Study report for GIZ project:

« LIFE-CYCLE COST PROJECT »

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Ministry of Health of the
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Contents

Introduction

This document reports the observations made during our study travel in Uzbekistan and recommendations to optimize procurement, administration and use of specific medical equipment.

In the first part, a foreword replaces our project in GIZ's larger one, defines our objectives and gives prerequisites. The second part develops observations and recommendations by type of equipment. Finally the third part adds transversal recommendations.

First Part Foreword

I. Description of the project

The objective of the Uzbekistan-German Development Cooperation Project "Advanced Training for Medical Doctors and Health Workers for the use of modern technology in Uzbekistan", carried out by the Ministry of Health of the Republic of Uzbekistan, and the Deutsche Gesellschaft für Internazionale Zusammenarbeit (GIZ), is directed to increase capacities of health professionals in the effective and efficient use of advanced technologies in selected clinical areas (imaging systems and minimal invasive surgery). Major activities to reach the objective are:

1) Capacity building of medical and technical professionals in the use of Advanced, Modern Health Technology;
2) Quality assurance and management improvement within procurement, logistic and maintenance in the selected clinical areas;
3) Improvement of procurement and financing planning in selected clinical areas,
4) PPP in centres specialized in advanced training for health professionals and technicians.

The project is implemented in cooperation with the key project partner, the Ministry of Health of the Republic of Uzbekistan and related structures such as the Institute of Advanced Medical Studies, the Republican Research Centre of Emergency Medicine and / or the privately organized "Uztibtechnika" in charge for maintenance.

The overall goal of the project is: "In selected clinical areas advanced, modern technology is used in a more efficient and effective way". The selected clinical areas are: (i) imaging systems / CT – and MRI Equipment and (ii) Endoscopy equipment / less invasive Surgery. The ultimate beneficiaries are the people of Uzbekistan as well as Health Professionals using the advance modern technologies as specified.

Within the framework of this project, a baseline study on the actual use of Computer Scanners, Magnetic Resonance Imaging and Rigid Endoscopes by Health Professionals in selected Hospitals of the public health system is needed.

There is little data in Uzbekistan regarding the use of medical equipment and the cost of maintenance. Therefore, budgets allowed are insufficient in order to secure the good use of equipment. Furthermore,

there is no accurate measure of the use of equipment and the out of service duration in order to optimize the operations. Total Cost of Ownership is not a notion commonly used in Uzbekistan in order to assess the budget needed when purchasing new equipment. Only acquisition cost is assessed, without taking into account operating or maintenance costs.

II. Objective of the Assignment

Resah has been asked to:

- Assess the life-cycle cost for MRI, CT Scan and Laparoscopy in emergency centres
- Identify the out of service time, analyse the reasons and assess the loss of earnings
- Make specific recommendations on how to optimize the use of equipment

III. Basis of preparation

a. Travel itinerary

Date and Time	Region/city	**Activity / Facility / Contacts**	**Interviews**
Sunday 23.09.13.	Tashkent	Arrival from France at 02:20	
23.09.13.	Tashkent	Visiting **Tashkent** Emergency Center (RRCEM) Tashkent **RRCEM Training Centre**	Pr Abdukhakim Khadjibaev, General Director Vice-director Chief of CT Scan and his engineer
24.09.13.	Tashkent	Visiting **Tashkent** Emergency Center (RRCEM) Tashkent **RRCEM Training Centre**	Pr Abdukhakim Khadjibaev Vice-director Chief of Laparoscopy, Chief of Ultrasound
25.09.13. 06:35	Tashkent - Navoi	Departure from Tashkent → Navoi by air plane	
25.09. 13.		Visiting **Navoi** Emergency Center	Dr Yusuf Malikov, Director Chief of Laparascopy Chief of CT Scan Chief of X-Ray Engineer
26.09.13.		Visiting **Navoi** Emergency Center	

26.09.13.		Transferring to Bukhara by private taxi	
26.09.13. 21:35	Bukhara – Tashkent	Departure from Bukhara →Tashkent by air plane	
27.09.13. 05:00	Andijan	Departure from **Tashkent** → Andijan by project car	
27.09.13.	Andijan	Visiting **Andijan** Emergency Center (RRCEM)	Pr Jumabaev Erkin Satkulovich, Director
28.09.13.	Andijan	Visiting **Andijan** Emergency Center (RRCEM)	
29.09.13.	Andijan	Departure from Andijan →**Tashkent** by project car	
Monday 30.09.13. 03:50	Tashkent	Departure to France	

b. Data needed

The following data was asked for in order to fulfill the mission:

- Exhaustive vision of the equipment of each hospital: number, technical characteristics, date of purchase, in-service date, acquisition costs…
- Activity data for each equipment
- Maintenance contracts & costs
- Insurances
- Equipment funding
- Components (global volume of procurement / expenditures)
- Data about out of service time (whenever existing)
- Number of FTEs dedicated to the maintenance of this equipment (and wages)
- End of life : revenues generated by the sale of the equipment or costs related to the end of life
- Revenues generated by the activity (revenue per exam whenever possible / linked to the activity data)

All the documents should be translated into English.

c. Data obtained

Three reports in English were provided before our on-site visit: “Operation and Maintenance of Medical Equipment” by Dieter Horneber, “Advanced training of doctors and medical staff to work on modern high-tech medical equipment in Uzbekistan” by Gulyamov and Uranova; “Assessment data of project’s indicators”.

