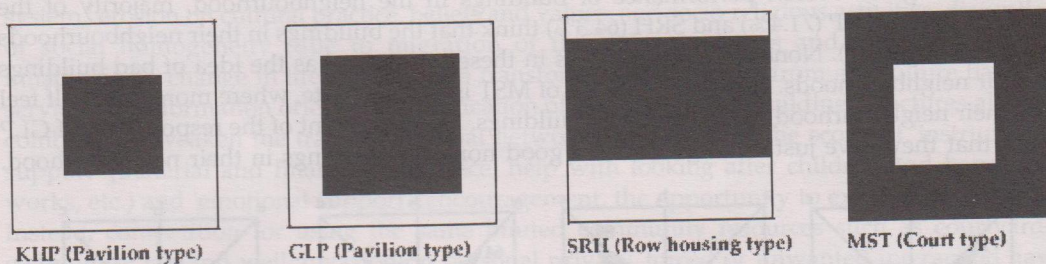


Fig. 6. Comparative study of typology of building layout on the plot in case study neighbourhoods

columns, pediments, sloppy coverage, and so on) on the facades (so called post modern architecture), mainly developed from the mid 1990's, and (c) RCC column beam structure with layer of traditional bricks, carved wooden windows, sloppy roofs and on, constructed from the last few years. Newly constructed buildings with different architectural design and detailing, material and technology used are difficult to relate with the existing surrounding houses.

Interesting design of individual unit with uniform building set back at SRH has failed to produce legible residential landscape due to repetition of the standard unit in a row on both sides of the streets without any reference point. Dwelling units of SRH, mostly of two to three storey high though oriented to North South axis, are climatically ineffective as almost all the rooms have one side window only with many spaces (dining hall, family lounge or staircase hall) without direct light and ventilation. Both the practice of renovation of the traditional buildings – addition of RCC floor on the existing mud and wood structures, haphazard creation of door and window openings on the load bearing facade walls, etc. – and the trend of new house construction – different plinth and floor height with soft ground floor, floor projection from second floor onwards, excessive non-structural decorative elements on the facade, large windows with formation of short columns and so on – have proved to be disaster for MST, as such activities have destroyed the earlier architectural composition, sense of enclosure of courtyards and streets, reduced light and ventilation on neighbouring houses and public spaces, and above all have significantly increased the earthquake vulnerability and rise of fire hazard (Shrestha, 2002).

Table 4. Comparative study of characteristics of housing

Particular	KHP	GLP	SRH	MST
<i>Building layout on plot</i>	Pavilion type	Pavilion type	Row housing type	Court type
<i>Orientation</i>	Arbitrary	Arbitrary but mostly on East - West axis	Mostly on North-South axis	To all sides due to court
<i>Access</i>	Vehicular (few with pedestrian path)	Vehicular	Vehicular (private street)	Mostly pedestrian and few vehicular
<i>Building type</i>	Detached/individual bungalow type	Detached/individual bungalow type	Mostly attached in row	Courtyards with common walls
<i>Building storey</i>	3-4 storey	3-4 storey	2-3 storey	4-6 storey
<i>Light & ventilation</i>	Mainly four sides but two for fronting street	Mainly four sides but two for fronting street	Only two sides	One or two sides only

While asking for overall performance of buildings in the neighbourhood, majority of the respondents of KHP (71.4%) and SRH (64.3%) think that the buildings in their neighbourhoods are good (Figure 7). None of the inhabitants in these two cases has the idea of bad buildings in their neighbourhoods. However, the case of MST is just opposite, where more than half feel that their neighbourhood comprise of bad buildings. Eighty percent of the respondents of GLP think that they have just 'average' (neither good nor bad) buildings in their neighbourhood.

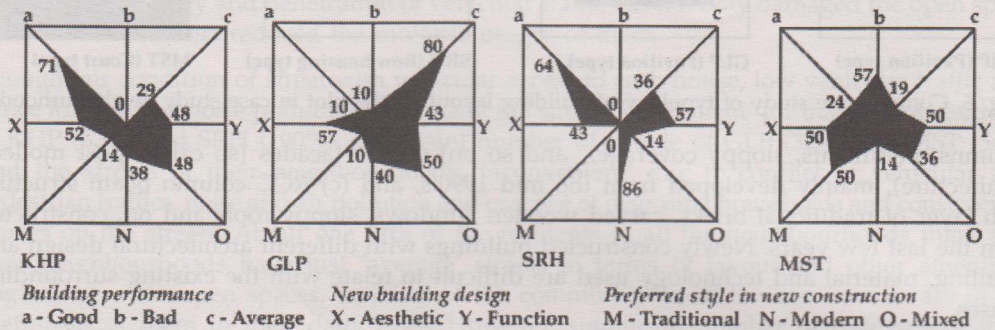


Fig. 7. Comparative study of residents' responses on building performance, preferred style and important aspect in new construction

Similarly, almost half of the residents of MST prefer to have either conservation of traditional buildings or new construction in traditional style, whereas none of the respondents of SRH want to have new buildings in traditional style in their community. In case of KHP and GLP, only small percentage of residents prefers to have traditional building in their neighbourhoods. Nearly half of the inhabitants of these communities would like to have buildings of mixed type rather than domination of either traditional or modern structures. Eighty five percent of people of SRH want to live in modern buildings with only fifteen percent preferring to have mixed typed buildings units (in style) in their neighbourhood. The interest for modern style buildings in the neighbourhood is low, just fourteen percent at MST. Finally, in all the cases, residents are roughly divided into half-half, regarding whether priority should be on aesthetic part or functional aspect in new construction.

Social Aspect of Neighbourhoods

Social aspect of neighbourhood includes an individual's social network, the support they receive from others and opportunity for interaction with other members of the community thereby not only increasing the mutual assistance and the concern for overall community but also enhancing the feeling of ownership and sense of belonging to the community. Social network refers to the various persons with whom an individual maintains significant relationship including relatives, friends, fellow workers and neighbours whereas social support is the quality of the relationship - the advice, encouragement and assistance of all kinds that the social network provides to individual.

