Involving Private Healthcare Providers to Reduce Maternal Mortality in India: A Simulation Study to Understand Implications on Provider Incentives

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Abstract

Gujarat State has implemented the "Chiranjeevi Yojana" to improve access to institutional delivery with an objective to reduce maternal mortality and at the same time providing financial protection to poor families. The scheme involves private providers in provision of maternity services through contracting-out and use of voucher type of mechanism. Five districts covered by this scheme have population of about 10.5 million of which 43 per cent are below poverty line having about 110,000 deliveries per annum. The scheme during first year of its implementation has covered 31,641 deliveries. Of the total 217 providers in these districts 133 (61 per cent) have been empanelled in this scheme.

This paper mainly examines two things, one, the revenue distribution a private provider would have experienced if the provider was not part of the Chiranjeevi Scheme and second, does the financial package provided in the scheme provides adequate incentives to the private provider to join the scheme. Further, given the number of providers empanelled in each district, does number of providers contracted-out in the scheme make any difference in revenue distribution of private provider? We use *Monte Carlo* simulation method to examine these issues.

The simulation results suggest that the average revenue is Rs. 1416 per delivery. This is less than what the provider is being reimbursed by the government on capitation fee basis, which is Rs. 1445 (Rs. 1795 less Rs. 350 towards reimbursement for food, transport and Dai). By joining this scheme, the provider's additional margin on an average is 2 per cent. This is over and above the profits included in the average revenue earned if the provider was not part of the scheme. The results further suggest that revenue distribution is scattered asymmetrically indicating significant risk in revenues to the provider. By joining in the Chiranjeevi Scheme, the provider is able to reduce the overall risk in revenue. In addition to this, the increased volume of services will spread the fixed cost of the provider and increase overall profitability further. Since the provider is paid up-front advance for delivering services under the scheme, there is no transaction cost of bureaucratic delays in payments. The provider in the absence of this scheme can maximise the revenue by doing more cesarean cases. The scheme has embedded incentive to minimise the cesarian cases to maximise the revenue and this produces larger indirect benefits from health systems point of view. The study identifies other issues that need further investigation.

Key words: Contracting out, Provider Incentive, Chiranjeevi Scheme, *Monte Carlo* Simulation, Capitation Fee

I. Introduction

The Gujarat State has implemented a health care scheme called the "Chiranjeevi Yojana" to improve access to institutional delivery with an objective to reduce maternal mortality and at the same time provide financial protection to poor families in Gujarat. The scheme covers 'below poverty line' (BPL) families who are generally under-represented, have limited access to institutional facilities and may experience economic and social hardships due to complications during delivery. The scheme aims at involving private providers in the provision of maternity services through contracting-out and use of voucher type of mechanism.

The success of such public-private partnerships critically hinge on financial and other incentives embedded in the scheme. The financial package of this scheme is pre-determined and is based on several assumptions made at the time of designing its financial package. The two key assumptions in this scheme relate to the probability of delivery status (i.e., the probability of occurrence of normal, cesarean and complicated cases) and the charges reimbursed for providing services. These assumptions are expected to have significant implications for the long-term continuity and sustainability of the scheme. The departure from assumed probabilities about delivery status, the distribution of cases among providers and the actual cost experience would affect the private provider incentives. The objective of this paper is to evaluate these assumptions using simulation and understand the implications of these assumptions from an implementation and a policy point of view.

The paper examines the following issues. The scheme contracts out each private provider for 100 deliveries. Given the utilisation of institutional facilities for deliveries and probability of delivery status (normal, cesarean and other complications), what are the characteristics of revenue distribution that a private provider would have experienced if the provider had not joined the Chiranjeevi Scheme and how does it compare with the financial package provided in the scheme?

Further, the number of providers contracted out may have implications for the distribution of cases across providers. Given the population of the district and number of deliveries that are likely to occur, does the number of providers in the scheme make any difference in revenue distribution of private providers? We use a Monte Carlo Simulation methodology to examine these questions.

The paper is divided into nine sections. The second section discusses the context of the scheme. Section three discusses the Chiranjeevi Yojana. Subsequent sections discuss the financial package of contracted services, implementation of the scheme and key challenges. Based on key policy challenges, we report the simulation results. Finally, we discuss the implications of the results.

II. Context

High maternal mortality continues to be one of the major health challenges in emerging economies like India. Nearly 65 per cent of the estimated 30 million deliveries in India occur at home. The access to appropriately equipped health care facilities is a major issue. As a result, maternal mortality ratio (MMR) in India remains high at an average of 389 deaths per

100,000 live births. Infant Mortality Rate (IMR) is 63 per 1000 live births. Further, 73.3 per cent of the infant deaths occur in their neo-natal period (within 28 days of birth). Haemorrhage, sepsis, obstructed labour, toxaemia, anemia and unsafe abortions are the major causes of maternal deaths. For this and other reasons, India adds a whopping 25.7 per cent to the burden of maternal deaths in the world. Most of these maternal deaths in India could be prevented by timely availability of healthcare facilities to women.

India is committed to the Millennium Development Goals (MDG) and the vision set for 2010 is to:

- reduce MMR from 389 (in 1998) to 100 per 100,000 live births by 2010,
- reduce IMR from 60 to 30 by 2010, and
- stabilise population by reducing total fertility rate (TFR) from 3.0 to 2.1 by 2010.

Addressing the maternal health and reduction in child mortality has a direct bearing on various other MDGs. The overall population health and life expectancy are directly affected by the maternal and child health. Non-availability of health services and lack of access to private providers may force the women in need to opt for home delivery, thereby increasing the chances of mortality. In cases of emergency and complicated deliveries, for the families opting for private services, costs incurred in the utilization of these services may push the families into abject poverty and bring them below BPL status. Krishna (2005) finds that ill health and high healthcare expenses are among the most important reasons for falling into poverty. For example, in Gujarat, 88 per cent of **the** responses indicated health related costs as the main reasons for falling into poverty. This happens despite Gujarat state being a relatively richer and faster growing state in India. People in villages and remote areas in many parts of India face a significantly greater threat of falling into poverty because of health-related reasons. This has implications for first MDG goal that is to eradicate extreme poverty and hunger.

Experiences elsewhere such as, in Sri Lanka and Tamil Nadu suggest that an increase in skilled birth attendants during delivery resulted in concurrent reduction in MMR. Therefore, strategies to reduce maternal mortality in past have focused on increasing the availability of trained birth attendants. However, it has also been observed that simply improving access to trained health attendant during delivery cannot ensure reduction in maternal mortality[1]. This has to be backed up by the provision for emergency obstetric care (EmOC) facility to save the lives of women who develop complications during pregnancy and delivery.