These reports included some of the information requested. Even after on-site visits we did not manage to obtain the following data:

- exhaustive vision of the technical characteristics of equipment, date of purchase, in-service date, in particular regarding ultrasound
- acquisition costs for CT Scans and Ultrasound
- costs of repairs
- costs of consumables
- wages of technicians in charge of the maintenance and physician / nurses needed to operate the equipment

IV. Scope of the consulting mission

The consulting mission took place from 23rd to 30th September 2013. At the beginning the mission was focused on MRI, CT Scans and Laparoscopes. Ultrasound equipment has been added to the scope when first meeting with GIZ in Tashkent. The mission included visits to three healthcare institutions:

- Republican Research Centre for Emergency Medicine (RRCEM) in Tashkent
- Regional branch of RRCEM in Navoi
- Regional branch of RRCEM in Andijan

These visits were conducted by Maria Varela and Delphine Billard (Resah), together with Sardor Nigmatov (in RRCEM and Navoi) and Dr Nigora Muratova in Andijan.

The healthcare institutions visited have the peculiarity of being only emergency centres, all patients are treated free of charge. This specification has its impact in the use of equipment as professionals are not allowed to have planned patients. Therefore, the use of equipment, as we may see afterwards, may vary from one centre to another depending on the number of emergencies treated. Nevertheless, for each kind of equipment, we will give a target number of patients per day in order to optimize its use.

We visited three health institutions: Tashkent RRCEM, Navoi RRCEM Regional Branch and Andijan RRCEM Regional Branch. In each hospital, we had an estimation of number of beds and professionals attached to the center:

	Average number of beds	Average number of medical professionals	Number of nurses and technicians
Tashkent RRCEM	760	400	1200
Navoi RRCEM Regional Branch	200	140	700
Andijan RRCEM Regional Branch	350 + 50 intensive care	430	600

The following equipment was installed in the different emergency centers (with in service date):

Region	MRI	CT Scan		Laparoscope	Ultrasound equipment
Tashkent RRCEM	1 unit : Hitachi Airis Vento LT - 2013	CT Philips Brillance 40 - 2007 (not working)	CT Siemens Somatom Emotion 6 - 2010	5 units : Storz – 2002, 2008 (3), 2011	8 units : 1 Philips HD11XE – 2010 3 Siemens Adara – 2001 1 Siemens Sonoline Omnia 3 Hitachi EU500 – 2001
Navoi RRCEM Regional Branch	-	CT Siemens Somatom Emotion 6 - 2010		Storz – 2008	1 Sonoscape SSI-5000 – 2007 1 Mindray (mobile) - 2007
Andijan RRCEM Regional Branch	-	CT Siemens Somatom Emotion 6 - 2010		Storz - 2009	1 Sonoscape SSI-5000 – 2009 1 Mindray (mobile) – 2007

V. Procurement and costs analysis

a. Procurement organization in Uzbekistan

Procurement is centralized and managed by the Republican Scientific Center. They pool the purchases for all regional branches and sub branches and launch global procedures covering all the needs. Goods are afterwards dispatched in every region/district center. Imaging equipment is not directly procured by healthcare centers but by a public organization, Uzmed Expert, specialized in public procurement. Another state agency, Uzmed Technika, is in charge of loan projects, assessment before purchase, installation and commissioning.

Therefore, healthcare centers have very little information on how imaging equipment are purchased and have little access to their budget.

Emergency centers benefit from three different sources of funding: global dotation from Uzbek State, loans from Islamic Bank and from Kuwait Bank for their procurement.

In order to optimize procurement efficiency, total cost of ownership should be taken into consideration. The assessment of life-cycle cost consists in analyzing beforehand all the costs linked to a product, from its acquisition until its end-of-life.

b. Life-cycle cost definition

The purpose of a full life cycle cost analysis is to enable better assessment of alternative asset choices and value-for-money outcomes through considering all the costs associated with an asset over its useful life, including acquisition, installation, operation, maintenance, refurbishment and disposal.

Three key elements of life cycle costing are:

- Costs of owning and operating an asset
- Period of time over which the costs are incurred
- Discount rate that is applied to future costs to adequate them with present day costs

All the costs that need to be taken into account are explained in the table below:

Initial acquisition costs	
Purchase cost	Purchase price of the equipment. If the equipment is procured via a lease arrangement, identify the annual lease payments in a leasing costs section.
Delivery and installation cost	Costs associated with having the equipment delivered and installed on site. This includes freight, foreign exchange costs and transit insurance.
Integration cost	Costs associated with integrating and interfacing the equipment with existing systems and other equipment such as software updates and connections to IT systems.
Facility modifications	Costs associated with modifying the facilities to accommodate the medical equipment such as floor reinforcement, air conditioning upgrades, filtering systems and protective linings. These costs may also include any costs to remove the equipment being replaced.
Initial training	Initial training costs such as 'train the trainer', course materials, biomedical engineering/engineering/technical support training and service manuals.
Trade-in	Discounts or allowances provided by the supplier for any equipment traded in. Only include actual discounts received. Do not include the written down value of the item being replaced.

Leasing costs	
Lease payments	Annual leasing costs for the item of equipment being acquired (if purchased via lease arrangement).
Residual lease payments	Identify (if applicable) any lump sum residual payments payable at the end of the lease term.

Maintenance costs	
Scheduled / preventative maintenance	Regular activities that need to be undertaken to maintain the equipment in safe working order such as preventative service kits. This would include additional resources required for in-house maintenance and/or maintenance contracts with external service providers.
Decontamination and waste disposal	Costs associated with cleaning, sterilisation, disinfection, decontamination and the disposal of hazardous waste such as radioactive materials or chemicals. Only include costs that are directly related to the item of equipment such as specific chemicals or decontamination equipment.
Other maintenance costs	Other significant maintenance costs associated with this type of equipment.