Social network, social support and community institutions

Social system of living community of the same profession or clan in the same locality of the neighbourhood in the historic core of Kathmandu strengthened the social network and work efficiency, whereas cultural practice through tradition of rituals and celebration of numerous festivals helped sustain community bond and social support. Financial and institutional sustainability of community and their socio-cultural activities were achieved through 'guthi system.' However, such a unique situation does not exist at present at MST. Demise of 'guthi

system,' erosion on cultural practice, beliefs and values, and socio-religious activities, disruption of social homogeneity (due to migration of the old neighbours and incoming of new inhabitants)¹³, change in life style (due to transformation of society from agriculture based to service and information oriented), densification of population and building structures all have combined to weaken the traditional social network and to reduce the scope of 'instrumental support' (material and financial assistance, help with looking after children and household works, etc.) and 'emotional support' (encouragement, the opportunity to express feeling, etc.). Instead, competition for using the same limited community resources such as courtyards, community tap and well, invasion on personal privacy, forced or unwanted interaction have helped the conversion of earlier neighbourhood ties into a situation with cognitive and social strain. Uncooperative attitude of neighbours - quarrelling with other members of the community even for a minor issues, littering the pathways and courtyards, disturbing the neighbours' privacy by different means - all are common scene of old neighbourhood like MST. As the remaining three neighbourhoods were developed on the virgin land in later periods, local Community Based Organisations (CBO) including Ward Office can play a crucial role in building social network and community support. However, numerous such institutions (Kuleswore Club, Kuleswore Housing Family Welfare Organisation, Self-help Community Committee, etc. at KHP and Housing Area Improvement Committee at GLP) are neither able to take the roles of traditional institutions nor capable to bring social support and community network due to poor financial and managerial capabilities, low community participation and little support from parental or governmental organisations. There exists a community committee at SRH, which is concerned on the issue of building maintenance and infrastructure services rather than building social network.

Nearly three fourth in the case of GLP and half of the respondents of the remaining neighbourhoods take part 'occasionally' on the programs organised by the local ward and social institution (Table 5). About one third of the community of KHP and SRH frequently visit the ward office mainly for their person works. In all the cases, most of such activities are related to either sports, cleaning of the local area or celebration of New Year, Deepawali festival, and so on.

Table 5. Frequency of public participation in activities carried out by community and ward office

Frequency of participation by community				
	Frequently (%)	Generally (%)	Occasionally (%)	Remarks
KHP	38.9	11.1	50	Related to sport activity
GLP	10.5	15.7	73.8	Related to cleaning local street
SRH	33.3	16.7	50	Related to infrastructure and building maintenance
MST	18.2	31.8	50	Related to cleaning courts/ pedestrian alleys and sports

Opportunity for socialisation

Community facility, recreation centre and social amenities such as school, health centre, day care facility and so on act as platform for socialisation among the residents. Street and open space if designed well can dramatically increase the level of socialisation by combining daily

¹³ Many new comers of different casts such as Brahmin, Chetri, Gurung, etc. living in the neighbourhood are either engaged in business works or on temporal rental basis.

'necessary activities' (going to school or to work, shopping, waiting for a bus or a person, etc.), 'optional activities' (taking a walk to get a breath of fresh air, standing around enjoying life, or sitting and sunbathing), and 'social activities' (children at play, greetings and conversations, passive contacts) (Gehl, 1987). Finally, significant religious places like Temple, Vihara, etc. including socio-cultural events facilitate interaction among different age groups. Absence of social amenities such as parks and sport centre, scene of 'incivilities' such as garbage accumulation on the streets and open spaces, dilapidated buildings, etc. have negative impacts on the health of residents (Cohen et. al. 2000).

However, minimum socialisation opportunity exists in the planned neighbourhoods due to numerous reasons. First, except for the allocation of few percentage of land for open spaces, no provisions of community facility, recreation centre, social amenities such as school, health post, etc. have been provided at KHP and GLP, allowing them to run in residential buildings on ad-hoc basis in the subsequent years. Such practice, instead of developing conducive environment for socialisation has created new set of problems of parking, seismic vulnerability, and chaotic streetscape. A single high rise structure housing local grocery shop and other activities at SRH provides little opportunity for socialisation among the residents due to its limited functions and services. Though close proximity of commercial outlets, schools, community facility including Temples and Viharas together with houses at MST brought sustained life and vitality and increased the interaction of people with others, nonetheless, gradual destruction of public buildings, rest houses, stone conduits, wells as well as encroachment of public spaces of temple complex, courtyards or street squares has reversed the trend. Day care facility, family-drop-in centre and out-of-school care facility, and so on, essential in present life style do not exist in any neighbourhood.

Second, absence of well defined semi-public and semi-private spaces in the transition from public street to private building, together with failure of individual building in producing meaningful spaces between the houses and streetfront due to arbitrary orientation of house, high boundary wall on the property line and variations in building setback has contributed to the formation of dead spaces (Figure 8). Interaction among neighbours and individual relaxation does not take place and hence the question of social mixing and assistance would be difficult. The situation is not different at SRH, where individual units are directly linked from the street without any semi-private spaces and facilities around which neighbouring relationships might develop.

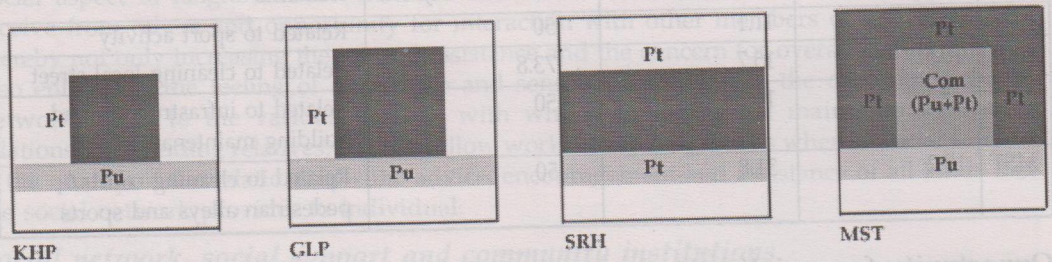


Fig. 8. Comparative study of public-private space relationship and linkage of building unit with the street

As the physical enclosure of homogenous community facilitates friendship and group formation due to increased level of interaction and privacy that the enclosure allows (Wells, 1965; Festinger, et. al, 1950), numerous residential courtyards, street squares and Viharas including narrow short streets and pedestrian lanes of MST provide a unique setting for people to come and interact (Figure 8). The courtyards and Vihars acting as 'semi-private' spaces with socio-

religious structures such as Temple, Chaitya, Community Tap, Well and 'Paati' are the stages for interacting different age groups at different period of time: worshipping place of old people in the early morning; grain drying and cloths washing venue of housewives in the afternoon; playing area of children and watching and conversation place of adults in the evening. However, commercialisation of spaces, changing of ground floors and building occupancy and destruction of traditional building stocks have reduced the social interaction and community activities by converting the multifunctional usages of public spaces into a singular function of business activity.

