

## **Chapter 2**

### **Literature review**

#### **Introduction**

The review is divided into five sections. Section 2.1 presents an overview of the epidemiology of oral disease in Thailand. Section 2.2 presents a general review of oral health-related quality of life and incorporating sociodental approach into normative needs. Section 2.3 presents review of oral health care system in Thailand. Section 2.4 presents Universal patterns of dental caries. Section 2.5 presents Thailand dental human resources. Section 2.6 presents factors influencing dental human resources needs. Section 2.7 reviews the calculation method for dental human resources. The last section gives a summary of the literature review.

#### **2.1 Oral health status in Thailand**

The National Oral Health Survey in Thailand was first conducted by the Department of Health in 1977. Currently, National Oral Health Surveys have been carried out every five years. The oral health status of key-age groups as prescribed by the World Health Organization (WHO) were regularly reported by the Ministry of Public Health. The major dental public health problems of the Thai people, included in a national survey are dental caries, periodontal status, fluorosis, dental prosthesis status, posterior occlusal pairs, dental health behavior, sweets consumption and drinking behavior, and tobacco and alcohol consumption behavior. In the most recent survey conducted in 2007, an oral health-related quality of life measure was included.

Major findings from past surveys are summarized in Table 1 (Dental Division, Department of Health, 2008).

**Table 1: Oral health status of Thai population from the 2<sup>nd</sup> – 6<sup>th</sup> National Surveys**

Age Group	Criteria	Global Goal, 2000	Country Goal, 2000	Year of Survey				
				1984	1989	1994	2001	2007
3	% caries free				33.5	38.3	33.3	38.63
	Mean dmft				4.0	3.4	3.6	3.21
5-6	% caries free	50	30	25.6	17.2	14.7	12.5	19.36
12	Mean DMFT	3	1.5	1.5	1.5	1.6	1.6	1.55
	Mean number of normal periodontium sextants		3	1.5	1.4	1.4	1.9	2.80
18	% of persons with at least 28 teeth	85	75	65.0	79.0	66.5	71.4	72.30
	Mean number of normal periodontium sextants		2	0.9	1.3	1.1	1.4	2.48
35-44	% of person with at least 20 functional teeth		95	92.5	91.7	91.9	92.3	96.20
60 +	% of persons with at least 20 functional teeth		50	47.2	40.8	47.7	49.0	54.80
	% of person with edentulousness			16.2	20.6	16.3	8.2	10.47

On national level, the mean DMFT of 12-year-old children has remained constant at 1.5 to 1.6 from the second to the sixth National Survey. It indicated that the D component of the DMFT index has continuously decreased over time.

Contrarily, the M and F components have increased gradually (Dental Division, Department of Health, 2008). This might be an indication of higher accessibility to dental care of this population group. The DMT index of the 12-year-old group from the 2<sup>nd</sup> to the 6<sup>th</sup> Thailand National Oral Health Survey is also presented in Table 2.

**Table 2: DMFT index of 12 year-old children from the 2<sup>nd</sup> – 6<sup>th</sup> Thailand National Oral Health Surveys**

Year of Survey	Mean number of teeth per person				DMFT
	Number of Teeth Present	Decayed	Missing	Filled	
1984	23.7	1.4	0.0	0.1	1.5
1989	24.2	1.3	0.1	0.1	1.5
1994	24.7	1.2	0.1	0.3	1.6
2001	25.0	1.1	0.1	0.4	1.6
2007	24.84	0.84	0.07	0.64	1.55

The summary of the most recent National Oral Health survey are as follows:

1. In the primary dentition, which was represented by 3-year-old children, 60% of this age group suffered from dental caries. Most of these caries were untreated. One year after the completion of eruption of the primary dentition, some 3-year-old children (2.3 percent) had lost at least one of their teeth. The prevalence of dental caries in a rural area was significantly higher than those in an urban area. The prevalence and severity of dental caries in the Bangkok metropolitan area were lower than the corresponding figures for other areas of the country.

2. Dental caries is an important oral problem in a 5-year-old-age group. Eighty per cent of this group has experienced dental caries. Mean dmft in this age group is 6.00.
3. Mean DMFT of 12-year-old-children in Thailand has remained constant over the 20-years period. More than half of the teeth (54.2%) with dental caries were untreated, 41.30% have been filled and 0.5% has been extracted.
4. In the 35-44-year-old group, mean tooth loss is 3.9 per person. The corresponding number in the 60 years and above group is 18.1. The mean posterior occlusal pairs (POPs) in the group aged 35-44 are 6.95. In the elderly, aged 60-74 and 80-year-old, the mean POPs are reduced to 3.27 and 1.28, respectively. Although the number of edentate elderly tends to decrease over time, the total numbers of older edentate people were 400,000.
5. The gingival condition shows that only 18% of 12-year-old children have a normal gingival status. A majority (58.94%) of children in this age group demonstrate gingival inflammation, with or without calculus. Another 22.6% percent have calculus without gingival inflammation. The Department of Health indicated that these groups of children needed scaling to prevent gingivitis in the future. In a 15-year-old group, the prevalence of gingivitis has increased to 60.90%. Those who reside in a rural area have a higher prevalence of gingivitis (64.54%) than those who reside in an urban area.
6. Ninety-three percent of adults aged 35-44 has gingival inflammation. Some of them have already developed periodontitis. As the prevalence of periodontitis increases with age, older adults become the group with the highest prevalence of periodontitis. More than eight out of ten elderly have periodontitis with

more than 4-millimeter pockets. They are in need of some kind of treatment from dental personnel.

In this most recent survey the sample was interviewed for sweet consumption behavior, the impact of oral disease on daily performance, dental service utilization, and toothbrushing behavior in schoolchildren and adolescents. The results show that 45.5% of the respondents drank soda water from time to time. The survey shows similar findings for snack consumption and soda water consumption. The consumption of snacks and sweets was found more frequently in the 15-year-old group than in the 12-year-old group.

Some respondents in the 12-year-old group (30.8%) had some dental experiences in the previous year. A small proportion (4.3%) of them indicated that they were absent from their schools because of toothache. The mean number of days absent from school in this group was 2.5 days per school year.

About half of the 12 year-old-children (45.11%) received some kind of dental service within one year prior to the interview. Most of the respondents received their dental treatment from a public hospital or a public health center.

The proportion of 12-year-old children who brush their teeth every day was 89.62%. Approximately all of them used a fluoride toothpaste. These children brushed their teeth an average of 2.2 times per day.

