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From the Editor

A friend had once observed that Nepalis are very reluctant readers of books. They indulge in light reading but when it comes to heavy reading, especially non-fictional, their aversion is directly proportional to the thickness of the book. All over the world, libraries are the pride of universities and local communities. In Nepal management rarely gives much importance to establishing good libraries even in educational institutions where the prestige of an institution is often gauged by the quality of its library.

The dearth of libraries naturally hampers children from building up reading habits right from the tender age. This becomes glaringly apparent in college level students. In the West, the library is probably the most frequented building in the campus, humming with activity even late into the night. In Nepal, despite continuous encouragement by teachers to visit the library, students rarely go there, preferring to download information from the internet, the contents of which are often dubious and irrelevant. While students in the West normally refer large number of reference books for their assignments, in Nepal we have to be thankful if they just refer their textbooks.

A direct consequence of the poor reading habit is that research is a rare and endangered activity in Nepal. Research activities, like good libraries, are often neglected by the government as well as the private sector. Research does not come cheap, but it is a solid investment for the future. But do Nepalis understand this or even care? No wonder scientific journals have to struggle to stay alive.

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LEARNING ENVIRONMENT IN THE SCHOOLS OF THE KATHMANDU VALLEY - A Comparative Study

*Bijaya K. Shrestha, Ph. D., Chandani Shrestha**

ABSTRACT

Despite variations in physical design and educational facilities among the case study schools, these schools do not provide the learning setting needed for today's educational philosophy, as they are not only weak in incorporating the concept of learning through 'multiple intelligences' and addressing different elements of ambient atmosphere and home like characters but also lack well defined diverse outdoor and indoor learning spaces, have poor classroom environment, and are vulnerable to seismic hazard. Lack of awareness of new learning paradigm among school community and the concerned authorities, on one hand, and existence of inadequate and ineffective legislations and their poor implementation, on the other hand, have helped further deterioration of the learning environment in the schools instead of mitigating their numerous weaknesses. To reverse this trend, a twofold strategy of formulating planning and design guidelines and their strict enforcement in future school design and of raising awareness on the need of addressing the numerous weaknesses in the existing schools is essential.

Key Words: Educational philosophy, School facility, Outdoor learning space, Ambient atmosphere, Home like elements, Earthquake resistant construction, Education act and regulation, etc.

INTRODUCTION

Children being the nation's future responsible citizens, school as a learning centre for studying academic lessons, developing student's attitude and behaviour, participating in sports and other extra curricular activities, and acquiring knowledge on politics and civic society including acting as an evacuation shelter during natural disaster like earthquake, can be taken as an icon of the nation's wealth and strength as well as symbol of our commitment to education. As educational approach and school facility should respond to the transformation of socio-economic development and advancement of science and technology, today's school needs to focus on overall development of children rather than emphasis on academic program alone. However, schools in the Kathmandu Valley (and Nepal) are getting little attention from His Majesty's Government of Nepal and are less understood by our society. Low public expenditure on education, lack of community's contributions, under-utilisation of available physical and human resources including frequent strikes by teachers and students, on one hand, and growth of numerous private schools with business motive rather than service orientation in the last few decades, on the other hand, have resulted in inefficiency in educational system contributing to low adult literacy rate (age >15) of 39.2% against the government's target of 70%, uneven access to school and poor quality of education with limited relevance to daily life of

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people. The government's numerous reform initiatives have little implications on school environment improvement and students' performance not only because those programs centrally planned have poor implementation mechanism, lack different stakeholders' participation, and give little consideration to the local context but also suffer from poor resources at local base, lack of incentives for teachers and high politicisation of the teaching profession (Bista 1999).

Against such background, this paper aims to analyse the learning environment in the schools of the Kathmandu Valley on a comparative basis with fourfold objectives. First, it acknowledges the changing pattern of educational approach and school facility and then develops a theoretical framework to analyse the learning environment in the schools. Second, based on the established framework, it makes a comparative study of the three existing schools of the Valley including analysis of the users' (students and teachers) response to identify numerous weaknesses including their causes in planning and design of the case study schools. Third, it relates those weaknesses to the existing legal and institutional frameworks to check their effectiveness. Finally it proposes some recommendations for the existing schools and key planning and design guidelines for the future school design.

CHANGING PATTERN OF EDUCATIONAL APPROACH AND SCHOOL FACILITY

Agricultural society (1650-1849) characterised by multigenerational joint family structure, priority on family (or community) needs over individual's requirements, reliance on renewal resources around the settlement, limited travel by foot, horse, wagon or by boat, high illiteracy rate with face to face oral communication, etc. did not require formal education as children while contributing labour either at home or in the farm for family survival learned the necessary skill, workmanship and knowledge from the parents (Fielding *et al.* 1998). Moral and social trainings were the primary purposes of an education whereas the three social institutions namely family, church and community dominated life for everyone.

The school facility was housed in one room building with simple furnishing and poor ventilation. The classroom, extremely cold in the winter and hot in the summer generally had separate wooden benches for boys and girls and had to depend on oil lamp for lighting. One teacher would preside over teaching to the multi-aged group, ranging from children to adult. Teachers used threats, intimidation, and beatings to discipline students and to control the classrooms. For instance, students were locked in windowless closets for whispering in class, and other students were tied to chairs for hours. It was believed that all teachers had bad reputations merely for being teachers (Baker & Rubel 1980). A common description of schools in the late 1800s can be termed as 'wild and unruly places.' Poor physical condition of the classroom, the teaching methods, and the discipline practices all were enough to aggravate students into more disruptive behaviour during the early nineteenth century (Crews & Counts 1997).

The shift from farm to the factory for production, migration of the rural village population to urban city, breakdown of the extended family to nuclear families all indicated the beginning of the industrial society (1850-1949). To teach students reading, writing and using number, the earlier one room building was replaced by school building with self-

contained classrooms lined up like a large egg-crate on both sides of the corridor. Toward the end of the 19th century, school buildings began to include hallways, auditoriums, and administrative offices in addition to the classroom with desks often bolted to floors in row and column arrangements with further addition of different types of auxiliary spaces such as laboratories, art studios, and gymnasiums including separate housing for junior and senior students (Fielding *et al.* 1998). The educational philosophy of this period popularly known as 'factory model' focused primarily on memorisation and passive learning with little connection to what was happening to workplace, society or communities. Students sat in rows facing a teacher tediously trying to transmit information through 'chalk, talk and books.'

With the emergence of information, knowledge and service oriented society (1940-present) resulting societal changes such as use of multi media and multi dimensional communication in global context, pluralistic society, etc. the earlier educational approach and school facility needs to be adjusted. To respond to the highest rate of vandalism which occurred in schools due to obsolete, aging facilities and equipments, low staff morale, high student dissatisfaction, and heavy financial burden placed on the students (Crews & Counts 1997), educational reform movement was initiated in the 1960s and 1970s focusing on curriculum and instruction method and introducing 'open plan' school building featured by flexible and movable walls but which could not succeed (Bennett *et al.* 1980). However, from the mid 1990s, the concept of 'community school' sharing facilities with a variety of community and government organisations from day-care, health and social service agencies to community education programs, sports and recreation and other life-long learning activities has been emerging (Fielding *et al.* 1998). Based on numerous works on school facility and students' performance in the United States of America, Kenneth R. Stevenson has identified at least ten changing trends of education such as smaller and neighbourhood oriented school, fewer students per class, technological dominated instruction and so on that affect the physical settings we use for learning (Kenneth 2002).

THEORETICAL FRAMEWORK OF LEARNING ENVIRONMENT IN SCHOOL

Learning is no longer a group of students in front of a teacher, feeding information for storage and regurgitation in tests but rather an understanding to construct knowledge in meaningful ways for a particular purpose or solution to a well defined problem. As in the new learning paradigm of the 21st century, students learn through 'multiple intelligences' by creating things, understanding with images, engaging in problem solving and working in teams, and teachers as 'discussion facilitators' rather than dispensers of knowledge, guide students using a variety of sources including computer-based instruction programs, the internet, video, as well as books and lectures. The successful schools, therefore, must provide a setting where the learner has many choices in how they want to learn and the materials and tools they want to learn with.

Good responsive schools should comprise three components namely (i) health and safety factor – cleanliness, egress, fire, security and vandalism, (ii) the ambient environment factor – air circulation and quality, lighting and acoustics, and (iii) curriculum-based factor – classroom design, facility size, and places for learning (Lackney 1999). To create intimate, human-scaled, flexible, enduring and effective educational spaces, planning and design guidelines known as 'Thirty-Three Principles of Educational Design' (Lackney

2003) is available and among them, community involvement, active learning environment, cooperation among teachers, administrators and parents, home like elements, and safety and security are the major ones (Lackney 2001). Moreover, there should be smooth functioning of three interdependent components namely, built environment (buildings and facilities) – optimum use of site, building and infrastructure, (ii) learning environment – teachers, administrative and supporting staffs, parents and volunteers who use curriculum and other teaching materials to help students reach academic and social goals in learning, and (iii) the operations and maintenance environment – the materials and systems to keep school building and ground operating safely and cost effectively (PNPPRC 2001). Finally, an effective learning environment can be further enhanced by accommodating the needs of learners, involving all stakeholders in planning and design process, ensuring health, safety and security, making effective use of all available resources and creating school as a centre of the community (USDE 1998) and then adding quality on the physical setting piece by piece (Greenman 1988).

Numerous researches have confirmed the relationship between a school's physical setting including its ambient quality and student's behaviour and class performance. Students participating on various programs both in the classroom and in extra curricular activities get the opportunities to take responsibility, to practice leadership and adult role, and to learn the skills of participation (Murphy *et al.* 1985, Henry 1994) resulting in better pupil behaviour, better attendance, less delinquency and higher achievement (Rutter *et al.* 1979). Teacher-student interactions outside the classroom, the willingness of teachers to work with students outside of regular class time including staff commitment to co-curricular activities all help students accept the school norms, develop good behaviour and tend to work harder and to enjoy their schoolwork more (Rutter *et al.* 1979, Wynne 1980). Other studies have indicated that all else equal, small schools (elementary – 200 to 400, middle – 400 to 600 and secondary – 500 to 800) produce higher achievement, lower dropout rates, greater attachment, and more participation in the curricular and extracurricular activities including lower incidence of crime levels and less serious student misconduct (Barker & Gump 1964). Besides welcoming, inviting, and being user friendly, today's schools should also be energy-efficient, cost effective and easy to maintain and above all should be safe from earthquake, fire and other hazard.

Thus a theoretical framework to analyse the learning environment in the schools can be established by combining the physical setting, comprising of (i) efficient site planning and building design (ii) development of diverse outdoor and indoor learning spaces with full resources (iii) construction of earthquake resistant structures, and the learning setting, consisting of (i) achievement of safety, security and health (ii) enhancement of ambient atmosphere and (iii) creation of home like element. Physical and learning settings of schools reflect the educational philosophy, impact on learning and teaching systems and contribute to children's overall development process.

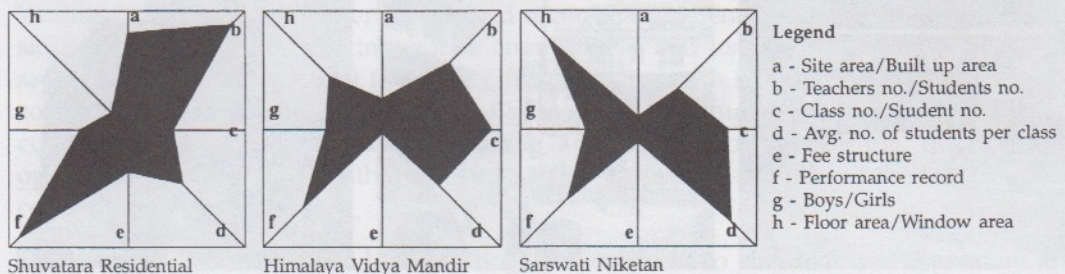
CASE STUDY SCHOOL SELECTION

Three existing schools in the Kathmandu Valley namely Shuvatara Residential School, Himalaya Vidya Mandir and Shree Sarswati Niketan with varying degree of similarities and differences in terms of location, size and facility, physical design and learning setting are selected for the comparative study (Table 1).

Table 1. Case study schools with similarities and differences

Particulars	Shuvatara Residential	Himalaya Vidya	Sarswati Niketan
Location	Lamatar, Patan (Rural)	Siphal, Kathmandu (Urban neighborhood)	Brahmatole, Kathmandu (Urban neighborhood)
Established Year	2000	1968	1980
Type	Residential	Non-residential	Non-residential
Students + Staffs (Total)	190 + 36 (226)	700 + 45 (745)	700 + 32 (732)
Class level	4-A level	Preschool-10	Preschool-10
Management	Private	Private	Government
Built up area/Site area (Rop.)	5/52	6/7.7	0.3/0.3 (approx.)
Fee structure (approx.) ¹	NRs. 10,000/month	NRs. 1,000/month	NRs. 125/month
Performance in SLC exam. (%)	100	90	70-80

Comparative analysis of numerous aspects such as built up and site areas, teacher- student ratio, number of students per class, fee structure and academic performance, and so on demonstrates that Himalaya Vidya Mandir lies between the better facilitated Shuvatara Residential and an ordinary government school, Sarswati Niketan (Figure 1). Though the excellent SLC examination result of Shuvatara can be related with its diverse physical facilities and extra curricular activities (ECA) including high fee structure, nonetheless, student's performance also depends on quality of intake students, learning and teaching styles in the school and time devoted by students at home. Moreover, academic performance alone is not sufficient to measure students' overall development.

Comparative study of numerous aspects of case study schools**Fig. 1.** Comparative study of numerous aspects of case study schools

COMPARATIVE STUDY OF THE EXISTING SCHOOLS

PHYSICAL SETTING

Site planning and building design

Designing individual buildings based on functional, climatic and contextual aspects and their clustering to create network of diverse open spaces results in the efficient site planning whereas unifying individual buildings by means of meaningful architectural elements

¹ This information given by the concerned staffs of the school should be taken as an average approximate value only.

fosters the sense of community, sense of order and cohesiveness. School architecture should reflect the children scale in building shape and size, neat and clean façade treatment, convenient and safety feeling.

Most of the building blocks except the staff quarters at Shuvatara Residential school complex are located in the middle dividing the whole site of 52 Ropani land into two parts allocating football ground, basket ball and squash courts and swimming pool including vehicle parking on the northern tip and the tennis court on the southern side. Grouping individual buildings in one location helps to minimise the infrastructure development cost but results in the isolation of the outdoor playing fields from other activity areas. Moreover, layout of boys and girls dormitories in two lines like row housing neither helps create any meaningful outdoor spaces nor allows utilisation of surrounding mountain view. Nonetheless, the exposed brick façade with cement pointing and low rise structure with slope roof unifies the monotonous individual buildings.

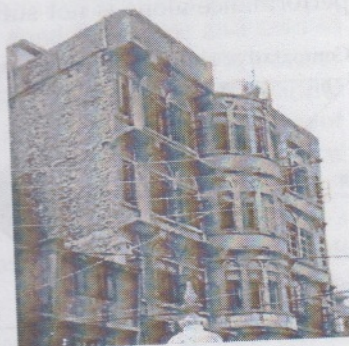
The 'L' shaped four storey building plus one single storey structure housing all the school facilities of Himalaya forms an enclosure for the outdoor area which is used as a playground, assembly area and parking (Photo 1). In the case of Sarswati, all the school activities take place in a five storey single block. Attached with the residential houses on two sides, this block covers almost all the site area except a narrow setback on the backside and hence lacks its own parking and outdoor playground. In such a situation consideration of orientation or wind direction in building design has little meaning.



Shuvatara Residential



Himalaya Vidya Mandir



Sarswati Niketan

Photo 1. Different building typology of case study schools

A 31-item questionnaire² targeting different aspects of school environment is randomly distributed to 50 students, ranging from eight to ten grade (some of them of A level) and a 12-item questionnaire focusing on educational approach and school facility is administered to at least 10 teachers of different approach and school facility is responses with the theory of good school design. Majority of the students of Shuvatara (72.10%) and Sarswati (70.37%) see the built environment of their schools as convenient and exciting whereas nearly half of the students of Himalaya (49%) find their school

2 The response from the students of Shuvatara and Himalaya was 100% and that of teachers was 70%. In the case of Sarswati, only 64% of the students and 60% of the teachers responded. Though all the students and teachers did not fill up all the items, the percentage calculated is based on the total responded numbers.

either inconvenient and boring or just an average (Figure 2). Nonetheless, teachers from all the schools have no complaint regarding use of the school buildings and their timely maintenance.

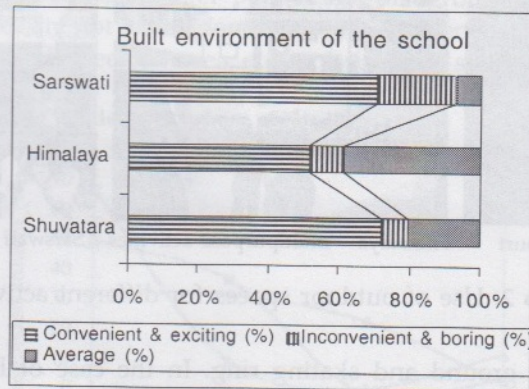


Fig. 2. Students' response on school's built environment

Diverse outdoor and indoor learning spaces/activity areas with full resources

As learning takes place in many different kinds and qualities of space, creation of network of diverse outdoor and indoor activity areas is essential. Outdoor spaces enhance collaborative and interactive activities, stimulate interest and curiosity and finally allow an experiential learning, which can not be achieved in indoor classrooms (Layton 2001, Wagner 2000). Students better absorb and retain math, science, language, arts, and other skills that incorporate their immediate environment and use all five senses (Lieberman and Hoody 1998). In contrast to the specific use spaces such as volleyball court, assembly courtyard, etc. other outdoor spaces of school grounds such as pathways and plazas, covered pavilion, porch, garden, seating areas of various sizes, etc. offer varied opportunities to socialise with a friend, in small groups or as a part of the larger school community.

Open spaces between individual buildings and adjacent to classrooms at Shuvatara are mainly used for lighting and ventilating interior spaces rather than for diverse educational activities as those outdoor spaces not only lack street furniture and sense of enclosure but are also inappropriate in size and shape. The other outdoor areas are mainly dedicated for different but formal games such as football ground, basketball and tennis courts, and so on (Photo 2). None of the classroom is extended to outdoor space. The brick and cement paved frontyard of Himalaya is little useful for outdoor learning whereas the open space in front of Sarswati school is the public street, used as a playground by students. In both cases the scope of experiential learning and socialising opportunity is low.

Almost two third of the students of Shuvatara and more than half of the students of Himalaya use outdoor spaces for chatting/talking with their friends, the remaining students mainly engage in 'formal sport' activity such as playing volleyball or badminton (Figure 3). As Shuvatara does not have well defined greenery spaces (gardens or small parks) at present, more than fifty percent of the students prefer to have such facility while other



Photo 2. Use of outdoor spaces for different activities

(43%) demand cricket ground and skating ring. In the case of Himalaya, ninety five percent of the students would like to have football ground, swimming pool, cricket field, volleyball and badminton courts and other similar facilities added in their school complex, with only few students looking for separate garden and park (Figure 3). Many students of Sarswati also prefer to have big open spaces for diverse playing activities. Except Shuvatara being a residential school, most of the students use outdoor spaces during the school time (Figure 3).