Reducing maternal mortality and promoting institutional deliveries is a multi-faceted task that involves improving the health service delivery, demand generation in the community, promoting community awareness and sensitisation about preventive measures, timely identification of early symptoms and referral. From a systems perspective, there is a need to strengthen the primary health centre (PHC) and EmOC facilities. A primary health care centre needs to be supported by secondary and tertiary level health services providing EmOC. The public health delivery system, however, faces many challenges and experiences

1 Hay, M. Cameron. 1999. Dying Mothers: Maternal Mortality in Rural Indonesia. Medical Anthropology. Vol. 18, pp.243-279.

problems in addressing the needs of community in an effective manner. The public health also faces challenge of inadequate funding and lack of accountability and responsiveness and incongruence between available funding and commitment. These problems are manifested in non-availability of qualified staff in government health centre. Non-availability of well-equipped facilities becomes a critical constraint. For example, in community health centres (CHCs) in Gujarat about 65 per cent of MD (Gynaecologist) positions are vacant. This number is about 30 per cent for district hospitals. In addition, there is serious shortage of Paediatricians (67 per cent vacancy) in the district hospitals[2] in Gujarat. Similarly, unavailability of anaesthetist and restrictive practices about anaesthesia in the country limits access[3].

These and other factors pose problems of access to public health care facilities. Most of the facilities are not having adequate health infrastructure and women may have to travel long distances to reach the nearest health facility. The health-seeking behaviour also poses problems of acceptability of various components of reproductive and child health (RCH) intervention. Attempts to address many of these issues have not produced satisfactory results.

It has been observed that a large number of people utilise private sector services. Given the presence of private sector, it is imperative to include the private providers in the delivery of services to improve the access and thereby improve the institutional delivery rate. Exploring public-private partnerships is one of the ways to address this problem. Several options have evolved over time for fostering effective public-private partnerships. These relate to contracting-out health services to private partners, contracting-in services from private parties, joint venture, involvement of professional association, involvement of corporate sector, involvement of NGOs, social marketing, social franchising, voucher system, promoting grant-in-aid institutions etc. To reduce maternal mortality, Gujarat has implemented a public-private partnership scheme in which private providers are involved through a financing mechanism to provide maternity health services. This scheme covers the BPL families by making their utilisation of private facility a cash-less event and covers direct and indirect out-of-pocket costs such as travel and cost of accompanying person.

III. The Chiranjeevi Yojana

The government of Gujarat has developed a pilot intervention to explore the option of involving private providers in provision of maternity services. The presence of private sector providers is quite significant in Gujarat. The state has an estimated 17738 registered doctors of which 3/4th are working in private health facilities[4]. However, the cost for accessing care in private facilities deters the poor from seeking care during delivery. One way of addressing financial barrier to care is through some effective health financing mechanism.

2 http://www.gujhealth.gov.in/job/rural_hlth.htm as accessed on 12 May 2006
3 Mavalankar DV (2001). Policy Barriers Preventing Access to Emergency Obstetric Care in Rural India. W.P. No. 2001-11-02. November 2001. IIM Ahmedabad.
4 Bhat Ramesh, Verma BB and Reuban E. (2001). An Empirical Analysis of District Hospitals and Grant-in-aid Hospitals in Gujarat State of India.

The Government of Gujarat has initiated a scheme on pilot basis to increase the proportion of institutional delivery in five of the most vulnerable districts[5]. The districts covered in pilot study, record the highest infant and maternal mortality rates in Gujarat. The scheme is known as the *Chiranjeevi Yojana* (meaning *"eternal life scheme")*. This initiative involves the private practitioners in service delivery in remote areas of Gujarat. The district health officials assume greater responsibility in implementing this scheme and facilitate the involvement of private providers. By increasing the institutional delivery, the scheme aims to achieve safe delivery and lower infant mortality rates. The Chiranjeevi Yojana intends to cover the BPL families in these districts. The beneficiary has an advantage of referring to any empanelled private nursing home or private hospital; get the delivery done (normal, caesarean, or having other complications) without paying the charges. The scheme is based on the concept of a voucher system and families having BPL card or having certificate by designated village leader can avail this facility. The benefits package also includes free medicines after delivery and transport reimbursement to the family. The scheme also provides a monetary incentive to the attendant to compensate loss of days' wages. The enrolled private doctors are given a fixed sum as a deposit in advance to conduct the deliveries and meet the expenses that covered by the scheme.

IV. Financial package for contracted-out services

Under the Chiranjeevi Yojana, BPL mothers receive cash-less maternity services. The government has contracted out services to private gynaecologists. The financial package of the scheme was prepared in consultation with SEWA rural Jhagadia and the Federation of Obstetric and Gynaecological Societies of India (FOGSI) members. This information was used to arrive at a uniform rate that could be paid to private provider conducting any type of delivery (normal as well as complicated cases). The financial package for the service providers was designed based on 100 deliveries of batch size. A sum of Rs. 800 was estimated for normal deliveries and Rs. 5000 for a cesarean. These charges were based on market prevailing rates and given the probability of risk and normal cases; a single rate per delivery was worked out.

The status of deliveries (probability of risk and normal cases) was arrived at keeping in mind the national average of complicated cases per 100 deliveries. For example, 15 per cent of the deliveries were considered **as** complicated cases. Out of this, 7 per cent includes cesarean cases and remaining 8 per cent includes blood transfusion, eclampsia and other complicated cases. Charges for pre-delivery consultation, sonography, transport and Dai were also included to arrive at the final sum of Rs. 179,500 per 100 deliveries irrespective of its nature. The details of these charges are provided in Table 1. The total charges include the profit of private providers. An advance of Rs. 20,000 is given to the Gynaecologists to commence treatment. Doctors are asked to maintain a separate file of the Chiranjeevi patients, reimburse Rs. 200 to the family to compensate for expenses incurred on transport and Rs. 50 as an honorarium to the attendant. The names and addresses of the private hospital are given to the PHC and the female health workers (FHWs) for referrals and a complete record of each doctor's performance is maintained at the district headquarters.

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[5] Bhat Ramesh, Amarjit Singh, Sunil Maheshwari and Somen Saha, "Maternal Health Financing – Issues and Options: A Study of the *Chiranjeevi Yojana* in Gujarat." WP No 2006-08-03, Indian Institute of Management, Ahmedabad

V. Implementation of the scheme

The scheme was implemented in November 2005 in five districts of Gujarat. These districts are Banaskantha, Dahod, Kutch, Panchmahal and Sabarkantha with a total population of about 10.5 million. The implementation of the scheme focused on targeting of beneficiaries, increasing awareness and community involvement, empanelling service providers and monitoring of the scheme. The Department of Health and Family Welfare (DoHFW) played key role in designing and developing this scheme. The district health officials hold the primary responsibility of managing the scheme.