Ratanarangsima and Prasertsom reported several statistics of the oral health status of 12-year-old children from 2005-2008 (Rattananarangsima and Prasertsom, 2008). The conclusion in their report was drawn from several provincial reports on oral health and behavior of 12-year-old schoolchildren from all over the country. They concluded that the dental caries and gingival health trends in this age group tend

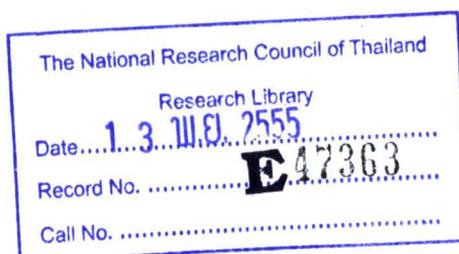
to improve over time. The effort related directly to this improvement was the brushing-after-lunch-at-school measure. Important figures of oral health status in 12-year-old children are shown in Table 3.

**Table 3: Oral health status of 12-year-old children from 2005-2008**

	Year of report			
	2005	2006	2007	2008
Number of provinces for which data were analyzed	73	75	68	66
12-year-old children caries free (%)	41.37	42.60	42.00	43.83
12-year-old children without gingivitis (%)	48.34	49.21	54.02	53.83
Mean DMFT of 12-year-old children (teeth/child)	1.88	2.02	1.63	1.75
School with toothbrushing after lunch activity (%)	94.10	92.18	95.45	95.82

## 2.2 Oral Health Care System for Schoolchildren

There are three levels of hospital classified by Ministry of Public Health responsible for deliver health and oral health service in Thailand, namely, Regional hospital, general hospital and community hospital (Jirapongsa, 2004). Those three level hospitals are defined by their service potential, number of health personnel, and number of people in service areas. As reported by Bureau of Policy and Strategy, Ministry of Public Health (2011) there are 25 regional hospitals, 69 general hospitals, and 736 community hospitals currently. Additional 58 hospitals of Ministry of Public Health are assigned for specialized treatment purposes. There are 111 government hospitals in Thailand that are not under Ministry of Public Health.



Since 2001 Thailand has launched universal coverage policy. Regional, general, and community hospitals have been assigned as the contracting units of the government financial agency to provide both preventive and curative care, including oral health care, to population resident in a specific catchment areas of each hospitals with minimal treatment fee. Primary prevention tasks are mostly carried out by health centers, as called as Primary Care Units (PCUs), which are networked to the hospitals. Currently there are 9,765 health centers across the country.

As summarized by Jirapongsa (2004), level of oral health services are categorized into self-oral health care, primary care, secondary care, and tertiary care approach. Self-oral health care in Thailand is mainly achieved through health promotion measures. Village health volunteers have been trained to be capability on providing oral health education and basic advice on oral hygiene maintenance. Health volunteers and other kind of government supports in community level form self-oral health care and community oral health care. In primary care level community hospital and its networked district health center provide oral screening and non-complicate treatment for community. The health center or primary care units (PCU) are assigned tasks on oral health promotion, oral examination, basic dental prevention, and preliminary emergency treatment. The community hospitals are assigned tasks on dental treatment, local oral health manpower development, and other related tasks. The higher level of dental treatment was performed in secondary care and tertiary care which are centered in general hospital and regional hospital respectively.

Primary schoolchildren were major target group in dental health care system since Ministry of Public Health first developed national oral health care plan in the

year 1977 (Dental Public Health Division, 1978). Before the development of the national oral health care plan there was attempt to provide schoolchildren oral care by school dental nurse. The schoolchildren dental services by dental nurses were proposed in the project called “multiplication dental care” occupied during 1977-1988. However, because of minimal coverage of service in this plan the following plan occupied since 1988 target was approached through surveillance process (Jirapngsa, 2004).

School oral health promotion activity such as after meal tooth brushing was carried out in primary schools across the country. There are other attempts to urge schoolchildren to behave their oral health through school activity and lessons studied in classrooms. Cooperation between Ministry of Public Health and Ministry of Education are performed to fill up primary school curriculum with knowledge and practice on oral health care since 2004 (Dental Public Health Division, 2004). Recent report on the 6<sup>th</sup> National Oral Health Survey demonstrated nearly 100 percent of schoolchildren brush their teeth at least twice a day. It is believed that tooth brushing practice of schoolchildren is highly influenced by school oral health promotion activities (Jirapongsa, 2004).

### **2.3 Universal patterns of dental caries**

Sheiham and Sabbah (2010) reviewed abundant data on epidemiological data of caries in the permanent dentition from a wide range of countries. They found that dental caries has characteristics that not varied regardless of time or fluoride

exposure. These characteristics are called universal patterns of dental caries. They are (1) caries levels follow trend lines; therefore; (2) as the mean DMFT increases, the percentage of caries-free individuals falls and the caries distribution widens; (3) there is a specific mathematical relationship between the mean DMFT and mean DMFS; (4) there is a hierarchy of caries susceptibility by tooth type and sites on teeth; (5) changes in mean DMFT scores for individuals and groups are 'stepped'; (6) as the mean DMFT declines, the post-eruptive time for initiation of caries increases and the progression rate of caries through enamel decreases.

The first pattern mentioned in Sheiham and Sabbah's report was relationship between current and future mean DMFT in population. It is obvious that individual or group with a particular level of dental caries would follow different specific tracks of increment. For example, individuals with lower caries prevalence would have different rate of caries increment from those with higher caries prevalence. From this rationale it is possible to predict caries prevalence of individual or group in the future from present caries prevalence. The second pattern is relationship between caries distribution and mean DMFT. The distribution curves of dental caries in the population show more negative skewness or longer left tails as the mean DMFTs increase. Batchalor and Sheiham (2002) demonstrated that the prevalence of population with mean DMFT 1 would be about 42%. They proposed mathematical equation demonstrating relationship between prevalence of dental caries and average DMFT of the population. From the equation one could assume the exact community's prevalence of dental caries from that community's mean DMFT. It could be implied from the equation that once mean DMFT of the population decrease the prevalence of disease are also decreases. The third pattern observed was relationship between

DMFT and DMFS. This relationship has been reported earlier (Knutson, 1958). The authors suggested that there might be not necessary to examine population oral health status by DMFS in the future. As proposed by Jarvinen (1983), DMFT and DMFS relationship could be demonstrated by the following equation;  $DMFT = 28 - 28.2008 * (0.9743^{DMFS})$ . Therefore, knowing DMFTs of survey subjects would allow examiner to calculate DMFS eventually. The fourth pattern is caries susceptibility is varied by groups of tooth sites and tooth types. As the different type and sites of tooth demonstrate different caries susceptibility it is possible to categorize tooth type and surfaces into groups depend on their caries susceptibility. Batchelor and Sheiham (2004) reported that as DMF increases the group of tooth type and surfaces with same caries susceptibility increase together. The fifth pattern of caries is stepped increasing of caries progression. There are always more than one surface in oral cavity that demonstrate same susceptibility to dental caries, for example the same surface on the left and right corresponding teeth. Authors reported that there are groups of teeth sites and surfaces with the same caries resistant property (Hannigan et al., 2000; Batchelor and Sheiham, 2004; Hopcraft and Morgan M, 2006). These similar caries resistant sites and surfaces groups become carious simultaneously. Therefore dental caries in oral cavity progresses at least by step of two surfaces. The last pattern of dental caries observed and reported by Sheiham and Sabbah is the relationship between enamel and dentin demineralization rate and DMFT. It was observed that the rate of caries progression in population with low DMFT was slower than that in population with higher DMFT. As a result of this relationship the time from tooth eruption to become carious are longer in individuals with lower caries rate compare to those with higher caries rate as caries progression rate in this group is lower.