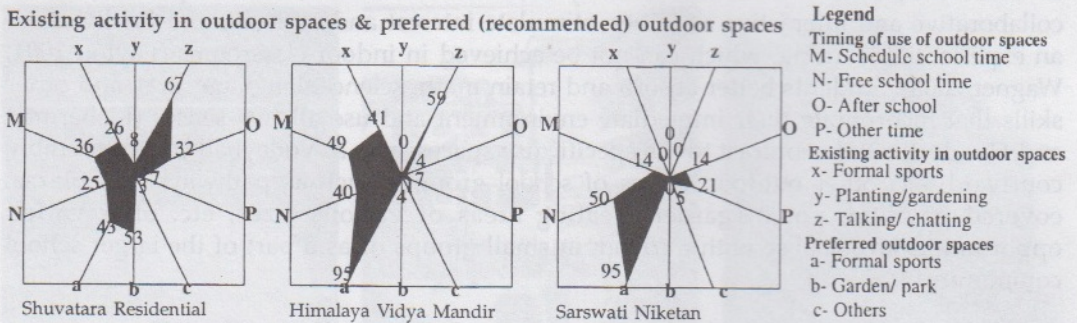


Fig. 3. Existing activity in outdoor spaces and preferred (recommended) outdoor spaces

Except for the classrooms which are arranged in a row on either a single or double sides of the corridor, the internal layout of spaces of the case study schools provides little opportunity for using entry hall as an exhibition place, corridor for informal meeting place and so on. As a result, interaction among students and teachers are minimised thereby reducing the educational opportunity. Instead noises from the corridor and lobby disturb the classroom activities at Himalaya and Sarswati. Children find it difficult to climb up to the upper fourth and fifth floors.

Due to lack of well defined personal spaces, most of the students of Himalaya (52.10%) and Sarswati (68.96%), upon getting free time, either stay in the classrooms or visit 'study related areas' such as library, science and computer laboratories, and so on (Figure 4).

Such situation does not arise at Shuvatara where most of the students either engage in extra curricular activities (playing different outdoor games) or go to 'other facility' area such as dormitory, multipurpose hall and so on. However, only few students visit 'isolated area' (backside of the buildings, upper part of the playground, etc.) indicates that the existing outdoor spaces are not 'user friendly.' In other schools, the isolated area includes the roof top, left over small greenery area, etc., only used by small fraction of the students.

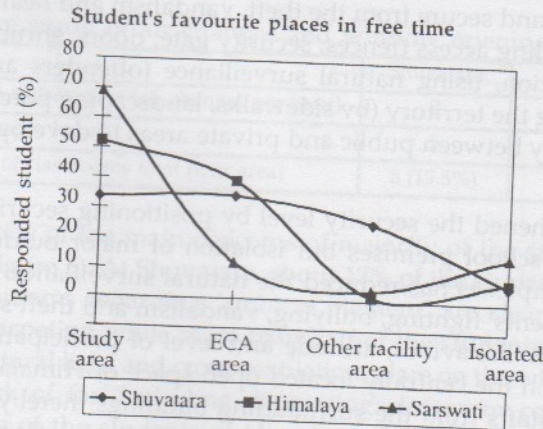


Fig. 4. Students' favourite places in free time

Earthquake resistant construction

As earthquake is the major unavoidable threat to the Kathmandu Valley (and Nepal) due to numerous reasons such as its location on the active tectonic plates with numerous fault lines crossing the valley, soft soil of prehistoric lake with low bearing capacity and susceptible to liquefaction, and frequent seismic tremors with many destructive ones in the past, consideration of earthquake resistant components in site planning, building design and detailing including preparedness for emergency situation is essential in 'mass gathering' place like school.

Though rectangular building form with simple reinforced cement concrete low rise structure (2-3 storeys) at Shuvatara is favourable for earthquake resistant design, lack of binding ties at corners and at sill and lintel levels and absence of reinforcement band around door and window openings makes the school building vulnerable to earthquake. Without an alternate access route in the classrooms from outside emergency rescue work in the event of fire and earthquake will be difficult. Nonetheless, installing fire extinguisher in different blocks, conducting emergency drill for students and providing first aid box all have strengthened the preparedness level. Football grounds and other open spaces including the multipurpose hall can be used as an evacuation centre and for rescue operations during a natural disaster. In the case of Himalaya, the earthquake vulnerability is due to its elongated building shape (Length > 3 Width), soft storey on the entry way and corridor columns without cross tie. The Sarswati school is also not safe against the seismic force not only due to its high rise construction, large window openings, and absence of earthquake resistant detailing but also because of lack of alternate access in the classroom for the emergency situation, absence of fire extinguishers, and inadequate

preparedness. Teachers from the latter two schools are less concerned on this important issue.

LEARNING SETTING

Safety, security and health situation

As children learn most effectively in a non-threatening and comfortable environment, schools should be safe and secure from the theft, vandalism and health hazard, which can be achieved by controlling access (fences, security gate, doors, shrubs and other physical elements) and circulation, using natural surveillance (offenders and intruders will be observed) and defining the territory (by sidewalks, landscaping porch and other elements that establish boundary between public and private areas to develop sense of ownership) (FCCD 1993).

Shuvatara has strengthened the security level by positioning security guard at the entry gate and fencing the school premises but isolation of major outdoor playing activities from the building complexes has reduced the natural surveillance. However, there is no serious record of students' fighting, bullying, vandalism and theft so far and teachers are satisfied with students' behaviour, attitude and level of participation in extra activities. Numerous activities on the centrally located open space of Himalaya are being watched by the students and staffs from the surrounding buildings thereby enhancing the safety level which is difficult in the case of Sarswati due to its location adjacent to the busy public street. In both cases, few students and teachers have reported their dissatisfaction over isolated cases of student's indiscipline act.

Shuvatara also offers hygienic food and water and has provision of infirmary and clean restrooms whereas the remaining two schools located in dense urban residential areas are frequently disturbed by noise in addition to the lack of potable drinking water and hygienic restrooms.

Ambient atmosphere

Natural lighting, air quality and its circulation, thermal condition and acoustic quality all contribute to a school environment that is not only conducive to learning but also helps achieving economic and energy conscious buildings. Students in the classroom with sufficient natural light can increase their academic performance by 5-14% (Nicklas and Bailey 1995) whereas others working in the classroom without daylight reduce their ability to concentrate or cooperate, and have an impact on annual body growth and absenteeism (Kuller and Lindsten 1992). Daylit schools need 22-64% less energy compared to non-daylit schools.

Despite sufficient window openings (19.5% of floor area) and comfortable level of air changes per hour, students of Shuvatara feel discomfort in their classrooms due to positioning of windows on the back side only and absence of cross ventilation (Table 2). Similarly, the single window (covering 13.5% of floor area) in the classroom of Sarswati is neither appropriate for day lighting nor sufficient for minimum level of air changes. Only the classrooms of Himalaya having big windows on the opposite sides have enough natural lighting and cross ventilation. Adjustable artificial lighting system with day light allows greater options in lighting throughout the classroom for different activities such as group discussion, studying and writing work, display work and so on. However, the

fixed fluorescent tube light at Shuvatara and simply power point connections without bulbs in the remaining two schools have reduced the scope of classrooms use for different teaching styles. Except the carpet flooring in academic block of Shuvatara, none of the school has taken special measures for thermal comfort and acoustic quality as all of them have normal cement concrete flooring, brick wall and reinforced cement ceiling without any treatment.

Table 2. Comparative study of air changes and window openings

Particulars	Shuvatara	Himalaya	Sarswati
Minimum air required in a classroom (air changes per hour)	2	4	6.5
Available air (air changes per hour)	5	16.5	5
Window area (sq. m) (% of classrooms total floor area)	8 (19.5%)	9.5 (43%)	2.7 (13.5%)

Ambient element is one of the main concerns of majority of the students in all the three case study schools (Figure 5). At Shuvatara, about 17% of the students think the best-liked elements of the classrooms regarding 'ambient element' are cleanliness, view from the windows and floor carpeting while more than half of the students dislike many features such as insufficient natural light and cross ventilation, glare on the whiteboard, nonworking fluorescent tubes, lack of fan including depressing classroom colour and dirty walls. Significant percentage of the students of Himalaya (56.84%) and Sarswati (60.55%) also dislike their classrooms due to dirty walls and floors, absence of bulbs and fan on the ceiling and glass on window panel, poor electric circuit and so on.

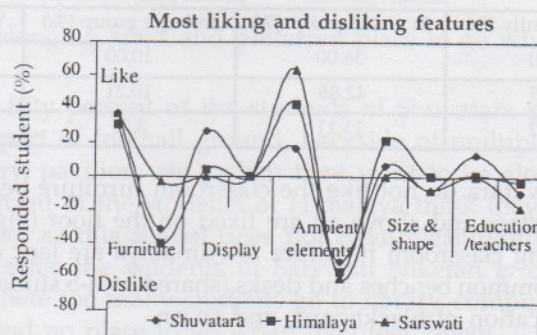


Fig. 5. Most liking and disliking features of the classroom

Home like element

Buildings with physical and social home-like characteristics such as creating smaller grouping of students, designing appropriate scaled elements, locating restrooms near institutional areas, creating spaces of one's own for teachers and for students and so on reduce anxiety on the part of both parents and children, help children feel more comfortable and enable to concentrate on learning. Moreover, creation of privacy niches or intimate counselling spaces that are relaxing, non-threatening and comfortable for single or small group meetings enhances informal social interaction. Allowing learners to personalise such spaces as much as possible will help them develop a more positive sense of ownership and take pride in their school.

Low rise structure with slope roof, conveniently located clean restroom, provision of individual desk for each student and teacher alongwith storage space and spacious classroom all contribute to home like character at Shuvatara school, which is missing at Himalaya and Sarswati. Compared to the earlier one, almost 50% more students are accommodated in approximately half the classroom area (Table 3).

Table 3. Comparative study of classroom features

Classroom	Shuvatara	Himalaya	Sarswati
Size (sq. m)	6.5 X 6.3 (41)	4.85 X 4.6 (22)	4.6 X 4.4 (20)
Average student no./class	24	32	39
Area per student (sq. m)	1.7	0.7	0.5
Furniture layout	Single fixed desk with book shelf for individual	Desk shared by 4-5 students without storage space	Desk shared by 5-6 students without storage space

Since many students particularly of Shuvatara (46.00%) and Himalaya (53.06%) most often work either in small or large groups in the classrooms (Table 4), the existing furniture layout in these schools neither allows for different styles of teaching/learning nor is it convenient for students (Figure 6) as research shows that individuals can not sit still and concentrate for more than 50 minutes in non-cushioned chairs (Bullock and Foster-Harrison 1997).

Table 4. Students' working styles in the classroom

Case study school	Students' working style in the classroom			
	Independently (%)	In small group (%)	In large group (%)	With the entire class (%)
Shuvatara	14.00	36.00	10.00	40.00
Himalaya	32.65	42.85	10.21	14.29
Sarswati	18.52	11.11	3.71	66.66

Many students of Shuvatara do not like the classroom furniture because they are small, old, dirty, lack lock system and above all are fixed on the floor (Figure 5). Similarly, the reasons behind disliking classroom furniture at Himalaya are lack of teacher's desk and cupboard, congested common benches and desks (shared by 4-5 students) without personal storage space, poor location of blackboard, and so on.

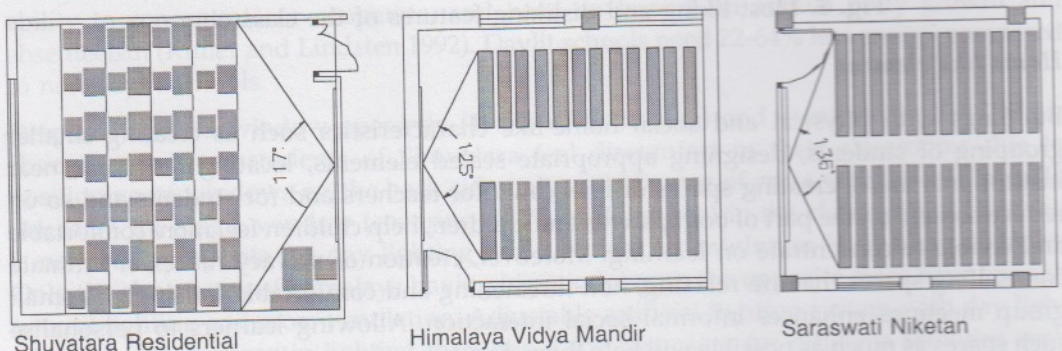


Fig. 6. Comparative study of classroom and its furniture arrangement

Again, majority of the students in each school admit that they have 'special belonging places' in their school premises and such places can be categorised into four different types (Figure 7). Nearly one third of the students of Shuvatara feel either 'sport area' (basketball court, football ground, etc.) or 'other facility area' (dining hall, dormitory, multipurpose hall) and the remaining students think 'study area' (classroom, library, etc.) and 'isolated area' (garden, backside of music department, etc.) are their 'belonging places' in the school complex whereas more than half of the students of Himalaya believe 'study area' (classroom, library, audio visual room, etc.), nearly one third of the students identify 'sport area' (playing ground, skating ring, etc.) and the remaining ten percent of the students mark 'other facility area' (school hall) as their special places. However, the case of Sarswati is totally different as almost all the students (only few students responded) think the public space in front of the school, where a small Sarswati temple also exists is their special belonging place.

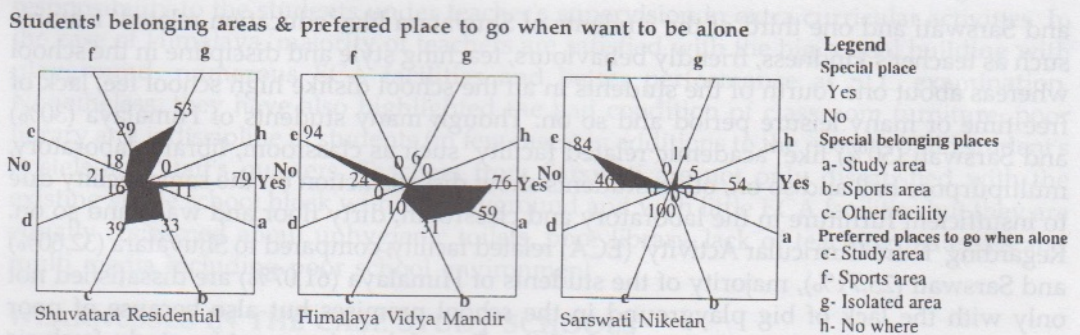


Fig. 7. Students' belonging areas and preferred place to go when want to be alone

Similarly, more than fifty percent of the students of Shuvatara prefer to visit 'isolated area' (jungle, upper part of football ground, backside of multipurpose hall and music department, dormitory, pavilion, etc.) when they want to be alone (Figure 7) whereas more than ninety percent of the students of Himalaya think they get privacy at library and audio visual room as this school does not have meaningful greenery areas. Such isolated privacy place for the students of Sarswati Niketan is on the roof top of the building. Otherwise, here too many students go to library, computer and reading rooms while few students find no place to go when they feel lonely.

Wall display, an essential personalizing feature of a classroom adds colour and diversity which reduces acoustical reverberations in the classroom. Classroom that is aesthetically pleasing in terms of colours, textures, patterns can increase students' sense of personal value and importance. Though majority of the students in each school mostly use the classroom walls for displaying their works, except the case of Shuvatara, the event of displaying work is rare and the classroom setting does not support such work (Figure 8). In few cases, their works are also displayed either on the bulletin boards placed in the corridors and in front of the multipurpose hall or in teachers' room and library, which are decided by students themselves, clubs, and sometimes by principal or vice principal.

Students' numerous liking and disliking features in overall school environment in each school can be categorised into four types (Figure 9). One fifth of the students of Himalaya

Students' work display area

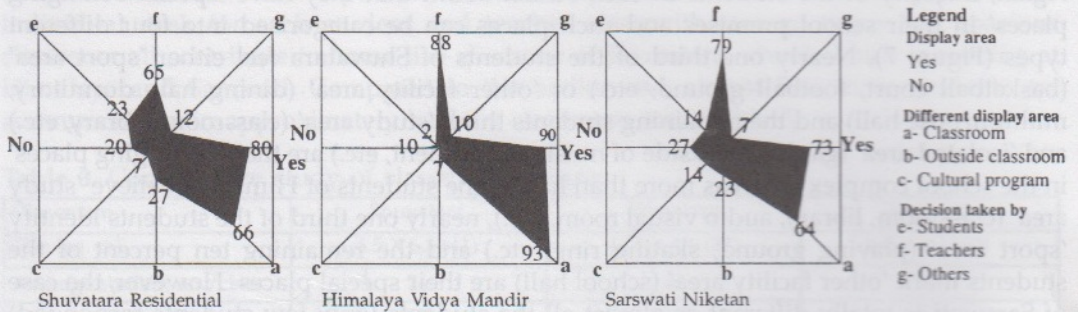


Fig. 8. Students' work display area

and Sarswati and one third of the students of Shuvatara like 'education related' features such as teacher's kindness, friendly behaviours, teaching style and discipline in the school whereas about one fourth of the students in all the school dislike high school fee, lack of free time or many leisure period and so on. Though many students of Himalaya (30%) and Sarswati (50%) like 'academic related facility' such as classroom, library, laboratory, multipurpose hall and so on, other students show dissatisfaction on the same facility due to insufficient furniture in the laboratory and classroom, dirty floor and walls and so on. Regarding 'Extra Curricular Activity' (ECA) related facility, compared to Shuvatara (32.60%) and Sarswati (25.71%), majority of the students of Himalaya (61.07%) are dissatisfied not only with the lack of big playground in the school premises but also because of poor services of bus, cafeteria and infirmary facilities. Peaceful environment for study, fresh air without pollution and background mountain view and similar other 'environment related' features are cited as liking features of their school by the students of Shuvatara (15.87%) whereas disturbance from the surrounding areas, bad smell of toilets, etc. are some of the disliking features of the schools reported by the students of Himalaya (2.29%) and Sarswati (17.15%).

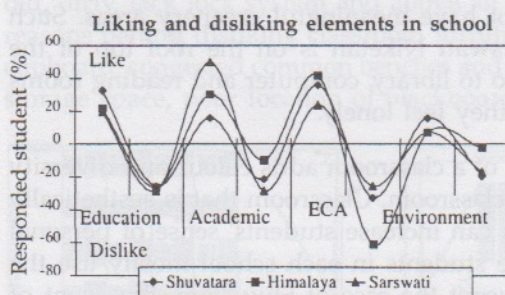


Fig. 9. Liking and disliking elements in the school

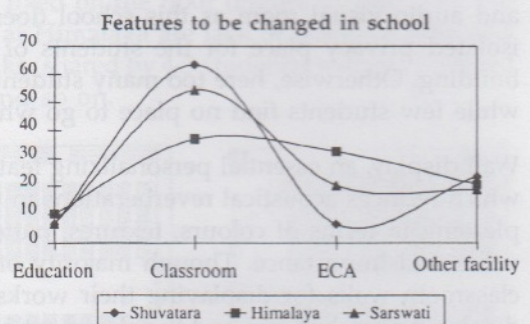


Fig. 10. Features to be changed in the school

Finally, majority of the students of all the three schools are dissatisfied with the classroom setting and their dissatisfaction includes small classroom size resulting in congestion and

noise, broken windows in some cases without glass panels, useless tube light and bulbs, absence of electric circuit, glare on the blackboard, dirty walls and slippery floors, user unfriendly benches and desk without storage place and so on (Figure 10). Such classroom environment also discourages the teachers, who prefer 'student centre' diverse teaching methods conducting group discussion and other activities in the classroom. Only few students show concern regarding the teaching styles. Others are more interested to change the ECA related facilities particularly the students of Himalaya (32.35%) and Sarswati (20.34%).

Except for the few cases of concern over the long commuting distance to school and few individual's attitude to take extra advantage, most of the teachers of Shuvatara believe peaceful environment (away from the city), diverse available facilities and effective school management including friendly attitude of teachers and other staffs as well as of well disciplined students are the positive aspects of the school. They see the need to give more responsibility to the students under teacher's supervision in extra curricular activities. In the case of Himalaya, majority of teachers are satisfied with the big school building with playground, numerous ECA facilities and better performance at SLC examination. Nonetheless, they have also highlighted the bad condition of classroom furniture, poor library and indiscipline in students (in few cases) in additions to the need to build student's hostels and staff's quarters. Teachers from Sarswati are not only dissatisfied with the existing single school block without playground and with little ECA facilities but they are equally concerned about unhygienic toilets, poor library, lack of teaching materials and multi media including poor school environment.