Five districts covered by this scheme have a population of about 10.5 million of which 43 per cent are below poverty line having about 110,000 deliveries per annum. The scheme during the first year of its implementation has covered 31,641 deliveries covering 34 per cent of the BPL deliveries.

Of the total 217 providers in these districts 133 (61 per cent) have been empanelled in this scheme. The average number of deliveries carried out by these providers has been 238. Of the total deliveries, 4.7 per cent have been lower segment caesarean section (LSCS) deliveries and 87 per cent have been normal deliveries.

The scheme shows that by providing financial protection through 100% subsidy of the delivery cost to BPL families through private providers has the potential to increase the institutional delivery rate and reduce the MMR and IMR substantially amongst the most vulnerable groups of the population. This scheme has increased the access to institutional facilities for maternity care. The cost of seeking delivery in private facilities by BPL families is high. This scheme covers both direct and indirect cost (for example travel and cost of an accompanying person). The financial burden in case of complications can be catastrophic for BPL families.

The main objective of the scheme has been to reduce the maternal mortality by increasing the number of institutional deliveries and at the same time removing financial barriers of poor families in accessing these facilities. Data suggests a steady increase in the number of deliveries in this scheme. Institutional deliveries in a government setup have remained nearly static at a low level throughout the period with an average of 8 per cent of the total deliveries. Although it is too early to predict success or failure of any scheme, early trend in data suggested an increase in institutional delivery in private set up since the inception of the Chiranjeevi Yojana.

VI. Key challenges

The Chiranjeevi Yojana implemented by the Government of Gujarat has the potential to improve the access to maternity care by contracting out the maternity services to private providers. Responsibility for monitoring the scheme is also delegated to the district authority, with the block health officer directly responsible for scheme implementation and monitoring. There is an inbuilt mechanism to discourage unnecessary cesarean section deliveries and promote institutional deliveries. However, the experiences in implementing the scheme pose several challenges for policy makers and programme managers. Most of the observations presented here are based on a focus group discussion of providers and beneficiaries in these districts. Some of the key challenges emanate from assumptions made in developing the scheme. For example, while developing the financial package for the Chiranjeevi Yojana, the total financial charges were fixed keeping in mind the national average of complicated cases per 100 deliveries. The payment package of Rs. 179,500 for 100 deliveries was based on this assumption. The feedback from providers suggest that the concept of the '100 delivery' package is not quite clear to them. They still measure their earnings based on a per delivery basis. This is further complicated by the fact that there may be asymmetric distribution of risk cases across the districts and providers. For example, it was reported that Dahod pilot district experiences an exceptionally high rate of cesarean section of 18 per cent of the total number of deliveries conducted in the district (see Table 2). The discussions with the provider also suggest that they have experienced larger number of risk cases than expected.

The broad challenges in implementing this type of scheme depend on:

- the assumption about the delivery status (i.e., the probability of occurrence of normal, caesarean or other complications in 100 deliveries);
- the assumptions made in developing the financial package and characteristics of revenue earned if the provider does not join the scheme;
- the number of providers empanelled and their geographic distribution and its affect on the distribution of cases and revenue distribution of a provider; and
- The distribution of risk cases across the regions and providers.

All these factors will affect the incentive structure of providers and therefore have implications for the long-term sustenance of this scheme. This paper examines these issues and discusses how sensitive these risks are to the entire incentive structure of the scheme. Departure from distribution of risk cases across providers will create strong disincentives for providers and may lead to implementation problems of the scheme. In the next section we describe a computer model that we developed to simulate the revenue performance of private providers who are not a part of the scheme and study whether the provider have incentive to join the Chiranjeevi Yojana.

VII. Simulation model

We use Monte Carlo simulation method to explore the questions listed in the previous section. For this purpose, we prepared a detailed simulation model of the delivery system. In Figure 1, we provide the flow chart of the delivery status of an expectant mother and we use this as the basis for developing the simulation model using the software @*Risk*. The flowchart shows the process followed by an expectant mother for delivery at a service provider's location. The simulation model specifies the following parameters:

(a) Arrival rate: Arrival rate of expectant mother has been assumed to be 100 deliveries per provider. This arrival pattern has been modelled as a Poisson process with inter-arrival time following exponential distribution. The mean inter-arrival time was set equal to total time period of one year divided by the total arrival cases of 100.

(b) Services and probabilities: The flow chart presented in Figure 1 describes the services and process flows. We simulate the process based on these flows. At any service provider, the expectant mother may go through a variety of investigation procedures (e.g., clinical investigation, sonography, blood test etc.) during her stay at the service unit. Based on this, her delivery status (e.g., normal delivery, complicated delivery etc.) is determined. For example, an expectant mother may come to an outpatient department (OPD) for clinical investigation. The diagnosis may suggest that there is still time for delivery and she may be advised to go back and come later. Alternatively, she may be admitted to the hospital and kept under observation. In case of any observable risk factor, the expectant mother would be suggested to go through a sonography test after which there is a chance that she may be referred a LSCS case. Such eventuality may also happen during the labour process. In case she is recommended for a normal delivery, she will undergo normal investigations like blood test, blood pressure etc. However, there is a chance that during the delivery process the expectant mother may experience difficulties resulting into certain complications. In such a situation depending on the risk factor, the provider may use forecep or a vacuum method of delivery or, depending on the risk assessment, the provider may decide to go for cesarean.

Once the baby is delivered, post-delivery observation time and stay in hospital will depend on whether it was a normal delivery or a complicated case. For example, in a normal delivery case both mother and the child will be kept under observation for sometime (generally, one to two hours). After observation, if the condition of both mother and child is normal, then the mother along with the child is shifted to a ward. Normally, they are discharged from the ward after two days. If there is any problem with the child then the baby is sent to the NICU section. If there is any problem with the mother (e.g., requiring blood transfusion or eclampsia etc.), then she undergoes the required treatment. The computer simulation models the above situation, for instance.

For these service flows, we use the probabilities as assumed in developing financial package of the scheme. Probabilities for services such as sonography etc. have been arrived at based on discussion with providers. Table 3 provides these probabilities. We use these in simulating various scenarios. For creating this probability matrix, we have assumed that arrival rate of delivery cases to a particular provider would be 100. In the simulation model, we have included the total population of the district, the birth rate and number of providers to check whether each provider is going to get 100 cases assuming each provider having same chance of receiving the case.

