



**FACTORS THAT INFLUENCE OBSTETRIC ULTRASOUND SCAN
TURNAROUND TIME AT THE KENYATTA NATIONAL HOSPITAL, KENYA**

(A CROSS SECTIONAL STUDY)

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DECLARATION

As the principal researcher, I declare that this is my original work and that it has not been presented at any University for the award of a degree.

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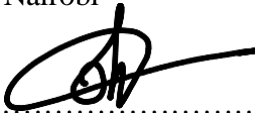
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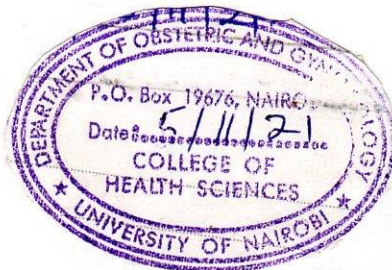
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DEDICATION

The dissertation is dedicated to my Fiancee, Rosemary Wanjiku Waithaka and My Parents,Dr
and Mrs Warugongo

LIST OF ABBREVIATIONS AND ACRONYMS

ANC:	Antenatal Care
DM:	Diabetes Mellitus
GA:	Gestational Age
KNH:	Kenyatta National Hospital
SDG:	Sustainable Development Goals
TAT:	Turnaround Time
TMS:	Time Motion Studies
UoN:	University of Nairobi
UPS:	Uninterruptible Power Supply
US:	Ultrasound
WHO:	World Health Organization

DEFINITION OF OPERATIONAL TERMS

Turnaround Time: The amount of time taken to fulfill a request.

Time Motion Study: Systematic observation, analysis, and measurement of the separate steps in the performance of a specific job for the purpose of establishing a standard time for each performance, improving procedures, and increasing productivity.

High Risk Pregnancy: A kind of state or pregnancy that threatens the health or life of the mother and the fetus.

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ABSTRACT

Background: Ultrasound is essential for clinical diagnosis and or management of normal and complicated pregnancies. With the implementation of Managed Equipment Project (MEP) in four national referral hospitals and 94 County hospitals (two in each of the 47 Counties) in Kenya, the technology is widely-used in Antenatal care due to its ability to offer potentially lifesaving information on the etiology of limiting differentials. Ultrasonography reports also guide the management of cases of emergencies during pregnancy and in the early postpartum period. Of importance too is the need to get timely reports in cases of obstetric emergencies as this significantly reduces the complications that may emanate from delayed management of the patients. In Kenya, turnaround time (TAT) for obstetric ultrasound its associated factors are poorly defined.

Objective: Determine the turnaround time of obstetric ultrasound and its associated factors at the Kenyatta National Hospital (KNH), Kenya.

Methodology: This was a Cross Sectional study at KNH labor ward in Kenya from November 2019 to February, 2020. The study population consisted of pregnant women for whom ultrasound is routinely required at 24 or more weeks gestation. Two hundred and seventy (270) participants were recruited and a questionnaire used to collect data. Trained research assistants observed the activities of consenting patients throughout the process of the ultrasound and documented real-time patient flow time from scheduling of ultrasounds to the receipt of requests by the radiology unit. The time it took to prepare and disseminate written reports was noted. Data analysis was done using version 21 of the Statistical Package for Social Scientists (SPSS) by first computing mean ultrasound wait times. The ANOVA test (with Bonferroni Post Hoc) was used to assess the factors that influence ultrasound wait times at KNH.

Results: The median gestation age for the study participants was 34 weeks. A majority of the women in the study, 90 (33.3%) had three children. out of the 270 ultrasound scan requests with documentation about when the scan was done, 231 (86%) had the scans done during the week while the rest (39, 14%) had the scans done during weekends. Most of the scans were done during the day, 144 (53.3%). The median duration between making the request and receipt at the radiology unit was 3.5hr (IQR 0.83-5.0); the median duration for performing the ultrasounds was 0.42hr (IQR 0.33-0.50); the median duration for generation and printing of reports was 1.05hr, (IQR 0.5-1.9) while the median duration for the delivery of the printed reports to the department was 0.5hr (IQR 0.33-1.0). The overall median period of time taken between making the request to the presentation of results to the clinician was 10hr (IQR 5.6-13.0). A total of 231 (85%) of the scans were performed during the day, while 39 (15%) during the night. The mean TAT for performing the ultrasounds during the week day (8.9hr, sd 4.8) was lower than the mean TAT when the ultrasound was performed during the weekend (9.6hr, s.d 6.1); ($F=0.54$, $p, <0.46$). The mean TAT for the ultrasounds that were performed during the day (8.7hr, s.d 4.3) was lower than the TAT for the ultrasounds performed at night (9.5hr, s.d 5.6); ($F=1.9$, $p,0.16$).

Conclusion: The turnaround time at the KNH maternity is comparatively longer than the recommended times, with the turnaround being shorter when the ultrasounds are done during the day and over the weekend.

CHAPTER ONE: INTRODUCTION AND LITERATURE REVIEW

1.1 Background

Ultrasound is essential in clinical diagnosis and management of complicated and normal pregnancy. It is widely applied in antenatal care in Kenya, more so after implementation of Managed Equipment Services (MES) where the National Government equipped two county referral hospitals and four national referral hospitals with state-of-the-art imaging equipment¹. Ultrasound is inexpensive relative to other diagnostic modalities. It is also safe, portable, and requires a simple power supply and maintenance².

Obstetric ultrasonography provides important and potentially lifesaving information³. It is also perceived to enhance antenatal care by ascertaining pregnancy status and enabling an accurate estimation of the fetal gestational age and status⁴. However, successful outcomes depend on timely diagnosis of disorders and appropriate clinical management. The use of ultrasound in emergencies in the field of Obstetrics is well established because it plays a critical role in identification of correct etiology and diagnosis as well as limiting differentials⁵. It is also a valuable tool for detecting etiology and guiding management of cases of emergencies faced by obstetricians during pregnancy or early postpartum period⁶.

Turnaround Time (TAT) is important for prompt diagnosis of any obstetric emergencies and decision making to guide appropriate management⁹. TAT can be shortened by point of care scans. The Kenyatta National Hospital (KNH) Departmental guidelines for TAT for ultrasound examinations range between 20 and 30 minutes¹⁰. This is in line with the Society of Radiographers (ScoR) guidelines on turnaround times for ultrasound examinations, which recommends 20 minutes for 3rd Trimester review as sufficient allocated time¹¹. Turnaround Time is one of the most critical performance indicators in any health institution¹².