WEAKNESSES IN THE CASE STUDY SCHOOLS

New learning paradigm of the 21st century - learning through 'multiple intelligences' - is yet to be fully realised

All the case study schools are characterised by 'factory model' buildings designed for lecture and passive learning and outdoor spaces mainly dedicated for 'specific use' sport activity. Apart from these activity areas, they lack other well defined outdoor and indoor spaces for informal gathering and socialisation. As a result, students are forced either to stay in the classrooms (and computer room, library and science laboratory) or to engage in the formal games. The overall impact is the reduction of interaction among students and teachers, opportunity lost of experiential learning and adverse affect on overall development of students. Such environment does not fit in today's educational system, where students' learn through multiple intelligences.

Ambient environment and home like characters complementing learning setting is less understood

Numerous features such as insufficient cross ventilation and glare on the blackboard, nonworking tube lights and broken window panels, missing fans, dirty and dull walls, slippery (and slope) floor, and above all, old, dirty fixed furniture shared by many students but without personal storage areas, all demonstrate that the existing classroom setting of all the three schools is neither conducive for learning environment nor suitable for diverse learning and teaching styles. Absence of privacy niches and intimate counselling spaces in the school premises has further worsened the situation. Its impacts on academic performance, children's health and psychology are enormous.

Earthquake vulnerability is not adequately dealt with

Weak construction detailing for earthquake resistant design, poor preparedness level for emergency situation and low awareness among teachers and students regarding natural disaster all make the existing case study schools vulnerable to earthquake and fire. Rescue and relief work will be difficult not only due to absence of alternate access to the classrooms but also because of late arrival of emergency vehicles to the schools (located either far away or in the dense urban neighbourhood areas). Provisions of fire extinguisher and first aid box alone may not be sufficient for big disaster like earthquake. Retrofitting of the existing school building for earthquake resistance is the least priority of school management. Finally, the need to play multiple roles by schools is not well established.

LEGAL AND INSTITUTIONAL FRAMEWORKS

The existing educational legislations (Education Act 1971, Teachers Service Commission Regulation 2057 BS, etc.) and the building bylaws, and the responsible institutions (District Education Office, (National) Private and Boarding Schools Organization Nepal ((N)PABSON) are simply inadequate and ineffective to address the above mentioned numerous weaknesses. The reasons are numerous.

First, the required pre-requisite conditions to establish a new school are vague, confusing and insufficient, as no qualitative and quantitative specifications are set in terms of light and ventilation, thermal comfort and acoustic, size, shape and furniture layout of the classroom, facilities in the library and laboratory, and so on. One can get the permission to run a new school from the educational office by filling up of a simple prescribed form irrespective of its teaching styles, educational facilities and building structure. The Education Act requires each classroom area not less than 1 sq. m. per student, however, Himalaya and Sarswati do not meet this standard. Second, according to the existing building bylaws, a new school building should have at least 3 m. wide setback around the building, 15% of plot area allocated for parking and maximum 40% of ground coverage. Since the bylaws are applicable only to new construction, they cannot control the new schools that use already existing buildings without parking provision and with 100% ground coverage. Third, school premises being a 'mass gathering' place should have seismic safer building structures with vehicular access to each building block for emergency but neither the building bylaws nor the Education Act mentions the need of it. Finally, school management committees (SMC) comprising parents, teachers and educationalists including representation from the District Education Office (DEO) are ineffective to monitor the academic activities and school facilities.

RECOMMENDATIONS FOR THE EXISTING SCHOOLS

Though Shuvatara is better than the other two schools in terms of educational facilities, nonetheless, it has missed many opportunities to enhance the learning environment. Its huge outdoor area should be developed particularly along the student's movement lines for diverse well defined areas (covered or semi covered area, park and greenery, privacy niches, natural landscape, etc.), which can be used by students and staffs at different time. Himalaya also needs small greenery space, privacy niches and other outdoor spaces for informal gathering which can be created by redesigning its existing outdoor area. In the

case of Sarswati, creation of some sort of outdoor spaces is essential either by acquiring the surrounding properties or by other means. In addition to improving the library and laboratories, toilets and drinking water facility, both Himalaya and Sarswati should also retrofit their school buildings for earthquake resistance. Nonetheless, in all the cases, the classroom setting should be redefined not only by remodelling the existing furniture and their layout and improving the ambient atmosphere but also linking the classroom with newly created diverse outdoor and indoor learning spaces. Finally, besides the continuation of the emergency drill, installation of fire hydrants at different locations and provision of first aid, preparation of emergency response plan is also recommended.

PLANNING AND DESIGN GUIDELINES FOR FUTURE GOOD SCHOOLS

- Provide multiple learning opportunities by creating network of diverse outdoor and indoor spaces of different size and shape (apart from the classrooms) and enhance the learning environment by emphasising numerous elements of ambient atmosphere, home like characters, safety and health in site planning and designing individual buildings as well as in the classroom setting;
- Arrange learning clusters (instead of traditional classrooms), staff and teachers' stations and laboratories around a well-equipped 'resource centre' to enhance effective use of resources as well as to promote interaction and participation among teachers and students;
- Develop the classroom like studio, research centre with modular furnishing, multi-media material and modern communication technology and link such self sufficient classrooms internally to an information technology (IT) unit and further to informal meeting spaces in the corridor and externally to semi covered spaces adjacent to the classroom and further to the outdoor learning spaces and finally to the larger gardens or landscape area, which links the students of the classroom to the global family, school family (friends and teachers) as well as to natural family and community (Figure 11); and

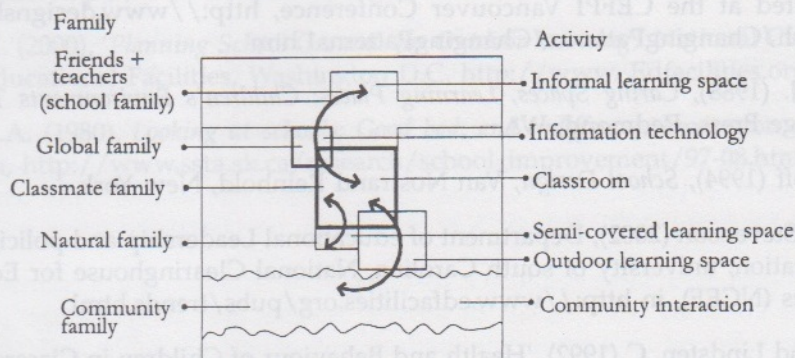


Fig. 11. Conceptual design of a classroom and its linkage with surrounding learning environment

- (d) Consider school as a 'special land use' and plan and design it for earthquake resistance as well as for evacuation centre in case of emergency.

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A SIMPLE TECHNIQUE FOR ESTIMATING LIFE EXPECTANCY AT BIRTH FOR NEPAL

Shambhu Prasad (Patel)*

ABSTRACT

This paper aims to estimate life expectancy at birth for Nepal from the minimum relevant parameter i.e. CDR. The validity of model was ascertained by applying the model to obtain e_0 for Nepal; comparing the estimated e_0 for Nepal with those from the other sources; and by computing various relevant tests of model adequacy. The model was found to provide satisfactory estimates for Nepal. For instance, the estimated e_0 for Nepal is 60.1 years for the year 2003, which may be considered close consistent to e_0 of 60 years provided by the ESCAP (2003). The model may be considered suitable for estimating e_0 for Nepal for a few decades.

Key words: Crude Death Rate, Development Indicator, Health Indicator, Mortality, Regression Model.

INTRODUCTION

Life expectancy at birth (e_0) is an important indicator of development. It is a more accurate reflection of mortality than the crude death rate because it is independent of the age structure of population, and it is not influenced by extraneous factors such as the selection of a standard population (Arriaga, E.E. 1994: 74).

The conventional way to obtain e_0 is through the construction of a life table, which has rigorous data requirements. Construction of a life table needs age specific death rates and the population by age. If vital registration system is complete, life table can be easily constructed using the system's data. However, complete vital registration system is practically non-existent in Nepal (Karki, Y.B. 1989). Moreover, adequate and reliable age distribution of deaths is not available in the country (CBS, 1995).

There are many methods to estimate e_0 which are based on stable population concept, biological theories of aging, age distribution of population, widowhood status and regression approach (see Mazur, 1969a, 1969b and 1972; Carrier and Hobcraft, 1971; Swanson and Palmore, 1976; Mccann, 1976; Swanson, Palmore and Sundarum, 1977; Hill, K. 1977; Hill and Trussell, 1977; Siler, 1979; Gunasekaran, Palmore and Gardner, 1981; Coale and Demeny, 1983; United Nations, 1983; Preston and Bennet, 1983; Malaker and Crook, 1989; Swanson, 1989; Pathak, K.B. and Singh, B.S. 1992)

The main problem with these methods is that they need rigorous data of relatively reliable quality to be collected from census or survey; reliable and adequate age patterns of mortality for selecting an appropriate method and model life table; and lastly, many assumptions to be satisfied by the population under study. But the irony is that demographic data collected from the censuses or surveys of Nepal are highly inaccurate

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(Chhetri, Radha Krishna 2084/049: 6-9; Pant, P.D. 1996: 1-8). Further, many assumptions underlying the models are not justifiable in the population under study. Moreover, there is no reliable age distribution of mortality for Nepal to use in deciding the right family that fits (CBS, 1995: 101). Apart from this, collection of census or survey data with fair accuracy needs a lot of time, money and highly skilled manpower. But the reality is that Nepal is a poor country where 42 percent of her people still live below the poverty line, and the half of the population can not yet read or write (UNDP, 2001). Most enumerators of censuses or surveys are found to fill their questionnaires at home without bothering to contact the real respondents.

In this paper, an attempt is made to develop a new regression model to estimate life expectancy at birth using the minimum relevant parameter i.e. CDR. CDR is selected as a relevant parameter needed for estimation of e_0 because it represents the "end result" of development; easy to compute and understand; can be obtained easily either from suitable models or various publications; and more importantly, it is strongly associated with the level of e_0 .

METHODOLOGY

The proposed methodology follows the usual path of establishing relation between a response variable (Y) which in this case is e_0 , and predictor variable (X) here in identified as CDR. Since empirical studies show almost exponential relationship between these variables, it was decided to fit a exponential regression equation of type:

$$Y = ab^X \text{ ----- (1)}$$

where Y ($=e_0$) is a response variable; X = CDR (per 1000 population); and 'a' and 'b' are the parameters to be estimated.

The following set of data extracted from some reliable sources has been used for fitting the equation (1).

Table 1. Estimates of CDR and e_0 Extracted from Asian Countries for Fitting the Equation (1)

Country	Year	CDR (=X)	e_0 (=Y)
Afghanistan	1965-70	26.5	37.5
Nepal	1965-70	22.9	40.6
Indonesia	1965-70	19.4	48.8 (for 1961)
Laos	1965-70	17.2	47.5
Iran	1965-70	16.6	50.0
China	1965-70	15.3	50.0
East Malaysia	1965-70	12.5	55.1
Philippines	1965-70	12.0	56.3 (for 1960)
Mongolia	1965-70	11.2	57.7
Western Samoa	1961-66	8.2	63.0

Source: UN (1973) Asian Population Series, Annex 2.

Using the data presented in the Table 1, the values of constants needed for estimating the parameters are:

$$\begin{array}{lll} \Sigma Y' = 16970193 & \Sigma Y'^2 = 28.842959 & \Sigma XY' = 271.054395 \\ \Sigma X = 16.18 & \Sigma X^2 = 2901.44 & n = 10 \end{array} \quad \text{where } Y' = \text{Log } Y$$

Using these data, regression approach gives the following estimated regression model to estimate life expectancy at birth for Nepal:

$$\hat{Y} = 1.898088 - 0.0012427 X \quad \text{----- (2)}$$

$$\text{Or, } \hat{Y} = 79.0839 (0.9718)^X \quad \text{----- (3), } n = 10, R^2 = 98.96\%, SE(Y') = 0.616$$

where $\hat{Y}$ = Estimated e_0^0 (years); X = CDR (per 1000 population).

This model can be used to obtain reliable estimates of e_0^0 for Nepal. However, it is noteworthy that model that fails in diagnostic checking for model adequacy will always remain suspect and little faith can be put in the results (Kerlinger, 1998). Diagnostic checking for model adequacy is done by applying the models to obtain estimates for Nepal; comparing the estimates of the model with those from the other sources (e.g., Singh M.L. 1979; CBS, 1987a, 1995, 2002, MMHDC, 2001; WB, 2001; UNICEF, 2001; ESCAP, 2003; UN, 1999); and by computing various relevant tests of model adequacy described elsewhere (e.g., Aryal and Gautam, 2001: 393-455; Singh, M.L. 2003: 232-255) whenever possible.

RESULTS

The findings of the study are presented systematically. The following tables and figures summarize the results computed for testing the model adequacy:

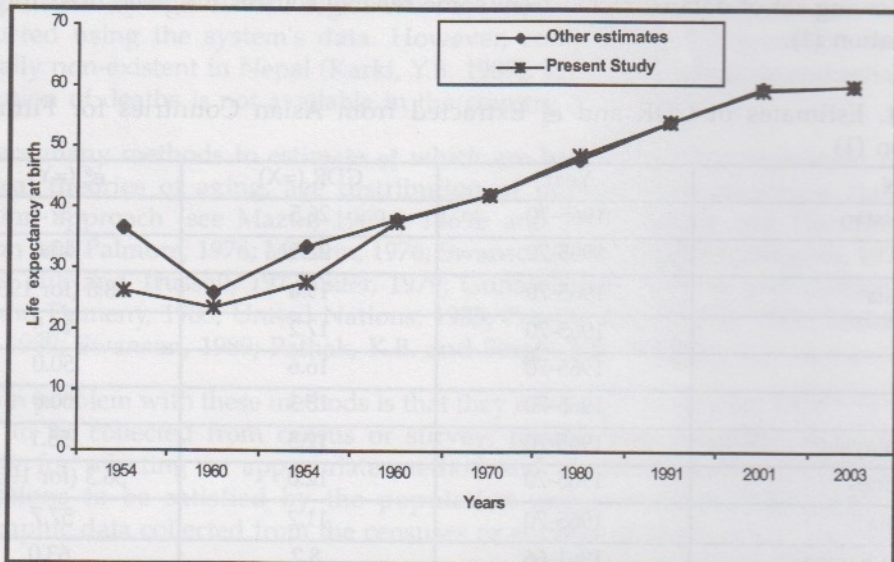


Fig. 1. Comparison of the Estimated e_0^0 for Nepal with the other the Estimates

Table 2. Comparison of the Estimated e_0^a for Nepal with the other Estimates

Estimates of the other Sources			Present Study
Years	CDR	$e_0^{a@}$	e_0^a
1954 ⁱ	36.70	33.45	34.58
1960 ⁱⁱ	26.00	38.00	37.10
1970 ⁱⁱⁱ	22.00	42.00	42.90
1980 ^{iv}	17.00	48.00	46.80
1991 ^v	13.00	54.25	53.18
2001 ^{vi}	9.96	59.70	59.74
2003 ^{vii}	9.60	60.00	61.15
1950-1955 ^{viii}	27.90	36.30	34.00
1955-1960 ^{viii}	26.70	37.60	36.00
1960-1965 ^{viii}	25.00	39.10	38.20
1965-1970 ^{viii}	22.80	41.00	40.50
1970-1975 ^{viii}	21.10	43.30	42.90
1975-1980 ^{viii}	18.40	46.20	45.50
1980-1985 ^{viii}	16.20	49.10	48.20
1985-1990 ^{viii}	14.10	52.00	51.10
1990-1995 ^{viii}	12.80	54.60	54.10
1995-2000 ^{viii}	10.90	57.30	57.40
2000-2005 ^{viii}	9.50	59.80	60.80

Source: CBS (1987a, 1995); Singh, M.L. (1979); UN (1999); UNICEF (2001); ESCAP (2003); WB (2001).

Notes: i Refers to the estimates of Baidyanathan and Gaige (1973). PP. 278-290.

ii Refers to the estimates of the MHHDC (2001). P. 164.

iii Refers to the estimates of the UNICEF (2001). P. 96.

iv Refers to the estimates of the WB (2001). P. 107.

v Refers to the estimates of the CBS (1995). P. 111.

vi Refers to the estimates of the CBS (2002). P. 4.

vii Refers to the estimates of the ESCAP (2003).

viii Refers to the estimates of the UN (1999). p. 304

a Refers to the average estimate of males and females.

@ Refers to the estimates of the proposed model (3)

@@ Refers to the estimates of the other sources.

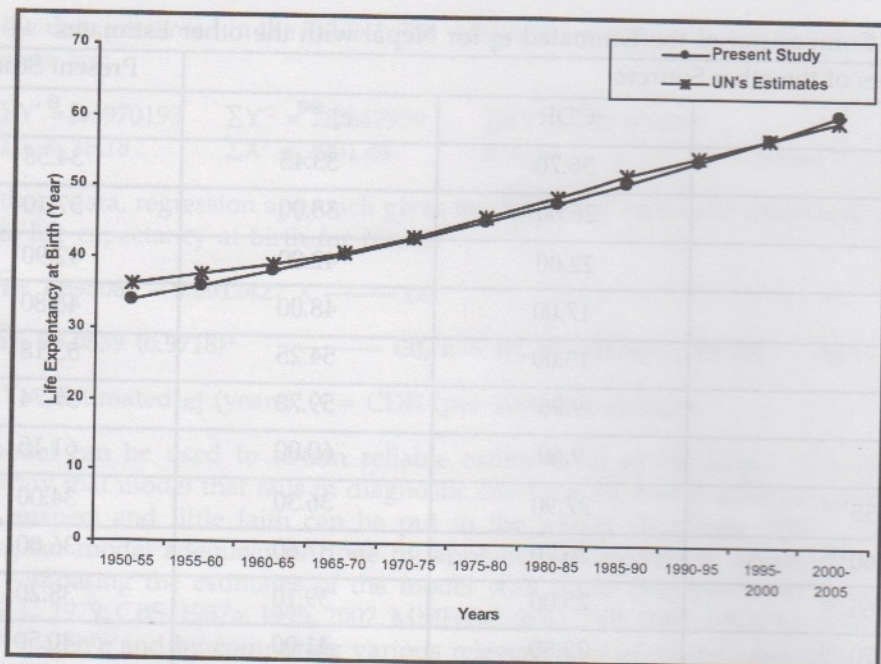


Fig. 2. Comparison of the Estimated e_0 s for Nepal with the UN's Estimates

Table 3. Tests Computed for Model Adequacy

Tests for Model Adequacy			Results®
1. Tests for Goodness of Fit:			
i. Based on Coefficient of Determination:		$R^2(\%)$	98.9627
		r	-0.9948
		n	10
2. S.E. of Estimates:			
		S.E. ($\bar{Y}$)	0.007348
		S.E. ($\bar{a}$)	0.007434
		S.E. ($\bar{b}$)	0.005120
3. Tests of Significance:			
i. Based on 't' test:			
		For $\bar{a}: t $	255.325
		For $\bar{b}: t $	2.427
		For $r: t $	39.218
		Tabulated t^*	2.306
		Tabulated t^{**}	1.860
ii. Based on ANOVA and 'F' Ratio' :			
		TSS	0.044214
		SSR	0.043785
		SSE	0.000429
		Calculated 'F Ratio'	99.0297
		Tabulated F^*	5.32
		Tabulated F^{**}	11.30
iii. Based on P.E. (r):			
		P.E. (r)	0.002

4. D-W test for Autocorrelation:	d statistic	2.047
	ρ	-0.329
	d_u^*	1.320
	d_L^*	0.879
	d_u^{**}	1.001
	d_L^{**}	0.604

Notes: * $P < 0.05$.

** $P < 0.01$.

Refers to the results of the tests computed for the model (2)

DISCUSSIONS AND CONCLUSIONS

The figures 1 and 2 clearly show increasing trends of the estimates of e_0^* for Nepal over the periods as is usually expected. More importantly, the figures show strong agreement between the estimated e_0^* s for Nepal with the other estimates. For instance, the estimated e_0^* for Nepal is 61.15 years for the recent year 2003 which is slightly higher than the e_0^* of 60 years provided by the ESCAP (2003). However, they also show slight disagreement between the estimated e_0^* s and the other estimates at distant past especially before 1980, which may be attributed to the limitations of the data source. In summary, the model seems to provide quite satisfactory estimates of e_0^* for more recent periods than for distant past.