(c) Service rates: The total number of cases that can be investigated at a particular service unit per unit of time (i.e., number of cases investigated divided by per unit of time say one hour) is defined as the service rate. For example, when an expectant mother reaches at a particular station say for her sonography, the time taken to complete the procedure is termed as the service time. Therefore, if the average service rate of the sonography centre is four patients per hour then the average service time per patient will be 15 minutes. Here the service time at any station may involve preparation of instrument, primary check up etc. Table 4 gives the service rates at various stations that a case might undergo during delivery process. These service times are based upon the data provided by a local hospital and available in the Chiranjeevi Yojana. In the simulation model, service times are assumed to follow exponential distribution.

(d) Capacity of resources: Each service provider would have a constraint on the number of cases they can admit to any service unit at any time. This will be determined by the capacity of the service unit. This can be defined as the number of cases investigated or served at a particular service unit at any specific instant of time. For example, the number of operation theatres (OTs) will determine the number of complicated cases the provider can handle. In case the service unit is busy, the patient has to wait. To capture this aspect, waiting place has been created in front of each station (shown in flow chart) to capture the average waiting time at each station in case services are not available at any specific point of time. Since this study focuses on simulating the charges reimbursed to providers, we have assumed capacities at all the stations very high, so there is no capacity constraint and waiting times are zero. We simulate the effect of the resource constraint and waiting time in a separate study.

(e) Financial charges for providing services: In the simulation model, when a particular delivery case undergoes a particular service unit, a financial charge is assigned to it for various services that are used. The simulation model adds the total charges for various services. The details of charges of various services are provided in Table 5. These charges are based on the estimates worked out for developing the total payment package for the scheme. There are service units such as initial consultation for which charges have not been provided as its cost is included in other service procedures and hence the charge of such services have been assumed to be equal to zero. These charges define the revenue distribution of a provider.

We model the above-mentioned maternal delivery process flow chart and the accompanying assumptions using the *@Risk* software. We perform *Monte Carlo* simulation and estimate the distribution of charges across each process and over all the cases. The analysis is based on the assumption that the delivery status of expectant mother remains the same as per the probabilities indicated in Table 3. We also assume that the underlying socio-economic-demographic characteristics of the population remain constant and do not change.

For simulating the experience of private providers in the Chiranjeevi Yojana, we approach the simulation in the following way. Using *@RISK* we run the simulation model with 100 iterations and 5000 simulations for Scenario 1, each time using a different random seed value (see Appendix 1). Here 100 iterations denote 100 cases and these are simulated 5000 times, thus giving us a distribution of average charges that a private provider would experience. Based on the above, we report the simulation results for the following two scenarios:

- **Scenario 1:** Simulation of provider payment system is based on probabilities and financial charges assumed in the scheme. Here the assumption is that each service provider will be getting exactly 100 cases of delivery.

- **Scenario 2**: In this scenario, the simulation is carried out for each district separately after considering the number of private providers in these districts.

VIII. Results

This section presents the results of the simulation study. To find out provider's incentive to join the scheme we first find the revenue distribution of private providers in case they were not part of the scheme and compare it with the financial package available under the Chiranjeevi Yojana. The results of the two scenarios discussed in the previous section are presented below.

Scenario 1

We run the first set of simulations based on the assumptions that all providers experience the same set of probabilities for complicated and normal cases and follow a common set of charges for various services. The revenue distribution of private provider based on simulation results is given in Figure 2. While fitting the data resulting from 5000 simulations, the distribution fit is gamma distribution, with infinite limit on one side (see Table 7).

The simulation results suggest that the average revenue (in terms of expenses incurred by the family on delivery) of the provider is Rs. 1416 per delivery. This is the revenue provider would have earned and if the provider is operating on its own and not a part of any scheme. This is less than what the provider would be reimbursed by the government on capitation fee, which is Rs. 1445 (Rs. 1795 less Rs. 350 towards reimbursement for food, transport and Dai). Provider will earn extra average revenue of 2 per cent by joining the Chiranjeevi Yojana. This is over and above the profits included in the average revenue the provider would have earned, if the provider was not part of the scheme.

Simulation results presented above suggest that there is a "minimum" possible average revenue of Rs. 700 which the provider would earn which is substantially less than the reimbursement in the scheme. However, there is no restriction on the maximum revenue possible because conceptually the maximum value of this distribution is infinity. Both these results have been generated by extrapolation of the simulation data values. However, the minimum average revenue that a provider can experience is Rs. 1089. The actual maximum value of this distribution based on results is Rs. 1869 (shown in parentheses in the Table 7), and the probability that the revenue will exceed these values is almost zero. Since in the present setup, number of simulations is large, these values can be accepted as the minimum and maximum values that this distribution can take instead of infinity.

The results also indicate that there is a probability of about 38 per cent that the revenue of a provider would exceed Rs. 1445, the reimbursement amount offered by the government if the provider is a part of the scheme. Consequently, there is a 62 per cent chance that his revenue will be less than Rs. 1445. So by not joining the scheme the provider is exposed to risk of earning lesser average revenue at higher percentage of time (62 per cent) than what is being reimbursed in scheme. The simulations results also suggest that risk in revenues is not symmetrically distributed, as even in the distribution of revenue values less than Rs.1445, 16 per cent are the chances that the revenue values will be between Rs.1399 (modal value) and Rs.1445 (government offered reimbursement amount). Also mean revenue value is right most to the mode and median revenue values respectively. This is verified by measures of skewness and kurtosis, which suggest that the distribution of revenue is scattered significantly. The results indicate that there is more likelihood of revenues being on the higher side as revenues are concentrated more to the right of the modal value of Rs.1399. However, as mentioned earlier a significant 16 per cent is between modal value Rs.1399 and government offered value Rs.1445.

Therefore, joining the Chiranjeevi Scheme helps the provider to reduce the overall risk in revenue. These providers are in most vulnerable districts and reduction in overall revenue risk is an important incentive for them. In addition to this, the increased volume will spread the fixed cost of the provider and increase overall profitability further. We have not examined the issue of economies of scale issues in this paper.

Given the complexities of healthcare, providers in an informational asymmetry setting have several options to maximise the revenue. Most of these options may not be desirable from consumer's/society's point of view. For example, the provider in the absence of this scheme can maximise the revenue by doing more cesarean cases. The scheme has embedded incentive to minimise the caesarean cases and yet maximise the revenue.

Scenario 2

As discussed earlier, the number of providers contracted out may have implications for the distribution of cases across providers and it may affect the revenue distribution of providers. Under Scenario 2 we examine the question that given the population of the district and number of deliveries which are likely to occur, does the number of providers in the scheme make any difference in the revenue distribution of private providers. The charges for deliveries and probability distribution of risk cases remain same. We run the simulation model using the @*RISK* software with (n*100) iterations and 1000 simulations, each time using a different random seed value (see Appendix 1 for a discussion on this part of modelling). Here "n" is the total number of service providers at a particular district, so the probability that a particular service provider will be preferred by a beneficiary is 1/n (assuming each provider has equal chance of being preferred). The total number of iterations required to obtain a cost figures for a package of 100 patients is (n*100).

