

Chapter 1 : Introduction to UAE

(United Arab Emirates)

UAE is one of the GCC (Gulf Co-operation Council) countries.



Fig 1 : UAE map

UAE Area :

- Total Area : 77000 Sq. Km.
- Desert : More than 75 %
- Abu Dhabi : The capital, (67000 Sq. Km. 87 %)
- Dubai : Commercial Emirate (3900 Sq. K., 5 %)
- Sharjah : (2600 Sq. Km., 3 %)
- Other 4 small emirates, totally 3880 Sq. Km., 5 % Ajman, Umm Al Quwain, Ras Al Khaimah and Al Fujarah
- More than 70 % of the UAE is desert.

Emirate	Abu Dhabi	Dubai	Sharjah	Ajman	Umm Al Quain	Ras AL Khaimah	Al Fujairah
Area (Sq M)	67000	3900	2600	260	770	1700	1150
%	86.59	5.04	3.36	0.34	1.00	2.20	1.49

Table 1 : UAE population

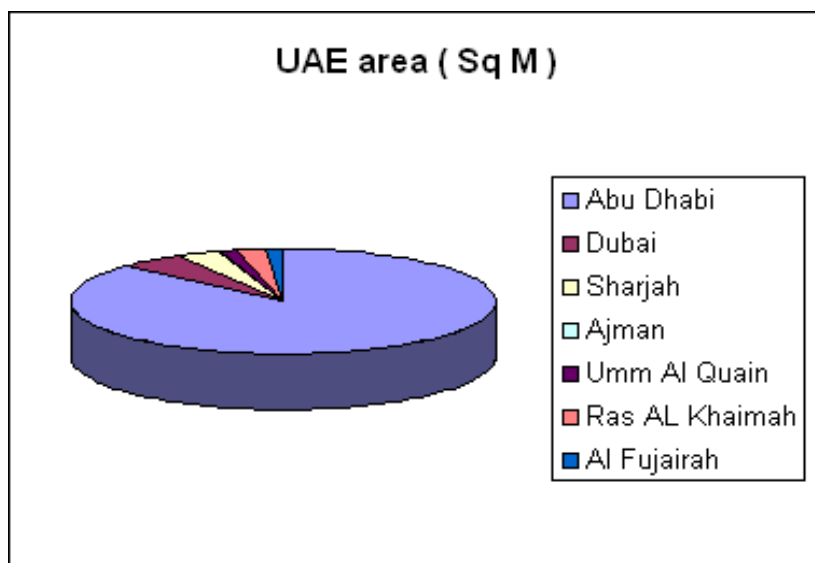


Fig 2 : UAE area

UAE Population

- The total population of the UAE is 4.3 million people, as per the latest statistical records, Ministry of Planning 2004.
- The locals represent 30% and the foreigners represent 70 % of the total population.
- The foreigners are from different nationalities, mainly India, Pakistan, Bangladesh, Philippine.
- Arabian (Palestine, Egypt, Iraq, Lebanon, Syria, Yemen, etc.)
- European nationalities, mainly England as well Bulgarian.

Emirate	Abu Dhabi	Dubai	Sharjah	Ajman	Umm Al Quain	Ras AL Khaimah	Al Fujairah	Total
Area (Thousands)	1678	1306	678	258	68	205	127	4320
%	38.84	30.23	15.69	5.97	1.57	4.75	2.94	

Table 2 : UAE area

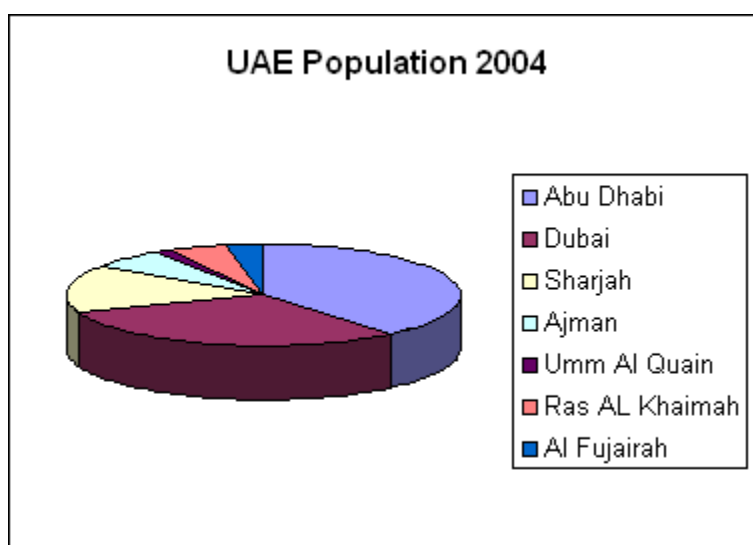


Fig 3 : UAE Population

UAE National Income :

Emirate	Abu Dhabi	Dubai	Sharjah	Ajman	Umm Al Quain	Ras AL Khaimah	Al Fujairah	Total
Oil	161245	7469	4123	0	0	258	0	173094.6
Non Oil	125301	132731	31595	5967	2033	8994	5797	312418
Total	286545	140200	35718	5967	2033	9252	5797	485512

Table 3 : GDP in UAE, 2005 (in Million Dirhams)

Emirate	Abu Dhabi	Dubai	Sharjah	Ajman	Umm Al Quain	Ras AL Khaimah	Al Fujairah	Total
Oil	43816	2030	1120	0	0	70	0	47037
Non Oil	34049	36068	8586	1621	552	2444	1575	84896
Total	77866	38098	9706	1621	552	2514	1575	131933

Table 4 : GDP in UAE, 2005 (in Million US\$)

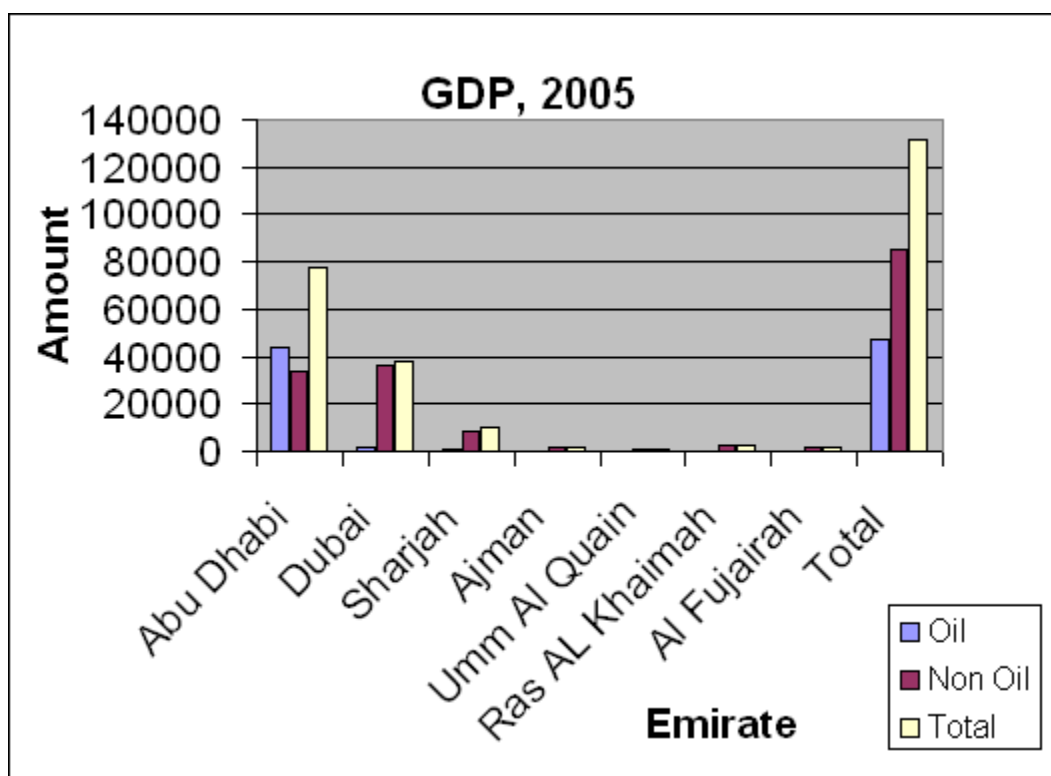


Figure 4 : GDP in UAE, 2005 (in Million US\$)

Chapter 2 : The medical equipment market in UAE

Introduction

This chapter includes information about the medical sector in UAE, showing the growth of the UAE medical market with statistical information about the medical professions.

All data in this chapter are as per the latest records of Ministry of Health, Department of Health and Medical Service – Dubai Chamber of commerce and industry – Abu Dhabi, Chamber of commerce and industry – Dubai.

The records are as of 2004. The records of 2005 have not been released yet.

The data and records about medical professions in this research do not include pharmacists, dentists.

For the purpose of records, the Emirate of Abu Dhabi is divided into three different medical districts : Abu Dhabi, Western Region and Al Ain.

For security reasons, there were no records for the defense hospital (Zayed Military hospital-Abu Dhabi and Zayed Military hospital-Al Ain).

Some changes happened during 2005, but do not affect the records.

For example, the General Authority for the Health Services for the Emirate of Abu Dhabi (GAHS) becomes responsible for all governmental hospitals and clinics in the Emirate Abu Dhabi (except police clinics and defense hospitals) instead of the MOH. Also, AL Jazeerah hospital was closed and all the staff had been shifted to other hospitals such as Mafraq & SKMC.

The number of doctors, clinics, polyclinics and private hospitals is increasing specially in the last few years due to banning of free governmental health services from the non-local residents.

Number of hospitals in UAE

	Hospital		Centers/Clinics	
	Governmental	Private	Governmental	Private
Abu Dhabi	20	11	47	327
Dubai	8	13	9	473
Sharjah	5	3	16	329
Ajman	1	1	6	62
Umm AL Quwain	1	0	4	10
Ras Al Khaimah	4	1	17	53
Al Fujairah	2	0	9	17
Total	41	29	108	1271

Table 5 : No. of hospitals in UAE

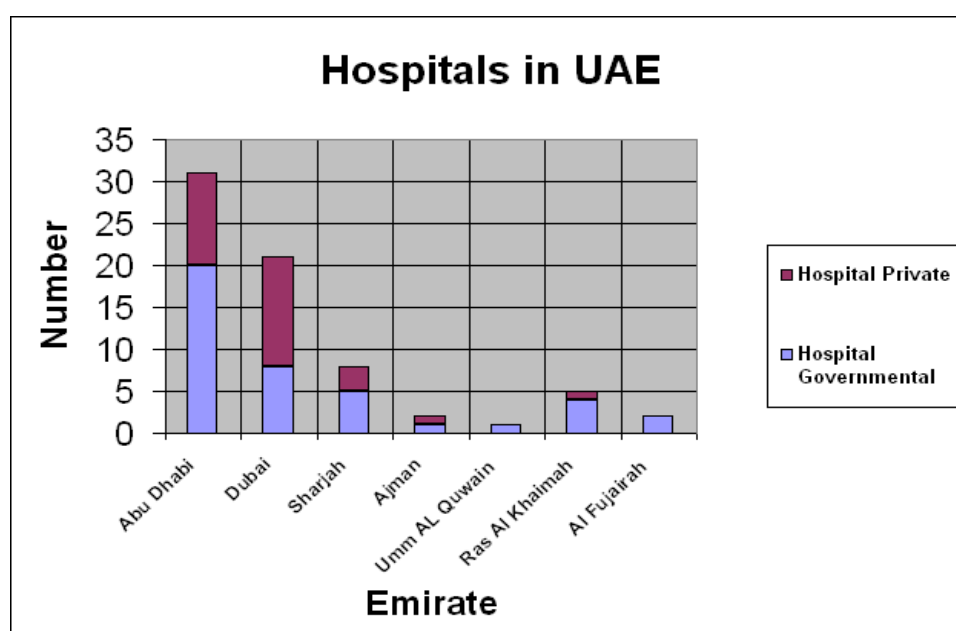


Figure 5 : Number of centers/clinics in UAE

	Centers/Clinics	
	Governmental	Private
Abu Dhabi	47	327
Dubai	29	473
Sharjah	16	329
Ajman	6	62
Umm AL Quwain	4	10
Ras Al Khaimah	17	53
Al Fujairah	9	17
Total	128	1271

Table 6 : No of clinics in UAE

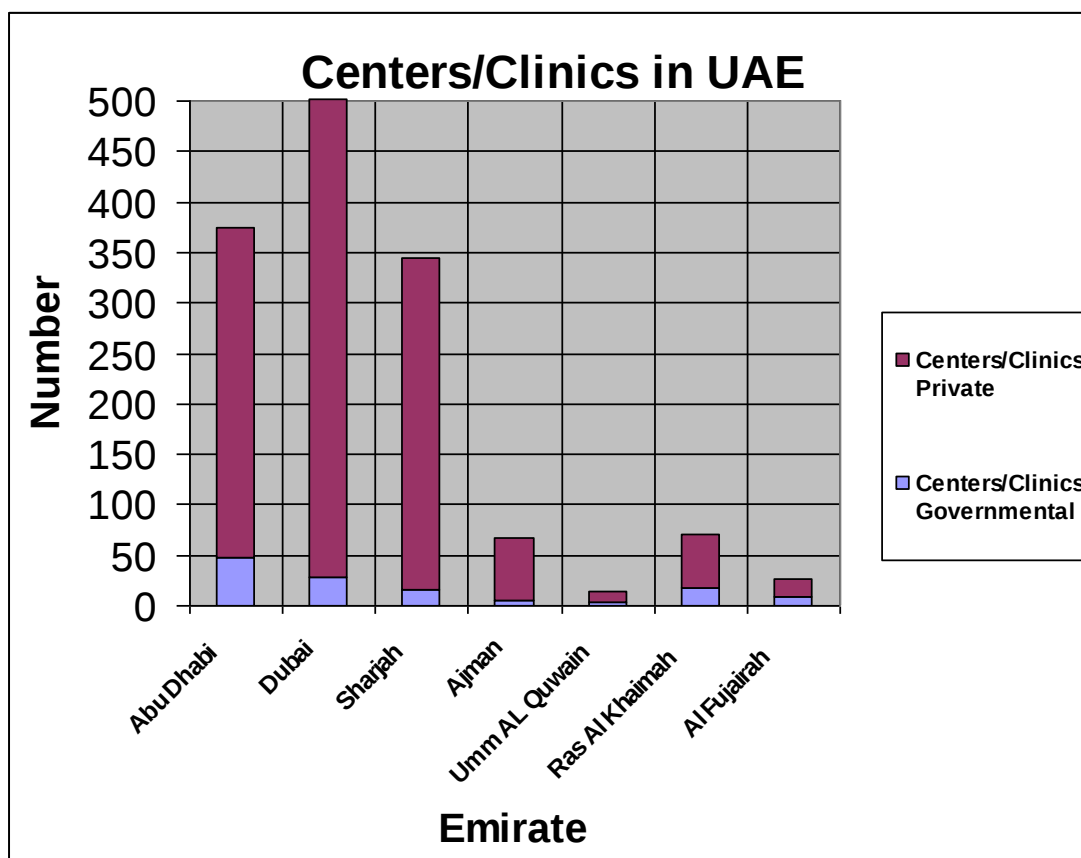


Figure 6 : No. of clinics in UAE

Authority	Emirate	Hospital	Doctors	Nurses	Technicians	No. of Hospitals
MOH	Abu Dhabi	Mafrag	223	616	225	
		AL Jazeerah	180	258	185	
		Central Hospital	64	308	102	
		Psychiatry	24	113	29	
		Rehabilitation	10	94	31	
		Total	501	1389	572	5
	West. Region	Ghayathi	16	30	12	
		Marfaa	13	31	5	
		Al Sela	9	31	8	
		Delma	10	20	6	
		Zayed City	63	137	50	
		Total	111	249	81	5
	Al Ain	Al Ain	204	600	164	
		AL Sad (Chest)	1	19	0	
		Total	205	619	164	2
	Dubai	Al Baraha	119	206	92	
		Al Amal (psychiatry)	13	60	9	
		Total	132	266	101	2
	Sharjah	Kuwait	39	174	51	
		Khorfakan	41	141	42	
		Kalba	36	112	32	
		Al Zaid	41	105	38	
		Qasemi	155	356	111	
		Total	312	888	274	5
	Ajman	Khalifa	67	227	72	1
	Umm AL Quwain	Umm AL Quwain	59	124	48	1

Ras Al Khaimah	Saqr	93	288	98	
	Shaam	9	35	9	
	Ibrahim Hamad	42	134	38	
	Saif	4	26	3	
	Total	148	483	148	4