The suitability of the model is also evident from the results of some major tests shown in the Table 2. The model may be considered significant for estimation purpose at $P < 0.05$ and $P < 0.01$ as it satisfied various tests of model adequacy. For instance, the computed value of R^2 (= 98.96%) is considerably very high which indicates the goodness of fit. Similarly, the computed value of S.E. ($\sqrt{Y}$) [= 0.007348] is very small which indicates the reliability of the model.

The goodness of fit of a regression model is mostly affected by the estimated values of parameters. In our case, the estimated parameters and the model may be considered significant at $P < 0.05$ and $P < 0.01$ as calculated $|t|$ for a_1' (= 255.325) is evidently greater than the tabulated t^* (= 2.306) and t^{**} (= 1.860) for $n - 2$ (= 8) degrees of freedom. This is also true for the remaining estimated values of the parameters. Similarly, the calculated 'F ratio' (= 816.88) is evidently greater than the tabulated F^* (= 5.32) and F^{**} (= 11.30) for (1, 8) degrees of freedom and therefore, the regression model may be considered significant at $P < 0.05$ and $P < 0.01$. Additionally, the results of D-W test clearly show the absence of autocorrelation in the residuals at $P < 0.05$ and $P < 0.01$ because the condition for the absence of autocorrelation:

$$d_u < d < 4 - d_u \text{ is well satisfied.}$$

For instance, d_u^* (= 1.320) $< d$ (= 2.047) $< 4 - d_u^*$ (= 2.680)

$$d_u^{**}$$
 (= 1.001) $< d$ (= 2.047) $< 4 - d_u^{**}$ (= 2.999) are well satisfied.

The suitability of the model is further enhanced in Nepal's context because the model is simple and easy to apply; does not require census or survey data for estimation of ; and

gives approximately reliable estimates for Nepal. The proposed model has some problems too. The main problem with the model is that it uses CDR which is affected by the age structure of population. Besides, the accuracy of the estimates is highly affected by the accuracy of CDR used. Conclusively, the model may be considered suitable for estimating for Nepal for few decades.

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BACHELOR LEVEL STUDENTS OF NEPAL ENGINEERING COLLEGE

Their Ethnic/Caste, Gender and Geographic Distribution

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1.0 Introduction

Nepal Engineering College (NEC), the first private sector pioneering college established in 1994, currently boasts of five faculties and an impressive number of students (900) and teachers with 40 permanent faculties. Nepal Engineering Students' Council (NESCO), the student welfare outfit of NEC wholly managed by the students' representatives themselves, has come out with a booklet. This booklet entitled *Memory Lane Biographics of Students of NEC Batch (1999)* provides biographical information about 182 bachelor level students of NEC. The 182 students include 67 students from the Faculty of Civil Engineering, 27 and 36 students from the Faculty of Computer Engineering, spring batch 1999 and fall batch 1999 respectively, and 21 and 31 students from the Faculty of Electronics and Communication Engineering, spring batch 1999 and fall batch 1999 respectively.

The researchers have attempted to analyze the information included in the booklet for this paper. They have mainly focused on the information relating to the students' ethnic/caste affiliation, gender and geographic region.

2.0 Ethnicity/Caste

2.1 Distribution of Students of Civil Engineering Faculty by Ethnic/Caste Affiliation

Faculty	Ethnicity	N = 67	Percentage
Civil Engineering-'99	Brahmin	24	36
	Chhetri	9	13
	Newar	29	43
	Tharu	1	1
	Others	4	6

In the Civil Engineering Faculty, the largest segment (43%) of students hails from Newar community. They are followed by Brahmin students (36%) and Chhetri (13%). Tharu and other indigenous and economically disadvantaged groups have only 7% of students in the Civil Engineering Faculty.

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2 Mr. Gupta, a civil engineer, is associated with CMS.

2.2 Distribution of Students of Computer Engineering (Spring Batch-'99) Faculty by Their Ethnic/Caste Affiliation

Faculty	Ethnicity	N = 27	Percentage
Computer B.E. (Spring Batch-'99)	Brahmin	10	37
	Chhetri	0	0
	Newar	13	48
	Tharu	1	4
	Others	3	11
Total		27	100

Also in the Computer Engineering Faculty (spring batch 1999), the largest segment (48%) of students hail from Newar community. They are followed by Brahmin students (37%). There is no Chhetri student in this batch of students. Tharu and other indigenous and economically disadvantaged groups have 15% of students in this faculty.

2.3 Distribution of Students of Computer Engineering (Fall Batch-'99) Faculty by Their Ethnic/Caste Affiliation

Faculty	Ethnicity	N = 36	Percentage
Computer B.E. (Fall Batch-'99)	Brahmin	15	42
	Newar	8	22
	Chhetri	4	11
	Tharu	0	0
	Others	9	25
Total		36	100

In the Computer Engineering Faculty (fall batch), the largest segment (42%) of students hail from the Brahmin community. They are followed by Newar (22%), and Chhetri students (11%). In this batch, other indigenous and economically disadvantaged groups have 25% of students.

2.4 Distribution of Students of Electronics and Communication Engineering Faculty (Spring Batch-'99) by Ethnic/Caste Affiliation

Faculty	Ethnicity	N = 21	Percentage
Electronics and Communication Engineering (Spring Batch-'99)	Brahmin	9	43
	Newar	6	29
	Chhetri	4	19
	Tharu	0	0
	Others	2	10
Total		21	100

In the Electronics and Communication Engineering Faculty (spring batch), the largest segment (43%) of students hail from the Brahmin community. They are followed by Newar (29%), and Chhetri students (19%). In this batch, other indigenous and economically disadvantaged groups constitute 10% of students.

2.5 Distribution of Students of Electronics and Communication Engineering Faculty (Fall Batch-'99) by Ethnic/Caste Affiliation

Faculty	Ethnicity	N = 31	Percentage
Electronics and Communication (Fall Batch-'99)	Brahmin	13	42
	Newar	7	23
	Chhetri	3	10
	Tharu	1	3
	Others	7	23
Total		31	100

In the Electronics and Communication Engineering Faculty (fall batch), the largest segment (42%) of students hail from the Brahmin community. They are followed by Tharu and other indigenous and economically disadvantaged groups, which constitute 26% of students. Newars come third in terms of their share (23%), followed by Chhetri students (10%).

3.0 Gender and Geographic Background

The distribution of students in the three Faculties of Civil, Computer, Electronics and Communication Engineering was further analyzed in terms of their gender and geographic background. The geographic background was divided into two categories, Kathmandu Valley and Out-of Kathmandu Valley.

3.1 Distribution of Students of Civil Engineering Faculty

Faculty	Gender N = 67	Kathmandu Valley	Out of Kathmandu Valley	Percentage of Kathmandu Valley		Percentage of Out of Kathmandu Valley		Percentage of Gender
				Male	Female	Male	Female	
Civil Engineering- '99	Male	31	29	46	-	43	-	89
	Female	6	1	-	9	-	2	11
Sub Total		37	30					100

Table 3.1 shows that 90% of civil engineering students are male. A slightly larger percent (46%) of male students come from Kathmandu Valley than Out-of-Kathmandu valley (43%). As compared to two percent of female student coming from Out-of Kathmandu Valley, 9% percent belong to Kathmandu Valley.

3.2 Distribution of Students of Computer Engineering Faculty (Spring Batch-'99)

Faculty	Gender N = 27	Kathmandu Valley	Out of Kathmandu Valley	Percentage of Kathmandu Valley		Percentage of Out of Kathmandu Valley		Percentage of Gender
				Male	Female	Male	Female	
Computer Engineering (Spring Batch-'99)	Female	8	0		30		0	30
	Male	11	8	40		30		70
Total		27						100

In Computer Engineering Faculty (Spring Batch 1999), male students constitute 70%. But as compared to Civil Engineering Faculty, which was attended by only 10% of female students, Computer Engineering Faculty had 30% of female students. Forty and 30% male students came from Kathmandu Valley and Out-of Kathmandu Valley respectively. In case of female students, each and every one belonged to Kathmandu Valley (Table 3.2).

3.3 Distribution of Students of Computer Engineering Faculty (Fall Batch-'99)

Faculty	Gender N = 36	Kathmandu Valley	Out of Kathmandu Valley	Percentage of Kathmandu Valley		Percentage of Out of Kathmandu Valley		Percentage of Gender
				Male	Female	Male	Female	
Computer Engineering (Fall Batch-'99)	Male	18	12	50		33		83
	Female	4	2		11		6	17
Total		36						100

The fall batch of Computer Engineering Faculty had larger percentage of male students (83%) as compared its spring batch (70%). The female student's percentage was 17% in this batch (Table 3.3), which was 13% less than in the previous admission session.

3.4 Distribution of Students of Electronics and Communication Engineering Faculty (Spring Batch-'99)

Faculty	Gender N = 21	Kathmandu Valley	Out of Kathmandu Valley	Percentage of Kathmandu Valley		Percentage of Out of Kathmandu Valley		Percentage of Gender
				Male	Female	Male	Female	
Electronics and Communication Engineering (Spring Batch-'99)	Male	11	9	52		43		95
	Female	1	0		5		0	5
Sub Total		12	9					
Percentage		57	43					100
Total		21						100

In the spring batch of Electronics and Communication Engineering Faculty, 95% of the students were male. Fifty two percent of this population came from Kathmandu Valley and 43% from Out-of Kathmandu Valley. Female students of this batch constituted five percent of the faculty and all of it came from Kathmandu Valley.

3.5 Distribution of Students of Electronics and Communication Engineering Faculty (Fall Batch-'99)

Faculty	Gender N = 31	Kathmandu Valley	Out of Kathmandu Valley	Percentage of Kathmandu Valley		Percentage of Out of Kathmandu Valley		Percentage of Gender
				Male	Female	Male	Female	
Electronics and Communication Engineering (Fall Batch-'99)	Male	15	14	48		45		93
	Female	2	0		7		0	7
Sub Total		17	14					
Total		31						

Male students formed 93% of the total intake in Electronics and Communication Engineering Faculty fall batch. About equal percentage of their population (48% and 45%) came from Kathmandu Valley and Out-of Kathmandu Valley. Only seven percent of female students were in this faculty and they all came from Kathmandu Valley.

4.0 General Findings

Analysis of information in the above tables brings out the following general findings:

4.1 Ethnicity/Caste Affiliation

- Newar as a separate caste group has the largest number of students in the Faculties of Civil and Computer (spring batch-1999) Engineering. The percentage of Newar population in the national census 2001 was 5.48%. In the college 34.62% Newar students were enrolled in batch - 1999.
- Brahmin as a separate caste group has the largest number of students in the Faculties of Computer (fall batch-1999), Electronics and Communication (both spring and fall batches -1999) Engineering. The percentage of Brahmin population in the national census 2001 was 13.33%. In the college 39.01% Brahmin students had been enrolled in batch - 1999.
- Except in Computer Engineering (spring batch-1999), where they had zero entry, Chhetri students constituted the third largest number in all the faculties under this study. The percentage of Chhetri population in the national census 2001 was 15.80%. In the college 11.00% of Chhetri students had been enrolled in batch - 1999.
- If the students from Tharu and other indigenous and economically disadvantaged groups are taken together, they replace Newar students as the second largest group in the Faculties of Computer Engineering (fall batch-1999), and Electronics and

Communication Engineering (fall batch-1999). The percentage of Tharu population in the national census 2001 was 6.75%. In the college 1.65% Tharu students had been enrolled in batch - 1999.

- The students from Tharu and other indigenous and economically disadvantaged groups constituted the second largest group in the Faculty of Computer Engineering (spring batch-1999).
- The students from Tharu and other indigenous and economically disadvantaged community constituted the smallest group in the Faculties of Civil Engineering and Computer Engineering (spring batch-1999). The percentage of other population in the national census 2001 was 58.64%. In the college 13.74% other students were enrolled in batch - 1999.

Ethnic distribution of national population and its proportion vis-à-vis the enrolled college student during batch-1999 is presented in the following Table 4.1

Table 4.1 Distribution of Students Based on Caste/Ethnicity vis-à-vis Population Census 2001

Ethnicity/ Caste	Students Batch 1999		National Population Census 2001	
	Total No. of Students	%	Total Population	%
Newar	63	34.62	3030973	5.48
Brahmin	71	39.01	1245232	13.33
Chhetri	20	11.00	3593496	15.80
Tharu	3	1.65	1533879	6.75
Others	25	13.74	13333354	58.64

4.2 Gender Distribution

The largest (30%) percentage of female students was in Computer Engineering Faculty (spring batch-1999). It was followed by Faculty of Computer Engineering (fall batch) with 17%, Civil Engineering 11%, Electronics and Communication Engineering 7% (fall batch-1999), and Electronics and Communication Engineering (spring batch-1999) 5%. Larger number of female students were more interested in getting involved in relatively new disciplines such as Computer Engineering than the traditional ones (Civil, Electronics).

4.3 Distribution by Region

There is representation of the students from the Kathmandu Valley as well as from outside the Kathmandu Valley in all faculties of NEC. On an average, the percentage of students is 59.6% from Kathmandu Valley and it is 40.4% from outside the Valley. The male students are better distributed in terms of regional representation (from the Kathmandu Valley and Out-of-the-Kathmandu Valley) in all the three faculties under the study. There were no female students from outside Kathmandu Valley in the faculties of Computer Engineering (spring batch-1999), and Electronics and Communication Engineering (spring and fall

batches-1999). Six percent was the highest percentage of the female students who came from outside Kathmandu Valley to join the Faculty of Computer Engineering (fall batch).

5.0 Recommendation

- As per the college records of admission in the Faculties of Computer Engineering (fall batch-99) and Computer Engineering (spring batch-99), Tharu and other indigenous and economically disadvantaged groups are more concentrated in the Faculties of Computer Engineering and Electronics & Communication Engineering. This indicates need to review the existing policies of granting scholarship to such categories of students to encourage them for enrollment in other faculties as well.
- Due to practical difficulties females are generally reluctant to be involved in Civil Engineering. They are found to be more interested in Computer Engineering. This fact should be considered in a practical way.
- Provision should be made to encourage female students even from outside Kathmandu Valley.

Note:

Caste and ethnic group of the students enrolled are classified as follows:

Brahmin

Adhikari; Bhatt; Dahal; Dhakal; Devkota; Dhungana; Ghimire; Mishra; Kaphle; Sharma; Pandey; Poudel; Prasai; Sapkota; Khaniya; Sigdel; Bastakoti; Bhattra; Acharya; Gautam; Koirala; Khanal; Baral; Nepal; Simkhada; Lamichhane and Regmi.

Chhetri

Khadka; Thapa; G.C.; Swar; and Basnet.

Newar

Shrestha; Dangol; Mathema; Tamrakar; Ranjitkar; Tuladhar; Manandhar; Shakya; Singh; Maharjan; Joshi; Kayastha; Gopaju and Byanju.

Tharu

Chaudhary.

Others

Das; Shah; Giri; Godar; Sai; Rai; Lama; Jaggo; Air; Dev; Srivastav; Gauchan and Gurung.

THE IMPACT OF INFORMATION TECHNOLOGY AS A KNOWLEDGE MANAGEMENT INITIATIVE ON CORPORATE PERFORMANCE

K.N.H.P. Liyanage¹ and K.O.D.D. Fernando²

ABSTRACT

Information Technology (IT) is said to play a significant role in Knowledge Management (KM). Yet there is little research that focuses on how IT as an enabler in KM Initiatives influences the overall performance of organizations. This paper presents a model that depicts the relationship of three key factors namely, IT Infrastructure, Corporate Knowledge Base and usefulness of the system with the performance of organizations. To explore this, an empirical study was done in the Sri Lanka Bureau of Foreign Employment (SLBFE), which is the regulator of the foreign employment industry of Sri Lanka. The results revealed that there exists a clear relationship between the success of KM efforts and usage of IT. Furthermore, the study also confirmed IT needs not only to be available, but it may require significant organizational and technical interference.

Keywords: Knowledge Management, Information Technology, and Corporate Performance

1. INTRODUCTION

The practice and the application of knowledge management create remarkable results in any organizational context. The concept of knowledge itself is not new. The desire of mankind on acquiring new knowledge created different laws & regulations, philosophies and social norms. The roots of the epistemological foundation of organizational knowledge management are philosophy, religion and psychology. Psychology deals with the role of knowledge in human behaviour, economics and social psychology depicts the role of knowledge in the life of society and business and organizational theory related to work and its organization. Religion and psychology describe the role and meaning of knowledge. There exist two types of knowledge and one is explicit knowledge that is "transmittable in formal, systematic language" and can be stored in specification, reference manuals and company handbooks etc, (Nonaka & Takeuchi, 1995) and the other is tacit knowledge or personal knowledge rooted in individual experience and involving personal belief, perspectives, and values (Polanyi, 1962).

As such, all sorts of Knowledge Management (KM) practices deal either with tacit, explicit or both types of knowledge components. It is a hard challenge to scan the human mind and its sense making capabilities, as most individuals may know more than they think they know. This is very relevant to their information processing and decision making capabilities that relates to non-routine and unstructured phenomena. The meaning of making capacity building of human mind facilitates dynamic adaptation of tacit knowledge to new and unfamiliar situations that may not fit previously recognised templates. Once

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data is accumulated different people may access it at different times or in different contexts. Hence, storing explicit static representations of an individual 'tacit' knowledge in technology databases and computer algorithms may not exactly represent capturing their dynamic sense making capabilities. As such, proper identification of the types of the knowledge available for right context is vitally important, for the better performance of an organisation.

2. ORGANISATIONAL KNOWLEDGE

Many researches attempted to identify the existence of organizational knowledge. Argyris and Schon (1978) as well as March (1991) point out that organizational learning is about aligning its knowledge with external reality. Organisational knowledge can exist in individuals, or it can be an organisation wide phenomenon, such as an organisational routine (Cohen, 1996). Through routines and standard procedures, organizations attempt to memorise valuable facts and findings. It also learns by institutionalising individuals' beliefs when they correspond better with reality than the organization's prior beliefs. Individuals are socialised by organisations and it causes them to learn a lot. They also learn from their own experience.

Spender (1994) concludes in his research that collective knowledge is not merely shared individual knowledge and is likely to be embedded in the organization's institutionalised collective practices. Different forms of organizational knowledge are given in figure 1.1.

	Individual	Social
Explicit	Conscious	Objectified
Tacit	Automatic	Collective

Fig.1.1 Different forms of Organisational knowledge

In organizational functions, it is frequently needed to transfer the knowledge that resides in one level, among the others for better results. Transfer of knowledge from one form to another form of knowledge may or may not change the previous type. Nonaka and Takeuchi (1995) have suggested that knowledge is created through the interaction between tacit and explicit knowledge through four different modes. These modes are socialization, externalisation, combination and internalisation. Socialisation converts explicit into tacit while externalisation changes tacit into explicit knowledge. Combination converts explicit to explicit while the internalisation changes explicit to tacit knowledge.

3. KNOWLEDGE MANAGEMENT INITIATIVES

A knowledge management initiative takes time, money and commitment. An ongoing measurement of the program's achievements will show that it can pay for itself and even start deriving revenue to the company.

There exist a number of enablers such as corporate culture, leadership, measurements and IT etc., that support KM initiatives and which is also needed to provide enterprise wise delivery, distribution and integration of digitally encoded content, and support for

the tacit knowledge transfer and sharing that take place in communication and collaboration (Raftt, 1998).

The progress of KM initiatives needs to be continually monitored to ensure progress toward their objectives. Technology that harnesses tacit skills, database repositories and programs that facilitate a culture of knowledge transfer and sharing are considered as effective KM initiatives for the success of organisations. (Davenport & Prusak, 1997).

In the existing reality of hierarchical and conservative organizations, it may be necessary to actively change the organization's culture. The leadership enabler consists of the will and decision-making required from top management to promote and support the KM effort as a top level strategic goal of the enterprise, with individuals hired and compensated for their measurable contribution to the development of organizational knowledge. However, this paper focuses on the role of IT as an enabler in KM initiatives.