1.1 Benefits of Obstetric Ultrasound Examinations in Obstetrics

Even though most of the pregnancies and childbirths worldwide are uneventful, all pregnancies are at risk. Up to 15% of all pregnant women can develop potentially life-threatening complications, which require major interventions and skills for survival. The World Health Organization (WHO) reports the five main causes of maternal deaths as hypertension – related disorders of pregnancy such as pre-eclampsia and eclampsia, severe hemorrhage, unsafe abortion, medical complications such as cardiac conditions, HIV/AIDS, Diabetes Mellitus (DM) complicating or complicated by pregnancy, unsafe abortion and maternal infections.

A high-risk pregnancy is kind of state or pregnancy that threatens the health, life of the mother and the fetus. Therefore, it often requires special care from specially trained obstetric caregivers. It is believed that some of these high-risk cases may develop with the progress of gestation, while some cases may have been attributed by complications prior to the pregnancy due to other comorbidities. Some of the known risk factors of high-risk pregnancies are existing health conditions, such as HIV infection, diabetes and high blood pressure¹³.

Obesity or overweight increases the risk of gestational diabetes, neural tube defects, high blood pressure, Pre-eclampsia, stillbirth and cesarean delivery. Multiple births have also been observed to pose high-risk complications. Known complications confounded by this include premature labor, preeclampsia and preterm birth. It has been observed that more than one-half of all the twins or higher order multiples are born at less than 37 weeks of gestation¹⁴.

Advanced or young maternal age also has high-risk related conditions these are especially common in teen pregnancy or women above 35 years of age with increased risks for preeclampsia and gestational high blood pressure¹⁴. Antepartum hemorrhage also signifies high risk pregnancy. High risk pregnancies are therefore a significant cause of perinatal as well as maternal morbidity and mortality: of these causes of maternal mortality, Obstetric Ultrasound plays a critical role in diagnosis and antepartum evaluation of the fetus and fetal wellbeing especially via fetal doppler ultrasound for measurement of blood flow velocities in the fetal vessels especially the Umbilical Artery. Doppler studies should be included for fetal assessment in high risk pregnancies thought to be at risk of placental insufficiency¹⁵.

The WHO in its 2016 antenatal care (ANC) recommendations for pregnant women, recommends one ultrasound (US) scan before 24 weeks gestation to improve a woman's pregnancy experience. Use of Doppler Ultrasound on the Umbilical artery in high risk pregnancies reduces the risk of perinatal deaths and may result in fewer obstetric interventions. Turnaround Time is important for prompt diagnosis of any obstetric emergencies and decision making to guide appropriate management to improve neonatal and maternal outcomes¹⁰.

1.2 Time Motion Studies in Ultrasound Examinations

Time motion studies (TMS) were first described by Frederick Taylor (1856-1915) in the early 20th century in industrial engineering as a quantitative method of data collection, where by an external observer captured detailed data on the duration and movements required to accomplish a specific task, coupled with an analysis focused on improving efficiency¹⁶. This was later expanded by Frank and Lilian Gilbreths who in 1914 began the application of

Time-Motion studies techniques to healthcare and life sciences to assess inefficiency in Healthcare

Since then healthcare managers have used TMS to study costs and inefficiencies in healthcare delivery and then expanded the focus towards patient safety and quality. Time Motion data can be produced by external observers, the subject being studied or automatically by computerized systems. In this study, data will be produced by external observers through continuous observation who will directly observe and follow in real time. The essence of TMS is the capture and or analysis of the time required to complete one or more events by an external observer²³.

Ultrasound TAT may be described as the precise time between ordering a test to the time of submission of the report. This study will seek to separate the processes that a high-risk mother goes through when an Obstetric ultrasound is requested into unique components and then determine the impact of these components on turnaround time. This will help to identify the components that need to be addressed if TAT is to be streamlined.

1.3 Factors influencing Obstetric Ultrasound Turnaround Time

It has been noted that the turnaround time (TAT) is very important in timing critical situations. It is believed that the optimal TAT should be as short as possible, often under 30 minutes^{17,18}. In a study by French *et al.* (2014), the average waiting time for US was around 3.8 hours, which was significantly higher than the ideal TAT of 30 minutes. Albrecht *et al.* (2013) reported a TAT of 56 minutes, which was lower than French's, but still high. It is therefore, deemed that many factors might play a role in affecting optimal TAT. These may include; the total volume of work, staff capacity, case complexity, radiologist speed and

diagnostic reporting time, time spent teaching trainees in an academic institution, and academic and nonacademic interruptions²⁷.

Factors that may influence optimal turnaround times for the ultrasound examinations may arise from the clinician in labour ward or the radiology department. In Canada, for instance, Abdullah *et al.* (2019) associated delay in TAT for obstetric ultrasounds with early maternal age and multi-parity. However, women with a history of premature births and a history of alcohol use during a pregnancy were more likely to have a shorter ultrasound TAT than those who did not. These kinds of delays have in the recent past led to complaints by the pregnant mothers undergoing the examinations.

Appropriate instructions can reduce errors, inconvenience, and delays in waiting for both patients and the staff. The radiology unit also has to ensure that there is adequate staff. Shortage of equipment is another factor of concern, which leads to development of long queues thus increasing the turnaround time. Frequent power disruptions have also contributed to increasing the turnaround time by prolonging the pre-analytical and post analytical US diagnostic intervention. Therefore, institutions should ensure there are enough back-ups (UPS) and generators notably when there is a prolonged duration of the power outage.

1.4 Conceptual Framework

The TAT for ultrasound in the obstetric department is influenced by an interplay of several factors, largely looked at from the health system perspective. The availability and functionality of the ultrasound machine is critical in the TAT just as much as the presence of qualified staff to perform the ultrasounds. Other influencers of the TAT include the available standard operating procedures that guide the utilization of the ultrasound services, the patient

flow and the availability of trainees, who would wish to participate in the process as part of learning.