The distributions are based on number of iterations to get 100 clients at a particular service provider. Since the arrival of maternal delivery cases is a discrete event, we fit discrete distributions to simulated data (i.e., number of patients arriving at the service provider). These results suggest that for each of the district, number of patients arriving at a particular service unit is following either Negative Binomial or Poisson distribution. Average number of patients arriving at a particular service station is 100 for each of the districts.

Since the number of observations (iterations or number of patients arriving for delivery) is very large, and probability of selection of a service provider is very small, so number of clients arriving at a particular service unit in any of five districts is assumed to follow a normal distribution with mean number of patients arriving being 100. This inference is verified with values of skewness and kurtosis, which are very close to 0 and 3 respectively thus showing the normal behavior of number of patients arriving at a particular service provider. This helps us to fulfil the assumption of doing simulation for 100 cases.

Given the uncertainty in flow of delivery cases, the simulation results also suggest that provider is exposed to some risk of not getting 100 cases all the time. For example, the distribution statistics given in Table 8 indicates that the provider may get 69 cases on minimum side. The minimum and maximum values have been arrived at after assessing the probability of getting delivery cases. Theoretically, there is possibility of getting no case at all. Similarly, there is possibility of getting large number of cases, but given the number of providers, the maximum number of cases can go up to 138.

So on the basis of these values, it can be inferred that at any point of time minimum number of patients that a service provider in a district can expect varies between 65 and 75. Similarly, maximum number of patients that a service provider can expect may vary between 120 and 140 (all the other assumptions remaining same). But most of the time, the difference between maximum number of patients and minimum number of patients visiting a service provider can be 33, as suggested by the last row of distribution statistics Table 8. This row gives that there is a probability of less than or equal to 0.1 that the difference between the maximum number of patients and minimum number of patients visiting the service provider will be more than 33 while average, modal and median values will be 100. This gives an idea about the minimum and maximum number of patients expected at a specific service provider. The simulation results of cost distributions are discussed below (see Figures 3.1-3.5).

The simulation results of Scenario 2 (see Table 9) suggest that the presence of number of providers is not having any significant impact on the revenue distribution of providers and their average revenue ranges between Rs. 1414 and Rs. 1423. Thus, the simulation results suggest that in all the cases average revenue earned by a provider in the absence of joining the Chiranjeevi Yojana is less than the government decided reimbursement package. The probability of earning revenue more than government offered reimbursement package for any provider is however smaller than the probability of earning revenue less than this value (see Table 10). Last column of that Table 10 shows that under both scenarios, if the private service provider is a part of the scheme, he will be earning a marginal extra profit per case however small as compared to the cases where the provider is not a part of the scheme.

In addition, in no case did the maximum revenue exceed Rs. 1622 at 95 per cent confidence level (see Table 9). However, theoretical value of the maximum revenue is extrapolated as infinity, yet the practical values based on simulated data suggest that the maximum revenue possible is less than Rs. 1920.

The risk characteristics of the revenue distribution also remain same as discussed in Scenario 1. As can be seen, the distributions for all the districts are right skewed, that is, costs are having an inclination towards the higher side, but a greater than 3 kurtosis value suggesting denser concentration of revenues around mode. This scheme also reduces the inconsistence in the revenue generation pattern for the service provider by ensuring a marginal profit per case, irrespective of the nature of the delivery case. Consequently, government scheme is attractive for the provider.

IX. Summary and conclusion

The objective of this paper was to understand whether the private provider has an incentive to join the Chiranjeevi Scheme. We use the methodology of *Monte Carlo* Simulation to answer this question. We examine the distribution of revenue of a private provider using same probabilities of risk cases in maternal delivery and charges for various procedures as assumed in the Chiranjeevi Scheme. The results suggest that if a provider does not join the Chiranjeevi Scheme, distribution of revenue per delivery of providers for each of the districts under study is significantly scattered. This reflects the situation when the service provider is outside the scheme and faces the entire distribution of different types of cases over the 100 patients. For example, from the results section, it is evident that under Scenario 1, the average revenue per delivery of a service provider who is not a service provider of the scheme, is Rs. 1416 and it is less than Rs. 1445 ((Rs. 1795 less Rs. 350 towards reimbursement for food, transport and Dai) that is reimbursed by the Chiranjeevi scheme. The results further suggest that distribution of the revenue is scattered asymmetrically indicating significant risk in revenues to provider. As compared, the Chiranjeevi Scheme provides a fixed amount of Rs.1445 for each of the 100 cases irrespective of the status of the cost. Therefore, by joining the Chiranjeevi Scheme the provider is able to reduce the overall risk in revenue. In addition, the increased volume will spread the fixed cost of the provider and increase overall profitability further. The provider, in the absence of this scheme, may maximise the revenue by doing more caesarean cases. The scheme has embedded incentive to minimise the cesarean cases to maximise the revenue and this produces larger indirect benefits from health systems point of view. Thus, we can conclude that the private provider has an incentive to join the scheme as it helps the provider to reduce overall risk, spread its fixed costs to larger volume, improve its profitability and stabilize its revenues. This is contrary to the view expressed by some providers in these districts that the scheme is not financially profitable to them. The providers use this argument to charge more money from users of their facilities. The government should take a clear view on this and discourage providers from charging additional amount from BPL users. We also argue that a batch size of 100 deliveries will produce these benefits to the provider. The scheme also provides incentives to providers to join the scheme and reduce their per-unit costs. When we simulate the results with the number of providers contracted out in each district the results do not change significantly. Since the provider under the scheme is paid up-front advance, there is no transaction cost of bureaucratic delays in payments. Given the incentives in the scheme, the government should negotiate the quality standards of care and institute mechanisms to monitor this.