Al Fujairah	Al Fujairah	89	224	70	
	Deba	36	110	34	
	Total	125	334	104	2

Grand Total	1660	4579	1564	27
-------------	------	------	------	----

GAHS	Abu Dhabi	SKMC	166	395	165	1
		AL Rahba	70	192	29	1
		Al Corniche	100	465	55	1
		Tawam	223	749	304	1
Police	Abu Dhabi	Police	86	241	40	1
Defecne	Abu Dhabi	Defence	?	?	?	1
	Al Ain	Defence	?	?	?	1
Adnoc	Western Region	Al Rewaise	24	71	19	1
DOH-MS	Dubai	Rashid	242	703	334	1
		Dubai	261	867	218	1
		AL Wasl	122	606	166	1
		Al Maktoom & Centers	189	524	134	1
		Iranian	19	223	159	1
		Delivery	1	9	0	1
		Total	1503	5045	1623	14

			doctors	nurses	tech	Hospitals
Private	Abu Dhabi		495	580	150	7
	Western Region		0	0	0	0
	Al Ain		87	125	30	4
	Dubai		356	759	233	13
	Sharjah		164	164	49	3
	Ajman		24	31	7	1
	Umm AL Quwain		0	0	0	0
	Ras Al Khaimah		11	4	0	1

Al Fujairah		0	0	0	0
Total		1137	1663	469	29

		doctors	nurses	tech	Hospitals
Grand Total		4300	11287	3656	70

Table 7 : Medical professions in UAE

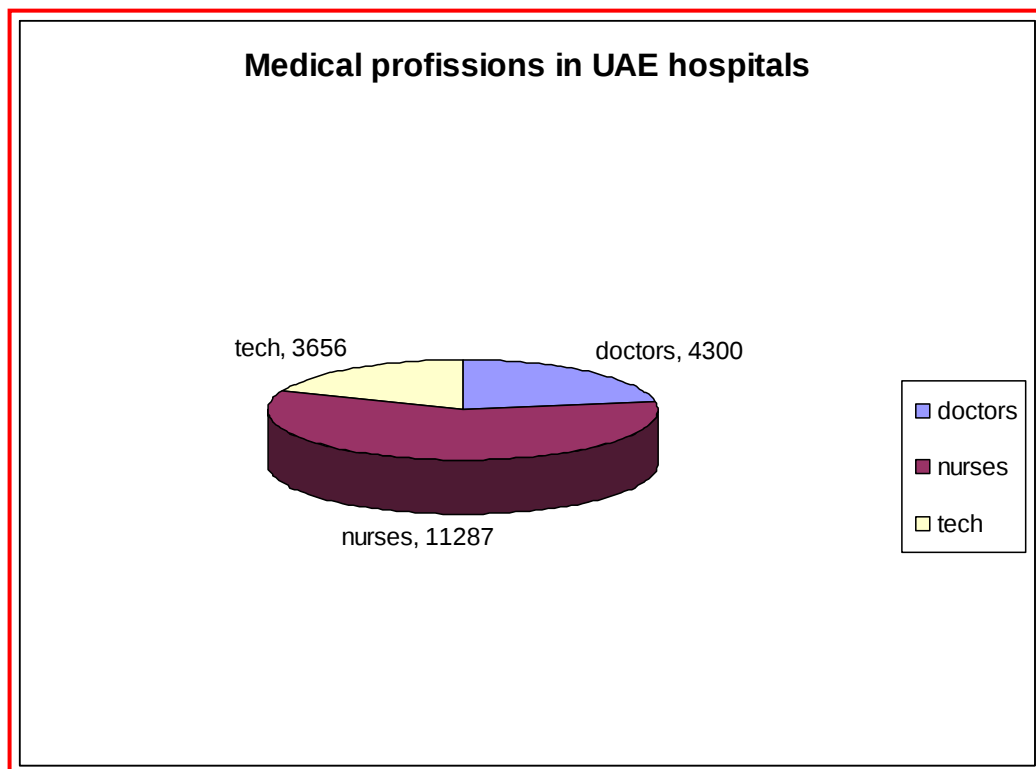


Figure 7 : No. of medical professions in UAE

Chapter 3 : Introduction about ultrasound scanning methods

Introduction :

In the last few decades, the ultrasound systems had been used in scanning with a result of two dimensional images.

In such technique we get just two dimensions either longitudinal section and depth or vertical section and depth according to probe position and depth of the ultrasound beam.

In 1980s, Kretz Company – Austria launched a new technique in diagnostic scanning which was three dimensional scanning.

At this time, few units (about 8 units worldwide) had been used for trial and comment from some professional sonographers. UAE was not one of the selected countries for this trial.

In 1990s, Medison company-Korea acquired Kretz company-Austria and became Medison-Kretz.

This merging helped the improvement of the 3D machines especially when the digital technology was applied.

Figure 8 : Voluson 530 ultrasound system



What is 3D scanning :

As mentioned before, in two dimensional scanning we get just a two dimensional image. But in 3D scanning, we can get longitudinal, vertical as well as horizontal image simultaneously (three axels sectional images, multi-planner image).

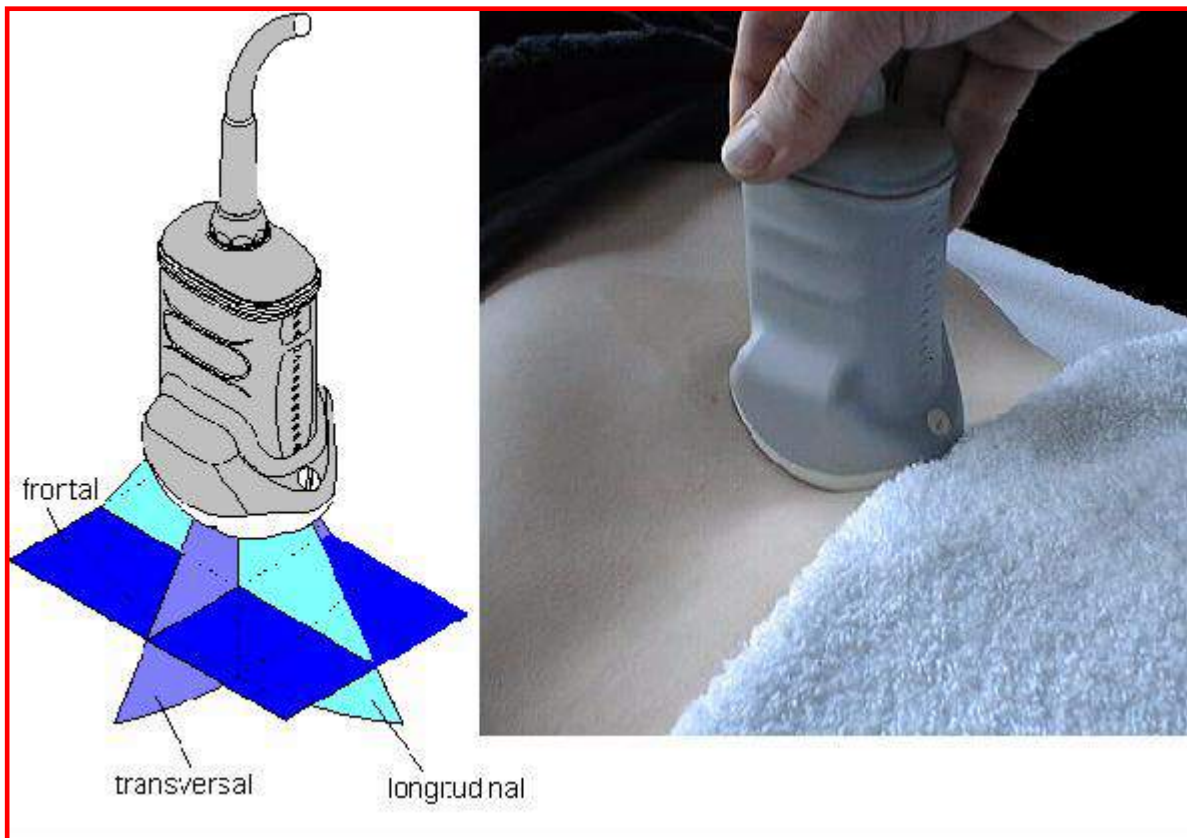


Figure 9 : How a volume probe does the scanning in 3 planes

In medical anatomy science these three planes are named Sagittal, Frontal and Coronal sections. These three images could be displayed simultaneously anatomically and topographically on the same screen.

Coronal section was the actual era resulted from 3D scanning. This section was possible only in CT scan and MRI imaging.

Plus the Coronal (horizontal) section era, the three sections could be reconstructed into a volume image.

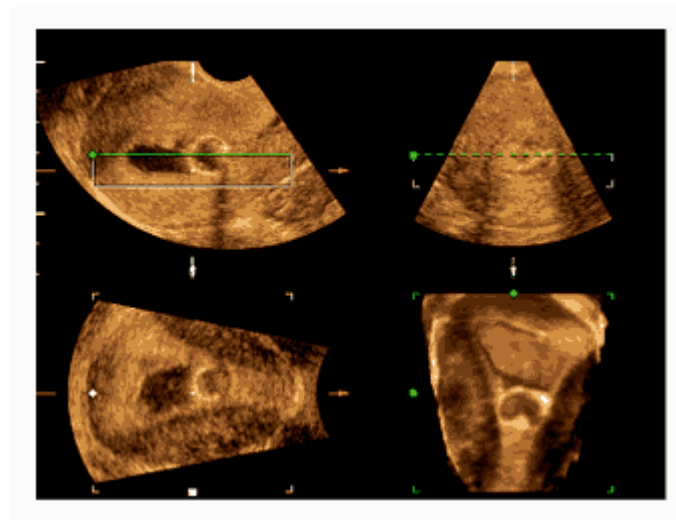
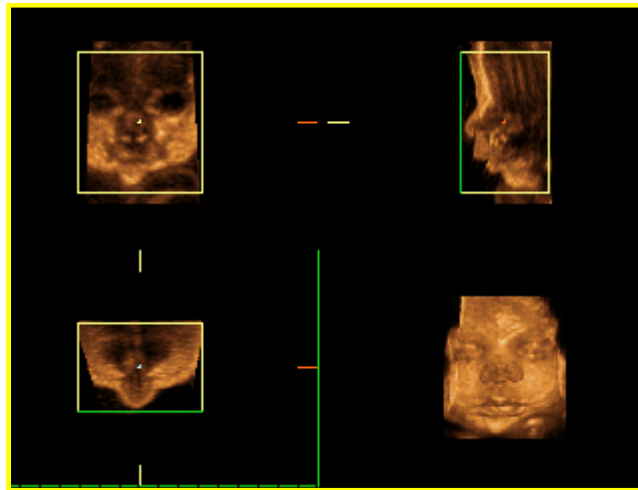


Figure 10 : Pictures of the 3 planes and volume image

What is real time 3D scanning :

In the analogue machines, we were getting multi-planner images. Reconstruction of these images into a volume image was taking a long time (15 to 17 minutes).

Moreover, any changes in one section (for example moving the frontal section image) the respond of the machine to get the corresponding changes in other planes (sagittal and coronal) as well as the volume image takes time.

With the introduction of the digital technology, reconstruction of the volume image takes fractions of a second.

Also any changes in one plane result immediately in the corresponding changes in the other planes as well as changes in the volume image as well.

This was called real time 3D.

What is live 3D :-

The 3D scanning was done once and the result was frozen multi-planner images as well as a reconstructed volume image.

If any changes happened in the scanned area (for example changed foetal position in the uterus) we have to get a new 3D scan to get the new position.

This is exactly resembles using a camera for getting a picture for a person. We can take the picture of a person in a certain position, but once he changes his position, the picture will not change. To get a picture for the new position we have to make another one, and so on.

With the application of live 3D, which mean live scanning we were able to include the 4th dimension (the time) in the scanning method. This means we can follow up by 3D scanning any changes in a moving organ in the once it happens.

This resembles using a video camera instead of a photography camera. By video camera we can make a record for a person while he is moving, taking different positions.

But as the frame rate was very slow (started by 2 frames per seconds, and when it was advanced, it reached 4 frames per second) so, there was some delay between

the real image in the scanned area and the 3D and volume images we get on the monitor of the machine.

This is exactly what is happening when we use a video camera with low frame rate.

What is 4D :-

With the enhancement of the frame rate, which increased to 16 frames per second (by launching Voluson 730 machine by Medison-Kretz Company) in 2001 we were able to get a nearly 3D and volume images on the monitor which are exactly the same as the scanned parts concerning the position and movement.

That is why it is called 4D, i.e. more inclusion of the 4th dimension (time).

Then the frame rate increased a little up to 25 frames per second to a limited scanned area.

In the last few weeks of this research, some manufacturers announced new 4D probes with high frame rate e.g. Medison, Philips (30 Frame per seconds).

Chapter 4 : Data collection about 3D/4D ultrasound in UAE market

Data collection method :

The following questionnaires were used to collect the data

These questionnaires had been designed according to

- 1- Studying the principals of marketing and marketing research methodology.
- 2- My medical background
- 3- Clinical and technical training courses in ultrasound scanning.
- 4- Experience in the UAE market. Sixteen years experience of sales, of which 13 years sales manger and ten years in the UAE market.

Questionnaires were submitted to the selected prospects by couriers (such as DHL) by fax and by hand (personal meeting).

After filling the data, the questionnaires were collected from the prospects by hand.

Sampling technique

Non probability sampling; Judgment sample :

Choosing the good prospects for accurate information by selecting the highly experienced ultrasound end users (radiologists) in all medical facilities in UAE (governmental hospitals, private hospitals, private clinics), plus the ultrasound technicians as well as some other specialties; mainly Ob/Gyn., then some surgeons and physicians.

The Ob/Gyn doctors represent the majority of ultrasound end-users, the radiologist represent the second major group of end-users.

The majority of selected samples are already had very good experience in 2D ultrasound scanning. Few of them have some experience in 3D/4D as well.

Population surveyed

Group of the ultrasound end-users had been selected in all the seven Emirates (governmental hospitals, private hospitals, and private clinics).

The data had been collected over 6 months of activities keeping contact with most of prospects especially by phone calls and sometimes by personal meetings.

Chapter 5 : Data analysis and results

- **Specialty :**

- Total number of cases is 475 cases.
- The majority of them were obstetricians and gynaecologists (Ob/Gyn) which is normal in ultrasound end users. They represent the majority customers of sonographers.
- Next specialty is ultrasound technicians.
- Third specialty is radiologists.

Specialty	Ob/Gyn	Radiology	Technicians	Surgeon	Physicians	Urology	Total
No	250	40	120	15	40	10	475
%	53%	8%	25%	3%	8%	2%	100%

Table 8 : Classification of Ultrasound end users by specialty

- More than 90 % of end-users are using 2D ultrasound. The others are using Volume scanning.

Users	2D	3D/4D	Total
No	430	45	475
%	91%	9%	100%

Table 9 : Classification of ultrasound users (2D : 3D/4D users)

- **Willingness to use The 3D/4D ultrasound :**

- Most of 2D users (more than 90 %) are willing to get 3D/4D machines. They explain willingness as the following :
 - a) This is a new technology and going on very fast. They have to follow it up otherwise the reluctance may make them non-desirable sonographers. Some of them explained this point by giving an example

of the colour Doppler scanning technique. When the colour Doppler was launched by Toshiba in early 1980s, many of sonographers claimed that it has no added value to the normal 2D scanning methods. Later on the colour Doppler was accepted by all the medical professions and proved that some diseases could not be diagnosed properly without the colour Doppler. They expect that the volume scanning will be the standard method in the 21st century. Even some of them were thinking beyond the 3D and 4D by giving some thoughts about 5D scanning. They meant by the fifth dimension the psychology of the fetus. For example when we scan the fetus by 3D or moving fetus by 4D we can assess the psychic conditions such as happiness, pain, resting , Some of them explained the fifth dimension by the function of the organ. For example, we can examine the endometrium (the lining of uterus) by 3D or 4D, we can assess the function of this endometrium and be sure exactly of its size and shape match the phase of menstrual cycle.

- b) The majority of the paid attention to the added value by this new technique. So many benefits could be added by using the volume scanning. These benefits are explained later in this [chapter \(Page XX\)](#)

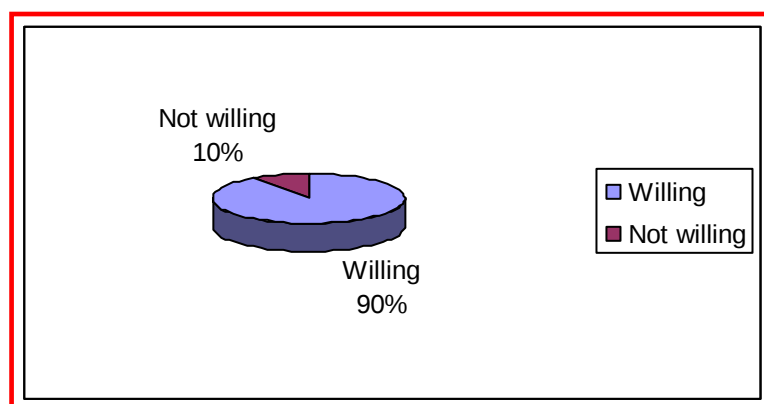


Figure 11 : Willingness to have 3D/4D ultrasound system

- The 10% they are not willing mainly due to non awareness. Some expressed other factors as shown in the chart below such as difficult technique, price of machines, ...