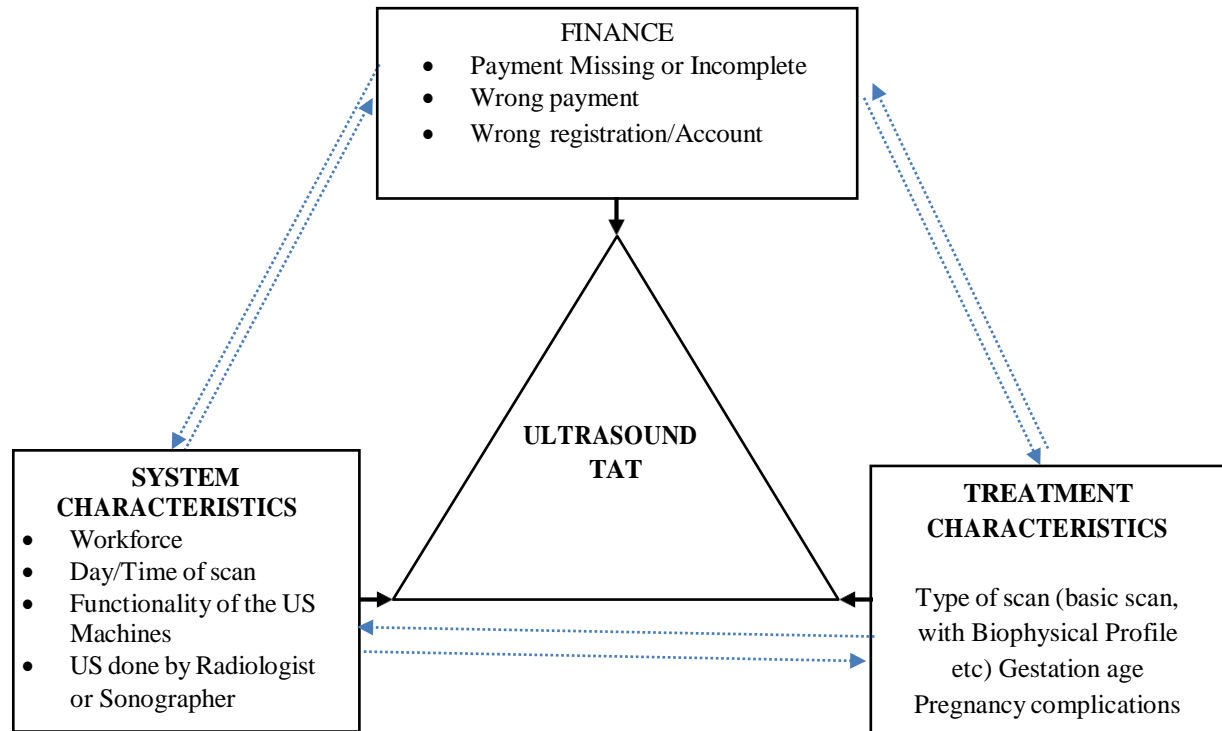


Figure 1: Conceptual Framework

1.5 Study Justification

Ultrasound imaging is an important medical procedure for diagnosing obstetric complications. Since the device is known for its safety and non-invasive nature as a modern diagnostic and monitoring aid, it can be helpful in timely decision making and a guide for appropriate clinical interventions to reduce maternal and perinatal morbidity and mortality and in line with sustainable development goal three. However, for the ultrasound to be effective, it should be executed in a timely fashion following standard protocol.

At the KNH, the ultrasound is one of the most frequently requested diagnostic imaging modality in obstetrics. However, its execution, which include the TAT from request for scan to delivery of reports has never been evaluated in-depth. The TAT is one of the major determinants in the overall institutional process's growth evaluation tool. This study therefore aims at assessing the TAT for obstetric ultrasound requests in comparison with globally acceptable TATs.

Our findings will determine the average TAT at KNH and identify specific areas that should be addressed to improve the efficiency of patient care and improve service delivery with regards to Obstetric ultrasound. Additionally, the findings will seek to enumerate the reasons behind the delays in Obstetric Ultrasound TAT and therefore inform formulation of hospital-based policy on point of care scans done at the bedside aimed at further reduction in the maternal and perinatal/neonatal morbidity and mortality.

1.6 Research Question

What is the Obstetric Ultrasound Scan Turnaround Time and its associated factors at the KNH Labour ward?

1.7 Broad Objective

To determine the obstetric ultrasound turnaround time and factors that influence ultrasound turnaround time at KNH Labour ward

1.8 Specific Objectives

- 1.8.1 To determine the average time taken from order of scan to transfer to radiology unit and average waiting time at the radiology unit

- 1.8.2 To determine the average time taken for Ultrasound scan at the Radiology unit
- 1.8.3 To determine the average time taken for generation of US reports in the radiology unit and delivery of reports to clinicians
- 1.8.4 To determine factors influencing ultrasound turnaround time at the Kenyatta National Hospital Labour Ward

CHAPTER TWO: METHODOLOGY

3.1 Study Design

The study adopted a cross sectional study design with documentation and analysis of Time Motion Series for Obstetric Ultrasound TAT and associated factors.

3.2: Study Site

This study was conducted in the Labour Ward and Radiology Units of the Kenyatta National Hospital (KNH). The KNH has been the main public and referral hospital in Kenya since 1901. It is also the training hospital for the College of Health Sciences of the University of Nairobi and offers comprehensive care to patients from Nairobi and its environs.

The radiology department has a 16-slice CT scanner, 1.5 Tesla MRI Machine, a 128-slice Somatom definition scanner, and a new reporting room with workstations for six staff. There are 5 ultrasound machines allocated to the obstetric unit: One at the labor ward (though not functional), two at the KNH radiology department and the last two at the UON radiology department. These are operated by qualified sonographers, senior radiology residents and radiologists. The KNH radiology department performs an estimated 2000 ultrasound scans per month. Slightly more than a quarter of these (500-600) are from the reproductive department with about three quarters (375) being obstetrics scans.

Decisions to perform an US are routinely made by the senior house officers or the consultants in the department. This is followed by the filling of the imaging form, clearly indicating the type of imaging modality and the indication. The filled form is placed at a designated area within the ward for picking by the porter who escorts the patient to the radiology department for the US to be performed. Upon completion of the US procedure, the patient is wheeled back to the ward, the results placed in the patient's file for review by the clinical team.