## **2.4 Oral Health Related Quality of Life and incorporating sociodental approach into normative needs**

### **2.4.1 Concept**

Oral Health Related Quality of Life was developed from concepts that oral diseases have clearly psychology and social impacts on daily life beside the biological one. Clinical indicators, such as widely used DMFT index or Community Periodontal index, are not suitable to assess effect of oral health on psychological or social function aspects of an individual. It is well accepted that Oral Health-Related Quality of Life (OHRQoL) measures reliably assess impacts on quality of life (Slade, 2002). They record subject's perceptions about oral impacts on their daily lives. This person-centered approach has gradually been accepted as a new public health paradigm that has replaced the traditional professional approach (Adulyanon et.al 1996, Srisilapanan and Sheiham 2000, Gerunpong et.al 2004).

### **2.4.2 Oral Health Related Quality of Life Measurements**

Several oral health-related quality of life indices have been introduced including SIDD (Social Impacts of Dental Disease) (Cushing et al., 1986), GOHAI (Geriatric Oral Health Assessment Index) (Atchison and Dolan, 1990), OHIP (Oral Health Impact Profile) (Slade and Spencer 1994), DIDL (Dental Impacts on Daily Living) (Leao and Sheiham, 1995), and OIDP (Oral Impacts on Daily Performance) (Adulyanon et al., 1996). Among these indices, OIDP is the only index which has special function to relate the OHRQoL impacts to the specific dental treatment (Gherunpong et al., 2006a).

Normative need, which is patient's need for treatment judged by professional alone, is not sufficient to use in health planning. Sheiham and Tsakos (2007) illustrated shortcomings of using only normative need to predict the health need of the population. They concluded that normative need assessment lacks objectivity and reliability, neglects psychological aspects and quality of life, lacks consideration of health behaviors and of patient compliance, neglects consumer rights, and provides unrealistic estimates for treatment planning. Additionally, it has been found that patients' attitudes might influence care seeking behavior (Schou, 2000). Therefore it is vital to include perceived needs and patients' attitudes and behaviors as well as the impacts of dental status with normative needs to estimate dental needs and manpower. That has been done in the sociodental approach (Adulyanon, 1992; Sheiham and Tsakos 2007). Srisilapanan and Sheiham (2001) found that only half the older people who were assessed as having normative needs for dental care, actually perceived a need for dental treatment. Several studies reached the same conclusion, namely, that normative need severely overestimates patients' perceived needs for dental treatment (Srisilapanan et al., 2003; Gherunpong et al., 2006b; Tsakos et al., 2006).

A new system for assessing dental treatment needs has been developed in which a socio-dental approach is integrated with the traditional normative measurement (Adulyanon et al., 1996; Srisilapanan, 2003; Sheiham and Tsakos, 2007). This approach conforms to the modern, theoretical, multifactorial approach for the assessment of oral health care needs and incorporates the following components:

- clinical estimates of normative need
- subjective perceptions, including perceived treatment needs and oral health-related quality of life measures

- propensity to adopt health promoting behaviors
- scientific evidence of the effectiveness of treatments

## **2.5 Thailand Dental Human Resources**

Currently, there are four types of dental manpower in Thailand, namely, dentist, dental nurse, dental assistant, and dental technician.

### **2.5.1 Dentist**

Dentists are the major human resource responsible for the treatment of all kinds of oral disease in the population. Even though the dental specialist system has been proclaimed in Thailand since 1997, the boundary of competencies between a general practitioner and a specialist has not been identified from the legal point of view. Legally, the general dental practitioner (GP dentist) can perform any kind of treatment, even those carried out by a dental specialist. In the previous studies on dental manpower in Thailand, general practitioners and specialists were considered in the same category (Dental division Department of Health, 1986; Tumkhosit, 1979; Udompanich, 1990; Working Group on Medical and Public Health Manpower Dental division, 2009; Yuktanant, 1972).

#### *2.5.1.1 Dental specialist*

There are 10 fields of dental specialty officially recognized by the Thai Dental Council. They are dental diagnostic science, oral and maxillofacial surgery, restorative dentistry, endodontics, prosthodontics, pedodontics, orthodontics, periodontics, dental public health, and general dentistry (Thai Dental Council, 1997). It is highly possible that the training experience of dentists might have some influence on the area and extent of their dental practice. Moreover, study in the United States

suggested that after training and being certified as a specialist, dentists tend to perform only the discipline acknowledged as their specialty (Casamassimo et al., 2002).

#### *2.5.1.2 The production of dentists*

Thailand's first dental school was established in 1940 as a department in Chulalongkorn University (Kanwanit, 1990). The first six Thai dentists graduated four years later. The other dental schools in Thailand were subsequently established in 1965, 1968, 1979, 1983, 1994, 1997, and 2005. Currently, there are eight public dental schools. Four of them are located in the Bangkok metropolitan area and the other four are located in peripheral regions of Thailand. There is only one private dental school, which is located in Pathum Thani, a province close to Bangkok. Its first group of student is expected to graduate in 2011. As reported by the Ministry of Education in 2004, approximately 500 new dentists graduate from public dental schools each year. The number has increased to 700 in 2011. Additionally, 60 dentists are expected to graduate from the private dental school each year from 2011 henceforward.

Producing more dental graduates has been encouraged by the Thai government for the past 20 years in order to resolve the maldistribution and the insufficiency of dentists in the health care system.

#### *2.5.1.3 Dentist distribution in the health care system*

Shortage of dental personnel was a critical problem in the health system in Thailand during the 1980s-2000s. As reported by the Ministry of Public Health, the dentist per population ratio for the whole country in 1981 was 1:44,636. It ranged from 1:7,901 in Bangkok to 1:204,639 in the northeastern region. There was

approximately a 25-times difference between the dentist per population proportion between the metropolitan and the peripheral areas. The situation becomes worst in an outreach rural area. To alleviate the problem, in 1983 the Thai government implemented a mandatory condition to every dental student accepted for study in public dental schools to work in the public sector for at least three years after their graduation. Along with the mandatory public service measure, the government has improved the allowances for dentists who worked in rural areas especially for those who have worked for years.