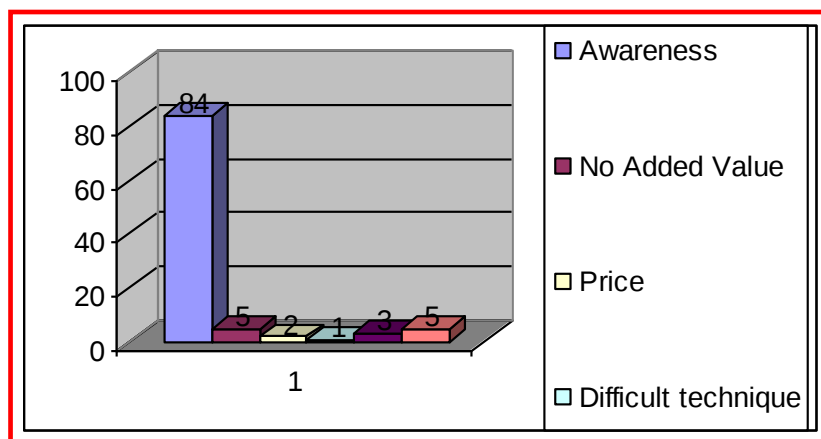


Figure 12 : Causes of non-willingness of using volume scanning

Hence, we should pay special attention to the non awareness of the volume scanning.

- **Awareness of the 3D/4D ultrasound :**

- More than 80 % of them are not aware of the volume scanning.

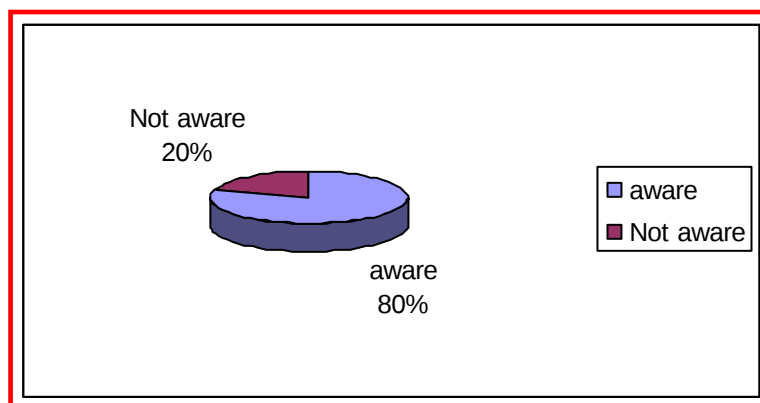


Figure 13 : Awareness of Volume scanning

The non awareness is due to the following factors :-

- 1) The ultrasound manufacturers do not advertise properly about this technology. So the 2D users they think that once they put the ultrasound probe on patient's abdomen, they will get a volume image exactly the same as in any atlas of anatomy without the respect to surrounding tissues.
- 2) The 2D users have no consideration to the fact that 3D/4D is a new technique and they must be taught how to use it. Most of them think that since they attend a lecture for volume scanning and being an experienced 2D sonographer, they -of course- should be able to perform volume scanning.
- 3) Lack of teaching institutes in UAE. All 2D end users have no real chance to be taught the volume scanning in UAE. They depend on conferences, congresses. exhibitions... etc which is absolutely no effective and not enough to get the leaning and experience of the volume scanning such in some other countries e.g. Austria and Egypt.
- 4) Very few of them are not willing to study and learn this new technique.

Benefits added by using volume scanning :

By data collection, benefits and values of 3D/4D scanning are wide and numerous. In the first few questionnaire forms, some end-users who know what 3D/4D added many points about the benefit of this technique. SO, the questionnaire was amended by adding more points about the benefit of 3D/4D scanning. Generally speaking, 3D, 4D and volume scanning methods add more technical values versus the conventional 2D scanning.

The following are benefits and values added from the technical point of view :

- Display of the three sections as well moving within the volume of each plane topographically, layer by layer with a distance between two

successive layers of 0.2 millimeter ensures an efficient and accurate diagnosis even in very small focal lesions.

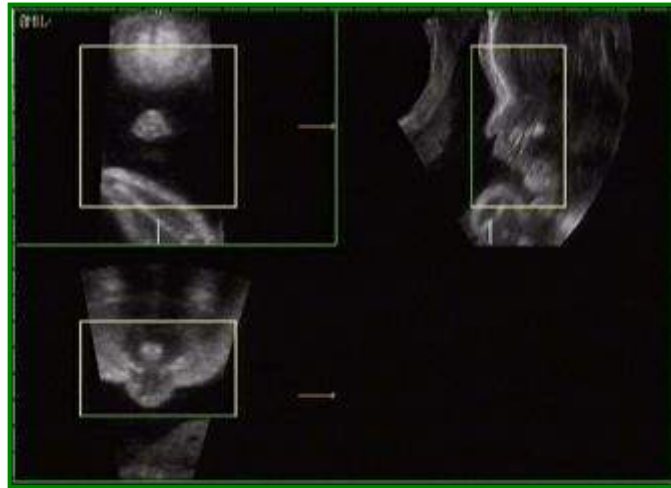


Fig 14 : the three orthogonal planes

- The coronal plane offers new access to structures normally are very difficult to scan by the conventional 2D scanners such as :
 1. Ventral wall defect of stomach.
 2. Stones in common bile duct. Usually in 2D scan stones may not be seen and. If the doctor has a suspicion, usually he refers the patient to do ERCP (Endoscopic Retrograde Cholangio -Pancreatography).
 3. In case of prostate tumors, we can diagnose accurately via 3D trans-rectal scan if the lesion is penetrating the prostate capsule or not.
- Volume scanning offers precise determination of the relations with the surrounding structures which ensures accurate diagnosis of benign versus malignant lesions as well as extension of the lesion to the surrounding structures.
- Rendering modes : Volume scanning has several rendering modes. These modes help to change the characteristics features of the displayed volume

image to help better and accurate diagnosis. Once the sonographer gets the volume image, he/she must make best use of resources available to get the maximal information from the data. The key lies in use of various reconstruction and rendering algorithms. The different rendering algorithms are :-

1. Surface modes :

Shows very impressive details of any congenital foetal malformations especially of the external structures as face, hands, legs, back , ...

- a) Smooth : allows to get good image of the surface but the image is dark and hazy.
- b) Surface Texture : allows to get bright and well focused image but coarse.

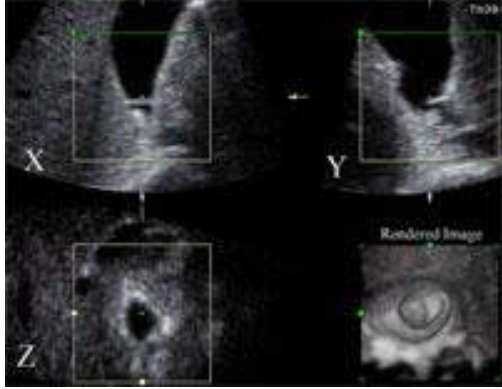
2. Maximum : Accentuate strong echo signals i.e. display mainly the tissue that gives high echoic signals, so that hard structures as bone and calculi are better displayed.

3. Minimum Accentuate weak echo signals so that the hollow structures as vessels, bile ducts, uterine cavity ... etc accurately and clearly displayed.

4. X ray Mode : gives an image similar to X-ray. I.e. concentrates mainly on the bony parts e.g. foetal skeleton.

5. Gradient light/Light Mode : superficial tissue gives bright resulting pixel, deep tissue gives – lower gray value pixel.

A sonographer can mix and match any of the two algorithms (rendering modes) and then decide the percentage of mixes. Its like adding two colors e.g. Red and white, and then altering the percentage of red or white, to get a darker or lighter pink shade.

	
3D View of Gall Bladder with minimum transparency mode.	3D View of Gall bladder lumen using mixed surface & smooth surface rendering modes.

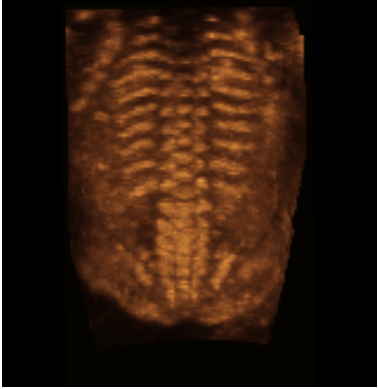
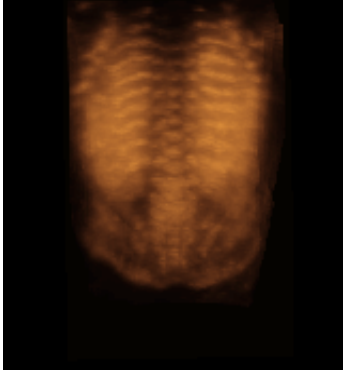
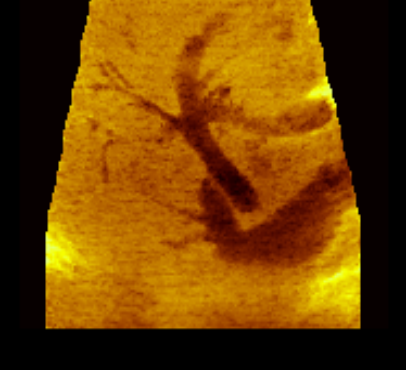
		
Maximum mode, Foetal skeleton	X-Ray mode, Foetal skeleton	Minimum mode, hepatic vessels

Figure 15 : 3D view with deferent rendering modes

- 4D ultrasound helps scanning of moving organs and helps accurate and precise free hand biopsy techniques.
- 3D/4D will open new fields in Medicine such as Intra-uterine foetal surgery.

In different specialties, there are many benefits and values of 3D/4D :

In Obstetric/Gynaecology :

1. Accurate assessment of congenital foetal anomalies and asymmetrical malformations :
 - Facial anomalies : Cleft lip, cleft palat, ...
 - Intracranial anomalies : Hydrocephalus.
 - Trisomies.
 - Hand and leg deformities e.g. hemimelia, polydactyly, syndactyly, a chondroplasia, ...
 - Skeletal deformities : Spina bifida.
 - Omphalocele.
 - Cardiac anomalies.
 - Hypospedias and epispedias.



Fig 16 : Bilateral cleft lip



Fig 17 : Achondroplasia



Figure 18 : Absent radius and ulna



Figure 19 : Exophthalmos



Figure 20 : Clenched fist in trisomy



Figure 21 : Polydactyly



Figure 22 : Foetal scoliosis

2. Diagnosis of cervical tumours, accurate assessment of parametrial infiltration and monitoring radio and chemotherapy.
3. Precise and accurate diagnosis of uterine and ovarian lesions (benign and malignant).
4. Diagnosis of Asherman syndrome (intrauterine adhesions) with accurate visualization and localization of uterine scars.

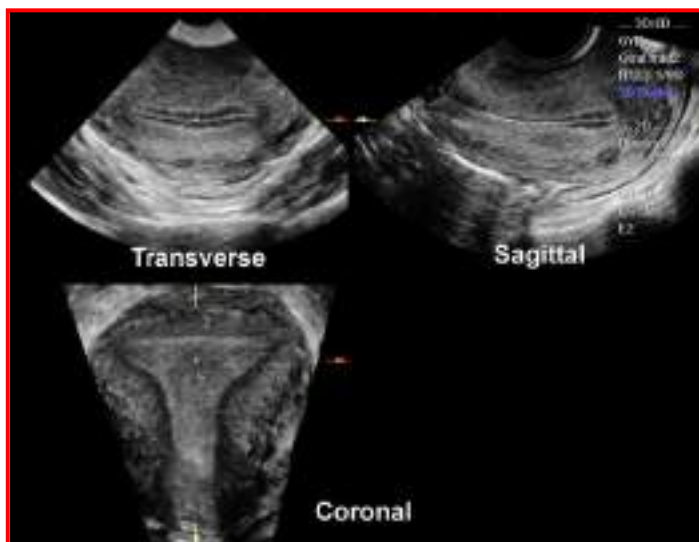


Figure 23 : Coronal view of uterus showing the triangular shape of normal endometrium.

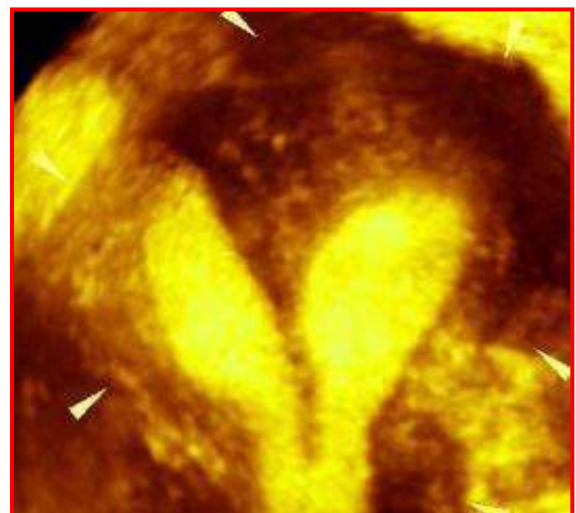


Figure 24 : Septate uterus

In Gastroenterology :

1. Accurate assessment of numbers, localization and shape of gall bladder stones and alterations of biliary ducts.
2. Accurate judgment of the extension and localization of liver tumours.



Figure 25 : Intestinal T.B.

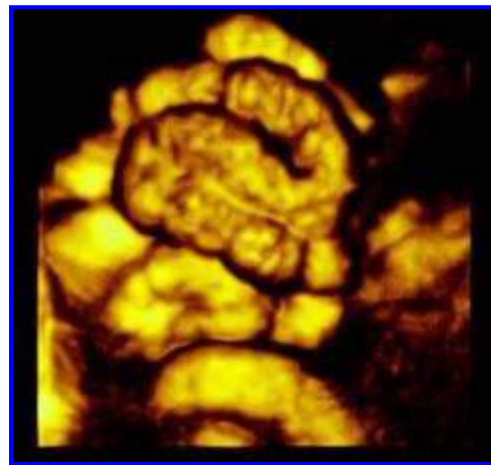


Figure 26 : Intestinal Typhoid

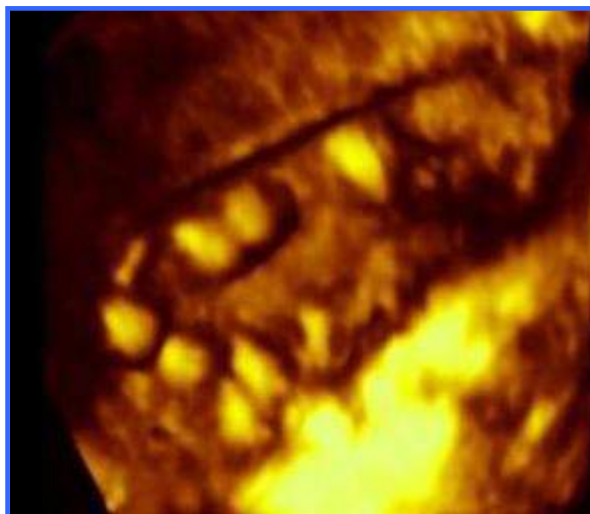


Figure 27 : Multiple gall bladder stones

In Surgery :**1. Evaluation of malignant tumours :**

- Tumour staging and volumetry.
- Detection of depth of infiltrations
- Accurate assessment of lymph nodes involvement.
- Tumour vascularization monitoring.
- Accurate tumour classification.
- Accurate judgment of seeds of implantation and follow up, e.g. colorectal tumours, prostate tumors, hepatic and pancreatic tumours ... etc.

In prostate :

- Easy and comfortable examination of prostate. Usually in 2D scanning there is painful manipulation of the trans-rectal probe to examine all parts of the prostate in both longitudinal and transverse planes. In 3D technique no need of such much manipulation as once the surgeon get a good image of the prostate he can hold the probe fixed and the ultrasound system will scan the prostate completely in few seconds in the three axial planes simultaneously.
- Monitoring prostate laser coagulation therapy due to enhanced contrast of the coagulated tissues by 3D.
- Easy demonstration of Cowper's gland and its cyst.
- Accurate diagnosis and measurement of prostate tumours with accurate judgment if the lesion is penetrating the prostate capsule or not.

In Vascular diseases :

- Localization of the site of thrombi and vascular compression.
- Exact judgment of the presence of aneurysms and their growth.