4. INFLUENCE OF IT ON CORPORATE PERFORMANCE

The knowledge matrix of Spender (Fig. 1.1) describes four distinct variations of knowledge namely conscious, objectified, automatic and collective. Furthermore four different models of Nonaka and Takeuchi (1995) were identified. The So-called theories can be visualised by the matrix shown in figure 1.2.

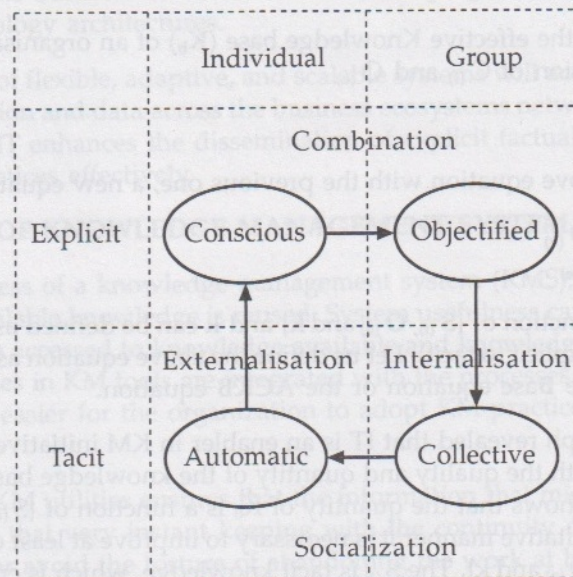


Fig. 1.2 Static and dynamic features of corporate knowledge

The modified matrix shows, a part of the objectified knowledge, which are available in documents, records, computer systems etc, are transferred into collective knowledge as a result of internalisation and let us define such knowledge as Transformed Knowledge $T_{(t)}$. Even after internalisation, new knowledge is created in the minds of people due to their mental capabilities and let us denote such knowledge as Successive Knowledge $S_{(t)}$.

As such the total collective knowledge, which is in tacit form, is a collection of those two knowledge components.

$$C_{(t)} = T_{(t)} + S_{(t)}$$

Where $C_{(t)}$ is Collective knowledge, $T_{(t)}$,

Transformed knowledge, $S_{(t)}$, Successive knowledge and t denotes tacit.

4.1 IT AND CORPORATE KNOWLEDGE BASE

It is a known fact that internalisation transfers only a fraction of objectified knowledge as transformed knowledge. Thus this phenomenon can be formulated as follows.

$T_{(t)} = k O_{(e)}$ combination of equations forms a new equation as follows.

$$C_{(t)} = S_{(t)} + k O_{(e)}$$

Corporate Knowledgebase (K_b) is the accumulated knowledge within the organisation, which guides and directs it to achieve its goals and objectives. The conscious and automatic types of knowledge in Fig.1.1 are related to personal attributes, such as determination, promptness etc, of an individual. As such the corporate knowledge which is considered as synergetic knowledge for organisational proceedings rather than interests of individuals, heavily depends on the other two forms of organisational knowledge namely, objectified and collective knowledge.

Thus we can assume the effective Knowledge base (K_b) of an organisation at any time is given by the summation of $C_{(t)}$ and $O_{(e)}$.

$$K_b = C_{(t)} + O_{(e)}$$

By combining the above equation with the previous one, a new equation can be formed.

$$K_b = S_{(t)} + k O_{(e)} + O_{(e)}$$

$$K_b = S_{(t)} + (1+k) O_{(e)}$$

This shows K_b as a function of $\{S_{(t)}, O_{(e)} \text{ and } k\}$ and k can be defined as the transfer factor of knowledge (from explicit to tacit). Let us define the above equation as the Approximated Corporate Knowledge Base equation or the ACKB equation.

The previous paragraph revealed that IT is an enabler in KM initiatives. As such the role of IT is to improve both the quality and quantity of the knowledge base of organisations. The ACKB equation shows that the quantity of K_b is a function of $\{S_{(t)}, O_{(e)}, k\}$. Hence to improve K_b , in a quantitative manner it is necessary to improve at least one of the variables in the group of $\{S_{(t)}, O_{(e)} \text{ and } k\}$. The $S_{(t)}$ is tacit knowledge, which is created in the minds of people. Hence it is considered as an independent of IT. However $O_{(e)}$ is a dependent of IT as IT infrastructure has an impact on the ways of storing explicit knowledge. IT also supports transfer of knowledge and thus k is also considered as a dependent of IT. As such the argument concludes that IT, as an enabler has an impact on the knowledge base of organisations through its direct relationship with $O_{(e)}$ and k .

The ACKB equation shows three independent variables of K_b representing knowledge processes, namely knowledge creation, (related with $S_{(t)}$) knowledge storage or application,

(related with $O_{(e)}$) and knowledge transfer (related with k). As we know there exist three different types of knowledge processes, namely knowledge generation, knowledge production and knowledge representation. These three distinct processes are involved in the creation, maintenance and diffusion or transfer knowledge (Bloodgood & Salisbury, 2001)

4.2 KNOWLEDGE INFRASTRUCTURE

The quality of the knowledge infrastructure of an organisation is not only influenced by the technical characteristics of the components of the system but also by attributes such as ease of use, characteristics of human-computer interface, and flexibility and effectiveness of search mechanisms. The loose coupling between technology architectures is considered as a prerequisite so that existing technology infrastructure should not straitjacket the evolution of the business model.

The interlinked information technologies employed by an organization from its knowledge infrastructure is to support knowledge repositories, enhance knowledge access and to transfer and facilitate the knowledge environment (Daniel, 1999). Greater technological integration will help in achieving more efficient optimisation of knowledge harvesting. The real experience of knowledge infrastructure of organisations revealed that there is a critical need for ensuring rapid adaptation of the business performance outcomes to the dynamic shifts in the business environment while keeping them loosely coupled with pre-specified technology architectures.

The new paradigm of flexible, adaptive, and scalable systems will accommodate real time changes in information and data across the business ecosystems network (Malhotra, 2002). The application of IT enhances the dissemination of explicit factual knowledge and the sharing of best practices effectively.

4.3 USEFULNESS OF KNOWLEDGE MANAGEMENT SYSTEM

In terms of usefulness of a knowledge management system (KMS), studies examine the extent to which available knowledge is reused. System usefulness can be identified by the ratios of knowledge accessed to knowledge available and knowledge used to knowledge accessed. The utilities in KM tools are integrated with the processes of an organisation to make it that much easier for the organization to adopt KM practices. This increases the usefulness of KMS.

The integration of KM utilities ensures that the information that might be wanted by the user is available at that very instant keeping with the continuity of the processes. This will also let the user avoid the torture of abandoning the work at hand and moving out to gather information. It is very important for any KMS to capture data once and at the origin. A simple search engine allows users of organisations to extract any document from the knowledge repository. Rapid technological advance, fortunately, increased the usefulness of KM system to organizations. First, communication media such as the Internet have enhanced individual capacity to find information pertinent to the performance of daily tasks. Second, the speed with which business is conducted today has increased. By considering the characteristics of the above elements and their similarities as well as the related theories the following model has been developed (Fig. 1.3).

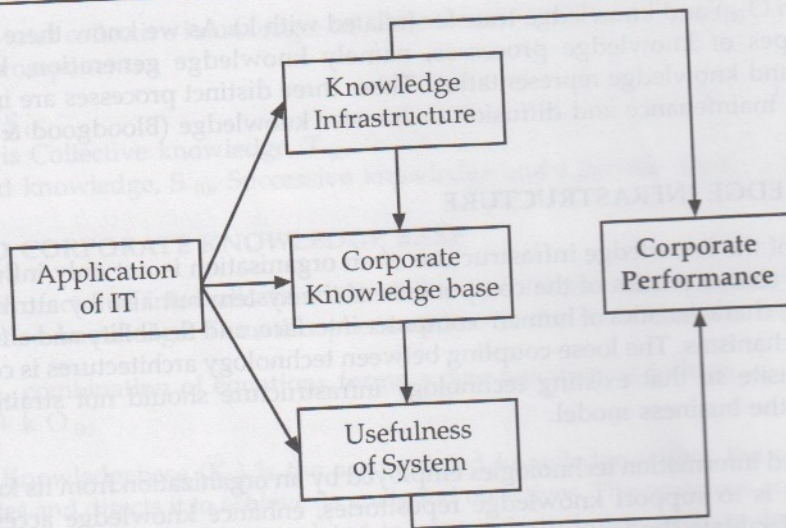


Fig. 1.3 KM initiatives, backed by IT vs. Corporate Performance

Does an increase in the breadth and depth of knowledge result in greater use of a knowledge management system and greater use of available knowledge, or contrarily, does such an expanded availability discourage usage due to the increase of time in searching? Does an increase in the breadth, depth, quality and timeliness of organizational knowledge result in improved decision-making, greater productivity or better customer services? As such it is better to see whether the efforts with regard to increasing the breadth, depth, quality and timeliness of organizational knowledge by means of IT are worthwhile.

5. FINDINGS OF THE CASE STUDY

The case study examined the impact of introducing IT, as an enabler in KM to the industry of foreign employment in Sri Lanka. The unprecedented and significant changes which have been taking place in the field of foreign employment coupled with the convergence and explosive growth of the IT left the Bureau, with little choice but to adapt itself to meet these challenges. With IT and KM initiatives paving the way for phenomenal growth and development globally, the Sri Lanka Bureau of Foreign Employment (SLBFE) too exposed its business processes to IT applications several years ago. Closer examination of the developments in the market and some of the literature available revealed that the performance of the industry is well connected with the management of knowledge accumulated within the industry. Knowledge management initiatives were underway in most countries and IT was considered as a key enabler in this regard. As such, IT was being recognised as a key driver of growth and development.

The analysis revealed that the application of IT and KM had improved considerably, albeit to a lesser extent in the rural areas, where internet facilities were not available. One of the objectives of the study was to assess the impact of IT as a facilitator for improving the nature of knowledge and by reviewing numerous secondary data sources, it was clear that the environment for knowledge processes had improved.

The empirical findings clearly indicated that the introduction of IT infrastructure has improved the quality of the knowledge processes by providing a better environment. The findings also confirmed the first hypothesis that the introduction of IT has improved the quality of the knowledge processes of the regulator to the industry of foreign employment in Sri Lanka.

The study found a heavy concentration of application of IT for easing the jobs of computer users. It also considered how to save time and to increase the independency of user with respect to the improvement of IT infrastructure. Little expansion had occurred for the benefit of the rural community. The users felt that upgrading existing technology (facilitating direct access to computer system for external users especially migrant workers and providing Optical/ Intelligent Character Recognition (OCR & ICR) facilities to avoid data entry backlogs) would benefit the network rollout. The lack of a strong universal service obligation was seen as a major weakness.

The study examined the influences on knowledgebase and customer orientation within the organisation. Evidence supported the second hypothesis that the introduction of IT has improved the quality of knowledge pertaining to the industry of foreign employment. The users confirmed that there was an increased focus on the quality of knowledge to maintain an efficient service and to satisfy customers. The degree of innovation and direct provision of knowledge were both found to have improved during the past five years. The SLBFE had taken several contributory steps in this regard. However the study found no perceived improvement in areas such as accuracy of information and feedback of external users of the knowledge system etc.

The third hypothesis was that the introduction of IT has improved the usefulness of the knowledge management system of the Bureau, for its stakeholders. In respect of capturing & integration of knowledge, the study could not establish evidence to support this hypothesis. In many instances users indicated a decrease in the creation of knowledge despite the introduction of IT. This is mainly due to the dislike of users to share knowledge.

It is also important that the persons at higher levels should not be valued because they know more than their subordinates, but for their ability to communicate with them and to facilitate the flow of ideas upwards. This is essential because there is a wealth of knowledge and experience at the operational levels waiting to be tapped to good effect (Jayatilaka, 2001). Knowledge is kept within the minds of users for their personal benefit. As such, even the introduction of IT has not made an impact on knowledge sharing. Although the role of the regulator was universally seen as crucial to the successful introduction of IT, there was no clear perception among the other stakeholders that the regulator had a positive influence on the development of the foreign employment industry in Sri Lanka. The recruitment agents are of the impression that the existing policies and regulations are outdated as far as the current environment is concerned. As such, the regulator had a negative influence on the development of foreign employment in Sri Lanka.

The overall impact of introducing IT to the Bureau of Foreign Employment was seen as a beneficial one in many respects by this study. Both the external and internal users of the KMS shared this view. It was clear that the users were pressurised to improve their

performance, customer orientation etc. as result of the application of IT. On the other hand, the individuals and groups had also benefited greatly from the application of knowledge. The evidence of the study established the fourth hypothesis that the introduction of IT has had an overall positive influence on the foreign employment industry of Sri Lanka. The application of IT, which took place in the SLBFE over the last five years, was also considered as adequate. However, further insight revealed that this was weighted more towards internal users rather than uniformly across the island.

6. LIMITATIONS FOR THE CASE STUDY

The scope of the study was limited to the knowledge management activities in SLBFE, while in reality it consists of several other players such as local recruiting agents, Sri Lankan labour missions abroad etc. many of whom are closely integrated with knowledge sharing. The sampling frame consists of all registered local recruiting agents listed in the database of agents. However, there are some agents who have not been listed in the directory either by choice or by being erroneously omitted. Many others have also been provided with IT service since then. The sample size of the direct interview was also limited to a few individuals.

The nature of the study in itself will have certain conditions when it comes to the degree of recall of historic information by respondents to the questionnaire. Recruitment of workers who preferred to work as teams was able to increase knowledge sharing culture of the organisation. Availability of equal opportunities to undergo training on the basis of meritocracy also supported KM activities. These factors too would have contributed in parallel towards the recent developments of the foreign employment industry in Sri Lanka.

7. CONCLUSION

The study leads to a few areas, which warrant further consideration. The SLBFE is facing large-scale internal and external challenges. The structures on the development service market are undergoing a radical change. With its strategic computerisation programme, the SLBFE generated an instrument for corporate development in 1998 that is designed to give initiatives geared to knowledge management on a strategic basis founded on a logically consistent concept. At the same time it was intended to identify packages of measures with which to improve the framework conditions and to generate the context required for KM to succeed. By initiating and cooperating with pilot projects and KM initiatives in the respective sectors, assurance was provided that the proposals for change have a solid footing. The change-inducing IT application programmes were considered as successful as it has generated sufficient impulses and provided sufficient orientation to make it superfluous because the initiatives had been adopted and was being pursued by management and staff both in Head office and in the regional centres.

How managers introduce KM initiatives to the Bureau, and how those managers help employees adjust to changes in their work routine- can make or break the program. The most important thing in KM initiatives is not the knowledge itself but the sharing of knowledge. Instead of gradually introducing the staff to the process of contributing information, measures have to be taken to create a campaign similar to what the firms do to gear up for new clients.

A key role for the Head of IT is to make sure every employee gets a hands-on training on IT, as it is an enabler for KM systems. If no one knows how to use new tools, even the best KM initiatives will fall flat on its face, he points out. The Head of IT can also integrate change management efforts into a KM project by recruiting thought leaders within each department. The thought leaders can ferret out frustrations, resistance and department-specific needs for a KM system, which will help IT, make the system as user-friendly as possible.

The introduction of IT has been a major step in propelling the foreign employment industry of Sri Lanka into this millennium. A clear focus on IT as an enabler in knowledge management has boosted the confidence of almost all the stakeholders and enabled them to apply the synergies of convergence to help Sri Lanka forge ahead into becoming a true knowledge based, information society.

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A TECHNICAL EVALUATION OF RENEWABLE ENERGY BIOGAS IN NEPAL

*Rhiddi Bir Singh, Ph.D**

ABSTRACT

The role and contribution of renewable energy in Nepal is reviewed with reference to the bio gas energy. The current status of bio-gas resources, production models, appliances, underlying technical facts and figures are presented. The rate of bio-gas production and its calorific value is discussed in relation to the green house gas reduction in Nepal along with the bio-gas production from 1992-2002. The natural and other renewable resources available within the country is pointed out for further extension of bio-gas plants which might need some serious consideration in policy formulation for further extension of bio-gas plants.

NATIONAL BACKGROUND

Energy is the basic resource required to meet the pace of developmental efforts of the nation. In contemporary society the relative quantity of energy will be in increasing order whether the resources are supplied internally or by import mechanism. The reliable and efficient energy supply to the 27 million Nepalese people is a serious concern to all of us. Energy consumption-wise, Nepal still relies heavily on traditional resources. The current status of energy consumption and supply in Nepal is presented in Table 1, with emphasis on residential sector domestic fuels.

The total energy consumption in 1998 comprised 89.02% from traditional fuels, 10.67% from commercial fuels and 0.29% from renewable fuels. In 2002, traditional fuels supplied 85.27%, commercial fuels 14.24% and renewable fuels 0.47% of the national fuel energy consumption.

From 1998 to 2002, the nation's total energy consumption increased at an average rate of 3.28% per annum. Energy production from traditional fuels increased at an average rate of 2.22% per year, but their percentage share decreased from 89.02% in 1998 to 85.27% in 2002. At the same time the consumption of commercial energy increased at an average rate of 11.41%. Similarly, the energy production from petroleum products increased at the rate of 6.52% per year.

Energy consumption from wood, which is the major domestic cooking fuel, is increasing at an average rate of 4.77% per year. Consumption of kerosene oil, the other cooking fuel which is exclusively consumed in suburban areas and serves as the poor man's fuel in the urban sector, is increasing at an average rate of 10.11% per year. Similarly, the major cooking fuel of urban households, liquefied petroleum gas (LPG), is also increasing at an average rate of 17.85% per year. But the net renewable fuel, the majority of which is being fulfilled by bio-gas generation mostly out of animal dung, despite forming an insignificant

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Table 1. Sectoral Energy Consumption Pattern in Nepal : 1998-2002
Expressed in 1000 Ton Oil Equivalent

Fuel Type	1998	1999	2000	2001	2002
Traditional	6402	6540	6680	6824	6997
% share	89.02	88.60	86.14	85.79	85.25
Wood fuel	5694	5816	5941	6068	6217
% share	79.17	78.85	76.61	76.28	75.78
Animal Dung	430	439	448	457	471
% share	5.97	5.95	5.77	5.74	5.74
Commercial	768	811	1044	1096	1169
% share	10.67	10.99	13.46	13.77	14.24
LPG	27	29	35	46	56
% share	0.37	0.39	0.45	0.57	0.68
Kerosene	240	251	282	269	329
% share	3.33	3.40	3.63	3.38	4.00
Electricity	83	89	99	108	121
% share	1.15	1.20	1.27	1.35	1.47
Renewables	21	25	29	34	39
% share	0.29	0.33	0.39	0.42	0.47
Total Energy	7192	7376	7754	7954	8205

Source : Water & Energy Commission Secretariat 2003.

percentage share of 0.29% in 1998 and 0.47% in 2002, is increasing significantly at an average rate of 21.39% per year.

Thus, there is a good prospect of substituting commercial cooking fuel and reducing the apparent pressure to conserve traditional fuels by increasing its efficiency through modernization, mainly based on the development, promotion and management of dung based bio-gas production.

Table 2. The Rate of Increase in Energy Production from Renewable Resources in Nepal
Expressed in Ton Oil Equivalent

	1997	1998	1999	2000	2001	2002
	15000	21000	25000	29000	34000	39000
% increment	-	40.00	19.04	16.00	17.24	14.70
Average rate of increment 21.39% per year						

Resource assessment, development and promotion of bio-fuel generation had been the core issue in the bio-fuel movement in Nepal. In this regard, the Bio-gas Support Program,

sponsored by the Netherlands Government and launched in 1992, has emerged as a successful campaign in Nepal. By the end of 2002, it had provided support in the construction of 95462 domestic bio-gas plants in 65 of the 75 districts of the nation. At present there are 123335 bio gas plants in the rural areas of the country installed between the period 1973/74 and August 2003.