**Table 4: Dentist per population by region in Thailand 2009**

<b>Region</b>	<b>Dentist</b>	<b>Population</b>	<b>Ratio</b>
Bangkok	4,779	5,710,883	1:1,195
Central	1,713	15,615,968	1:9,116
South	845	8,741,545	1:10,345
North	1,156	11,878,641	1:10,276
Northeast	1,153	21,442,693	1:18,597
<b>Country</b>	<b>9,646</b>	<b>63,389,730</b>	<b>1:6,572</b>

In 2008, there were 9,646 dentists in Thailand. The dentist-population ratio has improved to 1:6,572 for the whole country. To examine the ratio differences between areas, the ratio of dentist-population ranged from 1:1,195 in Bangkok to 1:18,597 in the northeast. The difference seems to be lower than what it has been in the last decades. It is believed that government measures on dental manpower have played an important role in improving the maldistribution situation during the last 20 years (Vichawut et al., 2007). Important figures for dentist distribution in Thailand are shown in Table 4.

As seen from the table above, about half of the dentists in Thailand (49.61%) work in the Bangkok metropolitan area. This figure supports the claim that there was some degree of maldistribution of dentists in Thailand.

**Table 5: Distribution of dentist in Thailand in 2009 by organization**

<b>Organization</b>	<b>Number of Dentists</b>	<b>Percentage</b>
<b>Public Sector</b>		
Ministry of Public Health	3,110	32.24
Ministry of Interior	54	0.56
Ministry of Defense	220	2.28
Ministry of Transportation	1	0.01
Bureau of the Royal Household	7	0.07
Ministry of Education	895	9.28
Bangkok Municipality	140	1.45
Other	31	0.32
<b>State Enterprise</b>	<b>45</b>	<b>0.47</b>
<b>Private Sector</b>	<b>5,143</b>	<b>53.32</b>
<b>Total</b>	<b>9,646</b>	<b>100.00</b>

More detail on percentages of dental workforce distribution by organization is presented in Table 5 (Dental Division, Department of Health, 2009). More than half of Thai dentists (53.3%) work in the private sector. Another 32.2% percent work for the Ministry of Public Health. The proportion of dentist in the public and private sectors seems to have been stable for the last 10 years (Working Group on Medical and Public Health Manpower, Dental Division, 2009).

#### *2.5.1.4 The production of new dentists*

The dentist production trajectory for Thailand in public university conventional production plan, government support scheme, and private university production from 1999-2014 is presented in Table 6 (Vichawut et al., 2007).

**Table 6: The dentist production trajectory of Thailand 1999-2014**

Year	Estimated number of dentist produced			Total
	Conventional Public University Production	Private University Production	Government-Supported dentist Production Scheme	
1999	504	-	-	504
2000	504	-	-	504
2001	486	-	-	486
2002	502	-	-	502
2003	525	-	-	525
2004	528	-	-	528
2005	503	80	200	783
2006	503	80	200	783
2007	503	80	200	783
2008	523	80	200	803
2009	523	80	200	803
2010	523	80	200	803
2011	523	80	200	803
2012	523	80	200	803
2013	523	80	200	803
2014	523	80	200	803
<b>Country</b>	<b>8,219</b>	<b>800</b>	<b>2,000</b>	<b>11,019</b>

In 2005, the government again approved a new project to allocate special budgets for the public dental schools to produce more 200 new dentists per year to reach a public sector dentist-to-population ratio of 1 to 10,000. Currently, there are 9,646 dentists for the whole country. Half of them are working in the public sector. Approximately 700 new dentists are graduated from eight dental schools each year.

#### *2.5.1.5 Gender balance of dentists*

Many studies have demonstrated that an increasing trend in the percentage of female dentists in many countries across the world (Brown, 1999; Zillen and Mindak, 2000; Laloo et al., 2005). Many studies found that this new trend of a higher proportion of female dentists might affect the overall production of the dental services system. A number of studies support this concern and have focused on issues such as the time that female dentists devote to professional activity, career development and academic contributions (Ahlberg, 1990; Brennan et al., 1992; van Dam and van Rossum 1992; Newton et al., 2000; Katrova, 2004).

Changes in the gender proportion of the dental workforce in a country might affect the dental profession in a wider perspective. It has been shown from a study in the United Kingdom that female dentists tend to take career break and engage in significantly fewer work hours than their male counterparts (Spencer and Lewis 1988; Ayers et al., 2008). The main reason that female dentists spend less time in dental practice than their male counterparts is family commitment (Mathews and Scully, 1994; Newton et al., 2000; Ayers et al., 2008). Studies found that women dentists with young children devoted less time to dentistry than those with grown children (Brennan et al., 1992; Ayers et al., 2008). Moreover, other factors related to the

gender difference in dental practices, for example, female dentists were less likely to be owner-dentists (Atchison and Dolan, 1990; Ayers, et al. 2008). Female dentists were keener to specialize in pediatric and operative dentistry, whereas male dentists were found more frequently in oral surgery and prosthodontics (Katrova, 2004). In preventive dental care, female dentists recommended at-home fluoride to a significantly larger number of their patients than did male dentists, and thus were inferred as being more focused on a preventive philosophy (Riley et al., 2011). Dental manpower estimation for the appropriate number of dentists in the future should consider the gender composition as a predictive factor.

Some factors were not different between male and female dentists. Spencer and Lewis in their Australian dentist survey (Spencer and Lewis, 1988) did not illustrate the hourly productivity difference among male and female dentists. Beazoglou et al. (2001) reported that women dentists in full-time practice work as many hours as do male dentists. Blasiusa and Pae (2005) accepted that there were some differences in work pattern between male and female orthodontists, but these differences were not highly significant.

In Thailand, gender proportions of new dentists in Thailand have changed over time. The male to female proportion of 57 to 43 in 1980 has changed to 31 to 69 in 2010 (The Dental Council of Thailand, 2010). As reported by the Dental Health Division, Ministry of Public Health, the proportion of female dentist in Thailand in the past 20 years has dramatically increased (Vichawut et al., 2005). Before 1989, the distribution of male and female dentists was approximately equal. After that time the number of female dentists has increased steadily. In 2005, the Thai Dental Council registered three times as many new female as male dentists (Vichawut et al., 2005).



There has not been any study to investigate the effect of time spent in dental practice between male and female dentists in Thailand. This information will be necessary in the estimation of dental manpower to serve in the oral health care system.