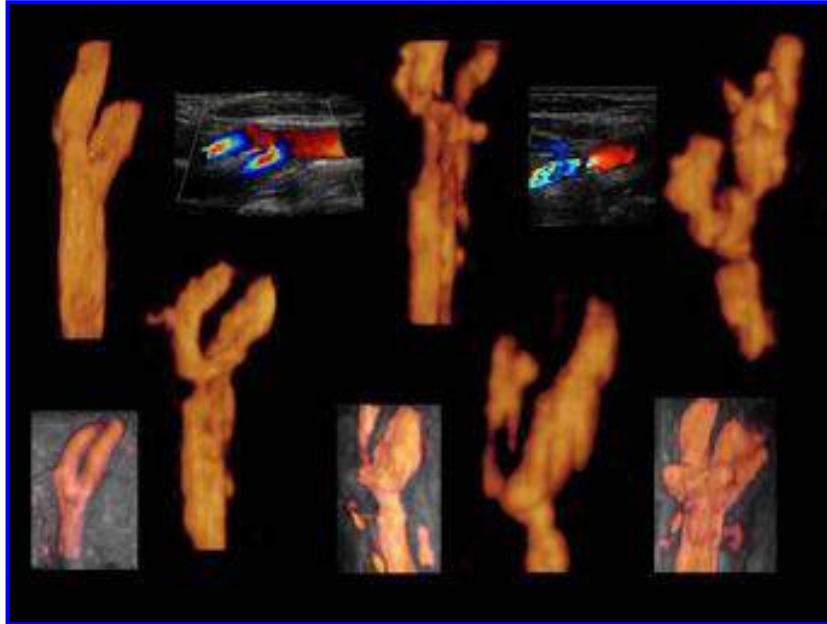


Figure 28 : Carotid arteries images of different cases showing different grade of stenosis and occlusion

In Orthopaedic :

- Precise information on the inner joint space, callus surface and synovial thickness.
- Volume determination of effusion and Baker cyst.

3D power Doppler :

- In Ovarian diseases : It is vital for the characteristics of :
 - Normal and abnormal folliculogenesis and luteogenesis.
 - Endometriosis.
 - Vascular lesions.
 - Inflammatory masses.
 - Neoplasia.
- In scrotal sac :
 - Graduation of diffuse testicular variations.

- Graduation of varicocoele.
 - Characterization of testicular torsion.
 - Characterization of inflammatory processes.
 - Characterization of neoplasia.
- In uterus :
- Infertility.
 - Abnormal proliferation of the endometrium.
 - Hormone replacement therapy in the postmenstrual patients.
 - Response of the uterine vasculature to drug therapy.
 - Myomas.
 - Carcinomas.
- In Kidney :
- It has the potential for study of :
- Cortical vascular network in chronic renal diseases.
 - Problems associated with transplanted kidneys and local lesions.
 - Evolution of an acute diffuse process.
- In Thyroid :
- It valuable for :
- Study of thyroiditis and various forms of goiter.
 - Characterization of solitary nodules.
- In Liver and biliary system :
- It useful for the study of :
- Portal hypertension.
 - Differentiation of anomalous vessels.
 - Transplants.

- Characterization of nodules.
- Cholecystitis.
- In obstetrics :

3D power Doppler is impressive in optimal visualization of the vascular tree of foetal, placental and maternal circulation.

It can be used for the diagnosis of :

- Absence of vessels.
- Abnormal vascular courses or pathological changes.

3D power Doppler can be useful in accurate diagnosis and precise evaluation of :

- Chronic foetal distress and its causes.
- Miscarriage and its causes.
- Ectopic gestation.
- Trophoblastic neoplasia.
- Congenital foetal malformation.
- Multiple gestations.

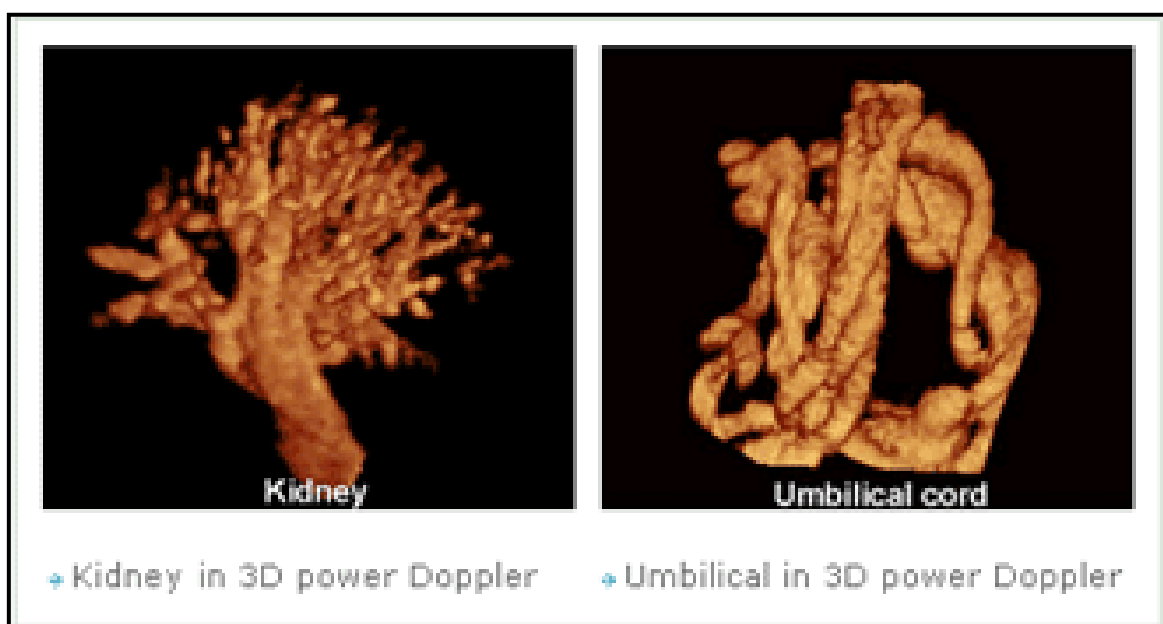


Figure 29 : 3D power Doppler

Other benefits and values of 3D/4D :

Patients now are aware (especially on obstetrics) that there is a 3D/4D scanning and prefer to be scanned by this new technique rather than the conventional 2D systems.

Volume scanning will enhance and enforce the relationship between mother and her fetus.

When the patient sees an understandable image, he will trust the doctor and his decision.

Accurate and precise diagnosis will help doctors to have the right decision and will reduce the treatment period, reduce the pre-operative time and hence may reduce the total hospitalization period.

Generally, we can say that 3D and 4D ultrasound scanning increases the diagnostic applications of ultrasound and improves its diagnostic accuracy.

3D and 4D ultrasound is the ultrasound of the 21st century.

Chapter 6 : Survey of 3D/4D Ultrasound systems in UAE market

In this chapter I have made a survey of all 3D/4D ultrasound systems which had been installed in UAE market.

By personal meeting I have seen all different brands and discussed with the end users about how long they are using the system, and if they are convenient or not. Also, I discussed if they are willing to change to another system (from the same manufacturer or from another manufacturer).

All end-users had filled a form for the important specifications in their system, hence I was able to identify what are the exact technical points they need in a 3D/4D ultrasound system (Customer voice).

Which brand/model they are currently using

Through all the 475 customers (sample of this research) as per the following table we can see that, in Volume Scanning Medison is the number one in sales in UAE market, GE is No. 2.

Other manufacturers e.g. Siemens – Germany, Philips – Netherlands, Esaote – Italy & Siui – China had sold fewer number of systems. Siui had sold two systems but without the 3D/4D. This function was an optional and had not been bought by the customer. Esaote had sold one unit only. Hitachi had not sold any unit.

Brand	Medison	GE	Siemens	Philips/ATL	Toshiba	Aloka	Others
No. of units	30	10	3	4	1	3	3
%	56	19	6	7	2	6	6

Table 10 : 3D ultrasound systems sold in UAE

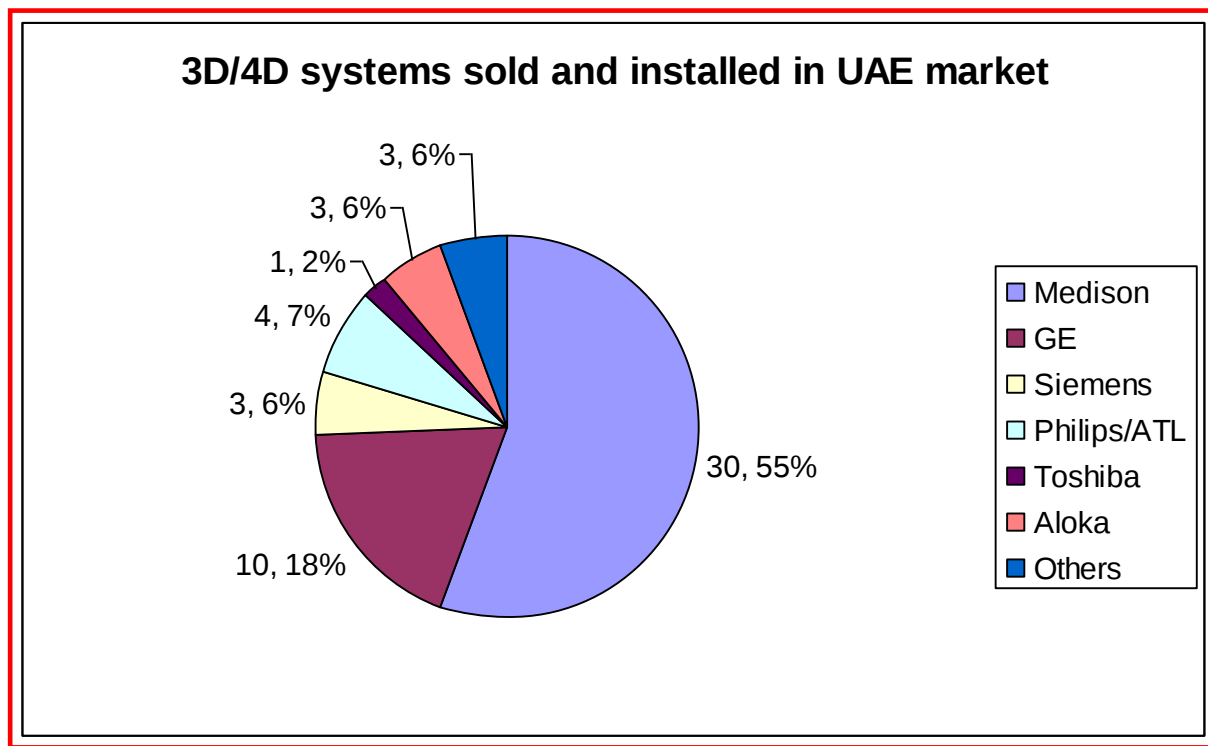


Figure 30 : 3D ultrasound systems sold in UAE

Since how long they are using you system?

From the following table we can see that

- 1- Medison is the first and oldest company who sold volume scanning machines in UAE market.
- 2- GE is No. 2.
- 3- Aloka is No. 3.
- 4- ATL (Philips) is No. 4.
- 5- Other brands such as Esaote & Siui are less than one year in UAE market.

Brand	Medison	GE	Siemens	Philips	Toshiba	Aloka	Others
Years	8	5	1	2	0.5	4	0.5
%	38	24	5	10	2	19	2

Table 11 : How long they are using 3D ultrasound?

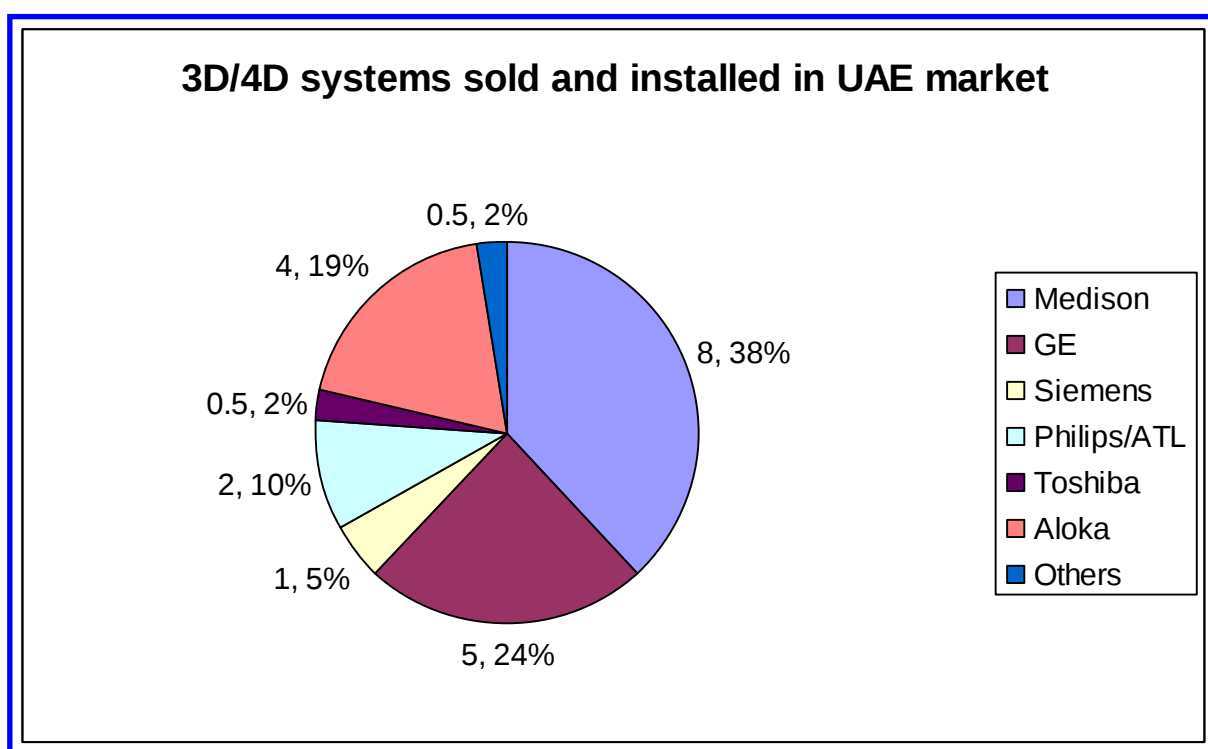


Figure 31 : How long they are using 3D ultrasound?

Customer satisfaction of the currently used system :

Are they satisfied with their current system?

Almost, with all customers the first reply was yes.

The reason behind this answer was mainly due to the fact that no customer would like to express that he has made a wrong decision by buying certain brand. Even

many of them were trying to prove that they have the best brand. Also, they had no up to date information about the other systems that are available in the UAE market.

But by discussion of some technical points, after sales service and other points many of them started to doubt their actual satisfaction of the existing systems.

The following tables and charts explain to what extent the customer were satisfied of their systems and to how much degree they are willing or not willing to change it to another higher system from the same brand or to change it to a different brand.

Yes	90
No	10

Table 12 : Are they satisfied with the current system?

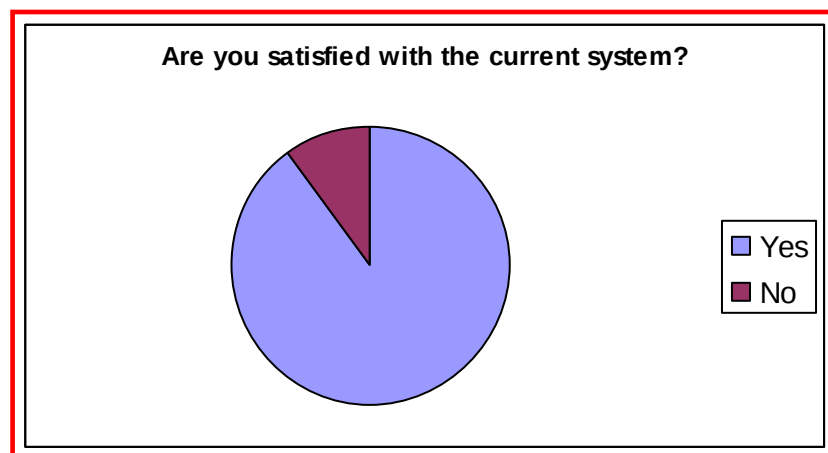


Figure 32 : Are they satisfied with the current system?

Why they are/are not satisfied with the current system?

1) Brand name :

70 % of customers were satisfied of the brand of their systems. Mainly, GE, Siemens & Toshiba.

	Good brand name
% Satisfied	70
% Non satisfied	30

Table 13 : Brand name satisfaction

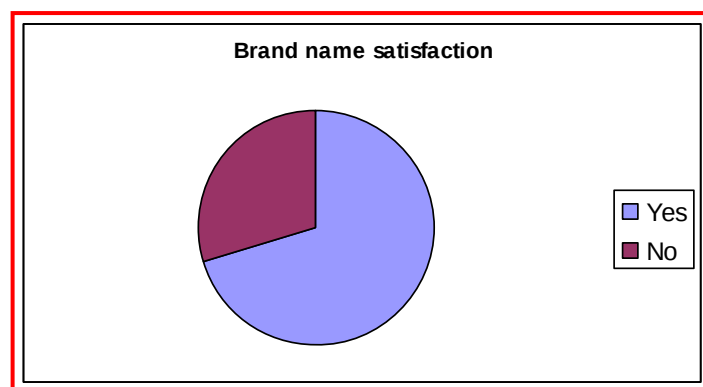


Figure 33 : Brand name satisfaction

2) Durability of the system :

Most of customers were satisfied of the durability of their systems. Rarely some systems had showed Sirius defect or malfunction that affects the system durability. Some customers were using their systems for many years (over 15 years).