Table 3. Statement of the Bio gas Production Plants in Nepal, BSP 1992-2002

Total No. of Gas Plants	95462
Average Plant Size	6. 23 m ³
Toilet Connected	60,000 Units (63%)
Annual Gas Production	45. 3 million m ³
Total Plant Volume	724 000 m ³
Annual Energy Production	900 000 GJ
Total Districts Covered	65
Basis of Methane Formation	60-70%
CO ₂ Formation	30-40%
Nature of Bio gas	20% lighter than Air
Gas Production / Kg. Dung	0. 036 m ³
Calorific Value of Bio gas	20 000 KJ / m ³
Average Gas Generation / Plant / Yr	474. 5 m ³

BIO GAS PRODUCTION IN NEPAL 1992-2002

In Nepal, 10 districts comprising Bajhang, Bajura, Kalikot, Jumla, Humla, Mugu, Dolpa, Mustang, Manang, and Sankhuwasabha do not have any bio-gas plants. The other 65 districts covering remote hills, hills and the terai are the regions where the majority of bio-gas plants have been constructed. The status of bio-gas production in Nepal is presented below.

Table 4. Status of Bio gas Plants in Nepal 1992-2002

Region	Households With Animals	Potential Bio-gas Households	Plants Built till 2002	% share
1. Remote Hills (12 Districts)	314874	139111	2592	1.86
2. Hills (33 Districts)	1005188	461340	50118	10.86
3. Terai (20 Districts)	891925	891925	42752	4.79
Grand Total	2211987	1492376	95462	6.39

Source : BSP, BIOGAS NEPAL 2002, January 2003.

In the remote hills, out of the total number of households with animals, 44.17% possessed the potential for bio-gas production but only 0.82% had actually built plants. In the hills, 45.89% of the households had the potential for bio-gas production but only 4.98% had built them. In the terai region although every household possessed the potential for bio-gas production, only 4.79% had installed such plants. At the national level, out of the total households with cattle only 4.31% possessed bio-gas plant. Thus, there is a big gap between the number of households with animals having the potential to produce bio-gas and the actual number of bio-gas plants developed so far.

If the progress is measured in terms of households with bio-gas potential, the actual number of plants built in the remote hills is 1.86%, in the hills 10.86% and in the terai only 4.79%. Nonetheless, the average number of bio-gas plants built in the country stands at only 6.39% of the total potential.

The study carried out so far indicated that in Nepal the production of dung based bio-gas was economically and technically limited only to the 65 districts. Also, because of the range in geo-climatic variations, the production of bio-gas faces regional constraints. The following table indicates the share among the three distinct geographical regions of the households with animals, potential bio-gas households and the number of bio-gas plants built so far.

Table 5. Regional Difference in Bio-gas Production Capacity

Region	Households With Animals %	Potential Bio-gas Households %	Working Bio-gas Plants
Remote Hills	14.23	9.32	2.71
Hills	45.44	30.91	52.50
Terai	40.32	59.76	44.78
	100.00	100.00	100.00

The relative percentage distribution of households with animals is very low for the remote hills at 14.23%, higher for the terai at 40.32%, but highest for the hills at 45.44%. But the figure for households with bio-gas potential shows a different trend with the remote hills accounting for 9.32%, the hills 30.91% and 59.76% for the terai.

The distribution of the functioning bio-gas plants is indicative of its unequal distribution among the different regions. The hill region comprising 33 districts had a share of 52.50%, the terai region with 20 accessible districts had a share of 44.78%, while the remote hills with 12 districts accounted for only 2.71% of the total gas plants.

Usually it is difficult to rationalize the available figures for the geographical regions without considering the numbers of districts involved. Average per district figure for the regions give the following picture (table 6).

MODEL OF BIO-GAS

The initial design of bio-gas production in Nepal was floating steel drum type, which was based on KVIC design adopted with some modifications by Gobar Gas Company (GGC).

Table 6. Average District Figure for Bio gas Production in Nepal

Region	Households With Animals	Total Potential for Bio gas	Total Production
Remote Hills	314874	139111	2592
<i>Per District</i>	26239.5	11592.6	216
Hills	1005188	461340	50118
<i>Per District</i>	30460.3	13980	1518.8
Terai	891925	891925	42752
<i>Per District</i>	44596.3	44596.3	2137.6
Grand Total	2211987	142376	95462
<i>Per District</i>	34030.6	2190.4	1468.7

The initially promoted model had a digester capacity ranging from 7-70 cubic meter.

Afterwards a fixed dome design based on the popular Chinese model was adopted by GGC with local modifications. Since the eighties various models of fixed dome type bio-gas plants of 4-50 cubic meter capacities were designed by GGC and made adaptable to Nepalese climatic conditions, particularly for rural application.

There are various models of bio-gas plants of different sizes and built of separate construction materials producing gaseous fuel for the domestic and industrial sector in Nepal. But the majority of bio-gas plants scattered in and around the 65 districts of the country, with altitudes ranging from 100 meter to 2100 meter above sea level, basically employed fixed drum type model (GGC Model 2047) promoted by GGC. All the bio-gas plants constructed by BSP employed this model with size variations from 4, 6, 8, 10, 15, and 20 cubic meter. Almost all the plants are individual household owned plants particularly for domestic fuel generation. Normally, the feeding materials for the plants are cattle dung & water but about 60,000 domestic units are connected to toilets, thereby enabling bio-gas generation out of human night soil as well.

BIO GAS APPLIANCE

Bio-gas is primarily a metabolic byproduct of the methanogenic bacteria generated in-situ during the anaerobic fermentation of the bio-mass slurry. It is not a homogenous gas but a mechanical mixture of a number of different gases at varying concentrations. Usually the cattle dung bio-gas contains methane as the major gas at 55-70%, carbon dioxide at 30-40%, hydrogen at 1-10%, air at 0.1-3%, hydrogen sulfide trace-1% and traces of carbon monoxide. However the relative percentages of these gases may vary from batch to batch and from time to time, because of differences in physical conditions, changes in chemical concentrations and other biological parameters within the reacting digester. But whatever the functioning condition, the major gas produced from the gas plant is associated with the fuel gas methane at a minimum of 50% to a maximum of 70%.

Since the dung based bio-gas contains a major portion of common fuel gas, it can be used to serve many purposes including cooking, heating, lighting, running engine, agro-processing, pumping water and generating electricity.

In Nepal the majority of bio-gas fuel is consumed in domestic cooking or heating. A very small proportion of it is being used for lighting. Although a bio-gas lamp generates a healthy environment, it incurs a slightly higher economic burden on the consumer as it burns out more mantle bulbs than a kerosene lamp. Bio-gas lanterns need fiber bulbs treated with thorium salts to extend their burning hours, which is not easily available in the market.

In some countries bio-gas has been used as a partial substitute fuel in IC engines, particularly in dual fuel diesel engines. If bio-gas can be purified to remove about 80-90% of carbon dioxide or methane content increased to above 80%, it can be directly used in automobiles provided its fuel quality is maintained. But the present conditions do not permit the application of bio-gas in engines in our context. The production of bio-gas is very limited and there is no plan, policy and provision for large scale promotion of bio-gas in the industrial sector.

METHANE PRODUCTION

The production of methane from cattle dung or organic wastes is the most tangible benefit of anaerobic digestion. But the bio-gas, which comes from the digester, is not pure methane. The quality and the composition of the bio-gas depends upon the feed materials.

The majority of the organic wastes is made up of a mixture of carbon, hydrogen and oxygen components and the resulting gas composition from their digestion is usually in the range 60-70% methane and 30-40% carbon dioxide. Invariably, bio-gas will contain other gases such as hydrogen, nitrogen, oxygen, carbon monoxide and hydrogen sulfide, the exact proportion of which depends largely on the feed stock to the digester.

The volume of bio-gas produced per weight of organic matter fed into the digester also varies. It depends upon many factors, such as the design of the digester, the temperature and the rate at which organic waste is loaded into the gas plant. In general about two-thirds of the gas is net production of fuel from the process. The net calorific value of the bio-gas obviously depends upon the relative proportions of methane and carbon dioxide, and upon the saturation of the gas with water.

When the produced bio-gas contains the normal range of 60-70% methane and 30-40% CO₂, its calorific value varies between 540-700 BTU/ ft³ (20-26 J /cm³).

The calorific value of the bio-gas can be enhanced in two ways

- if the gas is dried, and
- if the carbon dioxide is removed by scrubbing, the calorific value may approach that of pure methane.

STATEMENT OF PROBLEMS ASSOCIATED WITH BIO-GAS PRODUCTION IN NEPAL

In Nepal bio-gas production has emerged as a forerunner of all the renewable energy except perhaps hydropower generation. The total technical potential of bio-gas plant is estimated (1992) to be 1.4 million units, however total economic potential is justified for only 600,000 plants. By 2002, only 95462 plants had been installed which amounts to only

15.91% of the total. It is expected that many more domestic bio-gas plants will be built in due course of time.

Some of the shortcomings of the bio-gas promotion is categorically specified below.

1. The Rate of Bio-gas Production :

The current statement of bio-gas production based on cattle dung is specified at 0.036m^3 per kg of dung. There is a gap of information, particularly technical workouts for the rate of gas formation which is relatively low. Usually the volume of gas produced from cattle dung is lower than might be expected since a considerable proportion of cellulose, the major source of methane, has already been digested by anaerobic bacteria in the rumen of cattle. The correlation between the cellulose material present in the dung and the rate of gas formation has to be seriously considered for closer optimization of the gas formation.

Table 7. Quantities of gas produced from some typical organic wastes

Waste Type	Volume of gas Cu. ft / lb	per weight of m^3 / Kg	organic material % Methane	Volume / Animal / Day	
				Cu. ft	m^3
Pigs	6 - 8	0.37 - 0.50	65 - 70	8.4	0.24
Cattle	1.5 - 5	0.094 - 0.31	65	8.0	0.22
Poultry	5.0 - 10	0.31 - 0.61	60	0.5	0.014

2. The Density of Bio-gas :

It is stated that the density of bio-gas produced in Nepal is about 20% lighter than air. The density of bio-gas, which is valuable in monitoring its fuel characteristics, is also a factor that is important in assessing the danger of its leakage and varies with its composition.

The density of methane is 0.27 gm/liter while that of carbon dioxide is 1.98 gm/liter . The density of air is 1.29 gm/liter . When the CO_2 content reaches 45.7% of the bio-gas, the density of the bio-gas becomes equal to that of air. It is essential to analyze the concentration of gas composition of bio-gas in order to correlate the gas density with the fuel characteristics.

3. Calorific Value of Bio-gas :

The calorific value of bio-gas generated is reported to be $20,000\text{ KJ / m}^3$. But it is not specified what percentage of methane gas or other gases this corresponds to. Another report states that the bio-gas stove efficiency was found to be 52% in summer and 59% in winter seasons. The basis of analysis, heat of combustion of methane, is 8732.5 Kcal/m^3 and the volume of methane in bio-gas equals 55 percent.

The calorific value of bio-gas = 20.1355 MJ/m^3 .

The calorific value of bio-gas if assumed to be $20,000\text{ KJ/m}^3 = 20\text{ MJ/m}^3$, corresponds to 54.6% methane content, but on the other hand methane gas is reported exclusively

at 60-70% of the total volume. Thus, the calorific value of the bio-gas should be reassessed based on the correct percentage composition of the methane and other combustible gases.

4. Green House Gas Reduction :

Controlled conversion of dung into methane gas during bio-gas generation naturally prevents the serious contender for green house gas from escaping into the atmosphere. And the formal application of bio-gas as a fuel definitely reduces the emission of CO₂ gas. Thus it is stated that each kilogram of bio-gas reduces 1.5 Kg of CO₂ on fuel wood and 2.5 Kg of CO₂ on kerosene.

The dung-based bio-gas contains less than 70% of combustible methane gas. The amount of CO₂ produced by the combustion of methane can be assumed to be reabsorbed by the bio-mass, which is actually recycled in dung formation. Therefore, the carbon cycle is more or less balanced in the renewable fuel system.

But the considerable 30-40% of the CO₂ formed during the microbial bio-gas generation is a substantial green house gas, which is already present before the fuel combustion. In the workout of the CO₂ reduction by bio-gas fuel whether such quantity of CO₂ generated is properly considered or not is questionable.

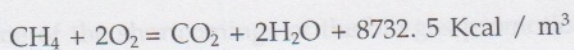
In consideration of clean development management, the net generation of CO₂ before and after the combustion of bio-gas is equally important. Therefore, the possible system approach in order to remove the CO₂ gas before the combustion of bio-gas should be worked out for the enrichment of methane gas. This shows the way ahead for the sustainable development of renewable fuel with wider prospects for CDM.

5. Further Extension of Bio-gas Plants :

Bio-gas plants are becoming popular particularly in the rural sector for the generation of fuel gas primarily for cooking purpose and to a lesser extent for lighting. But the careful consideration of bio-gas generation brings out the following figures particularly on pre-combustion CO₂ gas.

Bio-gas plants installed (1992-2002)	95462
Annual gas production	45, 300000 m ³
Volume of gas at 30% CO ₂	31,710000 m ³
Volume of gas at 40% CO ₂	27, 180000 m ³
Volume of gas at 45% CO ₂ (20 MJ / m ³ stand for 55% CH ₄)	24, 915000 m ³
Annual production of actual fuel gas	24. 915 million m ³
On an average each gas plant generates	474. 5 m ³ Bio-gas
Volume of combustible methane gas only	260. 99 m ³
Volume of non combustible CO ₂ gas	213. 52 m ³

During combustion each volume of CH_4 combines with two volumes of oxygen to produce unit volume of CO_2 and two volumes of water.



At each bio-gas plant after combustion 474.5 m^3 of CO_2 gas is released assuming the volume of methane is converted to the volume of carbon dioxide. As a result there is more CO_2 concentration at the site of the bio-gas plant, particularly around the bio-gas stove area, where health as well as CDM aspect have not been identified or studied so far. Therefore, the CO_2 scrubbing of bio-gas fuel should be seriously observed for further investigation not only from the fuel aspect but also from environmental point of view.

FEEDSTOCKS FOR BIO-GAS GENERATION

In Nepal the entire bio-gas movement was based exclusively on cattle dung. For many people the other name for bio-gas is 'Gobar Gas'. It is rather difficult for them to realize that bio-gas could be generated from resources other than Gobar, ie, dung.

The data collected in 1990-91 estimated that the total cattle and buffalo population in Nepal was 9.3 million comprising 6.3 million cattle and 3.0 million buffalo. It was also estimated that a total of 28.1 million ton of dung would be available per day for bio-gas production.

But these figures do not consider the millions of tons of domestic as well as municipal waste and the millions of tons of other renewable bio-mass that possess the potential for bio-gas generation. Besides, sizeable quantities of agro-forestry resource based industrial byproducts which can be used as feedstock for bio-gas generation has never been regarded as potential resources. Their regular and effective utilization would, however, require a major alteration in policy level decision

CONCLUDING REMARKS

The prospect of bio-gas generation based on animal dung is very much limited in the remote hills as compared to the hill or terai regions. And it is the remote hill areas which are thinly populated, geographically less accessible, resource poor and economically backward. In Nepal if there is any part of the country, which needs serious attention regarding general developmental activity or the common issue of energy resource or power production, it is definitely the remote hill area.

Therefore, it can be naturally concluded that the lack of animal based dung in the remote hills should not limit the production of much needed renewable bio-fuel such as the bio-gas, where the possibility of mainline grid connection is far from being realized and the prospect of micro-hydro as well as solar power is greatly limited primarily due to economic factors.

The lack of petroleum products or natural gas resources in the country greatly limits the domestic energy resource base. The only remaining hope regarding the internal energy development efforts has been limited to the indigenous fuel resources only. Although the

major chunk of the country's energy demand is still being fulfilled by the traditional fuel resources, their net energy efficiency is under the limit of 15-20%. This is reflected in the slow but steady takeover by the imported commercial fuels.

The feed-stocks for bio-gas production without the use of animal dung have already been implemented in Nepal by several government and private organizations.

- In Nakhu jail bio-gas for cooking purpose has been generated by employing only night soil from the toilets.
- At the Institute of Engineering, Pulchowk, bio-gas is generated from the plant out of the hostel kitchen garbage only.
- Since the last few years industrial scale generation and application of bio-gas solely based on post-fermented molasses has been in use at Shree Distillery Private Limited, Arun Khola, Nawal Parasi. The bio-gas generation plant was designed and constructed by Larson and Toubro India Limited, Bombay. The main digester tank is of 1800 m³ capacity with average feeding of 3-5 m³ per hour of spent molasses and the average gas generation rate is 0.03 m³ per hour.

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CRITICAL STUDY ON USE OF AN ECOLOGICAL INVENTORY IN URBAN PLANNING AS PREPARED BY MR. IAN MCHARG BASED ON HIS PRINCIPLE OF "DESIGN WITH NATURE"

*Prof. Bharat Sharma**

OVERVIEW

The basic proposition, employed in study of ecological inventory of the twin cities (USA) by Mr. Ian MCHARG is that any place is the sum of historical, physical and biological processes, that these are dynamic, that they constitute social values, that each area has intrinsic suitability for certain land uses and finally, that certain areas lend themselves to multiple coexisting land uses.

Once it has been agreed that the place is the sum of natural processes and that these processes constitute social values, inferences can be drawn regarding utilization to ensure optimum use and enhancement of social values and this is called its intrinsic suitability.

The method is rational and explicit and the criteria are not obscure or covert. The same conclusion will be drawn irrespective of the person accepting the method and evidence.

Mr. McHarg, who was assigned the job of urban planning of twin cities (St. Paul's – Minneapolis, USA) by the metropolitan council, strongly believes that nature should advise man as to the form and pattern of metropolitan growth. He theorizes that natural processes are expressive and these constitute natural determinants of land use.

Mr. McHarg's works respond to population growth and resulting development pressures. He states "new principles must be developed for human adaptations, for city, metropolis and megalopolis", and he strongly feels that "ecology" is emancipation to landscape architecture. The process developed by him uses the knowledge of natural sciences to planning the location and form of development. His means of achieving this is his theme of "ecosystem and its inventory". This inventory incorporates ecological concepts as community and plant succession to identify natural features as products of historical event, geology, climate, physiography, hydrology, soils plants, wildlife habitats and human land use.

The data collected on natural processes are applied to land use planning by systematically separating individual processes identifying their limiting factors, assigning value to them and eventually establishing policies. There are four major values, attributed to natural processes.

1. INHERENT QUALITIES OF THE PROCESS ITSELF, i.e., landscape is and has value for scenic beauty or education.

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2. PRODUCTIVITY OF THE RESOURCES, i.e., agriculture, forestry, recreation.
3. MAINTENANCE OF ECOLOGICAL BALANCE, i.e., water catchments, purification, storage.
4. POTENTIAL HAZARDS ARISING FROM IMPROPER USE OF NATURAL PROCESSES, i.e., negative value.

In brief McHarg's method is worth noting on the following points. One has to understand nature as a process and consequently causality is revealed. The analyst should interpret natural processes as resources and should predict and prescribe compatible communities of prospective land uses. The method provides insight into natural form of the environment and helps to understand the implication for the human made form.

THE METHOD USED IN TWIN CITIES

It started with the original proposition of Mr. McHarg that nature is a process and has value, exhibiting both opportunities and constraints to human uses. Hence major physical and biological processes that molded the twin cities region was identified as a prime job. It was required to identify for prospective land uses.

Basic data for climate, geology, physiography, hydrology, soils, plant ecology and wildlife were compiled and mapped. But these data were of very little use until they were interpreted and evaluated. For example, the general data on climate is not meaningful. But once they are interpreted and evaluated to know about flood plains and inundation, they become very useful and vital.

Thus the basic data was interpreted and reconstituted within a value system. From each of the major categories a number of factors were chosen and evaluated. For example, from geological inventory, features of geologic, scientific and educational values were identified and were graded from unique to abundant. Rocks were evaluated for foundation conditions and suitability. The same process of evaluation was done for each and every category. For certain land uses the maximum condition was preferable while for others the minimum had the highest value.

Each of the ecological criteria was mapped and then the major subject area was searched for attributes of relevance to prospective land uses. The major land use group to which the data were related were PRODUCTION including agriculture, forestry, wildlife and extractive minerals, PROTECTION including unique, scarce and vulnerable resources, RECREATION including active and passive, and URBANIZATION including residential, commercial and industrial activities. Attributes were evaluated from most to the least, with value range of 1 being highest and 5 being the least.