3.3 Study Population

Pregnant women who were managed at the KNH Labour Ward and met the inclusion criteria were recruited into the study. On average, 1500 women delivered at the KNH during the study period.

3.4 Sample Size Determination

The sample was calculated using Fishers Formula, taking assumptions from a similar study conducted by Vinayak et al, 2017 (0.4) where:

$$\frac{Z_{1-\alpha} - \alpha^2 (SD)^2}{d^2}$$

Where:

$Z_{1-\alpha}$ = standard normal variate for alpha (**1.96**)

SD = Standard Deviation for mean obstetric ultrasound turnaround time adopted from

Vinayak *et al.*, 2017 (**0.4**)

d = absolute error (**5%**)

$$\frac{1.96^2 (0.4)^2}{0.05^2} = 245$$

Sample of **245** adjusted by **10%** = **270** participants

Assumptions

1. Time series calculated from the point of initiation of one event to the end of the event
2. Observations made by one person across the process of performing the ultrasound from one point to the next

3.5 Sampling Procedure

Women who were scheduled for an obstetric ultrasound were approached at the labour ward and the study's objectives of the study explained. Consent was administered to all willing participants and a systematic sampling procedure used to recruit 270 participants randomly. An interviewer guided questionnaire was then administered and real time TAT for ultrasound monitored from the time of request to the time of receipt of ultrasound reports.

3.4 : Inclusion criteria

- i. Pregnant women for whom ultrasound intervention is required
- ii. Pregnant women with gestational age more than 24wks
- iii. Pregnant women who consent to the study

3.5 : Exclusion criteria

- i. Very sick Antenatal Mothers requiring ICU care

3.6 : Data Variables

3.6.1 Dependent Variables

Table 3: Dependent Variables

Outcome Variables	Definition
Ultrasound TAT	Time from booking to receipt at the radiology unit Wait time for scan at the radiology unit Duration for conducting ultrasound scans Time taken for generation of ultrasound reports Wait time for delivery of reports to clinicians

Table 4: Independent variables

Variables	Definition
Type of scan	Transvaginal Transabdominal
Priority of scan	Emergent Urgent

3.7 Study Procedure

This was a Time and Motion study which used a modified version of Cone C.D, Davidson S.J and Nguyen Q 1998 time-motion study of the emergency medical services turnaround interval. The fixed and events variables were prospectively defined (**Figure 1 above**). Following the terminology of the Utstein template³ and Spaite's model,² an "event" refers to a specific moment at which a given event occurs, and "interval" refers to the period which elapses between two events.

The six fixed events were used to track the physical movements of the patient and US diagnostic reports. The variable events (Table 1) were used to describe several of the delivery and recovery activities which did not necessarily occur in the same sequence on every run. The “true” turnaround interval shown in Figure 1 were prospectively defined as the time between actual advice and when the request for the US was made at the hospital and when the report was delivered back to the Obstetric Clinician from the radiology department.

The requisition generation time at the radiology department and patient preparation for the US procedure were defined as the time between the two corresponding clinician radiologist notifications. Spalte’s model uses “care transferred” as the event defining the boundary between these two intervals, but as a practical matter, transfer of care involves several events that can occur in varying order. The recovery interval begins with whichever event ends the delivery interval and ends the clinician notes the report in the patient file in the hospital.

3.8 : Ethical Considerations

The approval to conduct this study was obtained from the KNH-UON ERC board. Furthermore, permission was sought from the KNH administration to carry out the study in the labor ward and the antenatal wards. Before inclusion into the study, a written informed consent was sought from all the study participants; participants were free to pull out of the study at any time in the process, without coercion.

Confidentiality of the patients was upheld during data collection and analysis. Personal identifiers such as the names, file numbers, and identification number of subjects were recorded or shared. Filled questionnaires were kept under lock and key by the data manager and the collected data uploaded to a password protected excel sheet for cleaning and analysis.

3.9 : Data Collection Procedures

After ERC approval, patients scheduled for obstetric ultrasound at KNH were approached, the objectives of the study explained, and informed consent administered to those who were eligible to participate in the study. The sociodemographic characteristics of all participants (day, reporting time, age, and type of scan) were recorded on a study specific data collection tool and real time patient flow data on the duration of order of scan to receipt in radiology unit and generation time for reports of ultrasounds in radiology unit captured. A trained research assistant was engaged to follow patients from the time of admission at the KNH to the time of receipt of the US report.

3.10 : Data Quality Assurance

To collect accurate data, the following checks were implemented:

- a) The questionnaire was pretested and validated before use in the definitive study. This was study specific and organized into sections that captured unique sets of data.
- b) Two qualified nurses and a 6th year Medical Student, conversant with the KNH labor ward operations and patient flow were engaged for data collection. The team was trained on the study objectives and how to conduct a time-motion study before the data collection process.
- c) Errors during data collection were reported to the Principal Investigator as and when they occurred. In addition, all changes to the questionnaires will be dated and then signed by the research assistants in consultation with the principal investigator.
- d) The collected data was reviewed on a daily basis by the data manager, cleaned and uploaded on to a password protected excel software for analysis

3.12: Data Analysis

Data was entered in an SPSS version 23 worksheet for cleaning. The demographic characteristics of patients were computed and visualized as proportions on charts and tables. The ultrasound TAT was interpreted as the mean or median duration from request of scan to delivery of report. The waiting time at the radiology unit and TAT or delivery of reports were also computed and interpreted as means or median. Finally, ANOVA (with Bonferroni Post Hoc tests) was used to determine the patient and hospital-based factors that influenced the TAT of performing ultrasounds in the maternity unit. Statistical significance was taken at 95% CI level and a p value of 0.05 taken to be significant statistically.

CHAPTER THREE: RESULTS

In this chapter, we present the results of the study where a total of 270 participants were included in the analysis. Data was entered in an SPSS version 23 worksheet for data cleaning and analysis as shown in the study flow diagram.