Third, though streets and open spaces provide a unique setting for socialisation among the residents, the existing open spaces and streets of the planned neighbourhoods offer little opportunity to attract residents and to engage for multiple activities. Located away from daily pedestrian movement network, poor physical and visual permeability, lack of sense of enclosure combined with absence of basic amenities such as benches, street lamp, plantation and vegetation, including lack of provision for protection from Sun and rain all have discouraged people of using these spaces (Photo 1). As a result, the triangular open space at KHP is being converted into Volleyball court and the water storage tank, whereas the tiny scattered spaces



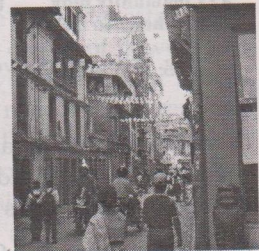
KHP



GLP



SRH



MST

Photo 1. Comparison of streetscape for socialisation in the case study neighbourhoods

are mainly used for parking vehicles or dumping construction and household waste. The open space of GLP also has similar faith.

Semi private spaces such as shared streets, the alleyways at the sides of houses or frontyards space around the house or within the home are perceived by women as 'their' or their children's legitimate and valued space, where they chat to their neighbours, keep an eye on children and observe the movement of the neighbours (Segovia, 1997). Street layout together with design of building affects the socialisation pattern of the people as well as the nature of retail activity in the community. Communal courtyards, mesh fences and windows of houses facing or adjacent to each other further offer opportunities for social interaction, stretching the boundaries between public and private spaces. However, both KHP and GLP do not possess such design attributes.

Majority of the community those were interviewed of KHP (57.1%) and MST (50%) do not find any suitable place or facility within the neighbourhood for building friendship with other members of their communities (Figure 9). The remaining respondents meet their fellow neighbours either at community buildings (community based organisations or ward office) (28.6% of KHP and 30% of MST) or on the street or open spaces (14.3% of KHP and 20% of MST). Nearly one third of the interviewees of GLP visit the community facility (swimming pool) whereas another one third interact their neighbours on the streets and open spaces; the remaining one third visit nowhere to socialise (Figure 9). It is only the case of SRH, where more than half of the respondents visit the shopping complex and interact with their neighbours.

However, such interaction in all the cases are not frequent: nearly one third of the people of KHP and MST meet their neighbours and chat, mostly on the street on the way to work (Figure 9) and only one fourth of the respondents of GLP and SRH interact on daily basis. Weekly interaction is as high as fifty percent in the case of SRH (mostly at the weekend on the grocery shop or open spaces). In rest of the cases it is generally on the monthly basis. Most

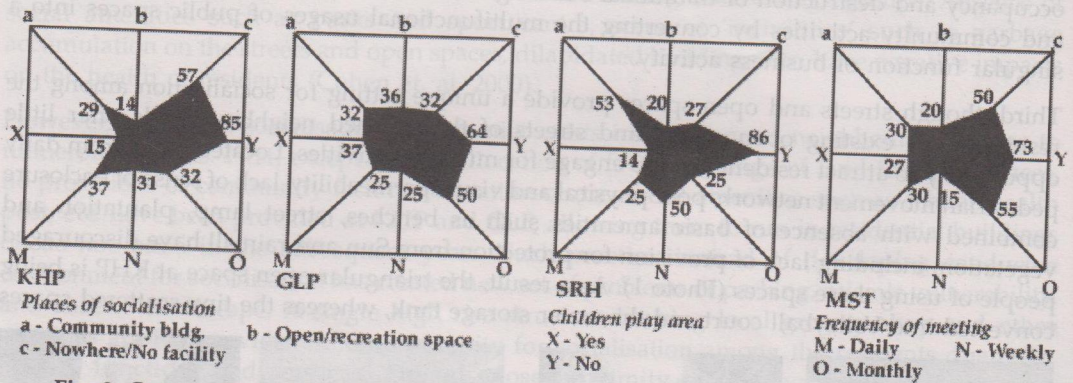


Fig. 9. Comparative study of residents' responses on places of socialisation, frequency of meeting and available of children play area

of such interactions are of casual type and are rarely converted into friendship, enough to share the feelings and seek help in needs. Finally, all the neighbourhoods lack comfortable children play area, as mentioned by majority of the interviewees in each case (Figure 9).

Cultural Aspect of Neighbourhoods

Cultural aspect of neighbourhood links the community to the physical built environment so that each member of the neighbourhood develops a strong sentiment with the urban settings, understands the other members of the community, and finally feels the sense of belonging to the neighbourhood. Culture is a system of inherited conceptions expressed in symbolic forms, by which people communicate, perpetuate, and develop their knowledge and attitudes toward life. It is intangible and can be defined in terms of shared meanings and shared conceptual maps.

Sense of place and community

Sense of place refers to the feeling of belonging to an environment and being part of a neighbourhood. Distinct features, either existing natural elements or man-made structures and shared experience in daily life are two important aspects that distinguish neighbourhood community from other community that does not have a connection to a specific locality (Hargreaves, 2004). Over time the distinctive features of the place become significant to local inhabitants who live there so that a relationship develops between people and awareness of local environment (Heidegger 1993; Norberg-Schulz 1980). Each person's relationship with environment can not be considered independently of an historical context and the accumulation of experiences of place over time (Wheeler, 1995). Combination of both material and mental results into one human experience that can be remembered, shared and communicated to become social.

None of the planned neighbourhoods acknowledges this fact in the planning and development process. The scope of utilising higher topography of KHP site and the surrounding mountains to experience nature as backdrop in daily lives is hardly realised in the layout of the street

network and orientation of urban blocks. Similarly, the reason behind the place name as 'Gongabu' (Cock Field), local Shamakhushi River and the surrounding mountain views, all have collective meanings are not addressed in the development process of GLP, whereas the local natural features such as Manohara River, mountain view, etc. are not utilised in the layout of housing and design of building units at SRH. New high rise construction have dominated Temples, Viharas and obstructed many important view corridors and landmark structures thus diluting the collective influence of such structures.