There are other questions requiring further analysis. First, the scheme contracts out private providers for 100 deliveries. Given the utilisation of institutional facilities for deliveries and probability of delivery status (normal, caesarean and other complications), is the batch size of 100 deliveries an optimum size from provider viewpoint? Optimality need to be measured in terms of (a) ability to break-even based on the financial package for 100 deliveries as set by the government, and (b) ability to break-even based on the stated/experienced costs of provider in that region. Second, the number of providers contracted out has implications for the distribution of cases across providers. Given the population of the district and the number of deliveries that are likely to occur, what is the optimal number of providers that should be contracted out for delivery services? The results of the present study suggest that if probabilities of risk cases remain uniform across providers and each provider has same probability of receiving delivery case, there is no problem. However, it is very unlikely that distribution of risk cases remains uniform across providers and households may have some preferences in selecting a provider. In addition, if number of providers is going to be large what should be the spatial distribution of these providers? Third, the distribution of risk cases may not get distributed as per the assumed probabilities. What are the implications of asymmetric distribution of risk cases of deliveries among providers? Given the distribution of cases among providers, is there a need for intervention at any stage to reduce the asymmetry in risk cases across the providers? At what level should this intervention be done? Fourth, this scheme has implications from viewpoint of the users. Given the out-of-pocket costs of delivery at the hand of private providers, what are the implications for a family incurring these costs in the absence of Chiranjeevi Yojana and descending in below poverty levels? Delivery status has significant implications for expenditures and affects the households in economic terms. This would have implications for income available particularly for households below the poverty line. The delivery related expenditures include both delivery and health related expenditures (normal and complicated) and other expenses in case of extreme negative outcomes resulting in death of mother and/or child (i.e., how many months of income spent on such expenses?). Most of these expenditures would be indispensable to the household. We need to examine the effect of delivery-related costs in absence of the Chiranjeevi Yojana, on reduction in the maximum income, as defined for BPL households. In the absence of Chiranjeevi Yojna, poorer people will be forced to either undergo private procedures with out-of-pocket costs of delivery, thereby forcing these families more towards economically poorer condition or take resort to home deliveries increasing the chances of mortality and morbidity.

Table 1: Financial Package for Chiranjeevi Yojana

Procedure	Cases per 100 deliveries	Cost (Rs.) Per procedure	Total (Rs.)
Normal Delivery	85	800	68000
Complicated Cases			
Eclampsia/Forceps/ Vacuum/ Breech	3	1000	3000
Septicemia	2	3000	6000
Blood Transfusion	3	1000	3000
Caesarean	7	5000	35000
Pre delivery visit	100	100	10000
Other Costs			
Investigation	100	50	5000
Sonography	30	150	4500
NICU Support	10	1000	10000
Food	100	100	10000
Dai	100	50	5000
Transport	100	200	20000
Total	100		179500

Source: Presentation given by Health Commissioner of Gujarat, Dr. Amarjit Singh in the IIM-A campus, March 2006 (in complicated cases Episiotomy has also been taken into account and cost per procedure is Rs. 800; Eclampsia is different from Forceps/Vacuum/Breech delivery, since cost per procedure is same has been clubbed together)

Table 2: Performance indicators from November 2005 to February 2006

Districts	Deliveries	Total Specialist	Enlisted under CY	Normal Delivery	LSCS	Complicated
Banaskantha	5945	50	58	90%	5%	5%
Dahod	6750	18	15	79%	4%	17%
Kutch	3912	47	21	74%	5%	21%
Panchmahals	10450	29	29	95%	3%	2%
Sabarkantha	4584	73	10	89%	10%	1%
Total	31641	217	133	87%	5%	8%

Source: Ramesh Bhat, Amarjit Singh, Sunil Maheshwari and Somen Saha (2006). Maternal Health Financing - Issues and Options: A Study of Chiranjeevi Yojana in Gujarat. Working Paper 2006-08-03, IIM Ahmedabad

Table 3 : Assignment of probabilities to various procedures as used in simulation				
Details	% of cases	# of cases	Probability	Source of information
Cases sent back or shifted to wards	0	0	0	Local hospital
Normal case after primary evaluation	70	70	0.7	Local hospital
Sonography after primary evaluation	30	30	0.3	Local hospital
Normal after Sonography	20	20	0.67	
Total normal cases	90	90		Chiranjeevi
Complicated after sonography	10	10	0.33	Same
Case is ready for labour	76	76	0.84	Local hospital
No, shift to ward	14	14	0.16	Local hospital
Total to labour room	90	90		
Normal delivery	85	85	0.95	
Forceps and vacuum	3	3	0.03	
Total Normal	88	88	0.98	Chiranjeevi
Cesarian from normal	2	2	0.02	
Cesarian from Sonography	5	5	0.5	
Total caesarean	7	7		Chiranjeevi
Blood transfusion	3	3	0.3	Chiranjeevi
Scepticemia	2	2	0.2	Chiranjeevi
Total # of cases	100	100		
Any complication in mother	0	0	0	
NICU	10	10	0.1	Chiranjeevi
Direct to ward	100	100	1	Local hospital
Cesarian investigation	7	7	1	Chiranjeevi
Blood in-house + Cesarian	0	0	0	Chiranjeevi
Blood outsourced + Cesarian	0	0	0	Chiranjeevi
Mother's complication (Blood transfusion)	0	0	0	Chiranjeevi
Mother's complication (Septicemia)	0	0	0	Chiranjeevi
Mother's complication (Eclampsia, others)	0	0	0	Chiranjeevi

Table 4: Service rates at various stations			
Services	Average service rate	Service time	units
Clinical Investigation (15)	96	15	min
Normal investigation	48	30	min
Ward	4	360	min
Sonography	96	15	min
Cesarian investigation	32	45	min
Blood In-house + cesarian investigation	24	60	min
Blood outsourced + cesarian investigation	16	90	min
Normal/Forcep	2.4	600	min
Sce	24	60	min
NICU	24	60	min
Mother complication	16	90	min
Ward after observation	0.5	2880	min
Ward after complication	0.2	7200	min
Observation		60	min

Table 5: Revenue assumptions used in simulation for Scenario 1 and 2	
Service station	Cost (Rs.)
Clinical Investigation	0
Normal investigation	150
Sonography	150
Cesarian investigation	150
Blood requirement	1000
Ward	0
Normal delivery	800
Forceps / vacuum	1000
Observation	0
Cesarian	5000
NICU	1000
Mother complication	5000
Ward stay	0
Ward stay after cesarian	0
Septicemia	3000
Eclampsia & others	1000
Food, Dai, Transport	350

Table 6: Providers and Deliveries

Districts	Total O&G in the district	Enrolled in Chiranjeevi Yojana		Number of Deliveries	
Banaskantha	50	58*	32%	5945	19%
Dahod	18	15	11%	6750	21%
Kutch	47	21	12%	3912	12%
Panchmahals	29	29	17%	10450	33%
Sabarkantha	73	10	28%	4584	14%
Total	217	133	100%	31641	100%

* includes providers from other adjoining districts

Table 7: Distribution statistics of revenue distribution of service provider not joining the Chiranjeevi Yojana under Scenario 1	
Minimum (Rs.)	699 (1089)
Maximum (Rs.)	+Infinity (1869)
Mean (Rs.)	1416
Mode (Rs.)	1399
Median (Rs.)	1410
Standard Deviation (Rs.)	112
Skewness	0.31
Kurtosis	3.15
Left X (p = 5%)	1242
Right X (p = 95%)	1609
Diff. X (p = 90%)	367