## **2.5.2 Dental Nurse**

### *2.5.2.1 The task of the dental nurse*

Dental nurses are authorized by a domestic regulation to be lawful in performing dental work mainly in preventive care. The Dental Nurse Training Program is offered in seven Colleges of Public Health in Thailand. Students with a high school qualification must take two years of training to be qualified as a dental nurse. As stated by Ministry of Public Health, dental nurses may perform four specific tasks in dentistry:

1. Preventive care
  - 1.1 Fluoride application for caries prevention
  - 1.2 Sealant application for caries prevention
  - 1.3 Scaling and prophylaxis
2. Emergency care in patients with acute symptoms
  - 2.1 Emergency treatment to relieve pain, for example, opening the pulp chamber for drainage.
  - 2.2 Initial emergency treatment before, during, and after dental treatment, for example, treatment of bleeding conditions.
  - 2.3 Screening and referring patients, for example, patients with systemic disease.
3. Curative care
  - 3.1 Diagnosis of dental disease.

3.2 Provision of uncomplicated dental restorations.

3.3 Simple tooth extraction.

3.4 Scaling in patients with gingivitis

Dental nurses in Thailand were originally assigned to practice mainly in the promotion of dental health and prevention of dental disease for schoolchildren, following their prototypes in New Zealand. Due to a shortage of dental personnel in rural areas, most of them carry out more complex treatments such as restorations, tooth extraction, and dental prophylaxis both in children and adults as their routine tasks. All operations accomplished by a dental nurse must be supervised by a dentist and are permitted only in public hospitals.

#### *2.5.2.2 Number of dental nurses*

The number of dental nurses in Thailand in the year 2007 was approximately 4,000 (The Thai Dental Council, 2009). Approximately 250 new dental nurses are produced each year. Since the establishment of the first dental nurse programs in the Colleges of Public Health in 1969, 788 dental nurses were lost from the public sector for various reasons. The number of dental nurses remaining in the public health system of Thailand up to 2006 was 3,697. Table 7 shows the number of active and inactive dental nurses in Thailand. (Working Group on Medical and Public Health Manpower Dental division, 2009)

**Table 7: Number of dental active and inactive dental nurses from 1969 to 2006**

	<b>Graduated 1969-1999</b>	<b>Graduated 2000-2006</b>	<b>Total</b>
Graduated (total)	2,695	1,780	4,475
Average graduated per year	87	254	
Presently work in public health system	2,340	1,357	3,697
Loss (persons)	355	423	778
Loss (percent)	13.2%	23.8%	17.4%

In November 2009, two out of eight Colleges of Public Health introduced a four-year dental nurse program leading to a bachelor degree in dental public health. The new 4-year-curriculum is claimed to be promotive- and preventive-oriented compared to the former 2-year counterpart (Table 8). As described in the curriculum, the clinical practice of permanent teeth extraction and nerve block anesthetic injection technique are excluded from this new 4-year-curriculum. Some curative techniques are also less emphasized. Additional courses in this new curriculum are courses on general education, basic medical science, and promotive and preventive dentistry, especially dental public health field practice (Praboromrajchanok Institute, 2009). Table 8 compares the two curricula in terms of time spent on subject matter. Clinical practice time in the 4-year program is slightly greater than that in the 2 year program. However, the 4-year curriculum provides more extensive study in dental preventive and promotive course (Sirindhorn College of Public Health Cholburi, 2010).

**Table 8: The 2-year and new 4-year curriculum for dental nurses**

	Credits	
	2-year curriculum	4-year curriculum
<b>General Education</b>		
Social sciences	3	9
Language	6	12
Mathematics and sciences	3	4
Information technology	5	3
Others	3	2
<b>Medical and Dental sciences</b>		
Basic medical sciences	22	42
Basic dental sciences	13	15
Clinical dentistry	8	10
Dental preventive sciences	4	4
Dental health promotion	5	20
Field practice in dental public health	8	10
Free electives	6	6
<b>Total</b>	<b>86</b>	<b>137</b>

The ideal number of dental nurses is very difficult to calculate, as the major responsibility of these personnel is to focus on prevention and promotion. In the calculation method based on eliminating existing disease, these personnel make very a

small contribution. On the other hand, these personnel play an important role in maintaining good oral health as well as preventing future dental disease.

### **2.5.3 Dental assistant**

Dental assistants and dental technicians are both valuable personnel in a dental health system. To be qualified for admission to a dental assistant curriculum, applicants must be at least 17 years old with high school qualification. The course takes at least one year of lecture and clinical experience in dental clinic (Faculty of Dentistry Mahidol University, 2008). Because there is no regulation or local administration controlling the practice of dental assisting, it is not forbidden to carry out this practice without a certificate. Many dental assistants in private clinics perform the tasks with only on-the-job experience. The Ministry of Public Health has reported that there are some 1,800 dental assistants who qualified in authorized institutions, working across the country (Dental Division, Department of Health, 2009).

### **2.5.4 Dental technician**

Dental technicians are dental personnel who work with laboratory assignments. There is also not any legal regulation or any other arrangement established for controlling or suggesting guidelines of performance for persons who perform this kind of task. Even though dental technician schools provide both certificate and academic degrees for persons who complete the courses, there are some technician-to-be who prefer studying by themselves and to work as private dental technicians across the country. In 2008, there were 100 active certified dental technicians. The rest are not certified and their numbers have not been reported (Dental Division, Department of Health, 2009).

## 2.6 Factors Influencing Dental Human Resources Needs

As Wirick postulated, five fundamental factors are critical in determining dental manpower need. Those factors are (Wirick, 1966):

1. **Need:** Need is defined as conditions requiring dental attention or some other reason for seeking supplies or services classified as dental care. Need is a major factor used to determine manpower in Thailand for the last two decades.
2. **Realization of Need:** This factor is referred to as the willingness to seek help including: (1) realization of the need, and (2) a propensity for or against seeking care. Both have been grouped into the single category of realization, including awareness of the existence and availability of medical skill and of the benefit likely to be gained through help. Intertwined with these elements are the hopes, fears, and beliefs of the individual, as well as such other personal factors as previous experiences, customs, and religion. A person with a strong religious conviction opposing medical treatment, though having the same understanding of the consequences of the disease and implications of the treatment, may still have a different realization of the need for care from that of someone else.
3. **Resources:** This capability may take many forms, including income and assets possessed by a person or one's family, insurance coverage, eligibility for free care under a group or government program, and availability of care through welfare programs. One's resources for medical care may be different from those for other items in one's budget and indeed may differ from one component of medical care to another.

Hospitalization insurance may give one almost complete accessibility to hospital care but may leave physician care unavailable. Resources may also include negative components in the form of commitments of income or assets, making them unavailable for medical care expenditures.