A good place is one that can be mapped mentally or has an easily remembered spatial organisation. Not only important are the landmarks but equally necessary are the well defined path leading to such objects. Thus good neighbourhoods should have not only legible environment with identity, structure and meaning but should also contain depth and meaningful temporal layers – the perception, understanding and celebration of the passage of time (Lynch, 1972). Few entry points to the neighbourhoods, long, unconnected blocks without cross passage, confusing street layout without any reference points including absence of any landmark structures are the characters of residential environment at KHP and GLP. Narrow long blocks with identical building units, connected by cul-de-sacs with surface parking of SRH do not offer legible setting. As the outsiders are not permitted to visit the housing estate, this neighbourhood is generally out of local people's mental map. Changing colour of flowers and plants on the street-side trees and celebration of local festivals and events in public spaces around the religious structures and similar activities not only stimulate residents' perceptions in daily activities but also provide the clue of passage of time. However, these neighbourhoods do not offer the feeling of such temporal layer. People living at SRH not only by houses but they should also be ready to live in the 'lifestyle' provided by the housing estate, as changes on outer facades are not allowed. Combination of above mentioned all the features have resulted in separation of people from their places. In the absence of movement, communication and socialisation, the task of achieving sense of place and building sense of community is too difficult. The social cost of development is very high but the quality of life is low in these residential areas.

The traditional neighbourhood of MST posses legible urban form (well defined hierarchy of streets and open spaces with identifiable community nodes and landmark structures), rich historic resources and cultural values that provide meaning, order and stability to human existence (Lowenthal, 1975). Numerous activities associated with the celebration of different festivals and religious rituals both in public places and the buildings provide a pleasing environment, totally different from the daily residential environment. Finally, celebration of chariot procession of 'White Machendranath Jatra' and 'Kumari' at 'Lagan' and 'Jaishi Dewal' has further enriched the cultural meaning of the place. However, negligence of social artefacts, erosion of religious beliefs and faiths, and invasion of public spaces have resulted in deterioration of spirit of place of MST.

Community resources and performance of daily lives and socio-cultural activities

Provision of resources for people in terms of services and social amenities can help to maintain a sense of place if they are positioned in a way that supports greater social integration. Moreover, community in the neighbourhood should be able to perform their daily activities as well as enjoy socio-religious functions in a safe and secure environment.

As the common land and resources – primary school, health post, recreational and cultural outlets, parks and gardens and similarly public owned elements are not provided in the planned residential areas (except allocation of minimum spaces for open spaces and in case of SRH a grocery shop), the task of taking responsibility and feeling of ownership of community

properties are never materialised. The scope of gathering and working together for the benefit of residents thereby creating opportunity for sharing experience is lost. Moreover, numerous local festivals and ritual can not be performed in these neighbourhoods due to lack of significant religious structures and places associated with them. This has reduced the beliefs and faiths on cultural activities among the residents.

The lack of mixed-land use and social amenities in the neighbourhood is realised by the community in each case. A substantial number (42%) of respondents at KHP think that 'office' activity is lacking, whereas similar percent of people at SRH feel that it is the 'educational institution' that is missing in their neighbourhood (Figure 10). However, nearly same number of residents of GLP guesses that commercial activity is lacking in the area. Surprisingly, nearly one fifth to one fourth of the respondents in each case is in the opinion that their neighbourhood lacks emergency facilities such as police station, fire fighter, etc. Of the reaming, they are concerned over lacking of commercial, institution and office usages.

Inadequate infrastructure provision and poor service deliver affects perceptions of the area in the minds of residents and ultimately develops negative attitudes and behaviour towards the neighbourhood environment and other residents.

Regarding the quality and services of physical infrastructure, significant percentage of respondents (61%) of KHP are dissatisfied with the water supply, while the remaining percentage of people are fairly divided over the issues of poor street and drainage (Figure 10). The problems related to the street and water supply are the major concern of the residents of GLP and MST, whereas the main issue is the non-availability of telephone lines in the case of SRH (Figure 10). Irregular and insufficient supply of water is the problems faced by all the residents except the case for SRH. Lack of maintenance, dumping on the street side, absence of foot-path, and so on are the reasons for dissatisfaction over street in the case of KHP and GLP, whereas lack of greenery and plantation is the main reason for not liking the streets of SRH. As the neighbourhoods of KHP and GLP comprise only few isolated retail outlets, for daily necessary items, the residents need to visit nearby places: residents of KHP often go to Kalimati, Kalanki, or Kuleswore main road, whereas inhabitants of GLP go to Thamel, Gongabu Chowk, Shamakhushi area. In a situation, where majority of the residents are still struggling

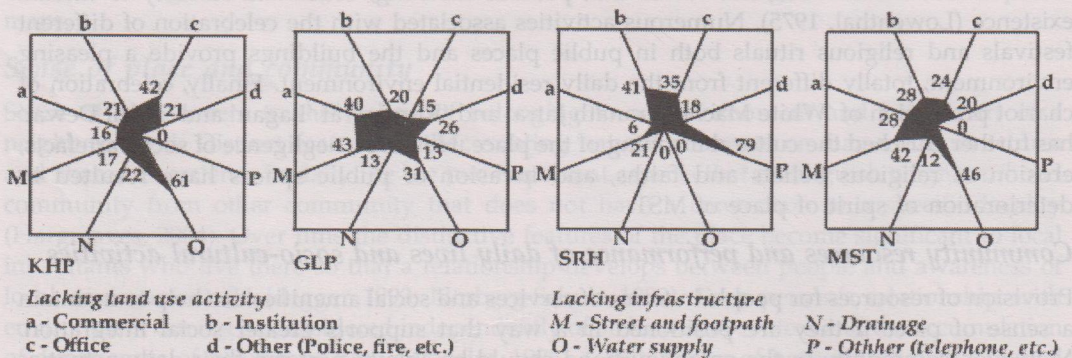


Fig. 10. Comparative study of residents' responses on lacking land use activity and quality of physical infrastructure

for basic needs of their daily lives such as inadequate water supply, poor drainage system, dilapidated street condition and so on, the question of socialising among the neighbours and sharing of experience, beliefs and values with them is of little relevant.

Security of residents and their properties is a major concern in neighbourhood which can be achieved through mixed land use, building and street layout, police and fire protection, visibility, lighting, appropriate landscape treatment including the concept of 'eyes on the streets' (Jacobs, 1961) and 'defensible spaces' (Newman, 1972). Both KHP and GLP hardly satisfy any of these criteria. Numerous features - singular land use, streets without sidewalks, identifiable nodes and disconnected from the houses through gates and walls, and lack of community amenities, all have combined to promote a strong sense of insecurity. Dark streets, empty lots and group of young men hanging out on the street corners have limited the use of street space by women, particularly at night. At SRH, the boundary wall with security guard on the gate, cul-de-sacs, large parking lots, high rise commercial box have all been aimed at limiting access for outsiders. Traditional neighbourhoods like MST provide a unique setting for safety and security. Enclosed courtyards and narrow short streets with many activities on the street level fulfil the criteria of 'public eyes on the street' and 'territoriality and surveillance' to enhance security. Moreover, it is the semiprivate spaces of the courtyards or house front, where women not only nurture the neighbourhood and familial ties but also helps shaping, defining and policing the boundaries of the neighbourhood.