Operating costs	
Staffing costs	Salary and related on-costs associated with employing additional staff to operate and maintain the equipment.
Accreditation and certification	Costs associated with undertaking certifications and compliance audits and ensuring that the equipment meets professional standards.
Supplies and consumables	Costs of supplies and consumables directly used in operating the equipment.
Ongoing training	Costs for undertaking 'train the trainer', in-house biomedical engineering/engineering/technical support training, refresher course and the production/acquisition of training material.
Utilities	Energy costs directly associated with operating the equipment where these costs are material and can be reliably estimated.
Licenses	Fees and charges associated with licenses required to operate and maintain the equipment such as software.
Other operating costs	Other significant operating costs associated with this type of equipment.

Repairs	
Repairs / unscheduled maintenance	Unanticipated costs to maintain the effective life and safe working order of the equipment. For simplicity, and given that repairs are by definition unforeseen, an annual 'best' estimate of possible repairs is satisfactory. This estimate should be based, where possible, on past experience for the type/brand of equipment and reliability cited by the manufacturer.
Upgrades and refurbishments	Periodic updates to the equipment to maintain the equipment in accordance with statutory or the manufacturer's requirements.
Spare parts and accessories	Costs of replacement spare parts and accessories over the life of the equipment such as monitor cables.
Other repair	Other significant repair costs associated with this type of equipment.

End-of-life disposal costs	
End-of-life disposal costs	These are costs to decommission, remove from service and safely dispose of the equipment at the end of its useful life such as removal costs, freight, 'make good' repairs to the facility. This should be the best estimate at the time of purchase. Where possible, disposal costs of similar items may provide a suitable guide to provide an estimate of these costs.

c. Different types of maintenance

There are different types of maintenance explained thereafter.

Breakdown maintenance: It means that people wait until equipment fails to repair it. Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost.

Preventive maintenance: It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into **periodic maintenance** and **predictive maintenance**. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

- Periodic maintenance (Time based maintenance): Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.
- Predictive maintenance: This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

Corrective maintenance: It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability

Maintenance prevention: It indicates the design of new equipment. Weakness of current machines are sufficiently studied (on site information leading to failure prevention, easier maintenance and prevent of defects, safety and ease of manufacturing) and are incorporated before commissioning a new equipment.

Second Part Observations and specific recommendations by equipment

I. CT Scan

a. Use of equipment in each center

Recall of the CT Scan installed in emergency centers (with in service date):

Region	Tashkent RRCEM		Navoi RRCEM Regional Branch	Andijan RRCEM Regional Branch
CT Scan	CT Philips Brillance 40 - 2007 (not working)	CT Siemens Somatom Emotion 6 - 2010	CT Siemens Somatom Emotion 6 - 2010	CT Siemens Somatom Emotion 6 - 2010

Photo of CT Siemens Somatom Emotion 6

The healthcare institutions targeted are only emergency centers so imaging systems can be used all day long, 7 days a week. The number of exams realized per day varies a lot from one center to another, from 25 in average at Navoy RRCEM Regional Branch, to 5 or 6 per day in Andijan, and 5 to 7 in Tashkent.

The CT Philips Brillance 40 was put into service in 2007 but has not been working since the first of March; it needs a new laser bloc.

The CT Siemens in Tashkent was put into operation in 2010. It had 2 years of warranty at acquisition. 3 physicians, 1 nurse and 3 operators are required to operate it for its use. One doctor is in charge for 5 or 6 hours. 3 operators' shifts take turns every 8 hours. There is a formation certificate for nurses and operators.

The CT Siemens in Navoi runs since 2010 without serious breakdown in 3 years, thanks to 2 physicians and 3 nurses. One doctor is on night call. In case of emergency, there are no backup plans nor any other hospital equipment identified to treat the patient.

Finally, 3 doctors and one engineer run the CT Siemens in Andijan. The clinical monitoring which records all examination information shows that in September 2013, 149 patients have used this imaging system.

CT Scan Siemens Somatom Emotion 6 is a 6 slices technology. Although it may not be the newest one, it is sufficient for the emergency diagnosis that is made in the targeted institutions

b. Maintenance and repairs

When a CT scanner has a defect, downtime until the repair is often very long. It can be explained by a cumbersome procedure.

In case of breakdown at the RRCEM in Tashkent, a first diagnostic is made by the hospital technician (there is one specialist by equipment type there). If this person can't do the repair, he writes an administrative letter to signal the undesirable event. Warned, the machine constructor dispatches an engineer. High technology imaging systems have complex IT components most often locked by the brand constructor. Siemens and Philips have their own brand representative for the country (Storz too for laparoscopes).

In RRCEM regional branches, there is only one technician for all the equipment. If there is a problem, he calls the RRCEM specialist who will travel to the institution if necessary and follow the explained procedure.

CT scanners carry a 2 years warranty including service and spare parts. After this period, the procedure is the same but with fees.

After diagnostic, if a spare piece is needed, research funding may be put on hiatus since this hadn't been anticipated. Uzbekistan Cabinet of Ministers Resolution #№ 456 dated 21.11.2000 states: Procurements to the amount over USD 100,000, the successful bidder is selected by decision of the Tender Committee. In case the procurement package is over USD 1 million, the composition of the Tender Committee should be agreed with the Cabinet of Minister of the Republic of Uzbekistan. Procurements to the amount over USD 300 up to USD 100,000 are conducted without tender by decision of a special committee set up by the client; the committee selects the best proposals. This selection procedure is not applied in case the goods, works and services are from the list that is specified by the Government Committee for public procurement. Direct contracting is authorized especially for goods manufactured by natural monopolies, procurement of goods amounting less than USD 300 equivalent, procurement from supplier that has exclusive rights for sale and contract amendments to the amount not exceeding 20% of the initial contract amount.