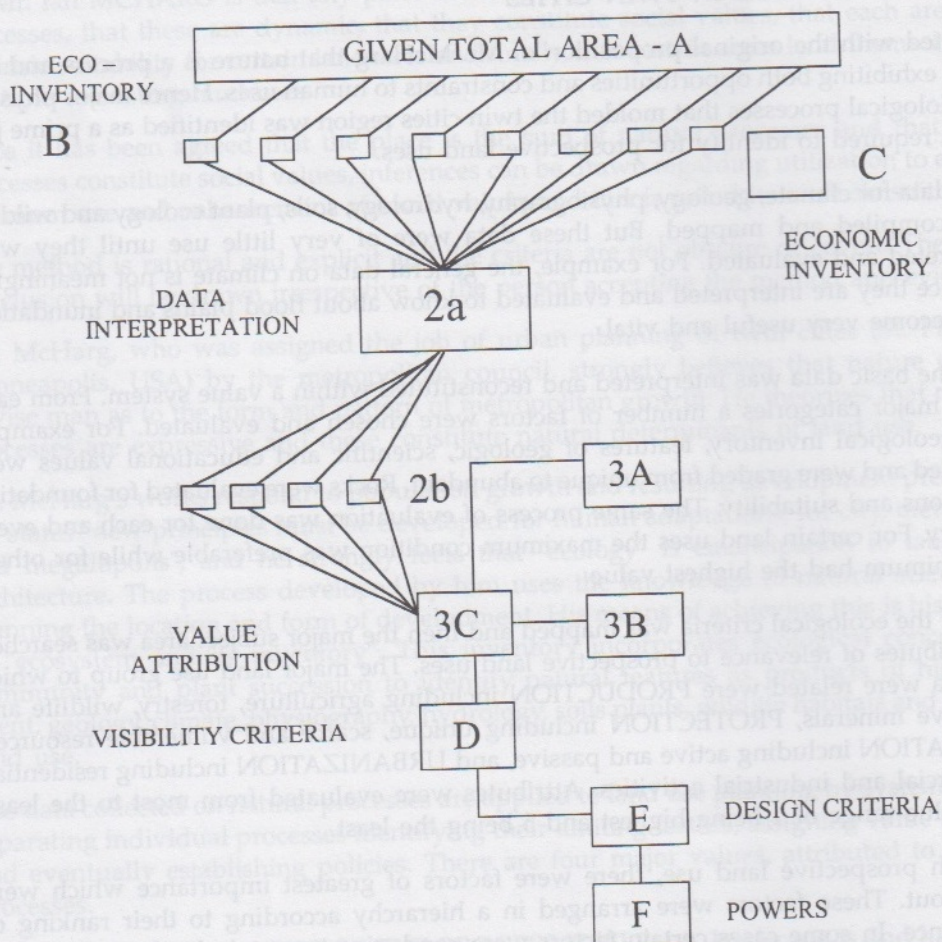
For each prospective land use, there were factors of greatest importance which were picked out. These factors were arranged in a hierarchy according to their ranking of importance. In some cases certain factors were conducive to certain land use but were restrictive to others.

An intrinsic suitability map for each of the four land uses, namely production, protection, recreation and urbanization was prepared.

The final intention of the study was to produce a SYNTHESIS of the data to reveal not only single intrinsic prospective land use but complementary and competitive uses. To achieve this a synthesis map was prepared. The method employed was preemptive value judgment. The rank order used for this purpose was respectively, PROTECTION, URBANIZATION, AGRICULTURE, ACTIVE RECREATION, FORESTRY and EXTRACTION.

A matrix was prepared in which all the land uses were indicated in each coordinate. Those, which were compatible if coexisting, were so identified as those which were incompatible. The procedure of mapping followed the hierarchy of rank order.

The map was an elaborate mosaic and professed diversity appropriate to variety of requirements. The map reflected opportunities and constraints and showed implications for the pattern of metropolitan growth.



MR. McHARG'S PROCESS DIAGRAM, USED IN THE STUDY OF TWIN CITIES, METROPOLITAN AREA

DESCRIPTION OF PROCESS DIAGRAM

- (A) Total study area A – it may vary in size within this area. Sub-areas are delineated on the basis of physiography.
- (B) An ecological inventory is prepared.
 - (i) Natural & Cultural features are inventoried and mapped – namely CLIMATE, GEOLOGY, PHYSIOGRAPHY, HYDROLOGY, PEDOLOGY, PLANTS, WILDLIFE and LANDUSE.
 - (ii) Inventoried data are interpreted to reveal dominant prospective land uses for each delineated area.
 - (a) Interpretation of relevance of data to broad range prospective land uses. All the eight categories of inventory are examined for their positive, negative and neutral effects on each prospective land use.
 - (b) Intrinsic suitability maps are prepared which would indicate the best individual uses for each area within study area.
 - (iii) A value is attributed to every land area. First, it is ascribed for single dominant land use and then to all possible compatible uses.
 - (a) Value of each intrinsic resource is rated. All the intrinsic resources are mapped in scale of values on transparencies and superimposed, resulting in a composite map showing area of least social value in lightest tone and area of highest social value in darkest tone.
 - (b) Compatible & incompatible land uses are separated with the help of a matrix which helps to measure degree of compatibility between existing and prospective single land use and all other land uses. The maps show present and prospective land uses in associations of compatibility with dominants and co-dominants.
 - (c) The final phase is synthesis of various data, the objective being to reveal the maximum conjunction of coexisting land uses that can be sustained by each area within the total area.
- (C) **Economic Inventory:** Mr. McHarg looks at supply and demand as separate issues and is more concerned about problem of supply.
- (D) **Criteria for Visibility:** Mr. McHarg attaches visual values to consequences of proposed land uses.
- (E) **Criteria for Design:** Positive guidelines for the form of prospective land uses are decided. The plan for this will demonstrate consequences of ecological method to the forms of building spaces and their distribution within study area.
- (F) **Necessary Powers:** Acquisition of regulatory powers is a must to accomplish planning objectives. Plan being realized for public interest must be provided with powers to undertake revenue producing activities and other capital improvements.

CRITICAL REVIEW OF THE STUDY

- (1) Mr. McHarg stresses on conception of complementary land uses, which support more than one use. This seems to be in total contrast with zoning principles which stress on segregation of land uses, thus remaining in conflict with established and widely used method.
- (2) There seems to be some technical problems in McHarg's model. The most striking is the "ENSURANCE OF PARITY OF FACTORS". The result will be very much different if the factors are of disproportionate weights. Then there is the trouble with photographic resolutions, which he takes, because of the limits. The transforming of tones of gray into colors of equal value creates mechanical problem.
- (3) The criteria, set by McHarg, do not seem to be obscure as noticed in many other planning methods.
- (4) The study in itself is not a complete plan but consist of analytical resolutions only. The maps in the study are like mosaic.
- (5) The process seems to present some problems when marginal decisions have to be made.
- (6) As the process is totally based on overlays, there seems to be difficulty in weighing criteria if the criteria were treated with equal importance.
- (7) McHarg's study is worth contemplating, as it requires understanding of nature as a process revealing "CAUSALITY". It expects analyst to interpret natural processes as resources. The process gives insight into natural form of environment and helps to define implications for man made designs.
- (8) Despite major differences in the planning principles, McHarg seems to accept the usefulness of zoning as a police power to regulate certain orders.
- (9) In the study the difficulty in some cases to ascertain relationship of parameter to prospective land use seems unsolved.
- (10) He seems to be justified when he says that if "form follows function" is aptly applicable to organic systems, then "form expresses process or process is expressive" is far truer in the case of organic systems.
- (11) It is very likely that one could raise questions as to whether one can derive value system from a set of facts and propositions as done by McHarg.
- (12) He strongly believes in chain of causality and it seems to be implicit in what he says because where you find similar environments, you could find totally dissimilar social and economic entities.
- (13) McHarg professes that singular monism of use is inappropriate, but then what constitute the criteria for compatible land uses? When a number of compatible land uses exist together, how does one fix compatibility?
- (14) If the biophysical history of a place were to intrinsically support two quite incompatible land uses, how could one select between the two?
- (15) Mr. McHarg takes natural processes as "Planning determinants and constants", but does not seem to give much consideration to human and cultural processes.

- (16) His study on historical aspect seems to be very valid with respect to certain factors, which could have altered certain events – perhaps an eye-opener for developing nations.
- (17) He does not specify the methods to determine carrying capacity of landscape for various activities.
- (18) He seems to theorize that ecologists and economists with their disciplines should work in isolation and then compare their data for final resource management recommendations. How these recommendations would work out together seems to be vague.

DATA USED & MODE OF STORAGE

McHarg's study of the twin cities is mainly based on most graphically elaborated example of overlay analysis.

He uses a procedure of mapping the individual elements and then photographs these as transparent prints. These transparent prints of light and dark values are superimposed over each other to construct the needful composite analysis maps. He names them "Suitability Maps" and refers them to broad land use classifications, namely conservation, recreation and urbanization.

These maps are then combined as overlays with each other to produce an overall composite suitability map. Due to the range and number of composite values, the final map is displayed graphically in four different colors and eight different tones within each in preparation of the final map. It is impossible to resolve the suitability, compatibility and conflicts by superimposition and photography so the preemptive method was used. This consisted of locating all primary suitability not in competition with any other primary values and mapping them, thus preempting the appropriate areas.

This is continued with secondary and tertiary values until the summary map indicates all unitary, complementary and competing intrinsic land uses. Those indicated as coequally suitable for more than one use may either compete or coexist.

CONSTRAINTS IMPOSED BY TIME, MONEY AND DATA

As the study done by Mr. McHarg on twin cities chalks out only the "modus operandi" based on natural processes, it does not talk about constraints imposed by time, money or data. He seems to rely on the expertise and findings of scientists for these data apart from his own research and collection of information.

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RETHINKING "ARCHITECTURE EDUCATION"

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ABSTRACT

The present state of architectural education shows signs of fossilization. The expectations of the society from this profession have changed; the technology has the capacity to offer new materials and methods to give better solutions to the problems of humanity. Therefore, a rethinking of this course is unavoidable. The author has put forward some of his thoughts for improving this professional course.

PREAMBLE

Architecture education is one of the technical branches of academia, mainly started in this part of continent during the last century. It began as a draftsmanship course, which later on was upgraded to regular diploma course and since the sixties it has been developed fully as a degree course in most of the institutions. It is high time to review the course content so as to produce better-qualified architects, who can respond to the needs of modern society.

The society and the professionals have their own specific need of a qualified architect. Academic training needs to be formulated accordingly. Let us identify the needs of each of them, which will provide a sound basis for rethinking of the educational system in general and architectural education in particular.

NEED OF AN ARCHITECT

The services of an architect are required by the society for the following :

- Designing of a residence for individuals.
- Designing of Group Housing.
- Designing of Public Building.
- Designing of Commercial Building.
- Designing of an Institutional Building.
- Designing of an Industrial Building.
- Valuation of an Existing Property or Real Estate.
- Valuation for Procurement of Loan or Mortgage Purpose.
- Purchase of Property [Land or Building]
- Estimation of Cost of a Building Project.
- Estimation of Materials required in a Building.
- Additions and Alterations in a Building.
- Major and Minor Repairs in a Building.
- Renovation, Restoration and Conservation of a Building.
- Campus Master Plan and Design of Associated Buildings.
- Interior Design and its Execution.

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- Urban Design and its Implementation.
- Requirement and Procurement of Funds as per Stages of Construction.
- Requirements of Labour as per Specialty and Trade.

The professionals working in any organization, private or government, need qualified architects to design, execute and plan current and future projects. The government, Municipal or National Planning Authorities, also require such trained architects who have to work along with experts of other disciplines such as civil engineers, sociologists, economists and geographers etc.

The needs of an Office and Organization are given below :

- They need a fresh visionary mind.
- They need qualified technical assistants.
- They need a person for developing sketch designs into presentation drawings.
- They need a person to develop them into working drawings.
- They need a person to prepare working details.
- They need a person to make scaled models.
- They need assistants for structural designs.
- Technical assistance required by the Planning Commission.
- Forecasting and visualizing the future needs of the Nation and its people at large.
- Assistance in various services like electrification, sanitation, plumbing, fire, air-conditioning, landscape, interior design, etc.
- Assistance in working out quantities, estimates, finance outflow, material inflow, labor requirement etc.
- Assistance in preparation of Tender Documents.
- Assistance in site management such as site clearance, preliminary works and winding up after the completion of the project.
- Assistance in making minor changes and alterations in the drawings, working details etc. as per site condition during execution.
- Coordination between site and office, as well as between office and client, and other organizations.
- Revision of documents and preparation of completion drawings.
- Preparation of applications, various types of sanctions and permissions required during and after execution of project.

In order to make the architectural course need based, the process of rethinking is necessary on the following points:

1. Background Knowledge, Aptitude Test;
2. Curriculum:
 - [A] Core Subjects;
 - [B] Auxiliary Subjects;
 - [C] Allied Subjects;
3. Timetable;
4. Assignments;
5. Examination System;
6. Teaching Methodology;

7. Duration of Course;
8. Site Visits and Excursions;
9. Practicum;
10. Infrastructure for the Course:

BACKGROUND KNOWLEDGE

The candidate, intending to take up the course of architecture, needs specific background knowledge. The background knowledge acquired during 10 + 2 level by the candidate is sufficient for imparting architecture education. The entrant studies subjects such as physics, chemistry and mathematics, along with social sciences and language. The knowledge and sufficient practice in drawing is not imparted at the school level, which may prove to be a setback to student undergoing architecture course.

It may be timely to mention some of the points which need special attention in the school level curriculum. For those likely to take up professional courses, the subject of drawing and instrumental geometry needs to be introduced to the students along with mathematics in which theoretical geometry is taught. There are some subjects, which are learnt by the student in their junior classes such as geography, hygiene, botany and sociology. These need to be refreshed by the candidates or teachers at the higher institutes where they are taking up the architectural course.

Aptitude test has become essential as the entrants have little background knowledge about drawing lessons. The test is an examination but no formal study or input is available for its preparation. As a consequence the applicants find it difficult or vague and many times wrong candidates land up in this course.

RETHINKING OF CURRICULUM

The subjects to be taught during the course of Architecture are divided in three categories. They are **Absolutely Essential (Core)**, **Auxiliary** and **Allied** subjects. The curricula, currently in use in architecture schools, need revision so as to make them more useful to the profession. The teachers of these subjects will have to take special interest and remold the subject matter according to the needs of the time. Some changes are presented below.

ABSOLUTE ESSENTIAL SUBJECTS (CORE SUBJECTS)

The core subjects can be divided into three sub-categories: 1) Graphics 2) Design, and 3) Construction. Maximum class periods are allotted for these subjects in the teaching schedule. The auxiliary subjects are allotted relatively less class periods.

Graphics, Freehand

This subject is imparted to entrants to develop their drawing skills and express their ideas through freehand sketches. The student is taught how to draw objects three dimensionally and how to shade or render them. The assignments in freehand drawing help the candidates to visualize and illustrate objects more correctly. The study of shade and shadow in two-dimensional artwork helps to create three-dimensional effect as well as bring liveliness in the artwork. The knowledge and use of colour, in various assignments, provides an opportunity to master the rendering techniques and principles of aesthetics.

The student must be encouraged to express the concept in freehand at a reasonable scale, giving all the necessary detailed information of the project. This practice helps the person who is assisting to develop the final drawings without trouble or asking for help from the senior. The student needs to take the help of grid or graph for this type of assignments. The student is also to be trained to prepare working drawings, which are to be used during the execution of the work. The dimensions of elements and material specified and the method of construction must be properly understood so that it can be presented in the drawings.

Instrument Drawing

The vital importance of graphics is to impart training in instrument drawing. This helps student to prepare drawings, based on knowledge of geometry, combined with drafting accuracy through use of drawing instruments. This helps develop the skill of draftsmanship and drawing figures correctly in terms of dimensions, shape and graphic presentation. The mastery in the use of orthographic projection principles, which is the language to be used in years to come for academic and professional works, is gauged by this method.

The teacher should be alert and progressive and give new thought provoking and intellectual examples to the students rather than simply carrying forward past examples from one batch to another. This will keep the students on their toes and they will be able to handle a variety of problems during the course.

Art and Craft

This is the subject in which a student is encouraged to prepare three-dimensional objects by which his concept is expressed. The exercises in craft work develop the imagination. The solution of the problem is converted into a model having volume, texture and play of forms. The solution is in the form of working model or finished model for presentation to the teacher or client. The assignments are to be properly selected as per the level of class or semester. The initial years are to be used to develop the skill in handling different types of materials to be used in model making. During the advanced years the same materials are to be used for clearer comprehension of the complicated design solutions as well as in construction. The student understands the assignment better by making the model. Internal design and constructional details are to be made out of paper or cardboard and the external envelope out of transparent plastic sheet. This will elucidate the design and construction properly. The art of model making is the best tool to be emphasized during the study to arrive at the final solution. It should be extensively adopted during the course.

The logic behind the use of computer software is similar to the process adopted in model making. It allows the student to generate drawings and three-dimensional models by using various computer softwares.

Basic Design

This is the subject introduced in the early classes in most of the architectural institutions. Here the relationship between art, craft, drawing and principles of aesthetics are integrated. More freedom is available to the student to express, experiment and get exposure to

different situations as per the assignments. The collective scheme is to be seen as an artwork. The play and selection of colours, area, shape, size and verbal expression all contribute to the final result of the assignment. The warm, cool, dull and bright effect created due to use of color is to be considered for judgment. The capability to generate illusions of receding or advancing forms, creating depth or surface difference, also contributes in the complete composition work.

The student is encouraged to apply the knowledge of basic design in subsequent designs whenever the opportunity occurs. This link is neglected in advanced years, therefore, the teacher needs to keep in mind its application to design.

Architectural Design

In every architecture educational institution the curriculum of Architectural Design is similar. The subject is unfolded to the student gradually. The most common and easy to understand topics are introduced in the early years as design problems. The problems are based on function and occupancy of the space. This exercise helps the student to arrive at the space requirement and the inter-relationship between spaces as per its use. The common and circulation spaces by which the formal area, shape and size of the project are arrived at are subsequently introduced. The student is further required to introduce the structural system and the building materials and the construction method to be adopted. This gives volume to the proposal and the mass of the building is clearly visualized. The knowledge of basic design is applied and the play of masses, solids and voids are finalized at this stage.

During the advance years the same knowledge is to be applied to more compact, complicated and complex problems. The student is expected to arrive at the most proper and analytical solution to the problem, which is to be presented in correct orthographic techniques. The accuracy in the graphic presentation must be given more importance in advance years. The planning solution may be argued, but no compromise is to be made in terms of graphics. The incremental complex nature of the problem, along with the introduction of structure and services such as electrical, mechanical, plumbing, communication, acoustic, natural lighting, ventilation as well as new and different modern building material is to be integrated in the design solutions in the advance years. The design problems are to be selected and framed to enable the preparation of working drawing and working details. This also leads to the study of quantities of materials and its specifications. Such drawings are required by the professionals and other organizations.

During the advance years the student is to be exposed to various examples of space planning. It should begin with more conversant examples of space use, area required for various human activities and how to put them in one entity as a design solution. The space analysis is to be studied as per function such as usable space, storage space, structural space, space for voids, horizontal and vertical circulation space in two dimensions and also in three dimensions. The application of local building byelaws and different codes and regulations are to be considered in the final solutions.

As the course progresses the nature of complexity is to be increased and the types of problems shall include more building area to be handled by the student. The structure

and all other essential services are to be simultaneously considered in the assigned problems. The complications likely to be faced in the construction details are to be given due importance and then solutions are to be sought. The acquired knowledge in other subjects must be suitably applied and used in the expected solution by the student.

The complete proposal is to be seen as an artwork, wherein the balance, rhythm, harmony, unity and proportions etc are all taken into account. The consideration of background and foreground and relationship with the surroundings has to be included in the proposal so that it is artistic, functional, stable and matches with the surrounding environment.

The presentation of the solution in the form of accurate drawings is essential. The various plans, sections and elevations have to be correct, as the student has mastered the graphic language during the course. The art of drawing perspective views and rendering them carefully may enable the common person to understand the project better. The lay person finds it easier to understand the perspective views than the orthographic drawings.