	Durability
% Satisfied	90
% Non satisfied	10

Table 14 : Durability satisfaction

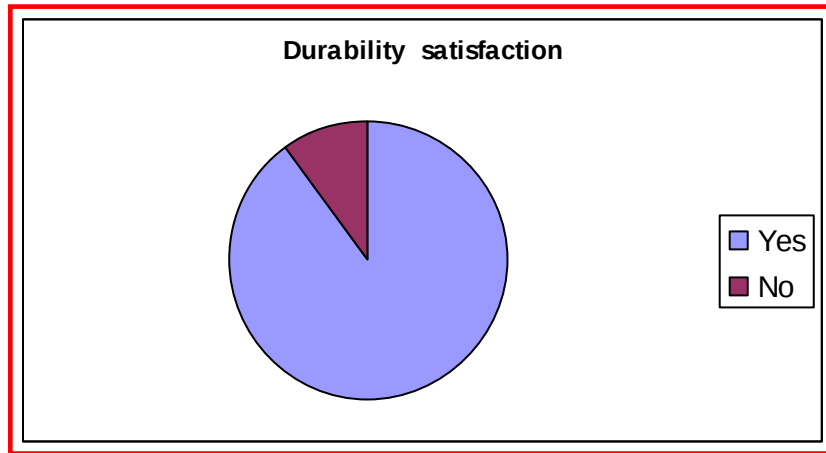


Figure 34 : Durability satisfaction

3) Performance of the system :

System performance was gradually decreasing with time. Some customers expressed their dissatisfaction of the performance by comparison to the new systems launched in the market with better performance.

	Durability
% Satisfied	70
% Non satisfied	30

Table 15 : Performance satisfaction

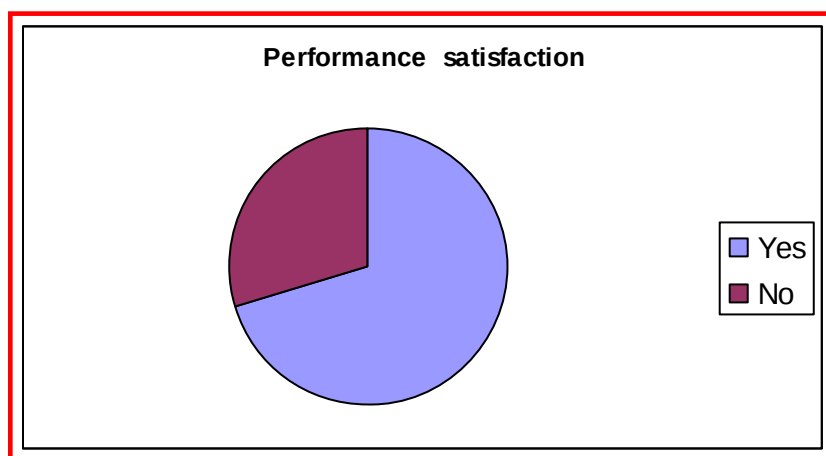


Figure 35 : Performance satisfaction

4) Price of the system :

Customers were expressing the price satisfaction as if they have got good quality system against what they had paid or not (customer perceived value).

	Price
% Satisfied	60
% Non satisfied	40

Table 16 : Price satisfaction

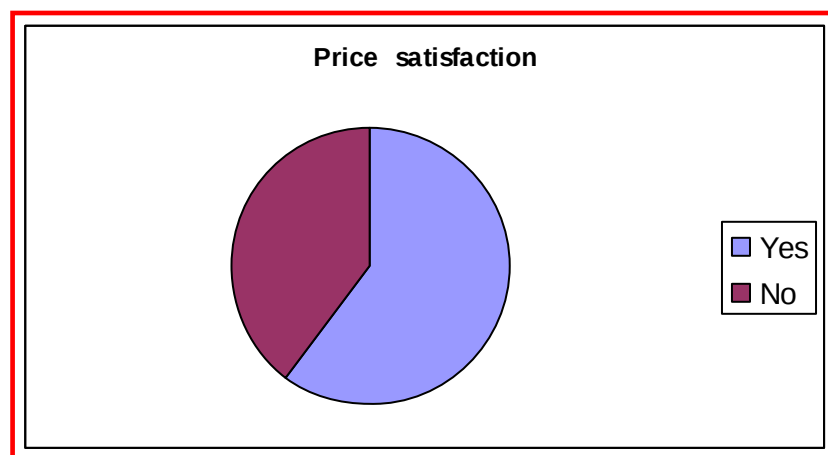


Figure 36 : Price satisfaction

5) After sales service :

	Price
% Satisfied	50
% Non satisfied	50

Table 17 : After sales service satisfaction



Figure 37 : After sales service satisfaction

Overall satisfaction

	Brand name	Durability	Performance	Price	After sales service	Total
% Satisfied	70	90	70	60	50	68
% Non satisfied	30	10	30	40	50	32

Table 18 : Overall satisfaction

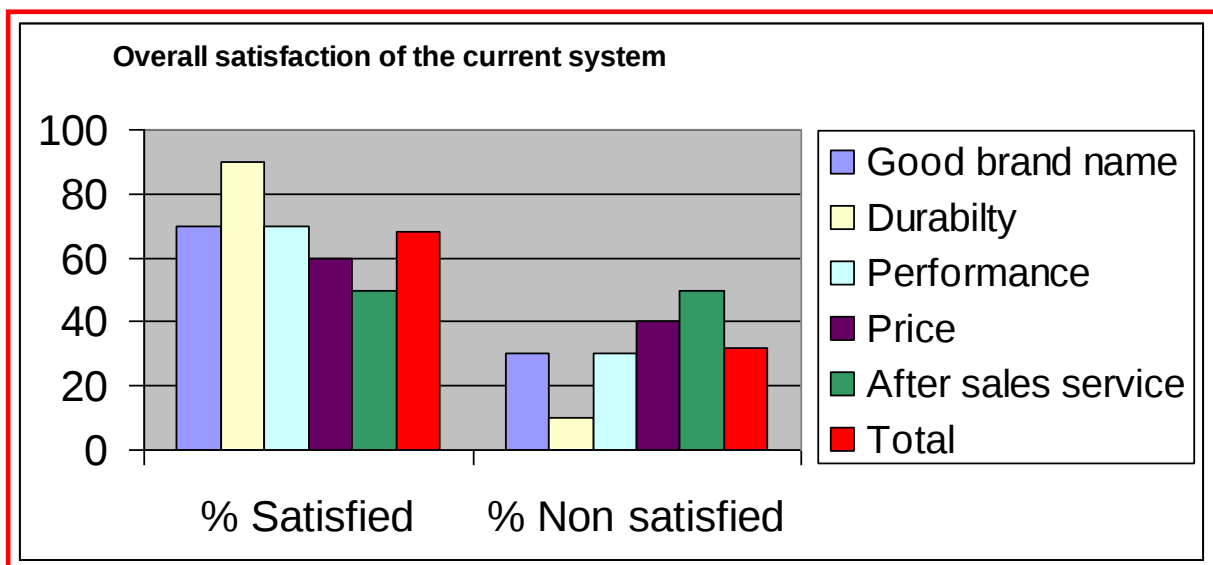


Figure 38 : Overall satisfaction

Overall satisfaction	
Yes	68
No	32

Table 19 : Overall satisfaction, summary

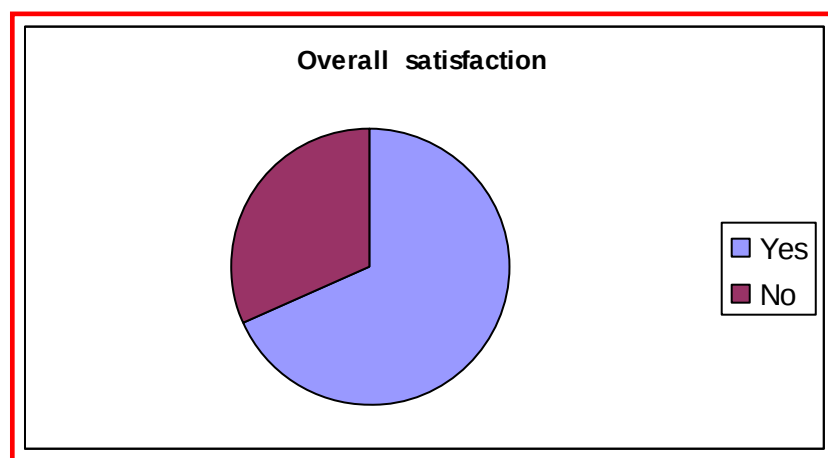


Figure 39 : Overall satisfaction, summary

Are they willing to change the current system?

This question was mainly for the satisfied customers. The entire non satisfied customers (32%) want to change their systems.

60% of satisfied customers (68%) are willing to change their current system. Even the customers who showed satisfaction of their current system some of them are willing to change to a new system.

Yes	60
No	40

Table 20 : Willingness of satisfied customers to change the current system

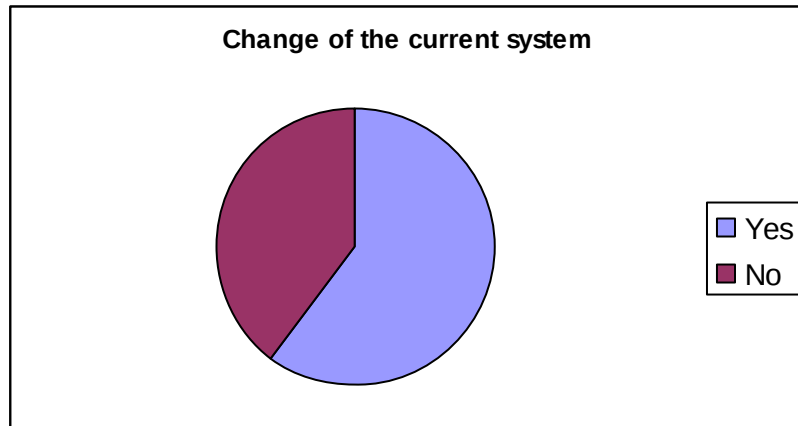


Figure 40 : Willingness of satisfied customers to change the current system

1) Going for a better brand

	Better brand name
% Yes	60
% No	40

Table 21 : Change the current system, brand factor

Many customers would like to go a better brand. Some brands although being well known but not existing as a strong brand name in UAE market anymore e.g. Hitachi – Japan, Aloka – Japan. Other brands which were not known in UAE are going up e.g. Medison – Korea.

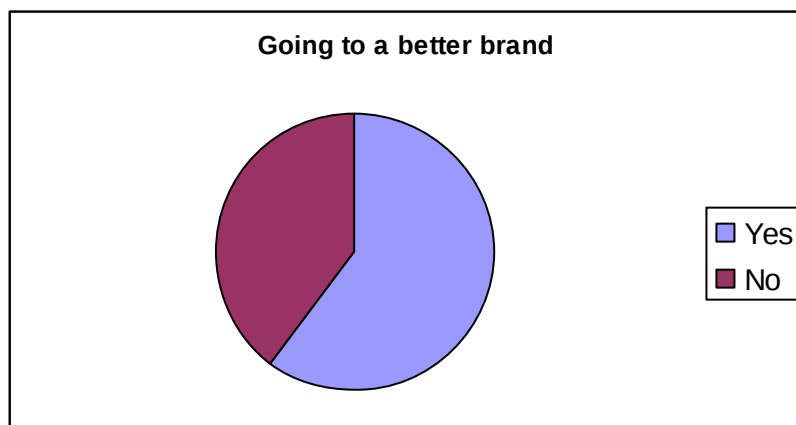


Figure 41 : Change the current system, brand factor

2) New technology

	New technology
% Yes	95
% No	5

Table 22 : Change the current system, technology factor

Majority of customers would like to go a new system because of the new technology such as Volume Scanning, better resolution of the new systems, digital technology...

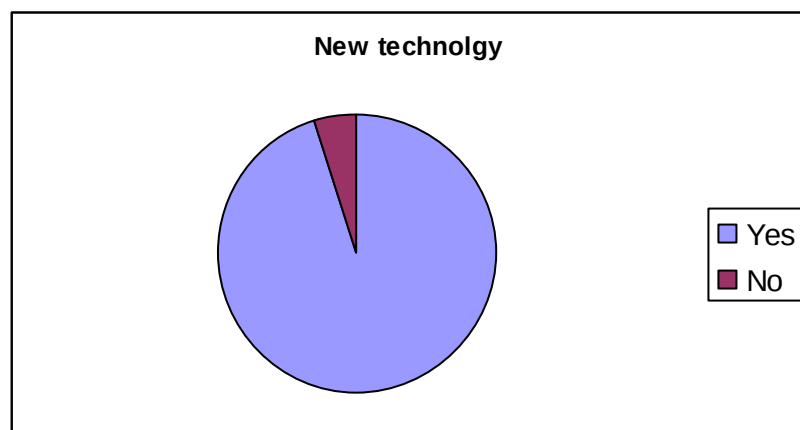


Figure 42 : Change the current system, technology factor

3) Better performance

	New technology
% Yes	80
% No	20

Table 23 : Change the current system, performance factor

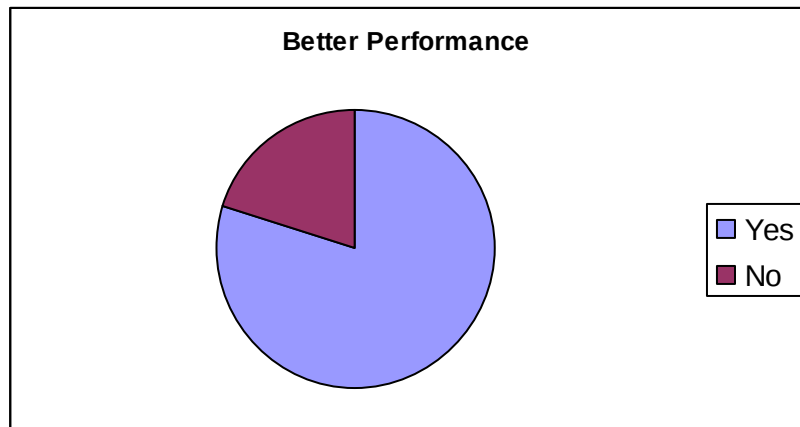


Figure 43 : Change the current system, performance factor

4) After sales service :

After sales service is one of the most important factors that were dissatisfying the customers and enforcing them to change their current systems to another one, specially to another brand.

	After Sales Service
% Yes	80
% No	20

Table 24 : Change the current system, After sales service factor

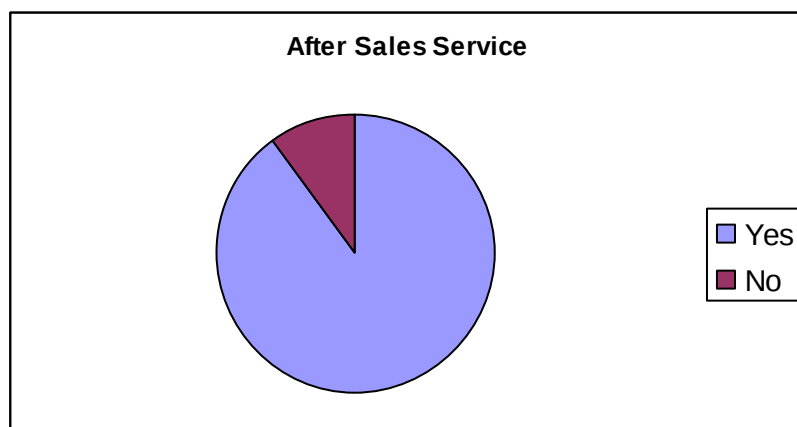


Figure 44 : Change the current system, After sales service factor

	Better brand name	New technology	Better Performance	After sales service	Total
% Yes	60	95	90	90	83.75
% No	40	5	10	10	16.25

Table 25 : Change the current system, overall factors

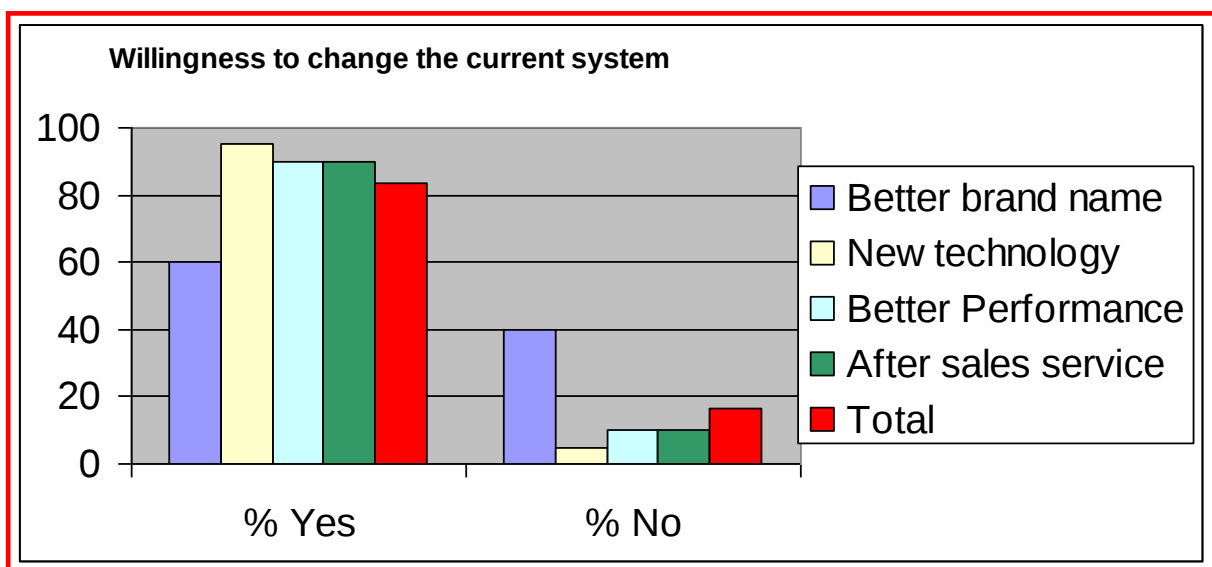


Figure 45 : Change the current system, overall factors

From the previous analysis we can recognize that most of customers are willing to change their systems to a new one.