Table 8 : Distribution Statistics of number of patients arriving at the service provider not joining the Chiranjeevi Yojana under Scenario 2

Statistics	Banaskantha	Sabarkantha	Dahod	Kutch	Panchmahals
Number of Iterations	5000	1600	4700	2900	7300
Number of simulations	1000	1000	1000	1000	1000
Function	Poisson	Negative Binomial	Poisson	Negative Binomial	Poisson
Minimum	0 (71)	0 (68)	0 (70)	0 (65)	0 (67)
Maximum	+Infinity (136)	+Infinity (133)	+Infinity (129)	+Infinity (139)	+Infinity (138)
Mean	100.03	99.89	100.27	100.48	99.98
Mode	100	99	100	100	99
Median	100	100	100	100	100
Std. Dev	10.0015	10.1091	10.0133	10.5927	9.9992
Skewness	0.1	0.1035	0.0999	0.1164	0.1
Kurtosis	3.01	3.0112	3.01	3.0159	3.01
Left X (p = 5%)	84	84	84	83	84
Right X (p = 95%)	117	117	117	118	117
Diff. X (p = 90%)	33	33	33	35	33

Table 9: District wise revenue distributions statistics of revenue distribution of the service provider not joining the Chiranjeevi Yojana under Scenario 2

Statistics	Banaskantha	Sabarkantha	Dahod	Kutch	Panchmahals
Functions	Beta General	Gamma	Beta general	Pearson type 3	Log Normal
Minimum	1016 (1146)	740 (1109)	735 (1108)	344 (1078)	440 (1122)
Maximum	2087 (1832)	+Infinity (1810)	2796 (1809)	+Infinity (1920)	+Infinity (1870)
Mean	1414	1417	1421	1418	1423
Mode	1398	1399	1411	1393	1404
Median	1409	1411	1418	1409	1416
Std. Dev	114	109	111	116	112
Skewness	0.22	0.32	0.16	0.44	0.34
Kurtosis	2.81	3.15	2.96	3.37	3.21
Left X (5%)	1235	1248	1243	1241	1250
Right X (95%)	1609	1605	1608	1622	1617
Diff. X (90%)	374	356	366	381	367

Table 10: Comparative study of the revenue more than 1445 and less than 1445

	Chance that the average cost will exceed 1445	Average cost of the distribution <=1445	Diff from 1445	Average cost of the distribution > 1445	Diff from 1445	Margin profit per case
Govt. Provider	0.38	1346.11	98.89	1530.74	85.74	13.15
Banaskantha	0.38	1343.16	101.84	1529.40	84.40	17.44
Dahod	0.40	1350.19	94.81	1531.06	86.06	8.75
Kutch	0.38	1344.57	100.43	1534.55	89.55	10.88
Panchmahal	0.40	1351.61	93.39	1533.45	88.45	4.94
Sabarkantha	0.38	1349.88	95.12	1528.06	83.06	12.06

Figure 1: Flowchart

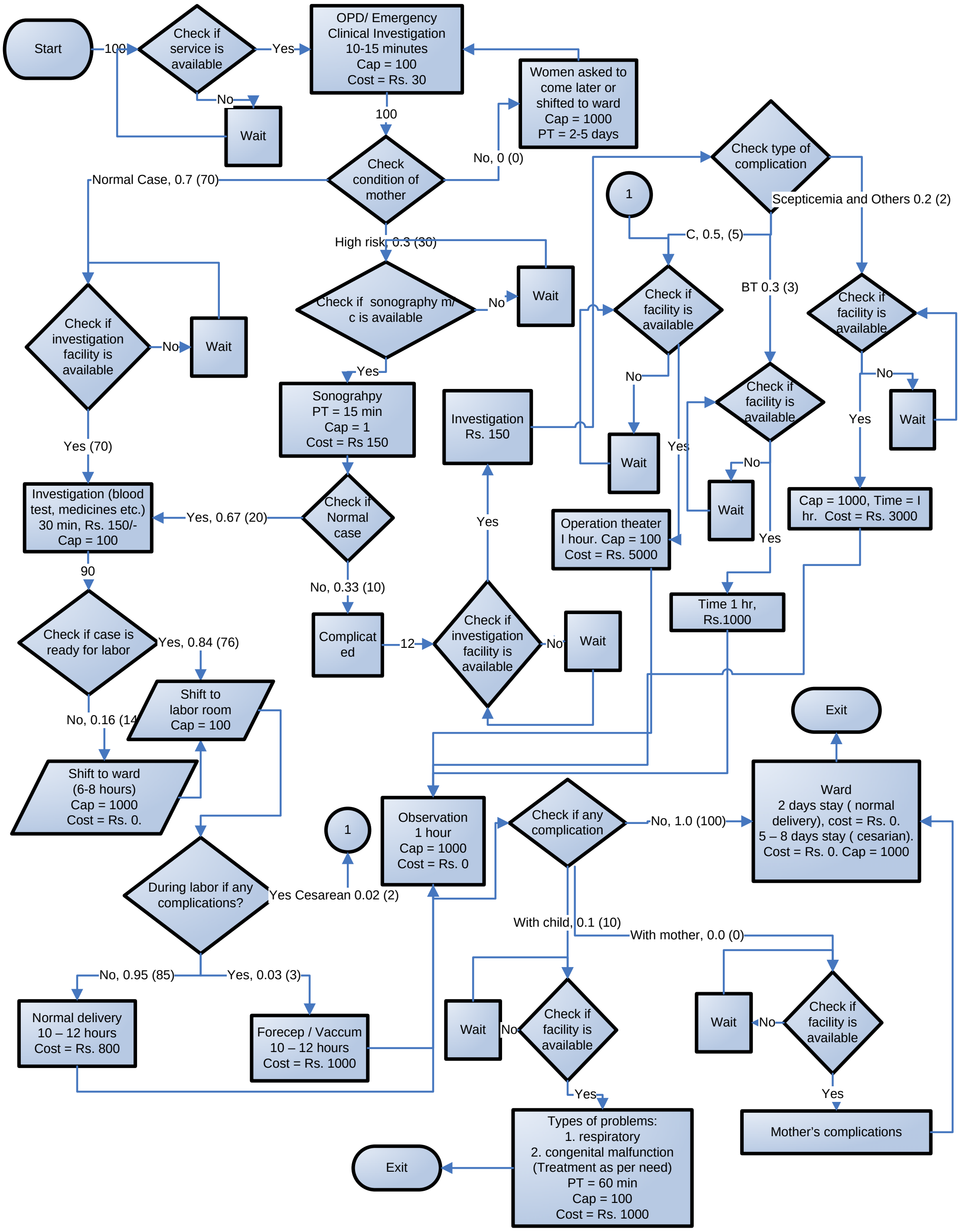

Figure 2
Revenue distribution of the service provider not joining the Chiranjeevi Yojana under Scenario 1