The help of study model, using different techniques, is handy in all situations. Such models are not finished models but give a clearer understanding of the expected complications in the drawing work and assist in decision-making.

The final stage of design leads to the handling of a design project independently during the project thesis in the last year of education. It is expected to be like a live project taken up by the student. In the project thesis the student is expected to proceed from concept creation to concept conversion and its presentation in the form of drawing, structural system, and services required and written report as a complete document.

The process of design, in short, is space determination as per function, selection of structural system as per the situation and type of construction expected, recommendation of material and its specification. The solution will lead to drawings for understanding and presentation. This will be supported by area statement and various schedules as per the nature of the problem. The teacher shall keep this in mind while framing the problem.

Building Construction

In any architectural course building construction is one of the major subjects after design. This is taught right from the entry year of the course. This helps to provide training and develop understanding of the use of different building materials in construction. The geometry of solids in different forms is applied in this course therefore it offers challenge to the student to understand and master them. The students can understand the subject of Building Construction if they are encouraged to make models for their construction assignments. It becomes very easy to prepare the drawings afterwards.

Adding short notes in construction drawings greatly helps solve the difficulties, normally faced in graphical expression. Construction can be expressed even more clearly through the subject of specification of materials. This entails extensive course work, hence it is to be carried over to the final year. Building construction is emphasized in the form of drafting work than on descriptive answers. In this subject site visits under the guidance of teachers or by the students themselves is the recommended method of learning through observation.

Building Materials

The knowledge of various building materials and their use in construction is to be given during the initial years of the course. The chemical properties, manufacturing process, trade names, available products in the market, weight and size of packet etc. are to be emphasized during the learning process. Assignments are to be given through which the student is exposed to the material and its marketing in the region. The chemistry portion may be suitably dealt with in the chemistry subject. Here too, site visits under the guidance of teachers or by the students themselves is recommended.

Professional Practice

This subject is a prelude to becoming an architect. The present course content ignores the knowledge regarding land ownership, procedure of land sale or purchase. What documents are required while purchasing land or property, the name of office where the registration of the property is done and any other legal requirements to be fulfilled should be taught to the students. The important issue of public notice in the daily newspaper at the time of purchase or sale of property is to be explained in the class. The precautions to be taken regarding payment for the real estate such as advance or part or full payment by the seller as well as purchaser should be explained to the students. These are some of the points to be added in the curriculum of this subject.

Structure

The curriculum of the structure subject begins with the introduction of applied mechanics and progresses on to the structural systems and design principles. The teacher may begin from the derivation of the formulas, with their mathematical base, but their actual application in the field is even more important for the architectural students. The rule of thumb may be introduced wherever possible. The teacher should make the student aware about the theory and practice in the profession. The practical aspects of structural design are to be made clear to the student before proceeding to the theoretical aspects. The presentation and preparation of structural drawing must be included in the subject.

This subject is to be imparted with the objective of giving the students a thorough understanding of the following: [a] Load factor [b] Forces induced [c] Bending moments & shear forces developed [d] Equilibrium achieved in load systems [e] Moment of resistance [f] Shape of various members [g] Concrete mix proportions [h] Number, spacing and diameter of reinforcement bars [j] overall size of the member etc. Flexibility in the selection of size of members which will not compromise the strength of the elements and at the same time will not affect the functional aspects of the architectural design also needs to be considered. Adhering strictly to sizes prescribed by structural design can at times create obstructions in the use of space.

History of Architecture

The history of architecture is very useful in understanding the building design, construction techniques and the use of building materials by man in the past. The structural analysis of different examples exposes the student to the logical approach used in the ancient times in the construction of buildings. The explanation by the teacher about the link

between spaces, system of construction and structure in the historical examples is more useful than the study of different styles during different periods. The study of history should focus mainly on the architecture of the nation and its surrounding region. Examples from other regions are to be used as general information and may not be taught in detail. This course is also used as supporting subject to make the students understand the theory of architecture.

Interior Design

Rethinking is now a must for the introduction of Interior Design in undergraduate course of architecture as it is the need of the time. The subjects is offered as an elective subject in some institutes, but the close association of interior design with architecture must be considered for its inclusion as a core course. Conversely, less or no emphasis is required for the subjects of Human Settlement Planning, Landscape Architecture and Town and Regional Planning. These subjects are available as regular postgraduate courses in most of the institutions.

AUXILIARY SUBJECTS

Water Supply and Sanitation

The auxiliary subjects such as building services are necessary to be taught at the appropriate level. The water supply, plumbing, sanitation, electrical & mechanical services are very important in the future professional work, therefore, these must be taught in detail. The assessment of water supply for individual and family in residential and other forms of buildings, the quality and quantity of water for domestic and emergency requirements and the supply and distribution methods are to be included in the curriculum. The fittings and fixtures of the water supply system and how to repair and maintain them are also to be included in the course.

The course on sanitation should cover the methods of wastewater disposal. The assessment of quantity to be disposed and accordingly the sizes of various members required are taught. The drawing work to study the entire network in the building is assigned to the student. This will help develop confidence and is useful to workout the quantities of various materials needed during the construction.

Electrical & Mechanical Services

The knowledge of electrical services gives insight to workout the power requirements of the building as per the gadgets and equipments to be used. The techniques and methods of supply and distribution of electricity, the controlling points and location of switches and outlets are to be ascertained and presented in the drawings. Such drawings are of direct help to the executing contractors. Emphasis is to be given to the electrical requirements for domestic, commercial and industrial use. It is not necessary to study the distribution of electrical supply to a city or region, as it will be dealt with in a different course.

Building Science

Some scientific subjects based on the knowledge of physics and geography need to be taught in this course. Building science studies how heat transfer, lighting, ventilation

[natural and artificial], sound, climate and the response offered by the building material and building form are to be integrated in the design solution. The theoretical knowledge and simple graphical gadgets available for this purpose are to be taught and sufficient practice in its use is to be carried out during class work.

Building Acoustics

This subject is based on physics and the topic of sound needs to be revised in the class. The teacher with interest in music is at an advantage to teach this subject. The modifications in the shape of building, proper selection of building material and its use at proper places are very important to this subject. The constructional details in the form of drawing carry great importance.

Engineering Survey

The knowledge of survey has direct application in architecture. The student should understand and have mastery over the methods by which a plot of land is to be measured and verified from the available documents. Knowledge is needed to mark the layout of the proposed building on the ground.

Quantity Survey

This is the most practical subject of the profession but it is not given due weightage in most of the institutions. The basic knowledge is based on mathematical principles but it needs a lot of practice during the studies. It is very handy for the preparation of estimates and determining the flow of materials during the execution of the project.

It is closely linked to the subject of working drawings. The preparation of working drawings is carried out so that the calculation of quantity of material will be easy. The assignments framed for students are to be such that they are expected to consider all the materials and their sequence during construction. This will give more accurate quantities and then with the application of unit rate the estimate of the task will be arrived at. The exercises under quantity survey will train the student in the preparation of tender documents supported with proper drawings. This is missing in most of the course works.

ALLIED SUBJECTS

The subjects which are indirectly useful in the academic course need change in their approach of teaching and modification in the course content. Some auxiliary subjects are discussed below.

Mathematics

The subject of mathematics provides a systematic and step-by-step approach to analyze and resolve problems. The teacher needs to develop this capacity in a student. More importance is to be given to the topic of mensuration, statistics and methods by which concrete inferences are obtained from numerical data. The teacher of mathematics has to remold the curriculum in such a way that the course content helps the student to better understand the subject of applied mechanics and structure.

Chemistry

The subject of chemistry is to be remodeled so the candidate is aware of the hidden chemical reactions and interactions taking place between various building materials and their use in the building industry. This could include the chemistry of water for drinking and washing purposes, study of the bonding property of cement or lime in brick masonry and concrete, water quality for different social purposes, industrial uses and reuses, gardening and agriculture, fire fighting and cooking etc. The chemical properties responsible for deterioration of building materials are to be covered by the teacher for the most common building materials. The properties of materials, which promote or retard fire, may be included in the chemistry course. The teacher of chemistry has to develop the contents of the course so as to highlight the application of chemistry in the building works.

Physics

Since the subject of physics is closely related to many disciplines, the teacher has to remold the course content to enable students to follow the respective subjects more easily. The topic of heat, sound, light is to be modified to the requirements of the course of architecture. The fundamentals of heat are to be explained in detail regarding the expansion and contraction taking place in the building materials. The heat flow through various layers of building materials and its influence on the internal environment of a building or space is to be explained. The physics teacher must touch upon the fundamentals of climatic elements based on the subject of geography so that the student understands their influence on building space and materials. The fundamentals of sound should be explained in relation to its absorption, reflection and reverberation, the response of building materials to sound, sound pollution, shape of buildings etc. Light and colour, light and perception, light requirement as per visual task to be performed is to be taught in detail. The fundamentals of natural and artificial light, the perception of things as per intensity of light etc. also need to be explained.

Special subjects such as hydraulics, thermodynamics, heat transfer, applied physics and any other subject needed to make the course content more clear and understandable may be included in an appropriate manner.

Language

The teacher of humanities subjects need to modify the content of the courses to be taught to the students of architecture. The medium of instruction being English, the subject matter instead of laying stress on grammar or basic language needs to emphasize its applied form. How to write different types of reports for the architectural profession must be included in the course. The format for project report and its sequence should be taught. How to compose the report, frame aims and objectives, elaborate on the methodology and draw conclusions need to be explained. Since the architect has to understand the culture and style of living of various ethnic groups; these must be included in the tutorials. How the culture, society, civilization, economy, science and technology influence the living pattern and thus modify architecture should be explained. An economist could be invited to highlight the repercussions of economic activities in the process of development which is manifested through the architecture of the place.

The above are some of the very general statements given as an example for remolding the course content mainly for students of architecture. The list may be extended and modified further through discussions.

RETHINKING OF TIMETABLE

In general a student is expected to attend a maximum of eight periods each day for five or five and half days per week. This system provides a total of forty periods per week. The periods are also marked for lecture and lecture cum studio work as per the requirement of the syllabus. The period allotment needs some revision, especially the bunching of periods for core subjects and auxiliary subjects. The design studio periods are bunched together in batches of two and four periods at a stretch. Although this arrangement makes site visits easier and is quite appropriate for time problems, it is generally observed that more periods are being wasted or underutilized in trying to keep contact with the class, mainly after the assignment has been issued and feedback given to the class. The submission date of the project is determined by the staff and students based on the preparation of the final drawings not in the studio but at home. This is the reason maximum mistakes occur in the design graphics. These are pointed out only at the time of jury presentation. This portrays a very bad picture of the subject and an undeserved poor impression about the administration of the institution. Therefore, the number of periods could be reduced for the design subject. Making students work in the class under the supervision of the teachers can resolve this problem. This can be achieved when the scope of the design project is reduced to scaled sketch designs to be drafted in the studio just like in a time problem.

RETHINKING SYSTEM OF STUDENT'S ASSIGNMENTS

The nature and style of assignments for the class work requires rethinking. Currently the assignments prepared for a particular class is repeated for the next batch of students during the following year. This is not proper or good for the academic development of the student. The framing of assignment should be closely linked to the topics covered during lecture. This gives the student an opportunity to apply the knowledge gained from the lecture in the assignment.

The framing of the assignment should be based both on its theoretical and practical application. The initial years may have more weight on direct application of theoretical knowledge but as the course advances it is oriented towards practical aspects. The site visit may be useful for better explanation and understanding of the assignment.

The assignments can be divided in the following sub-divisions. They are: [a] Drawing assignments [b] Descriptive assignments [c] Objective question assignments [d] Matching the Statements assignments [e] Selecting the statements and expressing the answer by stating the serial number of statement from a given list of statements [f] Crossword puzzle form of assignments [g] Identifying the hidden words from the jumble of alphabets [h] Identifying the right or wrong or mistakes from the assignments, [i] Correcting the figures, drawings, statements as the case may be [j] Rearranging proper word/s or sentence/s from the jumbled statements. The teacher has a variety of choices for the preparation of assignments for each subject.

RETHINKING OF TEACHING METHODOLOGY

The teaching methods are person dependent, but some guidelines can be established to achieve some form of uniformity. Blackboard and chalk is the most common technique used in most of the institutions. The theoretical subjects are better covered by this method. In the drawing and graphics subject this method creates misunderstandings in the minds of the fresh entrant to the architecture course. The effectiveness of teaching depends upon the skill of freehand drawing on the blackboard of the teacher. If the figure drawn is correct and accurate then understanding the subject content by the student is easy. When the figure drawn is incorrect and out of proportion, understanding it becomes difficult and confusing to the majority of students. Therefore, the teacher has to be good in accurately drawing freehand on the blackboard. The teaching technique can be made more impressive by using exercises drawn on big wall charts as per the explanation of the problem. Such charts may be prepared on opaque or transparent material. They shall be drawn properly to the scale with sufficient bold size font so that backbenchers can easily see and understand them.

The use of audiovisual aids with sufficient stock of such material should be prepared by the teacher every year; at least three years stock is better for the development of the institution. Such readymade stock of assignments may prove to be very handy to the teacher for suitable rotation of assignment to every fresh batch of students. This prevents a repetition of assignment handouts and forestalls students copying from their seniors, thereby forcing them to be more involved. The use of teaching aids during normal lecture is to be reduced to a minimum because it has some disadvantages of presenting the question and answer simultaneously. This is not good for the learning process of students. The preparation of teaching aids is done separately for the basic question and the sequential steps explaining the problem. A single item may need more number of charts or slides.

The equipment, to be used in the class, are to be kept ready, with all the necessary gadgets and facilities. The classrooms may be suitably modified for this purpose. This will reduce the time for setting up the paraphernalia for the class demonstration. The most common items required are overhead projector; slide projector, electrical outlet supply socket or extension cord, laser pointer, white screen and public address system such as stand mike or collar mike and amplifier. Modern visual aids such as power point projector and necessary computer with keyboard, mouse etc. should be arranged along with teaching material as per the topic to be taught. It is recommended to carryout pre-viewing and test the sequence of the text or illustrations beforehand. This saves time and shows the sincerity and devotion of the teacher towards the subject and teaching techniques.

Giving handout to a class is a good practice. It may be in the form of points or short statements by which the complete lecture will be covered. The suggestions made in the preparation of class assignment may be useful for this purpose.

RETHINKING EXAMINATION SYSTEM

The affiliated university generally determines the examination system, including the number of university examination papers per year or semester. In most of the institutes five to six papers are offered for examination. The subject of design is assessed internally

through a panel of jury. This makes the judgment more subjective and students are never happy about it. To overcome this problem the design subject should be conducted through university examination. The normal duration of examination of three hours is insufficient for concept formulation and presentation drawings. Therefore, six hours time is preferable for such examination. In some institutions the time period for design examination increases as per advancing years. It starts from six hours and goes up to thirty-six hours for senior years. Naturally the quantity of work expected is also more for the senior years. This leads to long duration of examination and extended timetable. This may create further complications if back papers of certain students need to be accommodated.

The examination of design can be conducted by the department before the annual or semester university examination but under the supervision of the university. This can take care of back papers and the examination timetable will not be disturbed. The jury also needs to be conducted under the supervision of the university.

RETHINKING OF DURATION OF COURSE

In general the architectural course everywhere is of five years duration. This invariably creates financial burden on the parents of the students. It also imposes significant financial burden on the institution. Rethinking to reduce this extra financial burden on the parents and the institute is necessary. When all the engineering courses have been reduced from five to four years' duration, why can't the course of architecture be at par with them?

In architecture, the subjects to be taught during the academic calendar must be those that are directly concerned with architecture and fulfill professional requirements. The subjects which are unrelated may be taken out from the architecture course. This can help curtail the duration of the course. The weightage given to some of the core and auxiliary subjects can also be curtailed to bring the duration to four years. The requirement of practicum or practical training to each student provides flexibility to reduce or increase the actual academic duration. Its removal allows the course to be compressed. This is a matter to be discussed among the professionals and teachers of the institute. However, the institute needs to be cautioned that this reduction in duration of graduate course in architecture may not be accepted by universities elsewhere while giving equivalency to the degree offered as well as for the admission to higher studies. This point must be kept in mind while thinking of curtailment in duration of course.

RETHINKING OF SITE VISITS AND EXCURSIONS

Since this is a professional course, site visit by students and teaching staff for most of the subjects is very useful for better understanding of the contents of the subjects. Teachers have to explore the relationship of the topic and the site for such visits. The site visit is like a laboratory assignment in the other engineering courses. For the architecture course the institute does not require equipment and space as is needed for other courses which is especially noteworthy. The institution has to provide transport facility for site visits. The teacher's initiative plays an important role in exploring and arranging such site visits. Subjects such as Design, Building Construction, Building Material, Structural Design, Working Drawings & Detailing, History of Architecture, and various other subjects dealing with services and sciences also benefit from site visits.

Trips within the city are site visits, but those outside the city or country may be considered excursion or educational tour. Travels to various places provide opportunities to every student to study something or the other directly or indirectly. These exposures to different parts of the city or country provide better education to the individual than classroom lectures. The excursions and site visits can be combined for the junior students and may be separated for the seniors. The pre-final & final year students can take up educational tours of longer duration.

RETHINKING PRACTICUM

The exposure of the architecture student to an office environment is necessary. This is because the academic and professional environments are significantly different, even though the outputs expected are similar. In academic institutions the student is more concerned about gaining basic knowledge and obtaining good marks. The time schedule and discipline in the institute is more relaxed. The output expected in the institute encourages greater imagination and new concepts and ideas. On the other hand the office environment is based on the output and its economic return. During this training the approach of the student is to gain maximum information and knowledge. Students make an effort to take up the challenges without putting the office into any difficulty or disadvantage. At the same time the office staff observe the candidate both as a trainee as well as a professional in the making. They serve a dual role, one as experienced professionals and the other as imparting tricks of the trade to juniors. The training in-charge is expected to provide reasonable opportunities to the trainee in all aspects of the profession and help the academic institution to improve the standard of architectural education.

This training should be considered a regular subject and therefore it should have regular examination. The nature and style of the examination for practicum should be through viva or through objective, multiple choice or short answer type questions.

RETHINKING OF INFRASTRUCTURE FOR COURSE

Establishing architecture course may appear to be very easy and simple. This impression may be because no specific supporting facilities with heavy investments seem to be required to start and run this course. In reality this is not true. The basic infrastructure for this course is a drawing studio with sufficient natural light throughout the year. The area per student required for a drafting table should be reasonable so that the studio looks decent and not crowded.

Space for exhibition of studio work, black board, white screen for audiovisual projection, electrical point at proper places in each classroom is necessary. Space and equipment for building science, conservation and field laboratory is also required. Space for display of building materials with necessary storage is a good asset for the department. Photography equipment both for snapshots and movies and necessary computer support systems are necessary to keep compact records of major works of past students. The student must be given knowledge of computers and architectural software in the early years but use and application in assignments should be permitted only in advance years.

CONCLUSION

The architecture curriculum has become a century old. The number of institutions imparting architecture education has increased many times during the last century. Many attempts are being made to improve and modify the course. The need of the society has changed drastically and new challenges in building activities have been created due to technological developments during the past four decades. All of these have forced architectural academicians to rethink about the profession, which has very close and direct links with the daily lives of citizens. No single person or academician has been able to arrive at viable and positive proposals. In this regard a roundtable discussion of professionals and teachers from other disciplines is needed to rethink the architectural curriculum to make it more effective and need based.

Call for Articles

Nepal Engineering College invites for its July 2004 Edition of SCITECH Nepal journal articles on topics related to Science, Engineering and Architecture from teachers, experts and field practitioners. The articles must be original and must not have been published earlier. The maximum length of papers shall be about 2500 words including references. An abstract must be sent along with the paper. The article should be sent in a computer diskette. The articles will be reviewed and only accepted articles will be published. Rejected articles will not be returned to the authors except for original illustrations. Author/s will be paid an honorarium for accepted papers.

Authors may send their papers, along with the address for correspondence to :

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The last date for the receipt of articles is June 30, 2003. For a typical format of an article, the author is advised to refer to SCITECH Vol. 7 No. 2.