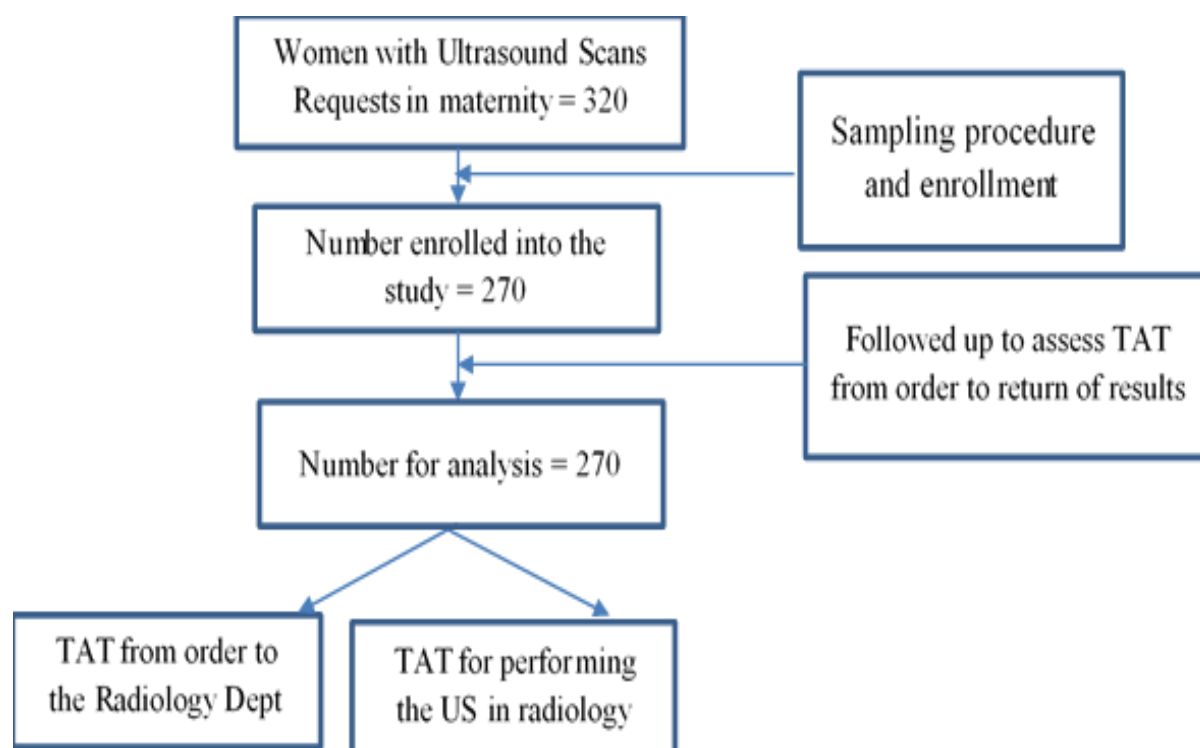


Figure 2: Study Flow Diagram

All the ultrasound scans done (270, 100%) were transabdominal and were done in the third trimester of pregnancy. Additionally, all the ultrasound scans (270, 100%) were considered critical and necessary for decision making. Porters were involved in the process of collecting the requests, taking the patients to the radiology department and delivery of the printed results.

The sociodemographic characteristics and the clinical characteristics of the study participants were documented as shown in table 3. The gestation age was computed and presented as median and mode; the median gestation age was 34 weeks (range, 31 to 38 weeks) while the most common gestation (mode) was 38 weeks. Table 3 shows the distribution of the study

participants by parity. A majority of the women in the study, 90 (33.3%) had three children while only 9 (3.3) had 6 or more children. Those who had 1, 2, 4 and 5 children were 58 (21.5%), 48 (17.8%), 54 (20.0%) and 11 (4.1%) respectively.

Table 3: Frequency Distribution for the Parities for the Study Participants

	Frequency	Percent (%)
Primiparous	58	21.5
Multiparous	212	78.5
Total	270	100.0

The indications for performing the ultrasounds were as documented in table 4. Out of the 270 participants, a majority, 100 (37.1%) had the ultrasound done due to reduced fetal movements. This was followed by the need to confirm the presentation, 66 (24.7%). The least documented indication for ultrasonography was to assess the biophysical profile (2, 0.6%) and for women with eclampsia (2, 0.6%).

Table 4: Indications for performing obstetric ultrasounds at the Kenyatta National Hospital, n = 178

Variable	Frequency	Valid Percent (%)
Antepartum Hemorrhage	16	5.6
BPP	03	0.6
Confirm presentation	66	24.7
Multiple Gestation	34	12.9
Post Term	10	3.9
Pre Labour-Rupture of Membranes	38	14.0
Pre-eclampsia	03	0.6
Reduced Fetal Movements	100	37.1
Total	270	100.0

As shown in table 5, out of the 270 ultrasound scan requests with documentation about when the scan was done, 231 (86%) had the scans done during the week while the rest (39, 14%)

had the scans done during weekends. Most of the scans were done during the day, 144 (53.3%).

Table 5: Time of the Day when the Ultra Sound Scans were Performed in the Radiology Department

Variable 4		N	Percentage (%)
Day of Scan (n=270)	Weekday	231	86
	Weekend	39	14
Time of Scan (n=270)	Day	144	53.3
	Night	126	46.7

Table 6 shows the median turnaround times for the various steps in performing ultrasonography in the maternity unit. The median duration between making the request and receipt at the radiology unit was 3.5hrs (5 hr, 30min), IQR 0.83-5.0); the median duration for performing the ultrasounds was 0.42hrs (25 mins), IQR 0.33-0.50); the median duration for generation and printing of reports was 1.05hours (1 hr 10min), (IQR 0.5-1.9) while the median duration for the delivery of the printed reports to the department was 0.5hrs (30mins) (IQR 0.33-1.0). The overall median period of time taken between making the request to the presentation of results to the clinician was 10hrs (IQR 5.6-13.0).

Table 6: Ultrasound Turn Around Time among Patients in the Maternity Unit at the Kenyatta National Hospital

	Median (hours)	IQR (hours)
Booking to receipt in the radiology unit	2.70	0.83-5.00
Duration of ultrasound scans	0.42	0.33-0.50
Time taken for generation of reports	1.05	0.50-1.90
Time taken for delivery of reports to the maternity	0.50	0.33-1.00
Overall time from request to results	10.0	5.60-13.0

Table 7 shows the clinical and health facility factors that influence the overall turnaround time for performance of ultrasounds at the KNH. A one-way ANOVA test was performed for factors such as the indication for the ultrasound (classified as either emergent - antepartum

hemorrhage, reduced fetal movements and preeclampsia or urgent - confirmation of presentation, post term, multiple gestation, biophysical profile and pre labour premature rapture of membranes); the day of the week when the ultrasound was performed (week day or weekend); and the time of the day when the ultrasound was performed (day or night).