Though majority of the community (except the case for GLP) feel that their neighbourhood are safe and secure, numerous social crimes do occur in the community. All the respondents of KHP who feel unsafe in the neighbourhood mention of the theft as a major social problem (Table 6). Residents of MST are more concerned on theft, vandalism and drug abuse in their community. Only residents of SRH have not so far experienced any sort of social crime in their housing estate. Both the resident's survey and the crime record of the whole ward demonstrate that GLP is the most unsafe neighbourhood. Majority of the residents (74%) mention the social problems of theft, vandalism, drug abuse or prostitution in their neighbourhood. Finally, in all the cases, more than seventy percentages of residents (68.1% at MST) generally return home before 8:00 PM (Table 6). Poor safety record coupled with little activity at night has promoted the psychological feeling of unsafe residential environment among the residents of all the neighbourhoods.

Table 6. Comparative study of community's safety feeling and crime in the neighbourhoods
Except for the residents of SRH, more than half of the respondents in each neighbourhood

	Safety in neighbourhood (%)		Type of social crime (%)			Time of returning home (%)	
	Yes	No	Theft	Vandalism	Drug/prostitution	Before 8 PM	After 8 PM
KHP	81	19	100 (36*)	0	0 (22*)	83.4	16.6
GLP	26.3	73.7	44.4 (15*)	27.7	27.9 (150*+50**)	70.5	29.5
SRH	92.8	7.2	0	0	0	75	25
MST	86.3	13.7	57.1	28.5	14.4	68.1	31.9

Note: * - no. of cases of drug abuse in the whole ward, ** - no. of prostitution cases in the whole ward.

prefer to have children play area, whereas less than one fifth of the community in each case think that they need shopping activities in their neighbourhoods (Figure 11). About one fourth of the interviewees of each neighbourhood mention the need of health club. Residents of SRH give first priority for construction of community buildings, other than the existing grocery shop. In the remaining cases, only about ten percent of respondents are in the opinion that they need to have community building first in their neighbourhoods.

Similarly, numerous features responded by the residents for the most liking and disliking features in the neighbourhoods can be categorised into four groups as (i) Neighbours, (ii) Local environment, (ii) Physical infrastructure, and (iv) Cultural facility. The most three liking

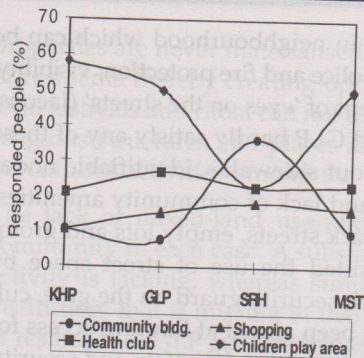


Fig. 11. Preferred community facilities

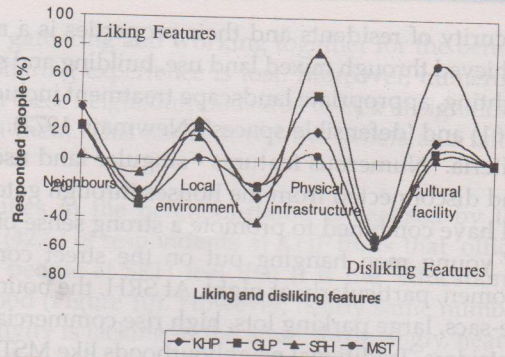


Fig. 12. Most liking and disliking features of the neighbourhood

features for the residents of KHP are their neighbours (36.3% - friendly and helpful), followed by local environment (27.3% - higher topography, green belt with open space, etc.) and physical infrastructure (21.2% - planned area, vehicular access to each plot, etc.) and cultural facility (15.2% - social gathering and celebration of festivals) (Figure 12). However, significant number of respondents cite disliking features as physical infrastructure (53.6% - poor water supply and drainage, dilapidated condition of streets, dense concrete construction, lack of health club, etc.), local environment (25% - poor use of open space, lack of children park, absence of greenery, etc.) and neighbours (21.4% - self-centred, less participatory, disturbs the others, etc.). In case of GLP, the most liking features include physical infrastructure (46.3% - facility of swimming pool, vehicular street, etc.), followed by local environment (23% - peaceful with open space, few beautiful bungalows, etc.) and neighbours (23% - cooperative, friendly, and helpful and supporting, etc.). However, majority of the residents dislike the same features: physical infrastructure (52.2% - narrow and poor condition of street, lack of greenery and meaningful open space, poor services of water and electricity, etc.) and neighbours (30.4% - selfish with attitude of quarrelling and disturbing the others, littering the street and open space, etc.). In the case of SRH, majority of the respondents (76.6%) mention 'physical infrastructure' as liking feature against the fifty percent of respondents, who dislike the same feature. However, nearly forty two percentages of inhabitants dislike the 'local environment' against the seventeen percent of disliking residents. Reasons for disliking local environment are cited as monotonous, boring and dead residential environment, without community building and insufficient greenery and park area. It is only MST, where majority of the inhabitants (68.4%) mention the cultural facilities - Manju Shree temples, Viharas, local festivals, traditional profession including traditional buildings - are the most liking features of the neighbourhood. In the remaining three cases, insignificant numbers of respondents mention the cultural facility' as liking feature of their locality. The neighbourhood of the core area (MST) is suffered from poor condition of infrastructure (57.2% - dilapidated condition of street, tall concrete buildings, leakage of drainage, etc.) and bad neighbours (26.5% - uncooperative, gang fight, negative attitude of people living on rental basis, etc.).