4. **Motivation to Obtain the Needed Care:** Even with the other forces present (need, realization, and resources) something must initiate the action. Going to the doctor with an acute condition involving pain or bleeding is occasioned by the condition itself, but the motivation is less clear with respect to other components. This force is also related to what was previously called willingness, but it is more than that. Rather than being only a static readiness to accept medical help, this factor entails an active move toward obtaining it. It may range from the specific (a doctor sending a patient to the hospital) to the general (a cultural precept that one should go to the dentist once a year).
5. **Availability of Services:** Medical and dental service represents those supplies and services demanded by the needs and desires of individuals. In the field of dentistry, promotive, preventive, curative and rehabilitative dental care are included, as they are all carried out by dental personnel.

The American Dental Association (ADA) Future of Dentistry Report of 2001 suggested some more factors that have potential impact on dental workforce as follows (American Dental Association, 2001):

1. **Number of practicing dentists:** the number of dental schools is directly related to the number of dentists who are actively practicing dentistry. This number of dental students and dental schools was affected somehow

by the “baby-boomer” era. Recently number of dental students increased dramatically. On the other hand, after this cohort reach retiring age. The large number of retiring dentists in the aging society will need to be taken into account.

2. The maintenance of the restorative load: The replacement and maintenance of old restorations of earlier generations could be a large workload for dentists in the next generation as the lifespan of the older generation of dental materials is short but the lifespan of people becomes longer.
3. Dental auxiliaries: The number of dental auxiliaries will have an effect on the oral care of the population reported by ADA. These shortages likely will remain well into the next decade or two and will limit dental care of the population.
4. Women dentists: The increasing number of women in dentistry will affect the dental work force, as many of these women may interrupt careers for family, or choose to practice part-time.

To estimate the required dental workforce, the FDI Dental Practice Committee describe the issues that should be considered when planning and reviewing the oral health workforce for a country or for regions of a country as follows (FDI Dental Practice Committee, 2005):

1. Supply of dental services
2. Need for dental services
3. Oral health status of the population
4. Public health interventions affecting oral health

## 5. Demand for dental services

In 1989, Joint Working Group of WHO and FDI (1989) developed a guideline for planning and monitoring oral health workers in order to help manpower planners to quantify the oral health needs of a country and the number of dental personnel necessary to achieve the problems. The guideline mentioned about what the International Dental Federation (FDI) found from the survey of dental health manpower from 35 member associations, which concluded that problems in past manpower planning were due to:

1. The preoccupation with disease, demand and intervention, rather than with health, need and prevention.
2. The tendency to plan as if the situation was static, rather than for one which was changing rapidly.
3. A lack of measurable goals and related monitoring which are the precision tools for modification and replanning.
4. A failure to co-ordinate planning by failing to involve all parties involved, i.e., the profession, educators of oral care personnel and government health authorities.

In the model, WHO/FDI urged planners to use oral health status data as an input of the calculation. The calculation can be shortly summarized into 4 steps:

1. Collection of data needed for calculation: The data necessary for calculation included oral health status of the population, oral health goal, and population estimates for planning period by age cohort.

2. Collection of data needed for modifying factor: These included government policy, care facilities and population parameters.
3. Calculation: The calculation for time per person per year for treatment. Four age cohorts were suggested in this manual. They were 0-14, 15-29, 30-64 and 65-79.
4. Decision: This step was to re-evaluate estimates carried out from the calculation. Types of personnel and service to be provided were suggested to be revised to make the final decision.

This guideline was promoted as easy way to calculate and plan for dental manpower planning for the country. This introduced the forms and checklist for the user to fill in. By estimating future disease prevalence from available data treatment workload could be calculated. Spreadsheet software was also suggested to assist the user to overcome tedious mathematical calculations.

This guideline was criticized by Bronkhost and colleagues (1991). They noted that instead of using future changes of DMFT the differences among cohorts observed in the past were used. This methodology might result shortcoming in the situation of that dental caries prevalence are not stable. Summarily, the model assumed that situation happened in the past would happen again in the future.

Another shortcoming of the WHO model mentioned by Bronkhost et al. was in the step of transforming population treatment need to demand. The models did not provide clear methodology to find out how many percent of population with dental treatment need would really seeking care. The suggestion that 60-100 percent of



population with treatment need should be transformed to manpower might be right or wrong. Conclusively, the simple mathematic structure of WHO guideline should be used with caution, and the “if-then” question might be more helpful in predicting future health services.

## 2.7 Methods for Calculating Dental Human Resources Needs

There are some different methods used to estimate manpower need. Most of them have a common main principle but may differ in detail. WHO stated 5 five important steps for planning oral health manpower and services (World Health Organisation, 1980). Those steps are:

1. Collection of epidemiologic and other relevant data for a situation analysis
2. Establishment of measurable goals for the oral health services, based on the data collected, and taking into consideration all the resource available, public and private, manpower, facilities, and funds.
3. Establishment of quantitative and qualitative manpower production goals linked with the oral health services goal
4. Inclusion of an evaluation program enabling the plan and the goals to be modified when appropriate
5. Careful costing of the plan.

In order to compute suitable number of manpower for health, several methods have been proposed (Kahn and Sithole, 1991).

### **Population Ratio Method:**

The required manpower is fixed as a ratio to country's population. The information needed in this method is only the number of the population. The merit of

this method is simplicity and ease of interpretation. Only two types of data are necessary in this method: population projection and ultimate health personnel to population ratio. In 1985, WHO recommended the ratio of 1 dentist per 5,000 population. A more sophisticated form of this method is the target group specific ratio, for example, the ratio of dental personnel to under-5-year-old children.

Dreesh et al. (2005) summarized assumption, advantages and limitations of this method as following:

**Assumption:** Often based on current best region ratio or a reference country, with a similar but presumably more developed health sector.

**Advantages:** Quick, easy to apply and to understand.

**Limitations:**

1. Provides no insight into personnel utilization.
2. Does not allow to explore interactions between numbers, mix, distribution, productivity and outcome.
3. Base year maldistribution will likely continue in target year.

**Health Need Method:**

This method aims to answer what kinds, amounts, and quality of services, are required to maintain a given health status. The procedure converts the prevalence and severity of disease in a population into time and then into number of health personnel required. The necessary information is epidemiological data on dental disease in the population. A prerequisite is an assessment of the need for preventive services for the target population, the incidence and prevalence of illnesses, the quantity of curative services for each illness, and the number of health workers required to carry out each service. The quantity of health providers needed to care for the population's health are

projected after their current annual working hours are calculated and the population/disease growth is estimated. The health needs approach can be explained using the following formula (Hornby et al., 1980):

$$M_{pt} = \frac{P \times C \times V \times T}{W}$$

Where:

- $M_{pt}$  = manpower required in year t; (What does “t” refer to?)
- $P$  = the population that needs a given type of care for a specific health problem in year t (current or projected)
- $C$  = the average number of ‘conditions’ per person per year
- $V$  = the average number of a given kind of service per condition per year, based on need
- $T$  = average time required per service
- $W$  = average workload of the individual practitioner – total amount of service time provided by the average practitioner per year for a given service.