Table 7: Clinical and Health Facility Factors that Influence the Overall Turnaround Time for Performance of Ultrasounds at the Kenyatta National Hospital

		Ultrasound TAT			
		Mean	SD	Mean diff.	P
Indication for Scan (n=270)	Emergent (77)	8.9	5.7	3.2	0.001
	Urgent (101)	12.1	6.5		
Day of Scan (n=270)	Day time (144)	9.8	5.4	2.6	<0.001
	Night time (126)	12.4	6.2		
Time of Scan (n=270)	Weekday (231)	10.6	5.8	0.6	0.801
	Weekend (03)	9.8	1.5		

All the 270 ultrasound studies that had the indication for performing the ultrasound documented, 116 (43%) were classified as emergent (mean TAT of 7.6hr, sd 4.6) while 154 (57%) were classified as urgent (mean TAT of 9.3hr, sd 5.3). The mean TAT for conducting the ultrasounds for cases considered emergent was significantly lower than the TAT for the cases that were classified as urgent as determined by one-way ANOVA ($F=5.2$ $p=0.024$).

Further classification of the ultrasound scans was done to assess whether there was a difference in TAT during the day and at night; 231 (85%) of the scans were performed during the day, while 39 (15%) during the night. The mean TAT for performing the ultrasounds during the week day (8.9hours, sd 4.8) was lower than the mean TAT when the ultrasound was performed during the weekend (9.6hours, s.d 6.1); this was not however significant statistically ($F=0.54$, $p=<0.46$).

A total of 144 (53%) ultrasounds were performed during the day while 126 (47%) during the night. The mean TAT for the ultrasounds that were performed during the day (8.7hours, s.d 4.3) was lower than the TAT for the ultrasounds performed at night (9.5hours, s.d 5.6); this mean difference was not significant statistically (F=1.9, p=0.16).

Table 8: Turnaround time for Specific Ultrasound Indications

Variable	Frequency	Mean (Hr) (SD)
Antepartum Hemorrhage	16	8.92 (5.231)
Confirm presentation	66	11.39 (6.029)
Multiple Gestation	34	12.19 (3.376)
Post Term	10	24.21 (0.146)
Pre Labour-Rupture of Membranes	38	9.81 (6.951)
Reduced Fetal Movements	100	8.71 (5.670)

Reduced fetal movements had the lowest TAT (8.71 hours) while post term had the highest at 24.21 hours.

CHAPTER FOUR: DISCUSSION

Time motion studies have, since the 20th century, received special interest aimed at studying the processes and factors that influence inefficiencies and waste on material resources and waste of human effort in the production and service delivery industry. Few studies have been done to understand the factors associated with long turnaround times for obstetric ultrasonography in the prompt assessment of the pregnancy has on the mother and the fetus/neonate.

This study, conducted at the KNH maternity unit among 270 pregnant women attending delivery services between January to March 2020 aimed at establishing the clinical, sociodemographic and health system factors that contributed to the long turnaround time of ultrasound requests. Ultrasound TAT was described as the precise time between ordering a test to the time of submission of the report.

We recruited women in the maternity department, with a median gestation age of 34 weeks (range, 31 to 38 weeks). A majority of the women in the study, 90 (33.3%) had three children while only 9 (3.3) had 6 or more children. A similar study performed at the KNH in 2015 by Agolah D et al, where the TAT for all patients undergoing ultrasound studies at the radiology department was assessed had 23 (24%) of the participants enrolled for obstetric ultrasound. The age and parity for the study participants was not however indicated.

The use of ultrasound in emergencies in maternity unit at the KNH is a common practice and plays a critical role in identification of correct etiology and diagnosis as well as limiting differentials (5). Unless otherwise specified, all ultrasound images in the 3rd trimester were performed using the transabdominal route, and required patient preparation, including

ensuring a full bladder. At all times, porters were involved in the process of collecting the requests from the maternity, escorting the patients to the radiology department and delivery of the printed results to back to the maternity. The standardization of these procedures was critical in reducing errors and inconvenience as emphasized by Frances et al, in the book on the manual of Laboratory and Diagnostic test¹⁹.

The overall time taken from placing a request for the ultrasound scan to return of the results to the clinician in the maternity unit is critical in assessing the impact of delays on maternal and perinatal outcomes. In scenarios where turnaround times are shorter, the guidelines by the Organization for Economic Cooperation and Development (OECD) in 2010, argues that consumer satisfaction is better with less delays before instituting treatment²⁰ hence better perinatal outcomes.

In our study, the overall median duration between requesting for the ultrasound scan and return of the results to for the clinician to use was 10 hours (IQR 5.6 to 13.0hours). Our findings showed a very long TAT for performing ultrasound studies at the KNH maternity, much longer than the recommended period of 45 minutes. The findings are similar to a study by John et al (blackwell 2008), whose findings indicated that advanced obstetric ultrasounds could take more than 45 minutes without notice²¹. Several observable factors attributed to this include failure for adequate patient preparation, failure for follow up of the requests by the clinician and midwives, lack of a central place to place the requests (at the KNH maternity unit, some are placed in the patients' files while others are placed at the nursing station, hence making it difficult for the porters to easily identify them), high patient numbers with few ultrasonography points, few porters to promptly take escort the patients to the radiology unit and lack of „real time“ ultrasonography machine at the maternity unit.

Further analysis was done to further assess the individual contribution by the different service delivery points towards the long TAT for the ultrasound results at the KNH. The steps were categorized as time from placing a request to the time when the patient arrives at the radiology unit; time at the radiology unit when the ultrasound is performed; time for writing the reports in the radiology unit and time taken between generation of the reports and delivery of the reports to the maternity unit for decision making. On average, it took 2.7 hours (IQR 0.83 to 5.0 hours) for the request to be taken from the maternity unit to the radiology unit, largely as a result of the systemic issues of lack of follow up for the requests done and the lack of consistency in the availability of the porters. More often than not, due to these delays, decisions are made based on the clinical assessment of the patients.