So captive pieces can be ordered by direct contracting. Spare parts for an imaging system are very often brand dependent; therefore we recommend that tenders be launched only after verifying that the needed spare part is not brand dependent. Generally, it is easier to deal directly with the manufacturer. In order to avoid purchasing spare parts one by one, we suggest that emergency centers have maintenance contracts that include spare parts.

After finding the budget and order the piece, it needs time for import from abroad and even more for going through custom. This step also delays the initial delivery of CT scanner, damaging it.

Set up in 2006, the Siemens CT scanner at RRCEM had few downtimes range from 2 weeks to 4 months (according to the recent, Dieter Horneber report), plus 9 months for replacement of x-ray tube (after warranty period), and is still out-of-service today for 8 months.

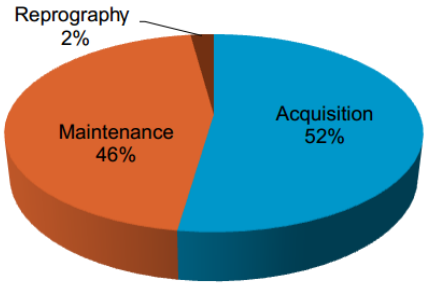
Besides, Siemen and Philips CT scanners at Tashkent Emergency Center include a maintenance contract which costs 8 million UZS per year, not including spare parts but brand engineer controls and adjustments. All the others equipment have not maintenance contracts.

Every medical equipment has a monitoring logbook, containing 2 parts for clinical monitoring and technical monitoring (date, defect, and action/repair). Each month, RRCEM is supposed to be informed of the condition and events regarding regional branches equipment.

c. Recommendations for costs / budget assessment

A full costs approach is indispensable from the start of an imaging system acquisition procedure. It is essential that costs for repairs and maintenance be budgeted. Many difficulties faced by emergency centres are linked to the lack of budget and the impossibility to find funding. It is the more important than it takes a lot of time while the equipment is down. Professionals and hospital managers should be conscious that all these difficulties faced during the procurement procedure are a great harm to patients and quality of care.

Illustration of the distribution of costs for slice imaging[1]:



As illustrated, acquisition costs of imaging equipment represent more or less half the budget needed to guarantee a good activity of the machine throughout its use. All sorts of outlays susceptible to appear on a life-cycle are defined in the first part of this report. This includes also end-of-life disposal costs, which aren't anticipated actually in visited health institutions. Consumables have to be taken into account when making a global budget. As we did not obtain any data on this topic, we are not able to say the percentage they represent.

The split between acquisition and maintenance costs presented in the graphics is based on a CT Scan lifetime of 7 years. If CT Scan is planned to run for more than seven years the maintenance contract would cost more or less 14% of the acquisition cost per year.

[1] Sources : Ministry of health - SNITEM

d. Recommendations procedures / use of equipment

As a general advice, we recommend that maintenance should be included in contract. For the procedure, the best solution may be a framework agreement with subsequent agreement entries directly managed by regional branches, in order to fit the needs of the different centers as the use of equipment is not identical in each center.

Call for tender should be divided in two different lots: first one for the acquisition and second one for the maintenance.

For the actual equipment that does not need to be immediately replaced we recommend a call for tender in order to have a maintenance contract. It is important than both preventive and corrective maintenance be included. This contract may be negotiated for the 1 or 2 years as a first test, it should stipulate the maximum time allowed to the manufacturer in order to perform the repair or change of parts. Contracting for maintenance may also help reducing the out of service time in general as the local representatives of the manufacturer should include the spare parts in their stocks in order to limit penalties due to time exceeding.

CT scanner usual service life is estimated at 7 years in average, from 5 to 15 years observed. CT can be use continually without inconvenient. One exam last from 5 to 15 minutes and a French clinic use it for 50 patients per day for example (5 days a week).

X-ray tube is a sensible part of the machine. Its ageing depends on its activity and its inactivity. Indeed, during prolonged non-use, a degasification phenomenon occurs. Yet, CT stayed a long time at customs before delivery in emergency centers which might have caused the tube replacement needed for all CT scanner during the first or second year after being put-into-operation. Generally, it should be planned to replace at least one or twice x-ray tubes.

II. MRI

a. Use of equipment

We recall that there is only one MRI installed in emergency centers visited:

Region	Tashkent RRCEM	Navoi RRCEM Regional Branch	Andijan RRCEM Regional Branch
MRI	1 unit : Hitachi Airis Vento LT – 2013	–	–

The MRI is in RRCEM at Tashkent, being installed during our visit. It costs 669 000 USD at acquisition. It is a 0.3 Tesla MR solution, economic and compact. Operators were in initial training for use, dispensed by a supplier engineer.

An extension of the hospital was specially built for his installation, from the constructor recommendations.

One MRI exam is longer that a scan, in average 30 to 40 minutes by patients. 2 doctors and 2 operators are needed for manipulations. The MRI is turned on all the time but have no vocation to be used for patients during night or week-end.

b. Recommendations

Main ideas for MRI costs and procedures optimization are the same than for CT scanner. They are both slice imaging equipment and distribution of costs is similar. Furthermore, others transversal recommendations will be develop in the third part. For instance, for this kind of MRI (procurement cost 669 000 USD) an additional budget of 590 000 USD should be planned for maintenance (for a lifetime of 7 years).