32% non satisfied + (60% X 68%) satisfied = 73 % of all customers are willing to change their systems.

This is a very high ratio which represents a promising market and good opportunity for ultrasound scanning manufacturers.

Chapter 7 : Comparison of 3D/4D Ultrasound systems in UAE market

Introduction :

This chapter is a part of questionnaire. But because it is a comparison between different 3D/4D ultrasound systems from most of suppliers worldwide that had sold (even one system) their products in UAE. So, information collected is better to be presented in a separate chapter.

Here in this chapter, I concentrated on specific points that are important from the customer point of view.

Some technical specifications may not be of any interest of the end-users such as what are the other operation languages of the system, i.e. the system can be operated in different languages such as German, Japanese, French, Italian, ... As all manufacturers supply the systems with the language suitable to each market so this point was not included in the questionnaire.

Also, some other points had not been studied e.g.

- 1- Power supply (voltage & Hertz) : Market related
- 2- Weight : All 3D/4D machines are mobile on castor and will not be carried by the end-user. Not of that weight to be considered in any constructions as X-Ray or MRI (weight in Tons). The most heavy ultrasound system is not more than 200 Kg.
- 3- System response (boot up time & shutdown time) as \there is no big variation among different systems.
- 4- Typing Key board : Some systems show typing key board as obvious external part of the control console. Some other systems have the typing key board as hidden retractable type, to be opened if typing is required. This does not make any advantage or disadvantage about the keyboard design itself. I showed this point in the comparison but in analysis I did not include it as it does not have any effect on customer satisfaction.

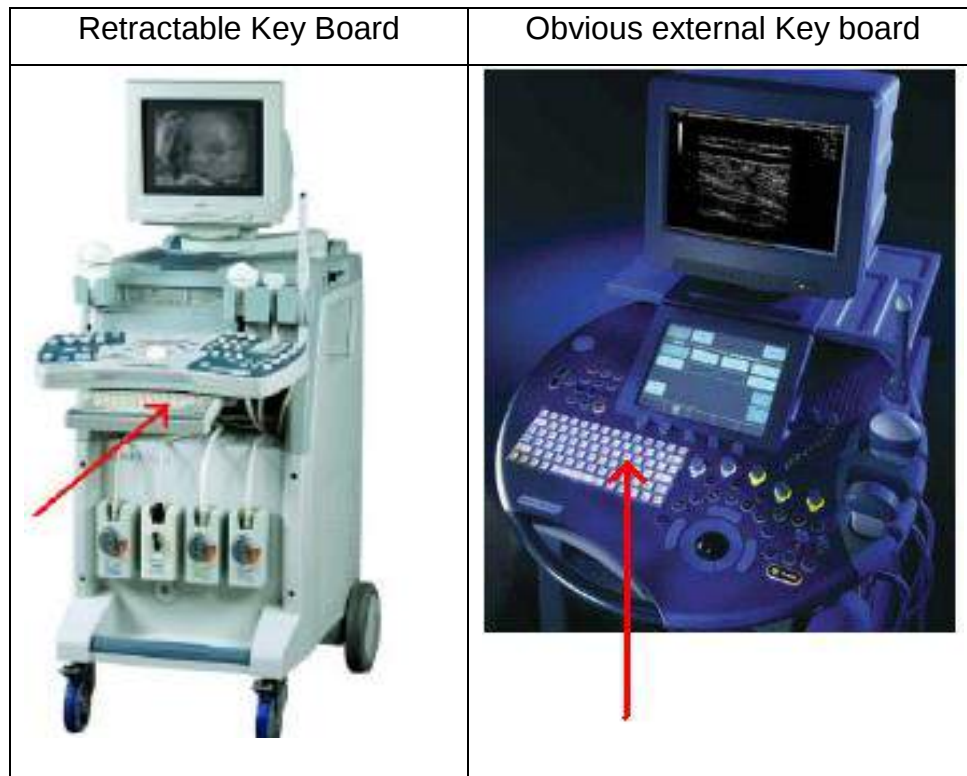


Figure 46 : Types of key board

Other some technical points, although they are important to the end-user, I have not concentrated on them such as the capacity of hard disk (HDD) as it is changing frequently. For example, when I started the research, HDD of some systems was just 40 GB, during the research changed to 60 & 80 GB, At the end of research, Some manufacturers are offering 120 GB HDD.

Some manufacturers (e.g.) Medison-Kretz had sold some units some years ago and these model had been discontinued (Voluson 530) and Aloka (SSD5500). So, I considered mainly the recent products of most of manufacturers.

At the end of my research some manufacturers released new systems such as Medison (X8), GE (Logiq 5, volume scanning option had been added recently), Esaote (My Lab 70). So, I have not included these products in my research.

Some manufacturers announce and advertise that they have volume scanning ultrasound systems e.g. Hitachi – Japan (Hi vision 8500) but Hitachi has not sold any volume scanning machines in UAE. Other manufacturers e.g. Siui – China (Apogee 3500) sold their system as 2D and colour Doppler ultrasound only. The 3D is option and had not been sold in UAE yet. Both manufacturers, their systems were included in the general comparison but not in the analysis.

Also GE launched one new model Voluson E8 on the web site but has not be sold or demonstrated in any event in UAE. Also, it had been included in comparison table but not in analysis.

All systems that have been excluded from the analysis (and included in the comparison tables) because of the fact that, the customers' and end-users' information about these systems are driven through web sites or brochures but not through actual use or trial or even demonstration of any of these system.

This makes the information more theoretical and not real. So, it was fair to exclude these systems from the analysis.

A) Comparison of volume scanning machines from the general point of view :-

General points of comparing ultrasound systems are :-

1. Design & outlook
2. Swivel Wheel : All systems move on 4 castors, two in front and 2 in the back. If the four castors are swiveling, the movement of the system is more easier.
3. Transducer holder
4. Gel bottle storage.
5. Handle position : To be used for moving the system. Some systems have handles in front as well as the back which allows more convenience in moving the system or adjusting its position to the end-user and patient.
6. Monitor height adjustment : to have more convenient view for the end-user according to his height (tall or short) and according to the end-user stool (chair) used.
7. Key height adjustment : same effect as the monitor height adjustment.
8. Ergonomic : comfort position of end-user while using the system.
9. User friendly :

Points 6, 7 & 8 had been described by the end-users themselves. All manufactures are claiming that their systems are the most ergonomic and user friendly systems among competitors.

10. LCD Panel (Touch Screen)

11. Soft key (shortcut keys)

12. Retractable alphanumeric keyboard.

Points No. 9, 10 & 11 are just mentioned in the comparison table but have not been weighed in analysis as they do not have real effect on end-users satisfaction.

Value	General	Medison			Krtex (GE)		GE	
		Accuvix XQ	SA 9900	SA 8000	730 Expert	730 Pro	Logic 9	Logic 7
1	Design & outlook	1	0.8	0.6	0.8	0.6	1	0.8
1	Ergonomic	1	0.8	0.8	1	0.8	1	0.8
1	No. of Transducer holder	0.8	0.8	0.8	0.8	0.8	0.8	0.8
1	User friendly	1	0.8	0.8	1	0.8	0.8	0.8
1	Swivel Wheel	0.5	0.5	0.5	0.5	0.5	0.5	1
1	Gel bottle storage	0	0	0	1	1	1	1
1	Handle position	1	1	0.5	1	1	1	0.5
1	Monitor height adjustment	0	0	0	0	0	0	0
1	Key board height adjustment	0	0	0	0	0	0	0
Total		5.3	4.7	4	6.1	5.5	6.1	5.7
%		59	52	44	68	61	68	63

Table 26 : Comparison of 3D ultrasound – General

		Siemens		Philips				Toshiba
Value	General	G60 S	G50	HDI 4000	HD 11	HD 11XE	IU 22	Nemio
1	Design & outlook	0.6	0.6	0.8	0.6	0.8	0.8	0.6
1	Ergonomic	0.6	0.6	0.8	0.8	0.8	1	0.8
1	No. of Transducer holder	0.8	0.8	0.8	0.8	0.8	0.8	0.6
1	User friendly	0.6	0.6	0.8	0.8	0.8	1	0.6
1	Swivel Wheel	1	1	0.5	1	1	1	1
1	Gel bottle storage	1	1	0	1	1	0	0
1	Handle position	1	1	1	0.5	0.5	0.5	1
1	Monitor height adjustment	0	0	0	1	1	0	1
1	Key board height adjustment	0	0	0	1	0	1	0
Total		5.6	5.6	4.7	7.5	6.7	6.1	5.6
%		62	62	52	83	74	68	62

Table 27 : Comparison of 3D ultrasound – General (cont.)

		Ultrasonix		Esaote	
Value	General	SP	RP	MyLab 15	MyLab 20
1	Design & outlook	0.4	0.4	0.4	0.4
1	Ergonomic	0.6	0.6	0.6	0.6
1	No. of Transducer holder	0.6	0.6	0.8	0.8
1	User friendly	0.6	0.6	0.6	0.6
1	Swivel Wheel	1	1	1	1
1	Gel bottle storage	1	1	1	1
1	Handle position	0.5	0.5	0.5	0.5
1	Monitor height adjustment	1	1	0	0
1	Key board height adjustment	0	0	0	0
Total		5.7	5.7	4.9	4.9
%		63	63	54	54

Table 28 : Comparison of 3D ultrasound – General (cont.)

B) Comparison of volume scanning machines regarding the computerization and hard ware configuration :-

Points of comparison are :-

1. Digital technology : Nowadays, the digital technology is a must any ultrasound system. Some manufacturers produce 100% digital systems while others are producing analogue components. Even the digital technology is variable form manufacturer to another.
2. Connectivity : I.e. what are the possible ways to connect the ultrasound system to external equipment, such as DICOM, Networking, Video, S-video, BNC, RGB, internet, ...

3. Image filling S/W : Storing patient data, images and reports and managing of these data.

4. Hard Ware Configuration

- a) HDD Capacity : Not of great importance as the HDD capacity is frequently changing.
- b) DVD.
- c) MO Drive. (Magnetic Optic Disk Drive)
- d) Flash Memo (USB)
- e) CD-RW

Points 2 to 5 are about the capability to burn the patient data and images, video files, as well as making a back up of all data.

		Medison			Krtex (GE)		GE	
Value	Computerization & H/W configuration	Accuvix XQ	SA 9900	SA 8000	730 Expert	730 Pro	Logic 9	Logic 7
1	Digital technology	1	1	1	1	1	0.8	0.8
1	Connectivity	1	0.8	0.8	1	0.8	0.8	0.8
2	Image filling S/W	1	1	1	1	1	0.8	0.8
2	H/W Configuration	1	0.8	0.8	1	1	0.8	0.8

Total	4	3.6	3.6	4	3.8	3.2	3.2
%	67	60	60	67	63	53	53

Table 29 : Comparison of 3D ultrasound – computerization and H/W configuration

		Siemens		Philips				Toshiba	Aloka
Value	Computerization & H/W configuration	G60 S	G50	HDI 4000	HD 11	HD 11XE	IU 22	Nemio	Alpha 10
1	Digital technology	0.6	0.6	0.8	0.6	0.6	0.8	0.6	0.4
1	Connectivity	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.6
2	Image filling S/W	0.6	0.6	0.8	0.8	0.8	0.8	0.6	0.6
2	H/W Configuration	0.6	0.6	0.8	0.8	0.8	1	0.8	0.6

Total	2.4	2.4	3.2	3	3	3.4	2.8	2.2
%	40	40	53	50	50	57	47	37

Table 30 : Comparison of 3D ultrasound – computerization and H/W configuration (cont.)

		Ultrasonix		Esaote	
Value	Computerization & H/W configuration	SP	RP	MyLab 15	MyLab 20
1	Digital technology	0.6	0.6	0.6	0.6
1	Connectivity	0.6	0.6	0.6	0.6
2	Image filling S/W	0.6	0.6	0.6	0.6
2	H/W Configuration	0.6	0.6	0.6	0.6
Total		2.4	2.4	2.4	2.4
%		40	40	40	40

Table 31 : Comparison of 3D ultrasound – computerization and H/W configuration (Cont.)

C) Number of active probe ports :-

This explains how many probes could be connected to the ultrasound simultaneously and the entire are active. I.e. could be used for scanning. Some systems have dead port which may be named "hanger" or "park". It is used just to hold the probe to an inactive socket. The probe connected to such park can not be used for scanning unless the end user connects it to an active port. For example, if an ultrasound system was sold with 4 probes, and it has just 3 active ports, in this case, if the sonographer wants to use the forth probe, he must disconnect one of the other three probes to be replaced with another the fourth one.

Sometimes, this step is dangerous. If the probe which will be disconnected was active (the probe used in scanning), some electronic components may be damaged. Although many manufacturers made protective measurements against this harmful step (the active probe could be disconnected without any harm) but a chance for damaging the probe is still there. Knowing that the probe is one of the most expensive pieces of the ultrasound system (The price of 2D probe is varying from AED 15000 to 35000 AED. The price of 3D/4D probe is varying from AED 50000 to AED 75000) so, the more the active probe ports, the less chance to disconnect a probe to replace it with another one.

Value	No. of Probe Ports	Medison			Krtex (GE)		GE	
		Accuvix XQ	SA 9900	SA 8000	730 Expert	730 Pro	Logic 9	Logic 7
4		4	3	3	4	3	4	4

Total	4	3	3	4	3	4	4
%	100	75	75	100	75	100	100

Table 32 : Comparison of 3D ultrasound – No. of probe ports

Value	No. of Probe Ports	Siemens		Philips				Toshiba	Aloka
		G60 S	G50	HDI 4000	HD 11	HD 11XE	IU 22	Nemio	Alpha 10
4		3	2	3	2	2	3	4	4

Total	3	2	3	2	2	3	4	4
%	75	50	75	50	50	75	100	100

Table 33 : Comparison of 3D ultrasound – No. of probe ports (cont.)

Value	No. of Probe Ports	Ultrasonix		Esaote	
		SP	RP	MyLab 15	MyLab 20
4		3	3	3	3

Total	3	3	3	3
%	75	75	75	75

Table 34 : Comparison of 3D ultrasound – No. of probe ports (cont.)

D) Monitor and image :-

1. Screen Size : Not of great value due to the fact the, once a sonographer buys a volume scanning machine, this means he will get one of the high end products. The system must have all other scanning functions such as B mode, M mode, Doppler, Colour flow mapping and others. This means he is buying a big machine. All of theses machines must have a monitor of 15 inches at least. 15 inches was the standard of these systems if the monitor is CRT type.

2. Monitor Type (CRT/LCD) : Some manufacturer produces ultrasound systems with LCD monitor. This gives a chance for better resolution, bigger screen size (usually 17 inches) and better appearance of the system.
3. Image resolution : this is one of the most important point in any ultrasound system whatever 2D or 3D or 4D. Image resolution can critically affect the decision of buying a system.