According to Zilligae et al (2010), the most frequent complaint in the radiology department included delay in attending to patients (47.1%), and long appointment periods (26.9%)²². In our study, the mean duration for this time for performing the ultrasound studies was 0.41 hours (24 minutes). This time was found to be similar to the findings by John et al, 2008, where the actual ultrasound examinations for a third trimester pregnancy scan was completed within 30 minutes (10). Similarly, the Society of Radiographers (ScoR) guidelines on turnaround times for ultrasound examinations, recommends 20 minutes for 3rd trimester review as sufficient allocated time (10). These findings could be due to the fact that for those patients who arrive at the radiology department, an attempt at prioritization of the ultrasound studies is done.

In order to assess the factors influencing the long TAT for ultrasound studies, at the KNH, the indication for the scan, time and day when the ultrasound was performed were assessed.

Ultrasound scans that were indicated as emergent had a significantly lower TAT compared to those that had been indicated as urgent or had no indication made (8.9 hrs vs 12.13, $p=0.001$). This delay is attributed to the system delays at the maternity unit.

The mean TAT for performing the ultrasounds during the week day (10.6hours, sd 5.8) was found to be higher than the mean TAT when the ultrasound was performed during the weekend (9.8hours, s.d 1.5), $p=0.801$. this was however not significant statistically and could be attributed to the high patient load at the maternity and radiology unit and low numbers of health care workers; midwives, porters and radiology staff members in the respective departments. Additionally, the mean TAT for the ultrasounds that were performed during the day (9.8hours, s.d 5.4) was lower than the TAT for the ultrasounds performed at night (12.4hours, s.d 1.5); this mean difference was significant statistically ($p=0.<0.001$). These findings could be attributed to the relatively higher number of health care workers (porters, midwives) patient load during the day with less stringent follow up at night.

Our findings are similar to the findings in the study by Betsy et al, who noted that patients presenting in the radiology department with an indication for emergent ultrasound scans such as per-vaginal bleeding requiring pelvic examinations in their late pregnancy states, needed utmost urgency (18), but experienced delays. In this study, the major causes for waiting before the ultrasound scan procedures included long queues (at 37.5%), jumping of queues by other emergency cases, lack of personnel to attend to the patients (18.75%) and power blackouts (at 13.54%). Our findings are also similar to a study by McGraw, who stated that power outages could contribute to patient waiting time increases in the hospital and Randolph (2006) who also noted that doctors on call also contributed to patient waiting time. These may include; the total volume of work, staff capacity, case complexity, radiologist speed and

diagnostic reporting time, time spent teaching trainees in an academic institution, and academic and nonacademic interruptions¹⁸.

In emergency situations, the TAT should be as short as possible, often under 30 minutes¹⁷. In a study by French *et al.* (2014), the average waiting time for ultrasound scans was around 3.8 hours, which was significantly higher than the ideal TAT of 30 minutes. Albrecht *et al.* (2013) reported a TAT of 56 minutes, which was lower than French's, but still high. It is therefore, deemed that many factors might play a role in affecting optimal turnaround time.

Study Limitations

Other factors may have influenced TAT and therefore potentially confound the findings; the study was not powered enough to assess potential confounding by the health system factors, including the seasonal variations brought about by machine repairs, fluctuating staffing levels and patient work load. Neither was it powered enough to assess the relative risk that long TAT has on obstetric outcomes.

Conclusion

The turnaround time at the KNH maternity is comparatively longer than the recommended times, with the turnaround being shorter when the ultrasounds are done during the day and over the weekend.

Recommendations

We recommend specific measures such as placement of a point of care ultrasound machine in the maternity unit and development to SOPs to guide on the patient flow, triaging of the ultrasound requests and adequate staffing to be instituted in the department aimed at reducing the TAT for the ultrasound requests in the maternity unit at the KNH. Further studies with a

larger sample size to assess more patient level and health system factors and the effect of the long TAT on the perinatal outcomes to be considered.

Study Results Dissemination Plan

The findings of this study will be presented to the department of obstetrics and gynecology as part of the fulfilment of the master in obstetrics and gynecology. Additionally, a report will be written and submitted to the KNH ERC and the KNH research Committee. A manuscript will also be developed for publication in peer reviewed journals and presentation in conferences.

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APPENDICES

Appendix I: Budget and Justification

Budget	Item	Amount (Ksh)
Proposal development	Printing questionnaires	10000
	Proposal copies	6000
	KNH	2000
	3 Research Assistant 3 @ 1000 per day	270000
	Stationary	3000
	Transport and meetings	10000
	Data analysis	Statistician
Thesis write up	Printing draft thesis	7500
	Printing main thesis	7500
	Contingency	30000
	Total	376,000

Appendix II: Questionnaire

FACTORS THAT INFLUENCE OBSTETRIC ULTRASOUND SCAN TURNAROUND
TIME AMONG PREGNANT WOMEN AT THE KENYATTA NATIONAL HOSPITAL IN
KENYA: A CROSS SECTIONAL STUDY

Questionnaire

Study number:.....

Day of Week:

Time of day of scan: Day Night

SOCIODEMORAPHC CHARACTERISTICS

- 1. Age in years:.....
- 2. Gestational Age in Weeks.....
- 3. Indication for Ultrasound
 - Antepartum Hemorrhage
 - Reduced fetal movements
 - Intrauterine fetal demise
 - PreTerm Premature Rupture Of Membranes
 - PostTerm
 - Multiple Gestation
 - Confirm Presentation
 - Any Other Indication.....

TIME MOTION ANALYSIS

- 3. Time of request of US scan from labour ward:
- a) Porter: Available
 Not Available
- b) Type Of Scan Requested:
 - Transvaginal
 - TransAbdominal

c) Priority of scan:

Critical

Normal

4. Time for booking US scan in radiology department:

Status Accepted Rejected

5. Time for start of US scan at the radiology department:.....

6. Time for completion of scan in radiology department:.....

7. Time US report was generated:

8. Delivery of ultrasound report to the clinician:

9. Any other comment

.....
.....