Dreesh et al. (2005) summarized assumption, advantages and limitations of this method as following:

#### Assumption

1. All health care needs can and should be met.
2. Cost-effective methods to address the needs can be identified and implemented.
3. Resources are used in accordance with needs.

#### Advantages

1. Has the potential of addressing the health needs of the population using a mix of Human Resource for Health.
2. Is independent of the current health service utilization.
3. Is logical, consistent with professional ethics, easy to understand.
4. Is useful for some programs such as prenatal and child care.
5. Is useful for advocacy.

#### Limitations

1. Ignores the question of efficiency in allocation of resources among other sectors.
2. Requires extensive data.
3. If technology changes, it requires norms update.
4. Is likely to project unattainable.

#### **Health Demand Method:**

In this approach, services are planned to meet what will be demanded. The method requires observation and quantification of present demand (possibly in a number of different categories, e.g., maternal and child health (MCH), outpatients, inpatients, etc.), projection to a target year (which may require scrutiny of determinants of demand and expected changes), and the translation of the demand for services into that for manpower. The approach makes no attempt to influence the demand itself, but may use a standard manpower/service mixes. In this method, manpower requirements are projected based on current and estimated future utilization rates.

Demand is based upon the utilization rates by age, sex, occupation and race; and the future demand is derived from the expected changes in the size of these

population groups and the proportionate change in services that might imply in the future (Hornby et al., 1980). Three types of information are needed for this calculation method:

- a Information on the current demographic and economic characteristics of the population, such as sex, age, income level and residence, as well as projected changes in these characteristics for the planning period;
- b Estimates of the current and projected productivity of manpower in different types of work situations;
- c Information on the current use of services available according to diverse population characteristics.

Dreesh et al. (2005) summarized assumption, advantages and limitations of this method as following:

#### Assumption

1. Current level, mix, distribution of health services is appropriate.
2. Age- and sex-specific requirements remain constant in the future.
3. Size and demographic profile of the population changes in ways predictable by observed trends in age- and sex-specific rates of mortality, fertility and migration.

Advantages: Economically feasible targets due to no or little change in population-specific utilization rates.

#### Limitations

1. Requires extensive data
2. Overlooks the consequences of 'errors' arising from the assumptions proving to be invalid

3. Produces a 'status quo' projection, since future population segments are assumed to have similar utilization

### **Service Target Method:**

In this approach the primary focus is on setting targets for the production and delivery of health services. The approach is theoretically identical to the manpower/population ratio method, but in practice this approach tends to consider appropriate manpower mixes for particular services in more detail. The service target method might adjust results from the health need method into more pragmatic basis, as every single lesion in the population does not need to be treated.

Dreesh et al. (2005) summarized assumption, advantages and limitations of this method as following:

**Assumption:** It assumes that the standards of each service covered are practicable and can be achieved within the timescale of the projection.

#### **Advantages**

1. Relatively easy and understandable.
2. Can assess interactions between variables.

**Limitations:** Potentially unrealistic assumptions

### **System Dynamic Method:**

The System Dynamic Method is defined as the method of studying a complex problem by explaining the structure of interactions among all the compositions as well as the behavior, or the change pattern of the system (Udompanich, 1990). Because multi - factorial factors of dental problems such as socio-economic factors, natural history of oral diseases, service utilization system, distribution of dental personnel, as

well as the population growth, affected the overall problems with their complex interactions the System Dynamic Method uses all the aforementioned factors in to the model of manpower estimation. The System Dynamic Method starts with developing causal loops of dental public health problems, and factors that increase or decrease those problems. Then, it transfers the loop into mathematics equation. This method uses computer software to perform the repeated experimentation for decision analysis. It works by transforming some major parameters to testify different assumptions of the system behavior (Udompanich, 1990).

In the year 1987, WHO released a book on health system development as a general guide to countries that are contemplating a comprehensive, action-oriented review of health manpower development in order to improve their national health systems (Fulop and Roemer, 1987). As described, WHO divided manpower estimation methods into four categories as follows:

1. Market-oriented method. This is the most common form of qualitative method for estimating manpower need. The need is based on demand for health care services in the country. The demand can be figured by including the demand of the Ministry of Health, other organized programs and those of private sectors.
2. Goal-setting method. The procedure is to set goals that are intended to produce personnel in a number exceeding the current supply by a certain percentage, e.g., by 5%, or 10%, within a certain period. It is recommended to consider in the estimation the rate of retirement or death of existing active personnel as well as the increasing population.

3. Normative method. Standards or norms are applied which have been derived in some systematic way. The standard may be based on manpower research in a certain region, where services are provided to a defined population, together with an empirical determination of the number of health personnel required. The health personnel to population ratio is one of the most common standards used in this type of calculation.
4. Combination method. Another approach is to combine all of the above methods, relying on the judgment of a panel of experts to whom the necessary data are different criteria: estimates of the market; an increase in the current supply; a standard based on empirical research, or foreign experience.

It is also recommended to consider qualitative method together with the quantitative one. Health manpower goal must be arranged under a clear understanding of a job in order to be carried out. Job profiles could affect directly the number of health personnel needed. Both qualitative and quantitative planning should be based on various types of research.

Some authors have compared the differences among different manpower estimation methods, including advantages and disadvantages of those procedures. Table 9 is replicated from the original publications of those authors (Dreesch et al., 2005).

## **2.8 A Skill Mix Approach**

Because of expensive cost of producing health manpower especially physician and dentist the idea of determining “right mix” of health manpower emerged recently.

Determining and achieving the “right” mix of health personnel are major challenges for most health care organisations and health systems (WHO, 2000b). To assign the appropriate task to the right kind of health personnel will improve cost-effectiveness arrangement of the health system of the country. The fact that economy would be best served through a better use of existing resources by employing a skill mix approach is often overlooked.