Value	Monitor & Image	Medison			Krtex (GE)		GE	
		Accuvix XQ	SA 9900	SA 8000	730 Expert	730 Pro	Logic 9	Logic 7
1	Screen Size	0.9	0.9	0.9	0.9	0.9	1	1
7	Image resolution	6	6	6	6	6	7	7
2	Type (CRT/LCD)	1	1	1	1	1	2	2
Total		7.9	7.9	7.9	7.9	7.9	10	10
%		79	79	79	79	79	100	100

Table 35 : Comparison of 3D ultrasound – monitor & image

Value	Monitor & Image	Siemens		Philips				Toshiba	Aloka
		G60 S	G50	HDI 4000	HD 11	HD 11XE	IU 22	Nemio	Alpha 10
1	Screen Size	0.9	0.9	0.9	0.9	0.9	1	0.9	0.9
7	Image resolution	6	6	6	6	6	7	7	6
2	Type (CRT/LCD)	1	1	1	1	1	2	2	2
Total		7.9	7.9	7.9	7.9	7.9	10	9.9	8.9
%		79	79	79	79	79	100	99	89

Table 36: Comparison of 3D ultrasound – monitor & image (cont.)

		Ultrasonix		Esaote	
Value	Monitor & Image	SP	RP	MyLab 15	MyLab 20
1	Screen Size	1	1	1	1
7	Image resolution	4	4	4	4
2	Type (CRT/LCD)	2	2	2	2
Total		7	7	7	7
%		70	70	70	70

Table 37 : Comparison of 3D ultrasound – monitor & image (cont.)

E) Price and after sales service :-

1. Price :

Sales price is a very important factor. To buy a volume scanning machine the price shows great variation from AED 200,000 to AED 1,000,000. So, the price plays an important role in the decision due to this great variation. Expensive machines of course may have extra advantages or functions, but during the survey a fact was discovered that the variation in specification does not deserve this high variation in price.

2. After sales service

It is another very important factor in the buying decision. Some manufacturers have very good brand names and very good history within the customers' mind, but they lost business because of the bad or non-satisfactory after sale service.

3. Training :

By training, we mean the volume scanning training. Not all manufacturers provide good training for the end-users. Some manufacturers are offering overseas training. Although it is a good chance for a sonographer to share the experience of others, but mostly it goes in vain as most of them join the overseas training without any background about the volume scanning. So, when they meet an experienced person, they can not follow his hand on training easily. General Electric has a very good institute in Austria to training the end-users overseas. Medison Company have an overseas training courses in Netherlands but their distributor in UAE is providing a strong on site training (prior to the overseas one) which creates a very good background and basics. So, the sonographer when joins an experienced person he can follow him perfectly in the hands-on training and gets almost all the benefits of the overseas course. Other companies have no planned policy for training their end-users. They may arrange for an overseas training in any place and sonographer gets no added value.

		Medison			Krtex (GE)		GE	
Value		Accuvix XQ	SA 9900	SA 8000	730 Expert	730 Pro	Logic 9	Logic 7
8	After sales service	7	7	7	6	6	6	6
8	Training	8	8	8	6	6	6	6
8	Price	6	7	7	6	7	5	6

Total	21	22	22	18	19	17	18
%	88	92	92	75	79	71	75

Table 38 : Comparison of 3D ultrasound – Price, Training & after sales service

		Siemens		Philips				Toshiba	Aloka
Value		G60 S	G50	HDI 4000	HD 11	HD 11XE	IU 22	Nemio	Alpha 10
8	After sales service	6	6	6	6	6	6	5	5
8	Training	4	4	4	4	4	4	3	3
8	Price	5	5	6	6	5	5	5	5

Total	15	15	16	16	15	15	13	13
%	63	63	67	67	63	63	54	54

Table 39: Comparison of 3D ultrasound – Price, Training & After sales service (cont.)

		Ultrasonix		Esaote	
Value		SP	RP	MyLab 15	MyLab 20
8	After sales service	5	5	5	5
8	Training	3	3	3	3
8	Price	6	6	6	6

Total	14	14	14	14
%	58	58	58	58

Table 40 : Comparison of 3D ultrasound – Price, Training & after sales service (cont.)

F) 3D functions :

1. Rendering Modes :

This was explained before (Chapter 4, page No. 44)

2. Multi-planar display :

This was explained before (Chapter 4, page No. 42)

3. Volume CT

Volume CT View technology with different views enables performing multiple examinations on multiple regions of interest and visually displays their relationships from data obtained with just one 3D volume scan. Therefore, eliminating the need for multiple scans and making it possible to examine the data even after the initial scan session.



Figure 47 : Volume CT view, different views

4. SeeThru

A volume scanning function that provides combination of 3D Power Doppler and Gray scale 3D information of the diagnosed organ which allows the sonographer to analyze the vascularization and analyze the exact position of vessels in regards of its pathology.

5. VCI (Volume Contrast Imaging) :

Volume Contrast Imaging is a technology based on a volume acquisition technique that leads to contrast enhancement and speckle suppression in the ultrasound image. In small parts applications, such as thyroid or breast, as well as in abdominal or gynecological applications this feature helps to clearer visualize solid organs and cystic structures, and offers a better assessment of size, margins and internal structures of lesions.

6. Auto ROI setting

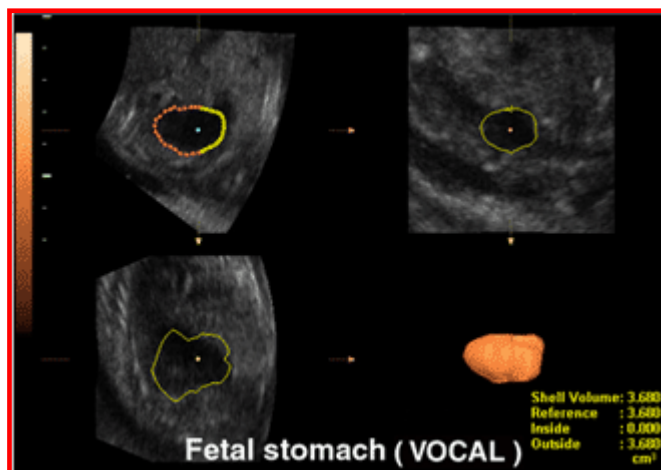
In order to obtain live 3D data or 4D data, the ROI (Region of Interest) box should be allotted on the 2D image.

For example, the face of the fetus may not be obtained with the live 3D or 4D as the ROI setting should follow the fetus face continuously.

As a new function in 4D scanning technique, the features of 2D image are automatically extracted (extraction feature) and classified (segmentation feature) to carry out the 3D ROI setting automatically. The ROI setting is made with one touch, obtaining the optimal rendering data as well as efficient image acquisition

7. Automatic volume calculation :

VOCAL is one of the most recognized programs that used to measure any part of the volume images precisely, especially useful for the irregular lesions. This program is produced originally by Medison Company – Korea. This is a software program that allows drawing contour of a region of interest, rotating that area over 360 degrees by predefined steps, and then calculating the volume of that selected region/lesion. This method of volume calculation is more sensitive than the conventional 2D method of calculating volumes using oblate spheroid formula ($\text{Volume} = L \times AL \times W / 1.57$).



The contours of foetal stomach traced using VOCAL. Volume is calculated (3.68cc)



The contours of prostate traced using VOCAL. Volume is calculated (24.9cc)

Figure 48 : VOCAL

8. Shell

If specific organization of the distribution of blood vessels is to be discovered, this function may be used.

Cancerous tissue can be discovered by :-

- Contour detection through VOCAL
- The thickness of the lesion is described in this contour to mark the distribution degree of blood vessels in response to the tissue on the specific body area.

9. Operational Help

A help mode is software that can be used to help sonographer during volume scanning operation.

10. 3D Cine

The perception of depth is best seen while the 3D rendered image rotates on an axis. This is called the Cine mode. The rendering improves and the textures appear to be more realistic. In some views the noise actually decreases and the contours are better visualized. This can be even stored as an AVI loop on a CD or a DVD and given to the patient or sent to the referring physician as a record.

11. 3D XI :

1. Multi-Slice View (MSV) : Enable viewing and diagnosing clinical cases much faster and most importantly with more precision and accuracy than ever before. Ex : In measuring the Nuchal Translucency, the 2D image has a limited measuring capabilities, while MSV is able to display the entire range from the maximum and minimum measurements, giving a more precise assessment.

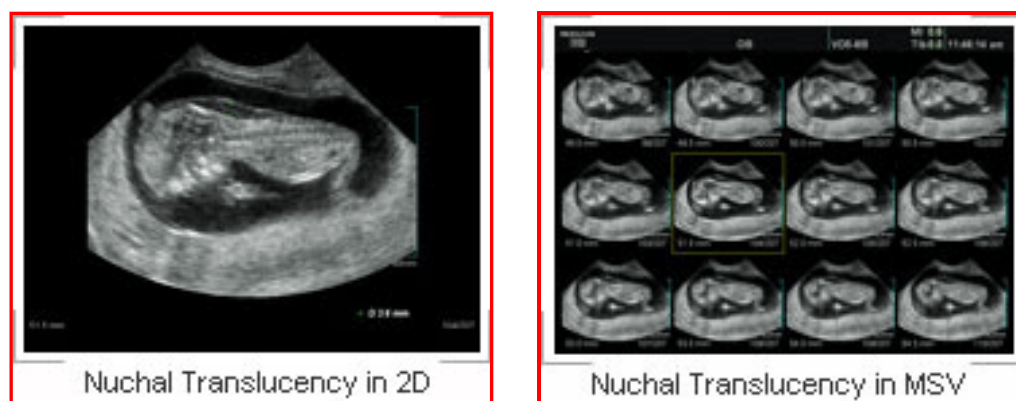
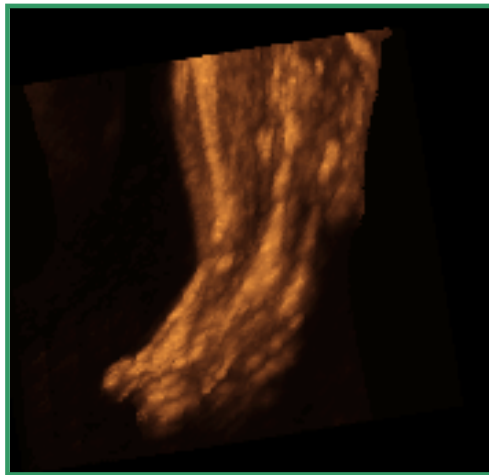


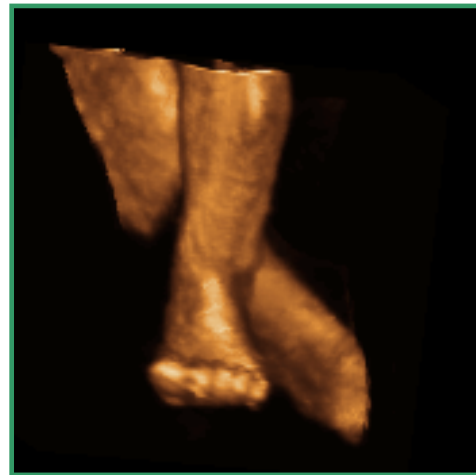
Figure 49 : Multi-Slice View

14. Cut modes

Cut mode is an electronic scalpel used to remove unwanted parts of the volume image or overlying tissues to get better one.



Before cutting



After cutting

Figure 51 : Foetal legs before and after use of cutting mode to remove overlying structures

15. Inversion 3D

Changing the echo-signals of the volume image, this would result in getting a better and clear volume image of hollow organs, e.g. colon.

16. 3D mouse :

A smart mouse used to simplify 3D operation. Exactly as we use a mouse in operating the PC which has more superior operation than the normal keyboard.

17. Frame Rate :

This had been explained before (chapter 3, page 26, 27)

18. Probe Volume & Weight

This point is specifically about the 3D convex probe. In the old versions of 3D systems the probe was very heavy and bulky. For example, Aloka was producing a very big probe of 1800 gm. Kretz was producing a probe of 400 gm.

All 3D probes are still bulky & heavy in comparison to the conventional 2D probes. This used to be an objection against the 3D specially from the sonographers those are not willing to 3D

This had been changed and Some manufacturers e.g. Kretz is enhancing their probes to a smaller size and a less weight.

By the end of this research, Medison announced new probes which are smaller in size and much less in weight. Also some manufacturer e.g. GE and Philips announced a new matrix probe which is an electronic 3D probe. Up till this moment all 3D probes are mechanical ones.

Value	3D Functions	Medison			Krtetz (GE)		GE	
		Accuvix XQ	SA 9900	SA 8000	730 Expert	730 Pro	Logic 9	Logic 7
1	Rendering Modes	1	1	1	1	1	1	1
1	Multi-planar display	1	1	1	1	1	1	1
1	Volume CT	1	1	1	1	1	1	1
1	SeeThru	1	0	0	0	0	0	0
1	VCI	0	0	0	1	1	0	0
1	Auto ROI setting	1	0	0	0	0	0	0
1	VOCAL	1	1	1	1	1	1	1
1	SHELL	1	1	1	1	1	1	1
1	Operational Help	1	1	1	1	1	1	1
1	3D CINE	1	1	1	1	1	1	1
3	3D XI	3	0	3	0	0	0	0
2	3D STIC	2	0	2	0	0	2	2
1	MR	1	0	1	0	0	0	0
1	Cut mode	1	1	1	1	1	1	1
1	Inversion 3D	0.5	0.5	0.5	1	1	1	1
1	3D mouse	1	1	0	0	0	0	0
3	Frame Rate	2	1	1	3	3	3	3
3	Probe Volume & Weight	2	2	2	3	3	3	3

Total	21.5	12.5	17.5	16	16	17	17
%	86	50	70	64	64	68	68

Table 41 : Comparison of 3D ultrasound – 3D functions

		Siemens		Philips				Toshiba	Aloka
Value	3D Functions	G60 S	G50	HDI 4000	HD 11	HD 11XE	IU 22	Nemio	Alpha 10
1	Rendering Modes	0.6	0.6	1	0.8	0.8	0.8	0.6	0.6
1	Multi-planar display	1	1	1	1	1	1	1	1
1	Volume CT	0	0	1	0	0	1	0	0
1	SeeThru	0	0	0	0	0	0	0	0
1	VCI	0	0	0	0	0	0	0	0
1	Auto ROI setting	0	0	0	0	0	0	0	0
1	VOCAL	0	0	1	0	0	1	0	0
1	SHELL	0	0	1	0	0	0	0	0
1	Operational Help	0	0	0	0	0	0	0	0
1	3D CINE	1	1	1	1	1	1	1	1
3	3D XI	0	0	0	0	0	0	0	0
2	3D STIC	0	0	0	2	2	2	0	0
1	MR	0	0	0	0	0	0	0	0
1	Cut mode	0.8	0.8	1	0.8	0.8	0.8	0.8	0.8
1	Inversion 3D	0	0	0	0	0	0	0	0
1	3D mouse	0	0	0	0	0	0	0	0
3	Frame Rate	1	1	1	1	1	1	2	2
3	Probe Volume & Weight	2	2	2	2	2	2	2	2

Total	6.4	6.4	10	8.6	8.6	10.6	7.4	7.4
%	26	26	40	34	34	42	30	30

Table 42 : Comparison of 3D ultrasound – 3D functions (cont.)

		Ultrasonix		Esaote	
Value	3D Functions	SP	RP	MyLab 15	MyLab 20
1	Rendering Modes	0.6	0.6	0.6	0.6
1	Multi-planar display	1	1	1	1
1	Volume CT	0	0	0	0
1	SeeThru	0	0	0	0
1	VCI	0	0	0	0
1	Auto ROI setting	0	0	0	0
1	VOCAL	0	0	0	0
1	SHELL	0	0	0	0
1	Operational Help	0	0	0	0
1	3D CINE	1	1	1	1
3	3D XI	0	0	0	0
2	3D STIC	0	0	0	0
1	MR	0	0	0	0
1	Cut mode	0	0	0	0
1	Inversion 3D	0	0	0	0
1	3D mouse	0	0	0	0
3	Frame Rate	1	1	1	1
3	Probe Volume & Weight	2	2	2	2

Total	5.6	5.6	5.6	5.6
%	22	22	22	22

Table 43 : Comparison of 3D ultrasound – 3D functions (cont.)

F) 3D probe types :

1. Convex :

Used for application in abdominal scanning and Ob/Gyn.

2. Linear

Used for scanning of superficial tissues such as thyroid, scrotum, breast and superficial vessels.

3. E/C

Endo-cavity probe is used for trans-vaginal and trans-rectal applications.

4. Urology

Trans-rectal probe used for special applications in urology, scanning for pelvis and prostate and helps in prostate biopsy.

5. Neonatal-Paediatrics

Used for scanning of infants and children. Ex : trans-cranial (through fontanelles, as in diagnosis of hydrocephalus) and hip joint in neonates to exclude congenital dislocation of the hip joint.