Appendix II: English Consent Form

Consent Form: Addressing Challenges Obstetric Ultra-Sound Examinations Utility Amongst High Risk Mothers in Kenyatta National Hospital

Consent Form

Investigators, contacts, and roles:

Name	Role	Contact
Dr. Peter Kioni	Principle investigator	0724125646
Dr. Anne Pulei	Supervisor	0722465924
Dr. Harrison Tamoooh	Supervisor	0722752143

Background

Obstetric ultrasound plays a significant role in obstetrics since its inception in the medical and clinic in prenatal care. The norm in the in the developed world see most pregnant women as exposed to obstetric ultrasound examinations. This has led to major improvements in pregnancy outcomes. However, for some reasons there seems to be reduction to the utility of ultrasound examinations even after it's succesful implimentation of the device in the Subsaharan Africa. This study will explore challanges affecting the utilization of ultrasound examinations for both normal and high-risk pregnant women at Kenyatta National Hospital.

Purpose of the study

You are invited to participate in this study to assist us formulate guidelines in appropriate management of labor. We think you could be a valuable source to help us finding relevant information on the delivery of health services to mothers.

Methods and procedures

If you agree to be a participant in our study, we shall follow your process of ultrasound from when you receive a request to when the process is complete and you have a report. You will not be required to answer questions during the process or record time. A nurses will do this.

Risk

There are no risks or benefits in this study.

Benefits

This study will help use to formulate hospital policy that will result in better service delivery at Kenyatta National Hospital

Compensation

You will not be paid for agreeing to be in this study.

Confidentiality

Information obtained from you the participant will not be shared outside this study. We will not write down your personal information (e.g., name, address) on the questionnaire thus there is no risk of personally identifying any respondent in our analyzed results.

Right not to participate and withdraw

Your participation in this study is completely voluntary, and you have the sole authority to withdraw at any point.

Contact persons

You may contact Dr. Peter Kioni at 0724125646 if any questions or concerns on this study may arise. If you agree to our proposal of enrolling you in our study, please indicate that by putting your signature or your left thumb print at the specified space below

Name of the Interviewer	Signature of the Interviewer	Date
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	If the participant is illiterate/unable to write in that case please take her/his left thumb impression
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Name of the Interviewer	Signature of the Interviewer	Date
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Please feel free to contact these persons if you have questions or concerns about the study:

Appendix III: Kiswahili Consent Form

Formu ya Idhini: Kichwa:

Jina	Jukumu	Nambari ya simu
Dr. Peter Kioni	Principle investigator	0724125646
Dr. Anne Pulei	Supervisor	0722465924
Dr. Harrison Tamoooh	Supervisor	0722752143

Historia

Ultrasound ya shida ina jukumu kubwa katika vikwazo tangu kuanzishwa kwake katika matibabu na kliniki katika huduma ya ujauzito. Kawaida katika ulimwengu ulioendelea kuona wanawake wengi wajawazito kama wanavyojitokeza kwenye mitihani ya ultrasound ya obstetric. Hii imesababisha maboresho makubwa katika matokeo ya ujauzito. Hata hivyo, kwa sababu fulani kunaonekana kupungua kwa matumizi ya uchunguzi wa ultrasound hata baada ya kufungwa kwa ufanisi wa kifaa katika Afrika ya Subsaharan. Kwa hiyo, utafiti huu utafuatilia changamoto zinazoathiri matumizi ya mitihani ya ultrasound kwa wanawake wajawazito wa kawaida na wa hatari katika Hospitali ya Taifa ya Kenyatta.

Kwa nini umealikwa kushiriki katika utafiti?

Unaalikwa kushiriki katika utafiti huu ili kutusaidia kuunda miongozo katika usimamizi sahihi wa kazi. Tunadhani unaweza kuwa chanzo muhimu kutusaidia kupata habari muhimu juu ya utoaji wa huduma za afya kwa mama.

Njia na taratibu

Tutaendesha utaratibu huo uliofanywa kwa mama wote wajawazito wa hatari katika KNH

Matatizo na Manufaa

Hakuna hatari au faida katika utafiti huu. Taarifa iliyopatikana kutoka kwako mshiriki hayatashirikiwa nje ya utafiti huu. Hatuwezi kuandika maelezo yako ya kibinafsi (k.m., jina, anwani) kwenye swali la maswali na hakuna hatari ya kutambua binafsi mtu yeyote anayejibiwa katika matokeo yetu.

Haki ya kushiriki na kujiondoa

Ushiriki wako katika masomo haya ni kwa hiari, na una mamlaka pekee ya kuondoka wakati wowote.

Kanuni ya fidia

Huwezi kulipwa kwa kukubali kuwa katika utafiti huu.

Kujibu maswali yako / watu wasiliana

Unaweza kuwasiliana na Dk Peter Kioni saa 0724125646 ikiwa maswali yoyote au wasiwasi juu ya utafiti huu yanaweza kutokea. Ikiwa unakubaliana na pendekezo lako la kukujiandikisha katika utafiti wetu, tafadhali onyesha kwamba kwa kuweka saini yako au kushoto kwa kidole chako cha kushoto kwenye nafasi iliyochapishwa hapo chini

Jina la Mhojiwaji

Sahihi ya Msaidizi

Tarehe



ikiwa mshiriki hayujui kusoma / hawezi kuandika katika kesi hiyo tafadhali piga picha kidole ya kushoto

Tafadhali jisikie huru kuwasiliana na watu wafuatayo ikiwa una maswali au wasiwasi juu ya utafiti:

Appendix IV: Dummy Tables

Table 1. Hospital factors

	N	%
Type of scan	Transvaginal	
	Transabdominal	
Priority of scan	Critical	
	Normal	
Day of scan	Weekday	
	Weekend	
Machine breakdown	Yes	
	No	

Table 2. Ultrasound TAT

	Ultrasound TAT	
	Mean (minutes)	SD
Booking to receipt and radiology unit		
Wait time in radiology unit		
Duration of ultrasound scans		
Time taken for generation of reports		
Wait time for delivery of reports		

Table 3. Factors influencing ultrasound TAT

		Ultrasound TAT			
		Mean	SD	Mean diff.	P
Type of scan	Transvaginal				
	Transabdominal				
Priority of scan	Critical				
	Normal				
Day of scan	Weekday				
	Weekend				
Machine breakdown	Yes				
	No				