We do not know how the MRI will be use when staff will be trained, but in general it can realize 20 up to 30 exams per days.

III. Laparoscopes

a. Use of equipment in each center

Recall of the Laparoscopes used in emergency centers (with in service date):

Region	Tashkent RRCEM	Navoi RRCEM Regional Branch	Andijan RRCEM Regional Branch
Laparoscope	5 units : Storz – 2002, 2008 (3), 2011	Stroz - 2008	Storz - 2009

Photo of Storz Laparoscope

In RRCEM in Tashkent we have observed five laparoscopes. All of them were manufactured by Storz. One Laparoscope was first on-service in 2002. It is the oldest one still in use today. It is used for 2 or 3 exams per day, mainly for routine diagnosis but also for some gynecological interventions. Three laparoscopes were put into service in 2008 and one in 2011, mostly used for gynecological interventions. All material was procured with a warranty period of two years with the exception of the last one that has a 3-year warranty period. They only have one set of instruments for each laparoscope which limits the number of interventions that can be done in one day, as chemical decontamination takes about one hour and a half.

In RRCEM Regional Branch in Navoiy, they have one laparoscope (Storz) for every kind of surgery. It was first put on service in 2007. They have three sets, all three operational and they make an average of 5 or 6 operations a day.

In RRCEM Regional Branch in Andijan they have also one laparoscope and realize 6 or 7 interventions a day. The General Director indicated that he wished to develop this activity but that he had a real constraint linked to the material as he did not have the budget to purchase another laparoscope.

b. Maintenance and repairs

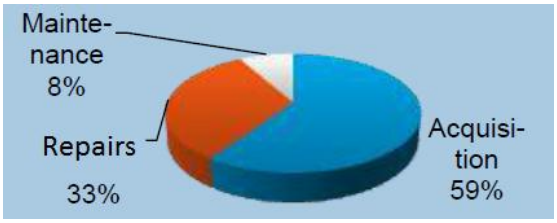
Even though there is a Storz local representative in Uzbekistan, hospitals try to manage the maintenance and repairs of their equipment by their own as they do not have any maintenance contract once the warranty period is over. Local representative may assist with the equipment but they mostly assist with training. In fact there is in Tashkent a quite new training center. But we felt a lack of training in the Regional Branches. In fact, most of the breakdown in the laparoscopes was caused by misuse of the equipment or not enough care when manipulating or storing the laparoscopes.

In RRCEM in Tashkent, cables are reported to break on a regular basis; repairs are made in the emergency center using the means they have at their disposal. For example they replenish sets with second-hand parts. Sometimes video systems and spare parts can be bought separately.

In the regional branches, some repairs were made by the manufacturer during the warranty period but most of the time their local engineer tries to fix the material.

c. Recommendations for costs / budget assessment

Illustration of the distribution of costs for rigid endoscopy[2]:



[2] Source : Ministry of health - ARMEN « Imagerie en coupe »

Regarding laparoscopes, it is commonly admitted that the average lifetime of an endoscope cart is around 10 years, whereas video-system (lens, optics, lighting…) has an average lifetime of two years depending on the type of surgery performed. It can last 4 to 5 years if it is exclusively used in laparoscopy buy may only last 1 year if used for urological or gynecological surgeries. It depends on many factors: activity, preventive maintenance, trained professionals…

Our first recommendation would be to have a maintenance contract for each laparoscope. In terms of budget it means that for each laparoscope purchased it is necessary to budget around 70% of the acquisition costs for maintenance and repairs during equipment lifetime.

For example, one Storz laparoscope procured for an amount of 18 000 euros would cost the hospital 30 600 euros (including spare parts and repairs) and should be replaced within 5 years.

d. Recommendations for procedures / use of equipment

Most breakdowns are related to wear-off (50%) or misuse (50%). Also we recommend that all professionals have an adequate training for the use of this equipment. Maintenance contracts should include preventive maintenance and possibly some kind of corrective maintenance. It may be interesting to include in the contracts a clause for standard exchange for broken parts.

We would also recommend that hospitals have as many sets as the number of patients treated per day and additional laparoscopes in order to face breakdowns. As a basis data, it would be useful to have 1 spare laparoscope for two or three operational laparoscopes.

IV. Ultrasound equipment

a. Use of equipment in each center

Recall of the ultrasound equipment used in emergency centers (with in service date):

Region	Tashkent RRCEM	Navoi RRCEM Regional Branch	Andijan RRCEM Regional Branch
Ultrasound equipment	8 units : 1 Philips HD11XE – 2010 3 Siemens Adara – 2001 1 Siemens Sonoline Omnia 3 Hitachi EU500 – 2001	1 Sonoscape SSI-5000 – 2007 1 Mindray (mobile) - 2007	1 Sonoscape SSI-5000 – 2009 1 Mindray (mobile) – 2007

Photo of Sonoscape Ultrasound equipment

Ultrasound equipment was not identified in the scope of the mission at the beginning but added by GiZ during our first meeting in Tashkent. Nevertheless, we managed to get some information about the equipment, the way it is used and the difficulties faced in each emergency center.

In RRCEM in Tashkent, they have 8 ultrasound systems and examine an average of 25 patients per day per equipment. Most of the equipment is old and was put into operation in 2001. Only one ultrasound (Philips) is less than 3 years old. The activity is fair but the difficulties faced by professionals are real and have a direct impact on the accuracy of the diagnosis and patients' care. Twelve professionals (physicians and nurses) are trained to work on this equipment.