Skill mix is defined as the mix of posts in the establishment; the mix of employees in a post; the combination of skills available at a specific time; or alternatively the combinations of activities that comprise each role, rather than the combination of different job titles (Buchan and O'May, 2000). Skill-mix changes may involve a variety of developments including enhancement of skills among a particular group of staff, substitution between different groups, delegation up and down a multidisciplinary ladder, and innovation in roles (Buchan and Calman, 2004). According to Buchan (1999), reasons for practicing skill mix or staff mix in health care system are including:

1. In guiding an organizational response to skills shortages in particular professions or occupations;
2. In improving the management of organizational costs, specifically unit labor costs (i.e. to reduce costs per unit of "output", or improve "productivity");
3. To sustain quality improvements (or maintenance) whilst reducing unit costs;
4. As an organizational response to technological innovation; motives including service innovation, shortages of particular categories of worker

(especially in inner cities or rural areas), quality improvement, and a desire to improve the cost- effectiveness of service delivery.

Buchan and Dal Poz (2002) in their article published in WHO bulletin suggested that skill mix are important for health system in many dimensions. Several skill mix interventions were proposed as present in Table 9.

**Table 9 Buchan's summarized of determinants, requirements, and possible interventions related to skill mix**

<b>Determinant</b>	<b>Requirement</b>	<b>Possible interventions</b>
Skill shortages	Response to shortages of staff in particular occupations or professions	Undertake skill substitution; improve use of available skills
Cost containment	Improved management of organizational costs, specifically labor costs	Reduce unit labor costs or improve productivity by altering staff mix or level
Quality improvement	Improved quality of care	Improve use and deployment of staff skills to achieve best mix
Technological innovation; new medical interventions	Cost-effective use of new medical technology and interventions	Re-train staff in new skills; introduce different mix or new types of worker
New health sector programs or initiatives (e.g. Roll Back Malaria)	Maximum health benefits of program implementation, by having appropriately skilled workers in place	Determine the cost-effective mix of staff required; enhance skills of current staff; introduce new types of worker

**Table 9 Buchan's summarized of determinants, requirements, and possible interventions related to skill mix (continued)**

<b>Determinant</b>	<b>Requirement</b>	<b>Possible interventions</b>
Health sector reform	Cost containment, improvements in quality of care and performance, and responsiveness of health sector organizations	Adjust staff roles; introduce new roles and new types of worker
Changes in the legislative/regulatory environment	Scope for changes in role for different occupations, professions	Adjust staff roles; introduce new skills and new types of worker

Buchan suggested that both quantity and quality of health staff are important in employing skill mix. Assessment of competence of staff would be required as this process made skill mix possible practically. In order to achieve staff evaluation, several approaches were proposed as described in Table 10 (Buchan, 1999).

**Table 10: Main approaches to determining skill mix (Buchan 1999)**

<b>Approach</b>	<b>Methods</b>	<b>Strengths / Weaknesses</b>
Task analysis	Frequency and cost of task elements of jobs identified. Skills and knowledge required for tasks agreed; use to profile staff and identify gaps.	Reliance on trained observers (costly, problematic if no agreement of skills/knowledge required). Task based approach criticized because it focuses on the measurable.
Activity analysis	Activity performed by each staff member recorded by observers at predetermined intervals, for agreed time period. Frequencies of different activities/time required identified. Data analyzed, used as basis for reallocation of activities/tasks to staff.	Quantitative approach can be used as basis for discussion and debate. Observers can be expensive; difficult approach if workplace is not a fixed ward or unit; danger that if staff are not involved they will not accept results.

**Table 10: Main approaches to determining skill mix (Buchan 1999) (continued)**

Approach	Methods	Strengths / Weaknesses
Daily diary / self recording	As above, but staff record activities	Can limit cost implications by using observers (but opportunity cost). Staff may not provide accurate details. Strength is direct involvement of staff.
Case mix / Patient dependency	Patients/clients classified in groupings according to diagnosis or dependency. Formula used to relate scores to staff hours required.	Uses mix of qualitative and quantitative methods. Benefits can include determining variations in staffing over time to match changing workload. Primarily gives only overall numbers of staff; further work required to determine mix.
Zero base reprofiling	Detailed analysis of current mix, activity, skills and costs. Working group considers alternatives within available resources; aim is to achieve ideal mix.	Radical and fundamental. Rarely applied in full because of organizational/political constraints. Danger of becoming a 'wish list', with less focus on 'how to get there'.

**Table 10: Main approaches to determining skill mix (Buchan 1999) (continued)**

Approach	Methods	Strengths / Weaknesses
Professional judgment	Staff/management in work area assesses current activity and staffing, review data available, apply collective judgment to reallocation of work.	Low tech approach, involves staff, can be quick. Constraints are that there can be lack of transparency/objectivity; possibility of little change.
Job analysis interviews	Detailed individual or group interviews; can include critical incident technique; repertory grid.	Structured approach, if interviewers are skilled can reveal much relevant information. Involves staff. Main problems are potential for bias and lack of objectivity.
Group discussion/ brainstorming	Facilitates workshop/discussion group of staff to identify issues requiring change. Use of available data as basis for discussion.	Can be quick – often used as diagnostic phase of approach. Involves staff. Requires skilled facilitation; raises expectations and can generate mass of contradictory information.

Once the appropriate approach was chosen to use Buchan (2000) suggested the following checklist to assist skill mix implementation.

- work to achieve staff ownership
- define the organizational “boundaries” of the approach
- develop and agree on a timed action plan
- develop and agree on an associated communication strategy
- determine what will be the information requirements
- undertake an analysis of existing information
- move forward with implementing the new skill mix
- evaluate implementation

Skill mix concept is suggested for health planner and policymaker to improve effectiveness of the health care system. It is possible that there is more than one staff-mix option. The strength and weakness of those options are suggested to be considered.

In dentistry, skill mix is not yet widely concerned. Only few literatures on skill mix have been reported. Richard (2011) reviewed evidences on cost-effectiveness comparison between moving and not-moving professional to outreach clinics. Anyway he could not reach the conclusion because limited evidence of the cost-effectiveness and health outcomes associated with changes in setting and skill-mix could be found. Falcon (2011) found that using skill mix might improve coverage of dental service providing to elderly in England. His “no skill-mix model” required more than 8,000 dentists for providing dental care to elderly. On the other hand, only 2,623 dentists would be required if “maximum skill-mix” was applied. The former study by Gallagher and colleagues (2010) also supported this conclusion. They

summarized that, with widening skill-mix, dental care professionals can play a major role in building dental care capacity for older people in future.

To determine the success of implementing the skill mix approach in dentistry, dentists must be willing to delegate some of their routine and appropriate tasks to dental therapists or auxiliaries (Burman, 1987; Gallagher and Wright, 2003). Gallagher and Wright (2003) believed that there is demand for a fresh debate on the future dental workforce which should extend beyond professional and national boundaries and inform workforce planning. This debate would be of great importance to future generations of dental healthcare professionals, funders, commissioners and providers of both dental services and dental education and training, and most importantly the patients and the public whom dental professional serve.