Weaknesses of the Case Study Neighbourhoods

Inadequate and ineffective physical planning and (re)development

In all the three planned areas, the physical layout - street layout, urban block and the plot configuration - is guided by the singular element of individual plot (either to be returned to the land owners in case of GLD or formation of plots of standard at KHP) aiming at creating maximum number of serviced plots. After completion of land plotting and demarcation of

street network, the individual land owner constructs the buildings and defines their usage based on the existing building bylaws.¹⁴ This ends the planning process. In private housing scheme of SRH, the design of built environment reflects developer's desire to maximise profit rather than to fulfil community's needs. These developments even fail to fulfil the basic criteria of neighbourhood such as provision of a primary school or a health post at walking distance. The needs of identification of distinct features of the site and its contextual study for integration with the surrounding areas, layout of well defined hierarchy of interconnected short streets and open spaces for multiple-functions, continuity of architectural meaning all to achieve legible urban setting, to create socialisation and recreation spaces, and finally to build community in the neighbourhood, are out of thinking. Such myopic vision of focusing on individual plot and building on it can never create healthy residential environment. The urban transformation process of MST – replacement of the traditional building stocks by new incompatible high rise structures, change of building occupancy and land use on ad hoc basis, dictated by market force, invasion of public spaces and streets by vehicular traffic – is neither successful to maintain the traditional townscape character nor capable to fulfil the present needs of community. As a result, the destruction of traditional unique residential environment of MST has continuously unabated.

Low opportunity for socialisation

Allocation of singular land use of housing without provision of social, community and emergency facilities, failure in physical planning resulting in formation of poor street and open space network, isolated building structure without creating meaningful spaces in streetfronts and to the surrounding houses, combined with inability of social institutions to enhance social network have reduced the opportunity for interaction and socialisation among the residents in the planned areas thereby not only minimising the mutual assistance but also deteriorating the sense of place and community. Moreover, densification of population and vehicles at MST resulting in replacing the old neighbours by new incomers and old building by new commercial activity, invasion of public spaces by business activity together with haphazard transformation of building fabrics have decreased the socialisation opportunity, eroded the earlier social system and cultural practice that has sustained the neighbourhood for many generation. In terms of social aspect, these planned developments are inferior to the spontaneously growth residential settlement.¹⁵

Poor sense of place and belonging to community

Poor physical setting in combination with low socialisation opportunity has separated the people from their places in all the planned neighbourhoods. As a result, people's interaction with their built environment as well as with other members of the community has minimised. Residents of these communities still face the problems of inadequate water supply, poor drainage system and bad streets and open spaces in their daily lives. Finally, they find it difficult to perform daily rituals and socio-cultural activities due to lack of religious related amenities. The overall result is the development of poor sense of place and low level of feeling of belonging to community.

¹⁴ There are some extra clauses for Kuleswore Housing Development area such as a front setback of 2M from the edge of the street and 2M set back from sides for the window opening and total height restriction of 40' (4 storeys).

¹⁵ In spontaneously developed areas, inhabitants bring access (alleyways or narrow vehicular street) and other amenities with the help of neighbours, communicate with them through terraces, windows and door fronts, whereas many daily needed items are easily available within walking distance without crossing the vehicular street.

Inadequate and ineffective legal and institutional frameworks

No legal vehicle is available at present to guide the planning and design of new residential development as well as to regulate the redevelopment of the old settlement. The Joint Apartment Ownership Act -2054 focuses on permission to construct housing, its sale, ownership transfer, etc. rather than regulating master layout plan, infrastructure development and individual building construction. The only legal apparatus to control such development at present is the existing building bylaws. Hence, land use allocation, open space and street layout, provision of social amenities and infrastructure development and so on are carried out on adhoc, differ from project to project.

Five tiers of government institutions responsible for land development and urban development have not only failed to prepare master layout plan with allocation of mixed land use and their area calculations but have also proved to be weak in controlling individual building construction and infrastructure provision. They are also not successful to control the destruction of traditional neighbourhood of MST. The scope of planning a new residential precinct with mixed land use, allocation of social and emergency amenities, and controlling the individual building construction and infrastructure provision including integration of disaster mitigation components into master layout planning and design of buildings to achieve a safe, secured and healthy neighbourhood has been lost.

Conclusions and Recommendations

If the developed analytical framework and the qualitative and quantitative analysis are the basis, then the studied residential precincts of Kathmandu are not the successful storey. In true sense, these planned neighbourhoods are 'placeless' and their inhabitants are 'homeless.' It is the setting of many individual private cells, where member of single family perform eating, sleeping and to some extent socialisation among their relatives and friends. These planned developments illustrate many things. First, they (except the case of MST) are the best development example of how one should not design a residential neighbourhood in future at any cost. Second, it indicates the inadequate and ineffectiveness of the existing legal apparatus and institutional capability on planning, development and management of residential areas. Third, it symbolises the lost of opportunity to build a safe and vibrant neighbourhood community that not continues the past but also fulfils today's needs. Finally, it illustrates the failure to recognise the unique characters of the old neighbourhood of the core area as well as its destruction and deterioration. Last but not the least, it also demonstrates residents' low level of awareness of their neighbourhoods.

Planning and Design Guidelines for Healthy Residential Neighbourhoods

Physical aspect

- (a) Identify the natural and historical features of the site that have collective meanings and then, incorporate them into the layout and built form design;
- (b) Develop legible master plan juxtaposing street and open space network with building design and detailing not only to get appropriate scale and size, variety of public spaces but also to achieve desirable density, diversity and lively urban settings;
- (c) Ensure the provision of social and emergency amenities in appropriate location both in terms of quality and quantity;
- (d) Design individual buildings that not only respect the traditional architectural vocabulary, but also response to the climate and immediate surrounding buildings and the streets thereby complementing to residential environment.

Social aspect

- (a) Develop community based institutions at local level that enhance the social network and social support;
- (b) Develop a clearly defined spatial hierarchy: public space – semi public space –semi private space – private space – which residents have clearly identifiable places in which they can socialise, work and relax. Also create functional and human scale spaces for different age groups of the society, which can be used at different times in a variety of ways, thus producing a livelier and safer public realm.

Cultural aspect

- (a) Design places and promote activities or events where residents can learn the customs and traditions as well as gain the unifying values and beliefs thereby strengthening community ties and mutual dependencies;
- (b) Provide community amenities and diverse facilities in appropriate location and ensure that community can not only perform conveniently and comfortably their daily activities but are also able to celebrate rituals and festivals in safe and secure environment.

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MICRO CONCRETE ROOFING TILE TECHNOLOGY

*Rabin Giri**

1.0 Background

The MCR Tile technology was developed in the early 1980's mainly by John Parry & Associates, with support and involvement from SKAT, SDC, DFID, and ITDG.

The MCR technology is labour intensive and eminently suitable for decentralized production.

Micro Concrete Roofing (MCR) tiles are a cost effective, aesthetic and durable alternative sloping roof technology. MCR Technology is a result of global research and development effort. The tiles are being marketed extensively in Latin America, East and West Africa and South East Asia. Each year, over forty million tiles are installed.