In RRCEM Regional Branch in Navoiy, three ultrasound systems are on service. They are newer than the ones in Tashkent (on-service in 2007) and operated only by three physicians, who treat an average of 35 patients a day for each ultrasound; they face some difficulties due to the wear-off of the probes.

In RRCEM Regional Branch in Andijan, they have one ultrasound equipment and one mobile system. Their Sonoscape was procured in 2009 thanks to a loan from the Islamic Bank. They try to optimize the use of their equipment and make an average of 50 examinations a day. They face the same difficulties recorded in Navoiy due to the wear-off of the probes.

b. Maintenance and repairs

Ultrasound equipment is not as crucial as CT Scan, as they have many units in each emergency center. Maintenance procedures are the same as for the other types of equipment both in Tashkent and in the Regional branches. Main problems faced are the ones due to the wear-off of the probes that do not allow an accurate diagnosis as the image may be defective.

Eventually, we recommend that each hospital should have a spare abdominal probe for each ultrasound (as it is the most frequently used).

c. Recommendations for costs / budget assessment

For ultrasound, the average expenditure for procurement was 70 000 euros per equipment (2009). The budget allowed covered only the acquisition and nothing was foreseen for maintenance or repairs.

The life-duration of ultrasound equipment is considered to be around 7 to 10 years. Two options are commonly used considering the maintenance of ultrasound: contracts including the maintenance of the probes and contracts excluding this maintenance.

- First option: maintenance contracts probes included. The additional cost traditionally observed for this kind of maintenance represents around 10 – 12% of the acquisition cost per year. This includes maintenance against all risks and the change of the probes (the number of changes should be negotiated in the contract).

Considering this data and if we assume that the equipment is used from 7 to 10 years, we can assess the cost of the equipment during its lifetime (consumables excluded, in euros):

Time of use	7 years	8 years	9 years	10 years
Acquisition costs	70 000	70 000	70 000	70 000
Maintenance costs (11% per year)	53 900	61 600	69 300	77 000
Total costs	**123 900**	**131 600**	**139 300**	**147 000**

- Second option: maintenance contracts probes excluded. The additional cost traditionally observed for this kind of maintenance represents around 6 – 7% of the acquisition cost per year. This includes maintenance against all risks. An additional cost of 3 000 to 6 000 euros per year should be planned for the change of one single probe.

Time of use	7 years	8 years	9 years	10 years
Acquisition costs	70 000	70 000	70 000	70 000
Maintenance costs (6,5% per year)	31 850	36 400	40 950	45 500
Total cost probes excluded	**101 850**	**106 400**	**110 950**	**115 500**
Extra-cost for probes (5K/year)	35 000	40 000	45 000	50 000
Total costs	**136 857**	**146 408**	**155 959**	**165 510**

We also suggest that the change of the ultrasound should be planned every 7 to 10 years.

d. Recommendations for procedures / use of equipment

As we mention for CT scanner, whenever acquiring new material, the maintenance contracts should be included in the call for tender.

Best practices regarding ultrasound include negotiating all-risks maintenance contracts with providers. It is important than both preventive and corrective maintenance be included in particular regarding the probes.

Regarding the use of equipment, knowing that one examination lasts twenty minutes in average, with one ultrasound you can treat 25 patients a day (on an 8 hours-day basis). This means that the use of ultrasound equipment is optimized in the three emergency centers we have visited.

Third part Transversal recommendations

In addition to specific recommendations for each type of equipment, we recommend three major changes in the actual procedure:

- Changes in procurement
- Changes in the way equipment and material (spare parts) are conveyed
- Changes in the on-site maintenance

I. Procurement recommendations

We recommend that all equipment be procured with a maintenance contract or, in the beginning, with an extension of the warranty period, going from three to five years. We have seen that many repairs had to be done during the warranty period.

These repairs were less time-consuming than the ones made after the warranty period. Most important is to assess global costs when planning to replace or buy new equipment in order to forecast the budget needed every year.

Launching a tendering procedure must not be automatic. In fact when the objective is to procure captive spare parts, we believe that the most efficient way to do it is to contract directly with the manufacturer: it saves time and money and it enables a quicker repair of equipment and a better patient's care. The tendering procedure must be reserved in priority for acquisitions.

We already talked about budget and the importance of having funds allowed for spare parts/repairs. We will not insist any further on this point but just point out that every breakdown may have a major impact on diagnosis and patient's care.

Regarding financial options, it would be interesting to separate global procurement (framework agreement) from local execution of the contract (subsequent market). Regional branches should have their own budget in order to realize their purchases even though procurement is centralized. The idea would be to collect the needs for each Regional Branch or District emergency center, have a global procedure led by Uzmed experts but let each emergency center launch its own subsequent market when they face specific needs. Here is an example in order to illustrate this idea:

1st step: Uzmed experts collect the estimated needs (for the next 5 years) regarding laparoscopes for every emergency center