Value	3D Probes	Medison			Krtex (GE)		GE	
		Accuvix XQ	SA 9900	SA 8000	730 Expert	730 Pro	Logic 9	Logic 7
6	Convex	6	6	6	6	6	6	6
4	Linear	4	4	0	4	4	4	4
5	E/C	5	5	5	5	5	5	5
4	Urology	0	0	0	4	0	0	0
3	Neonatal-Paed.	0	0	0	3	3	3	3

Total	15	15	11	22	18	18	18
%	68	68	50	100	82	82	82

Table 44: Comparison of 3D ultrasound – Probe volume & weight

Value	3D Probes	Siemens		Philips				Toshiba	Aloka
		G60 S	G50	HDI 4000	HD 11	HD 11XE	IU 22	Nemio	Alpha 10
6	Convex	6	6	6	6	6	6	6	6
4	Linear	0	0	4	0	0	0	0	0
5	E/C	0	5	5	5	5	5	0	5
4	Urology	0	0	0	0	0	0	0	0
3	Neonatal-Paed.	0	0	0	0	0	0	0	0

Total	6	11	15	11	11	11	6	11
%	27	50	68	50	50	50	27	50

Table 45 : Comparison of 3D ultrasound – Probe volume & weight (cont.)

		Ultrasonix		Esaote	
Value	3D Probes	SP	RP	MyLab 15	MyLab 20
6	Convex	6	6	6	6
4	Linear	0	0	0	0
5	E/C	0	0	0	0
4	Urology	0	0	0	0
3	Neonatal-Paed.	0	0	0	0

Total	6	6	6	6
%	27	27	27	27

Table 46 : Comparison of 3D ultrasound – Probe volume & weight (cont.)



Figure 52 : Image of different kinds of 3D probes

Overall grading according to comparison

Value	Description	Medison			Krtex (GE)		GE	
		Accuvix XQ	SA 9900	SA 8000	730 Expert	730 Pro	Logic 9	Logic 7
9	General	5.3	4.7	4	6.1	5.5	6.1	5.7
6	Computerization & H/W configuration	4	3.6	3.6	4	3.8	3.2	3.2
4	No. of Probe ports	4	3	3	4	3	4	4
10	Monitor & Image	7.9	7.9	7.9	7.9	7.9	10	10
24	Price , Service, 3DTraining	21	22	22	18	19	17	18
25	3D functions	21.5	12.5	17.5	16	16	17	17
22	3D probe types	15	15	11	22	18	18	18

Total	78.7	68.7	69	78	73.2	75.3	75.9
%	79	69	69	78	73	75	76

Table 47 : Overall grading according to comprehensive comparison

Value	Description	Siemens		Philips				Toshiba	Aloka
		G60 S	G50	HDI 4000	HD 11	HD 11XE	IU 22	Nemio	Alpha 10
9	General	0.6	0.6	0.8	0.6	0.8	0.8	0.6	0.8
6	Pc & H/W configuration	2.4	2.4	3.2	3	3	3.4	2.8	2.2
4	No. Of Probe ports	3	2	3	2	2	3	4	4
10	Monitor & Image	7.9	7.9	7.9	7.9	7.9	10	9.9	8.9
24	Service, 3DTraining & Price	15	15	16	16	15	15	13	13
25	3D functions	6.4	6.4	10	8.6	8.6	10.6	7.4	7.4
22	3D probe types	6	11	15	11	11	11	6	11

Total	41.3	45.3	55.9	49.1	48.3	53.8	43.7	47.3
%	41	45	56	49	48	54	44	47

Table 48 : Overall grading according to comprehensive comparison (cont.)

Value	Description	Ultrasonix		Esaote	
		SP	RP	MyLab 15	MyLab 20
9	General	0.4	0.4	0.4	0.4
6	Pc & H/W configuration	2.4	2.4	2.4	2.4
4	No. Of Probe ports	3	3	3	3
10	Monitor & Image	7	7	7	7
24	Service, 3DTraining & Price	14	14	14	14
25	3D functions	5.6	5.6	5.6	5.6
22	3D probe types	6	6	6	6
Total		38.4	38.4	38.4	38.4
%		38	38	38	38

Table 49 : Overall grading according to comprehensive comparison (cont.)

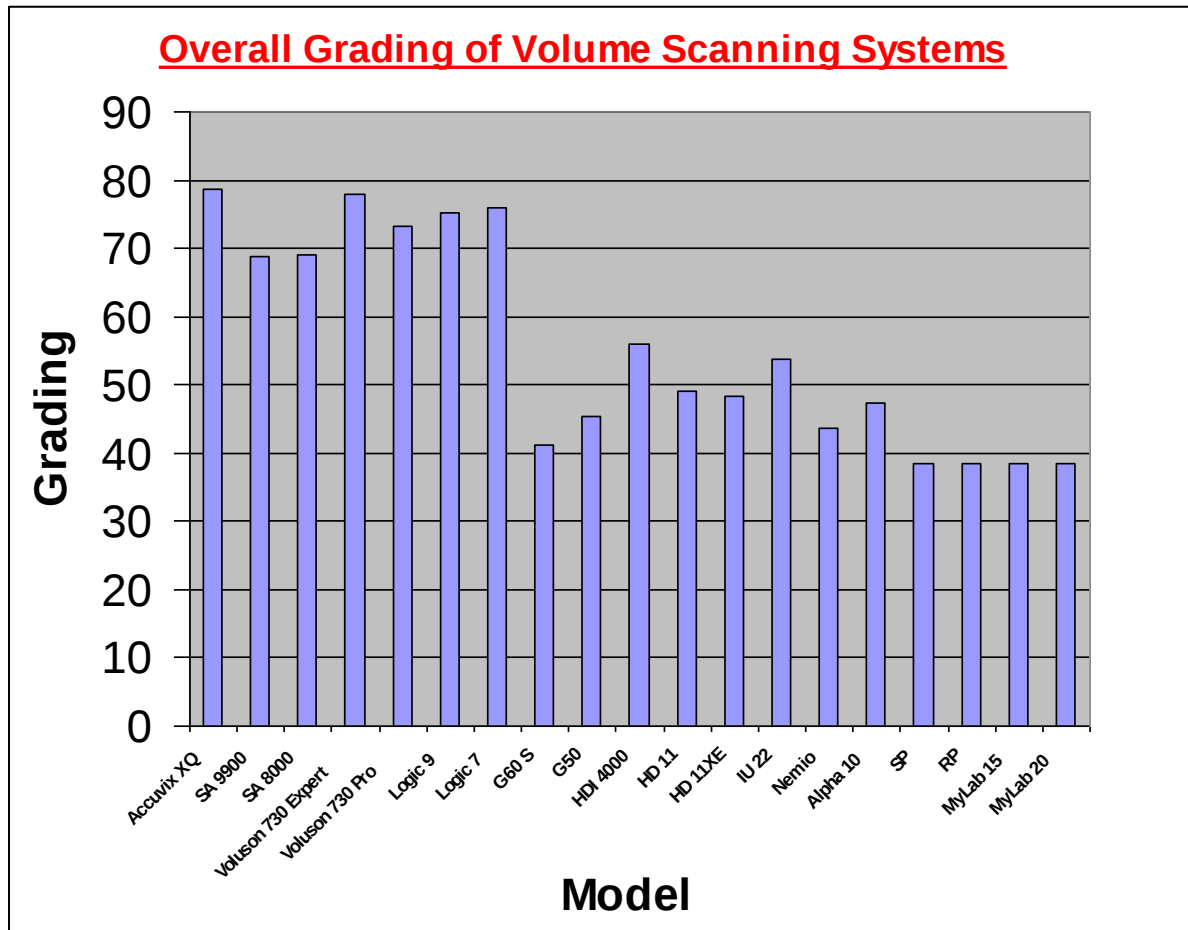


Figure 53 : Overall grading according to comprehensive comparison

So, from the previous analysis of information in this chapter, we can notice that the main market players are

1. Medison – Korea.
2. General Electric (USA) + Kretz (Austria).
3. Phillips (Netherlands).
4. Siemens (Germany).

Chapter 8 : Proposals and suggestions

After analysis of the UAE market from different points of view (strong growing economy, demography, health industry, ...) and study of the volume scanning methods and systems, the following are some ideas to enforce and increase the volume scanning market in UAE :-

1- Proper advertisement :-

Usually the manufacturers in their advertisement concentrate how to influence the end-user to buy their systems. For example, as we mentioned before (page 73) each manufacturer claim that his systems are the most ergonomic and well designed systems. Although, when we listen to the customer voice we find different opinion. So, manufacturer should advertise in a proper way to give customers and idea about what is 3D, what is 4D and to concentrate on the benefits of this technology.

2- Establish of educational institutes :-

In allover the UAE, up till now there is no any institute to teach the ultrasound scanning neither 2D nor 3D/4D. Some clinics or hospitals may arrange a training course (which is mainly commercial rather than teaching). In other countries e.g. Egypt, USA and so many other countries there are many institutes to teach the ultrasound scanning at different levels from beginners to professionals.

Few countries had established an institute (as in Austria, Vienna Institute for Ultrasound Scanning - VISUS) which has fixed regular courses for 3D/4D scanning. In some other few countries e.g. Egypt, Netherlands there are other facilities to teach 3D/4D.

If an educational institute for ultrasound scanning is established in Dubai, it will attract sonographers from allover the worlds specially the Middle East. Here we will not discuss about Dubai and the great flow of tourists from allover the world. But for sure, it will be a good chance for any manufacturer to establish an educational

institute with the co-operation of related authorities such ministry health, accredited faculty of medicine and others.

3- Frequent activities :-

Manufacturer and their distributors should sponsor different activities in the health industry to give lectures, seminars arrange for workshops and road shows to promote the 3D/4D scanning in a proper way. Not just for promotion but for education and increasing awareness of sonographers about this technology. For example, in Arab Health Exhibition, almost all manufacturers exhibit their systems just for sales and distribution agreements.

4- Show rooms and museums :-

Almost all manufacturers have a museum in the country of origin to exhibit different models of their ultrasound systems including all systems (from the first model produced to the latest model). A museum for 3D/4D systems would help sonographers to have an actual demonstration of these systems and help them getting full and clear idea about the systems and all their functions, not just getting information through brochures and internet. Application specialists should be available in this museum to carry out demonstration and giving full clear idea about the systems.

5- Continuous communication with other institutes :-

All related facilities in UAE such as educational institutes (when established), hospitals and medical centers must share the experience of others in the world by : continuous communication and arranging of frequent visors for training and discussion of work done. This would help increasing the experience of teachers in the institutes and help supplying more information and experience for the sonographers as well as the new trainees.

6- Proper training of end-users :-

When a distributor sells a 3D/4D system must arrange (better if with the help or co-operation of the manufacturer) for actual and proper training of the end-users. What had been noticed during the research and survey that some sonographers had been trained overseas (in another country) but had not got enough experience, and the course was just a mere tourism. Each distributor must have at least an application specialist who can carry out a good training in 3D/4D ultrasound scanning. And then, arrange an overseas training course to help the trainee sharing the experience of other sonographers.

The aim of all the above mentioned points is to establish a well based and strong education centers and generating well experienced practitioners with the proper training facilities especially for the new sonographers. Also, aiming to create and increase an awareness of the medical professionals for the volume scanning. As a result of all, the market volume for 3D/4D scanning will increase, which is beneficial for all related people; manufacturers, distributors, end-users and patients as well.

REFERENCES

1. Ministry of Health - AUE , Abu Dhabi
2. Ministry of Planning - AUE , Abu Dhabi
3. Chamber of commerce - Abu Dhabi
4. Chamber of commerce - Dubai
5. Department of Health & Medical Services - Dubai
6. Chamber of commerce - Sharjah
7. Manufacturer web sites :-
 - a) Medison : www.medison.com
 - b) General Electric - www.gehealthcare.com/us/en/ultrasound
 - c) Hitachi - www.hitachi-ultrasound.com
 - d) Philips - www.medical.philips.com/main/products/
 - e) Aloka - www.aloka.ch/english/welcome.asp
 - f) Esa Ote - www.esaote.com/products/ultrasound
 - g) Siemens - www.medical.siemens.com
 - h) Toshiba : www.toshiba-europe.com/medical
 - i) Ultrasonix : www.ultrasonix.com

Bibliography

Achnodroplasia	Failure of formation of cartilage. Known as one of the most common form of short-limb dwarfism
Aneurysms	Means a widening. In medicine, a sac formed by dilatation of the wall of an artery, a vein or the heart.
Asherman syndrome	Intra-uterine adhesions, adhesions of the tissue lining the uterus.
Billiary ducts.	Bile is greenish yellow fluid secreted by liver and stored in gall bladder. Billiary ducts are channels that carry this secretion from liver cells to gall bladder.
Callus	Tissue produced at the edge of fracture of bones
Caricnomas	A type of malignant tumours, arises from epithelium
Cholecystitis	Chole = bile, itis = inflammation. Inflammation of the gall bladder
Chondroplasis	The formation of cartilage by specialized cells called chondrocytes.
Congenital	Exists before birth.
Coronal	A vertical plane from head to foot and parallel to shoulders
CT	Computed tomography, A special radiographic technique that uses a computer to assimilate multiple X-ray images into a 2 dimensional cross-sectional image.
Doppler	The use of an ultrasound in detecting the pulse in and study of blood flow characters a vessel.

Ectopic gestation.	Pregnancy outside the uterus.
Endometriosis	An active endometrium outside the uterine cavity.
Endometrium	The lining tissue of uterus.
Epispedias	A rare congenital (present from birth) defect in the location of the opening of the urethra.
ERCP	Endoscopic Retrograde Cholangio Pancreatography. In this procedure, a flexible endoscope is passed through the mouth and down into the duodenum. A catheter is then passed through the endoscope and inserted into the pancreatic and bile ducts. It is uncomfortable but not painful, is performed under intravenous sedation, usually without general anaesthesia, and has a low incidence of complications.
Exophthalmos	An abnormal protrusion of the eyeball in the orbit when observed from the side.
Foetus	A developing unborn offspring of a human or an animal that gives birth to its young (as opposed to laying eggs).
Folliculogenesis	Growth of ovarian follicle till reaching maturity for ovulation.
Fontanel	Normal membranous intervals between skull bones of a foetus or a neonate, closes by time. In the human foetus, there are six fontanel.
Goiter	An enlargement of the thyroid gland
Gynaecologist	A medical doctor who specializes in gynecology and diseases affecting the female reproductive system.

Hemimelia	Complete absence of the upper limb beyond the elbow
Hepatic Hydrocephalus	Related to the liver Dilatation of cerebral ventricles (chambers in brain), most often occurring secondarily to obstruction of cerebrospinal fluid (fluids inside the ventricles) pathways and accompanied by an accumulation of the cerebrospinal fluids within the skull.
Hypospadias	A malformation that affects the urethral tube and the foreskin on a male's penis.
Intestinal	Related to the small intestine
Intra-uterine	Inside the uterus
Luteogenesis	Formation of corpus luteum -which is known as the yellow body- in the ovary after ovulation
MRI	A special imaging technique used to image internal structures of the body, particularly the soft tissues. An MRI image is often superior to a normal X-ray image. It uses the influence of a large magnet to polarize hydrogen atoms in the tissues and then monitors the summation of the spinning energies within living cells. Images are very clear and are particularly good for soft tissue, brain and spinal cord, joints and abdomen. These scans may be used for detecting some cancers or for following their progress.
Myoma	A benign tumour of the uterus.
Neoplasia	Abnormal new growth. Means the same as tumour, which may be benign or malignant.
OB/Gyn	Obstetric and Gynaecology

Omphalocele	A hernia (protrusion of a loop or knuckle of an organ or tissue through an abnormal opening of the abdominal wall) at the umbilicus.
Parametrial	Parametrium is the soft tissue on both sides of uterus (connective tissue of the pelvic floor extending from the fibrous sub-serous coat of the supracervical portion of the uterus laterally between the layers of the broad ligament).
Polydactyly	Abnormal Extra finger or toe
Portal hypertension	Any increase in the portal vein (in the liver) pressure due to anatomic or functional obstruction
Sagittal	A vertical plane from head that divides the body into right and left halves.
Scoliosis	Lateral curvature of the spine.
Septate uterus	A uterus divided into two cavities by an antero-posterior septum.
Sonographers	A person who uses ultrasound system
Spina bifida	A congenital limited defect in the spinal column, characterized by the absence of the vertebral arches through which the spinal membranes and spinal cord may protrude.
Syndactyly	Webbing between the digits of the hands or feet.
Synovial	Of pertaining to or secreting synovia.
T.B.	Tuberculosis, An infection caused by a species of Mycobacterium, still remains a major worldwide health problem.
Thyroiditis	Inflammation of the thyroid gland.

Trans-rectal
Trans-vaginal

Through the rectum.
Through the vagina.

Trisomies

The presence of an additional whole chromosome. Each cell usually has 46 but in trisomy this is increased to 47.

Trophoblasts

Cells forming the outer layer of embryo and invading the uterine wall for connecting maternal blood to foetal blood.

Typhoid

An infectious febrile illness usually spread by contamination of food, milk or water supplies with *Salmonella typhi*, either directly by sewage, indirectly by flies or by faulty personal hygiene.

Varicocoele

Permanent dilation and tortuosity of veins in the scrotum.