In the 1980s, this technology was first introduced in Nepal by Development and Consulting Services (DCS), Butwal (DCS is a Joint Venture of United Mission to Nepal and HMG/N).

The aim of importing this technology into Nepal was technology dissemination so that lower income groups could get the benefits of appropriate roofing materials as well as create an opportunity for self-employment. Tile production requires a certain degree of vibration for compaction. This is done on the Vibrating Machine for compacting wet mixture. The British model used electricity to create vibration. DCS took the task of remodeling it into a manual one i.e. foot-powered. The modification was done by adding peddles and a bicycle wheel which enables the rotation of an eccentrically fitted shaft. This modification lowered the investment, maintenance, and operating cost, thus lowering the cost of production of per unit MCR tile.

Low investment and short payback period on investment of MCR Tile industry encouraged small scale entrepreneurs to consider this business as an alternative to agriculture and a primary source of livelihood.

The key to the success of this technology was the development of equipment and techniques to produce the tiles on a small scale from locally available raw materials and components.

2.0 Technology Dissemination

It was essential to make the technology appropriate for Nepal, since the imported technology used electricity, the availability of which in the context of rural Nepal was not encouraging. Another problem of using electric powered Vibrating Machine (VM) was higher operating/running cost, initial investment and its specialized maintenance procedures.

In order to overcome such vivid problems, DCS concentrated on R&D of the machine, firstly, by simply converting the VM into the foot powered unit and secondly, by conducting market research for the easily available components and parts to lower the production and maintenance cost. This modified model of the VM became cheaper, could be easily assembled and maintained by the entrepreneurs.

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Only overcoming the technical problem may not solve the problems posed in technology transformation. Further it is essential to impart knowledge of the production process. This called for the skill based training programme for the production of VM and MCR tiles. It demanded short but extensive training programmes, which would impart the knowledge to the trainees or potential entrepreneurs on technical, financial and managerial skills. DCS ran a package of 15 day hands-on training to the potential entrepreneurs and skilled labour from the different parts of the country.

It is noteworthy that one time training programme does not ensure the sustainability and overcome the problems faced in the practical field. To make the technology transformation sustainable, DCS devised a mechanism of continuous feedback from entrepreneurs. The author was directly involved in the feedback process from material suppliers, entrepreneurs, operators and the users.

The continuous efforts of improvement made this technology at par with the state-of-the-art technology. The success of MCR Tile production is not solely because of its virtues but also due to the support from various INGOs and HMG/N policies to encourage self-employment. In the beginning, MCR Tile Production and Management Training programme was sponsored and subsidized by the Small and Cottage Industry Department of HMG/N.

3.0 Achievement

About 10,000 households had already got the benefit of the MCR tile, most of them in the Tarai and a few in mid-hills- particularly Okhaldhunga, Pyuthan, Argakhanchi, Syangja, Gulmi and Palpa have used MCR technology during the last 10 years. The easy production, mobility, easy availability of raw materials, simple tile laying technology, eco-friendliness is the virtue of MCR Tile compared with conventional tiles and CGI sheet. This technology generated employment for more than 1500 rural people. The MCR tile business provided alternative source of income to agro-based families. The number of entrepreneurs grew to more than 500 mostly concentrated in the western region of Nepal.

3.1 Type of buildings where MCR has been used in Nepal

MCR tiles have been found used in rural hospitals, schools, cattle sheds, country houses, farm houses, verandahs and pavilions and detached toilets. They have also been used in industrial sheds, workshops etc.

The architectural innovation in different forms of the roof is also possible with this modular unit

4.0 Characteristics

- It is durable for more than 15 years.
- Tile is less susceptible to fire hazard than thatch.
- It transmits less heat than CGI sheet so the room is cooler in summer.
- It does not leak, if correctly laid.
- It does not corrode and is resistant to weathering.

5.0 Merits

- Tiles can be locally produced
- Tiles are light.
- It is easy to carry and transport in basket, rickshaw and vehicle.
- It is easy to fix and replace
- Roof maintenance is easy

- The industry itself is light and could be made mobile for in-situ production if the raw materials are available nearby.
- It cannot be damaged by rats and insects
- It does not make noise during rains
- It can be easily dismantled and reused

6.0 Cost

- Production cost per tile ranges from NRs.7 to NRs.9, depending upon the price of raw materials in the area.
- Approximately Rs. 6000 worth of tiles are required to roof a house of 5m X6 m size.

7.0 Raw Materials

MCR is made from a mixture of cement, sand, aggregate and water.

Cement, sand, aggregate and water are the basic raw materials for MCR tile production. The quality of cement should essentially meet the standard required for normal concrete work. The sand (from river or quarry) should be clean, and the particle size required is 0.125 mm - 2 mm. The aggregate size should be up to 5 mm and the water should be clean and free from pollution to avoid any chemical reaction with the cement.

7.1 Proportion and Ingredients

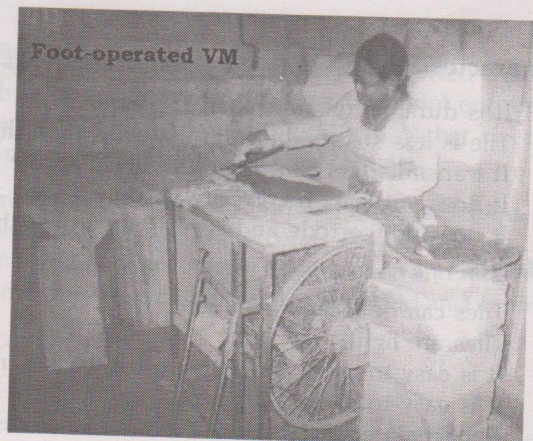
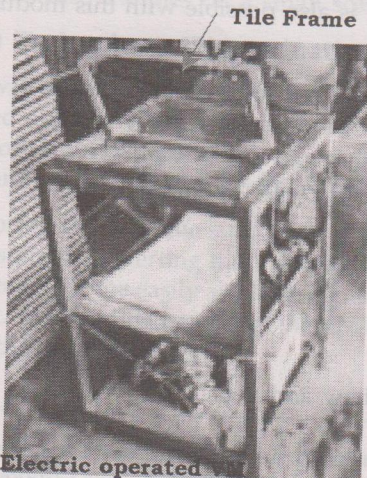
One part of cement, 1 part of clean fine sand and 1 part of 4.75 mm down clean aggregate are put together for making mortar.