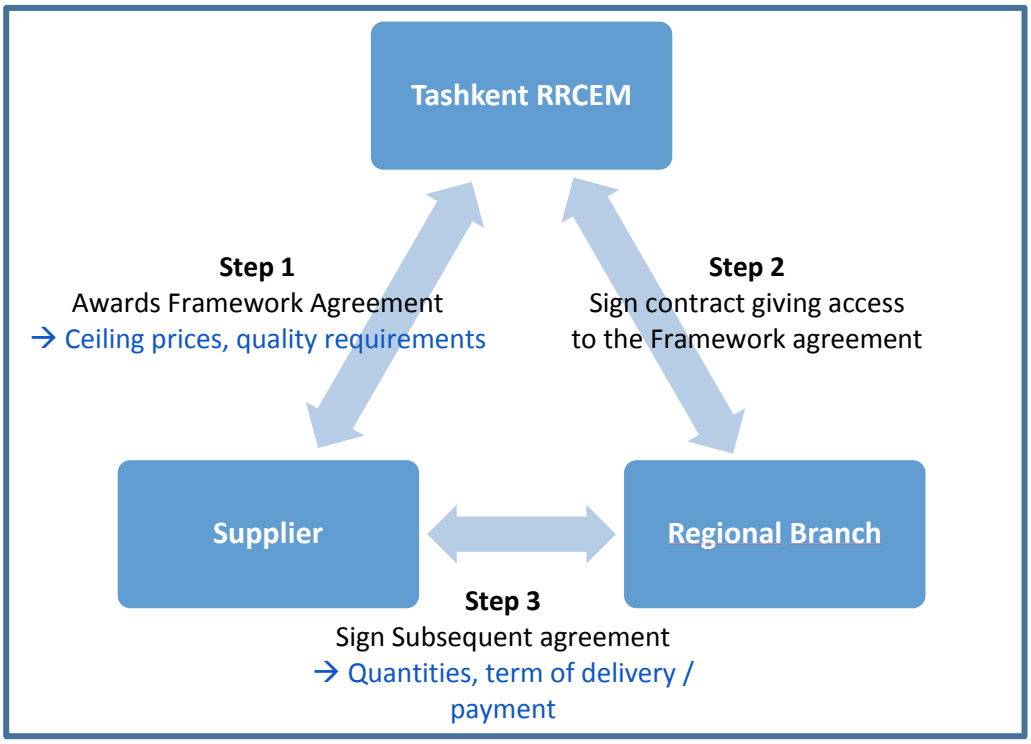
2nd step: Uzmed experts launch the tendering procedure: framework agreement with subsequent markets that would be launched by centers afterwards. We recommend that the framework agreement reference two manufacturers.

3rd step: Choice of manufacturers.

4th step: When needed, emergency centers launch the subsequent market and choose between the two selected manufacturers according to their needs.

This procedure presents both the advantage of pooling the needs and of letting the centers decide what is best for their needs (product and timing).

Here is a figure to illustrate the procedure and the way the different actors work together:



Other options that can be explored:

Leasing: the global cost is not necessarily inferior than when equipment is purchased but it has major advantages when there is a regular plan of equipment replacement. It smooth the impact on budget as a fee is annually reversed to the manufacturer, it enables better maintenance (charge of the manufacturer) and, additionally, it may be a way to have more efficient equipment after a certain period of use.

Buying second-hand imaging equipment may also be an option: Good material is available on the second-hand market; prices are much more affordable than for new products and products offered generally meet the expectations. In this case, it is essential to have a maintenance contract, most of the time with some experts able to realize maintenance on different brands, less often directly with the manufacturer.

II. Transport recommendations

During our on-site visit we have observed many items that had an impact on the efficiency of the procurement process:

- Constraint of public procurement
- Difficulties in finding budgets
- Difficulties in conveying goods: equipment and spare parts may stay over one year at customs. It happened with CT Scans, and that is why X-Ray tubes had to be replaced within the warranty period.

We suggest that a procedure describing how equipment and pieces should be imported be written down in order to identify the qualified persons enabled to perform customs duties.

We recommend identifying one person for CT Scans and MRI, one for ultrasound and another one for laparoscopy. These persons would be the unique contacts for customs and manufacturers local representatives. Their job would consist in facilitating customs duties and ensuring that everything is compliant. This may help reducing the time products stay stuck at customs, provoking a delay in the delivery of equipment or spare parts, having a direct effect on diagnosis and patient's care possibilities.

III. Maintenance recommendations

Maintenance is one of the big issues of emergency centers regarding imaging equipment. As there is no full-cost analysis before launching a procurement procedure, healthcare centers do not have budget for maintaining and repairing their equipment. Therefore, this study aims to make deciders aware that maintenance is a key issue to prevent breakdowns and to enable continuity in patient's care. We already recommended that maintenance contracts should be taken for all equipment. Furthermore we would recommend:

1. To externalize all maintenance in the beginning as it is very difficult for engineers and technicians to perform maintenance on complex imaging equipment, often locked by manufacturers. Therefore, manufacturers are best qualified to perform preventive and corrective maintenance.
2. Invest on training for engineers and technicians: all engineers and technicians should be able to perform simple repairs on every type of equipment. For more complex interventions we suggest that a few engineers (3) should be correctly trained. They will be "mobile" engineers and could intervene on equipment in every center (RRCEM, Regional branches and district centers). These engineers should be specialized by equipment (one for laparoscopes, one for ultrasound, one for MRI & CT Scan) in order to follow interventions when repairs are needed.

One last point has to be taken into consideration: in the whole study we have given information about average lifetime of equipment. This data is given as a decision-support tool: after a certain period of time (7 years for CT Scans, 4 to 5 years for laparoscopes…) it is essential to wonder whether it is better to continue maintaining the equipment or replace it. Due to quick obsolescence of this kind of equipment, sometimes replacement would be a better option than repair.

IV. Loss of earnings

It has been asked at the beginning of the project to identify the out of service time, analyse the reasons and assess the loss of earnings (second objective). Unfortunately, due to the difficulty to obtain data, we are in the impossibility to give an appropriate response. Available data about downtime are fully detailed in Dieter Horneber report, "Operation and Maintenance of Medical Equipment" – December 2012, so have not need to be repeated in the present report. It can only be added the last Tashkent CT Philips Brillance 40 breakdown mentioned previously.