Grain Size

maximum grain size	4.75mm
0.5 to 2mm	15-40%
Above 2mm	30-50%
below 0.5mm	15-45%

7.2 Mixing

Aggregates of different sizes are mixed thoroughly before adding cement. As far as possible the dry mixture is made homogenous and then water is added at 0.5 to 0.65 by weight.

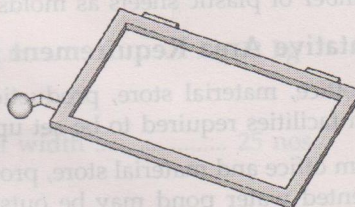
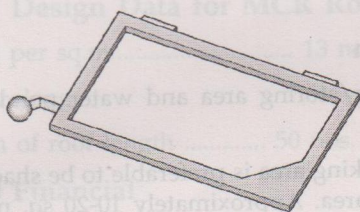


8.0 Equipment

8.1 Vibrating Machine

Locally made vibrating machine is used to produce MCR tiles. The vibrating machine allows thorough compaction of the mixture ingredients - cement, sand, aggregate and water. Most of the machine parts can be locally manufactured. Other components like bearings, aluminum plate, bicycle wheel etc are available in the local or Indian market.

8.2 Tile Frames



There are two types of frames for making tiles, one for ridge tile and another for roof tile. Frame is hinged to the vibrating plate for producing tiles which can be easily dismounted. Ridge frame is rectangular and Tile frame has chamfer at one corner.

Roof Tile Frame

Ridge Tile Frame

8.3 Accessories

Different types of molds are required to produce tiles viz. tile mold and ridge mold. Mother molds for shaping tiles are made up of same material as of MCR molded on the grandmother molds. Mother molds are molded in Grandmother molds. Ridge molds and grandmother molds are necessary for molding tiles in required shapes and sizes. Batching boxes, scoops and ridges, bottom and ordinary tile frames are the other essential accessories.

9. Manpower and Training Requirements

Up to 4 people are required to run an enterprise using one VM. The 15 days training covers both the production process and book keeping for running the business. Because of manual operation, the MCR technology creates job opportunity for men and women.

10. Tile Production Process

To make 12,000 tiles per month, 160 cement bags, 10 cu.m of sand and 5 cu.m of aggregate are required along with two skilled staff and five workers.

Production of the tiles should be done very accurately. Hair cracks developed during vibrating and mostly during molding should be instantly sealed by running trowel lightly over them.

Curing is another important process of the production. Air curing for 24 hrs under shade and underwater for 15 days is very essential. Further for 7 days tiles are stacked to dry in shade.

This process brings the strength and permeability to the tiles. So the first batch of tile is produced only on the 24th day. No additive like hardeners and waterproofing compounds are

necessary.

10.1 Production of Mother Mold from Grandmother Mold

The mix of cement, sand, aggregate and water is vibrated for about 45 seconds and then transferred on to a High Impact Polystyrene mold to give MCR tiles their profile.

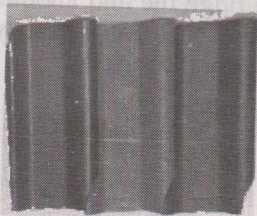
10.2 Production of MCR tile

A plastic sheet is clamped onto the vibrating table and a measured scoop of mortar mix is placed into the frame. While vibrating with the feet, the mixture is towed flat. The frame is lifted to enable removal of the wet screed. After vibration, the tile is removed carefully from the vibrator, still on its plastic sheet, and positioned on the mold which forms its shape. The same number of plastic sheets as molds will be needed.

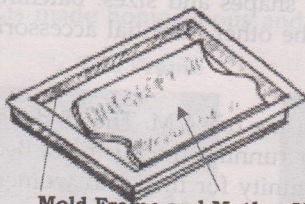
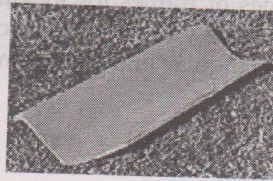
11.0 Tentative Area Requirement for Production

A small office, material store, production area, stacking/storing area and water pond are minimum facilities required to be set up.

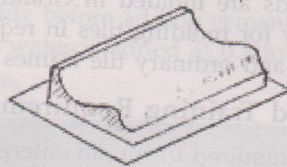
Apart from office and material store, production and stacking area is preferable to be shaded. The cemented water pond may be outside in an open area. Approximately 10-20 sq. m. is enough for this industry.



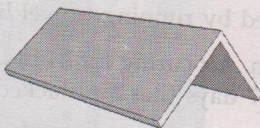
**MCR Tiles of
Different
Colours &
Shapes**



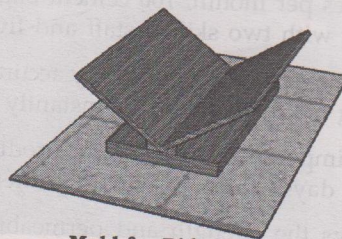
Mold Frame and Mother Mold



Grand Mother Mold



Ridge Tile



**Mold for Ridge
Tile**

12.0 Technical Data

12.1 MCR Tile

- o Clear length of tile 500 mm
- o Length after overlap 400 mm
- o Clear width of tile 240 mm
- o Width after overlap..... 200 mm
- o Thickness 8 mm
- o Corrugated depth 50 mm
- o Nominal weight 2.25 kg
- o Load bearing capacity of tile 80 kg

12.2 Design Data for MCR Roofs

Tiles per sq.m..... 13 nos. Wt. per sq.m..... 32 kg

Tiles along

10 m of roof length 50 nos. 10 m of width 25 nos.

13.0 Financial

MCR is highly profitable for micro & small scale building material producers. A capital investment of about Rs. 3 lakh yields up to 40% profit in the first year of operation.

14.0 Potential Market

Little promotion creates vast market for the MCR tile. It has higher feasibility compared to conventional thatched roofs as the raw material of latter is becoming scarce. Its technical superiority over all other conventional roofing materials makes MCR tile versatile for all season and for all parts of the Nepal. At present, rural and semi urban Terai and mid-hill regions can be taken as potential market. DCS has promoted this technology in about 50 districts of Nepal.

15.0 Environmental Impact

Production of roofing tiles requires much less energy input compared to the production of corrugated galvanized sheet or burnt tiles. Use of tiles in place of burnt clay tiles and CGI sheets will save energy and reduce negative impact on environment.

16.0 Technology Source

United Mission to Nepal, Development and Consulting Services, Butwal,