Regarding the assessment of loss of earning, few remarks can be expressed. This indicator will necessarily be fictive since all emergency centers are free of charges for all patients. Theses healthcare institutions haven't incomes by a patient billing or a repayment by the state according to the activity; their budget is a global annual dotation.

Nevertheless, this can be interesting seen as an indicator of a loss of service or a decrease in care quality.

We can distingue 2 types of loss of earnings:

Firstly, a loss of earning caused by an underutilization. For instance the Tashkent CT Scan Siemens is only used for 5 to 7 patients per day in average whereas it could reach 20 to 25 exams a day, as it is done at the Medical Academy Clinic in Tashkent. As a reference, Dieter Horneber indicates that Tashkent Clinic fees for a CT exam are 65'000 UZS / case. So the loss of earnings could be estimate as following:

(20 – 6) x 65'000 = 14 x 65'000 = 910'000 UZS / day. Approximately 420 420 USD lost per day.

Secondly, losses due to none functioning equipment. For example, the Tashkent CT Philips is broken since the 1st of March 2013. Six months non-use could be evaluate as below:

(365/2) days x 6 patients per day x 65'000 UZS per case = 71 175 000 UZS lost for RRCEM.

And if exams were more frequent with 20 patients per day:

(365/2) days x 20 patients per day x 65'000 UZS per case = 237 250 000 UZS.
I.e. 1 300 000 UZS lost per day.

But we can't assess the global loss of earning with partial data.

Anyway this is a theoretical calculus. The most important is that nonoperational equipment constitutes a major risk for healthcare continuity and quality of diagnostic and patient care.

Conclusion

Purchasing and cost assessment have not been priorities for healthcare centers in Uzbekistan. Budget difficulties are inducing changes in the way procurement is perceived and procurement planning is becoming a real issue. Changes in procurement are necessary in order to guarantee the efficiency of the service provided. Evaluating equipment, assessing costs before purchasing and thinking in full cost are key.

Eventually, here are some tips for evaluating and reviewing equipment performance:

- *Condition* – is the equipment adequally maintained? Is there a maintenance backlog? Are major replacements of refurbishments likely to be required in the short term?
- *Utilisation* – How often and how intensively is the asset used? What is the actual usage compared to throughput capacity? What are the waiting times to use the equipment? What is the level of « down time » for the equipment compared with the manufacturer's benchmarks?
- *Critical risk assessment* – Does the equipment currently pose any serious risks for patient safety? Service availability? How would a delay in the acquisition of replacement equipment affect critical risk factors? How dependent is the health service on this item of medical equipment? What are the possible flow-on implications if the equipment is not available?
- *Functionality/clinical efficacy* - How well suited are the equipment to the services it supports? What is the evidence-based efficacy of the procedures that are proposed to be undertaken? Which procedures are research related and how will they be funded?
- *Costs* – Are the equipment's operating costs higher/lower than for those of comparable equipment? Are the energy, maintenance, and repair costs reasonable?
- *Age/effective life* – Is the current asset reaching the end of its effective life? What future service potential could be obtained from the equipment?
- *Disposal* – what opportunities are there for the disposal or re-allocation of the equipment?
- *Importance or criticality of the medical equipment to the health service*

Appendix – TCO in figures

Below are detailed the yearly budgets needed to run the different types of equipment (acquisition costs excluded) in each city, summarizing all the information given before.

Tashkent

CT Scan - Philips Brilliance 40

Maintenance and repairs	80 000 USD
Staffing costs	22 200 USD
Energy consumption (including AC)	4 438 USD
Total	107 102 USD

CT Scan - Somatom Emotion 6

Maintenance and repairs	80 000 USD
Staffing costs	22 200 USD
Energy consumption (including AC)	1 937 USD
Total	104 601 USD

MRI

Maintenance and repairs	85 000 USD
Staffing costs	13 200 USD
Energy consumption (including AC)	4 467 USD
Total	102 267 USD

Laparoscope

Maintenance and repairs	5 000 USD
Staffing costs	16 800 USD
Energy consumption	9 USD
Total	21 809 USD

Ultrasound

Maintenance and repairs	7 700 USD
Staffing costs	5 400 USD
Energy consumption	465 USD
Total	13 565 USD

Navoy

CT Scan - Somatom Emotion 6

Maintenance and repairs	80 000 USD
Staffing costs	16 800 USD
Energy consumption (including AC)	5 402 USD
Total	102 202 USD

Laparoscope

Maintenance and repairs	5 000 USD
Staffing costs	14 400 USD
Energy consumption	9 USD
Total	19 409 USD

Ultrasound

Maintenance and repairs	7 700 USD
Staffing costs	14 400 USD
Energy consumption	651 USD
Total	22 751 USD

Andijan

CT Scan - Somatom Emotion 6

Maintenance and repairs	80 000 USD
Staffing costs	16 800 USD
Energy consumption (including AC)	4 902 USD
Total	101 702 USD

Laparoscope

Maintenance and repairs	5 000 USD
Staffing costs	9 600 USD
Energy consumption	9 USD
Total	14 609 USD

Ultrasound

Maintenance and repairs	7 700 USD
Staffing costs	14 400 USD
Energy consumption	930 USD
Total	23 030 USD

NB :

- For staffing costs, we have taken into account the data given by the hospitals regarding the number of doctors and nurses needed to run the equipment
- For energy consumption, figures take into account average consumption given by the manufacturer and number of examinations made in each center. The rate of kwh has been taken from this official announcement: “Approved by the Ministry of Finance of the Republic of Uzbekistan Register№19-03-22-05-RUz-21-2013. dated March 15, 2013”