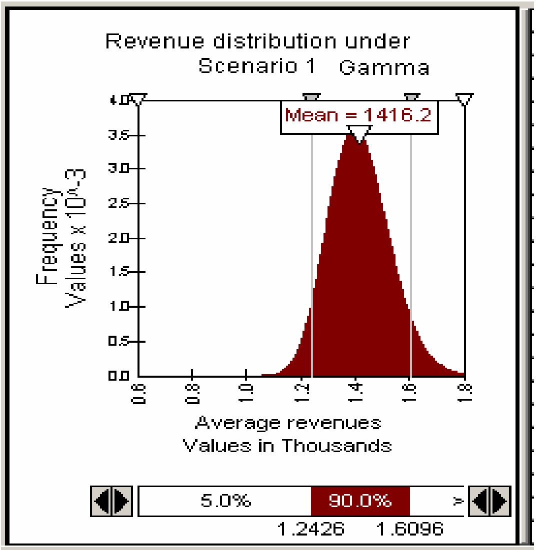

Figure 3
Cost distribution of the service provider not joining the Chiranjeevi Yojana under Scenario 2

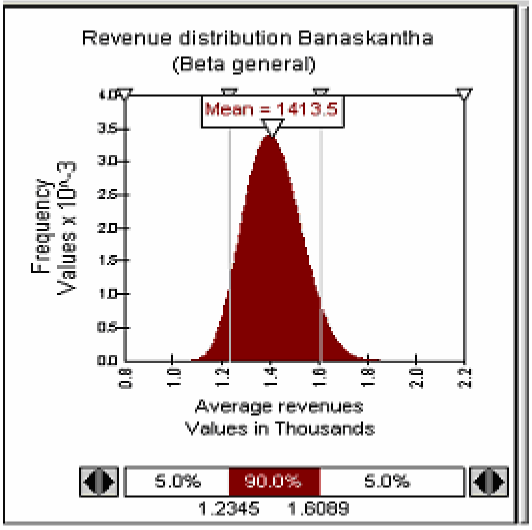

Figure 3.1

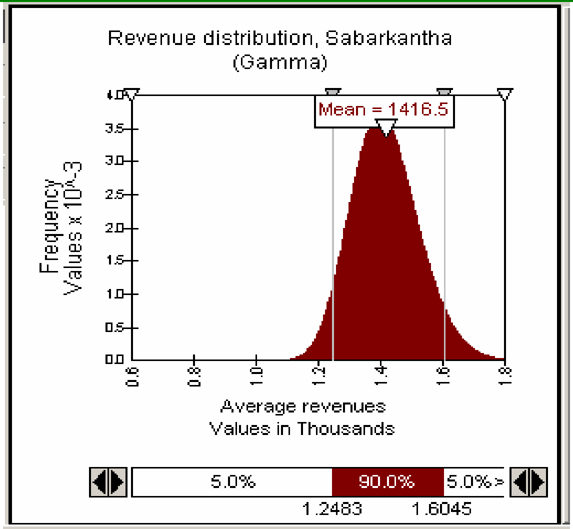

Figure 3.2

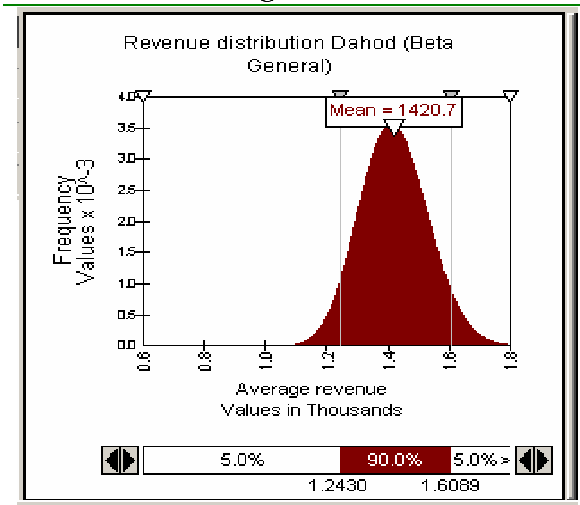

Figure 3.3

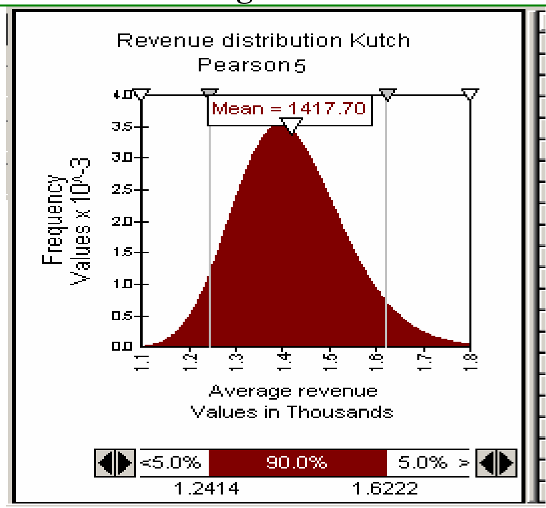

Figure 3.4

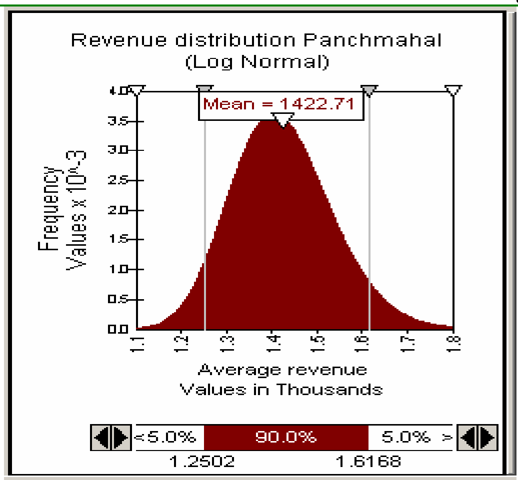

Figure 3.5

Appendix 1

Simulation technique

In simulation technique, we design a model of an actual or theoretical physical system. We execute the model and analyze the execution output. This technique is very helpful in situations, which are perishable or too vast or too complicated to study. It can also be used in situations where creating the actual system may not be feasible or it is too expensive. Using this methodology, we can create the system artificially, execute it any number of times, use various assumptions to examine the impact on the system and examine and study the effect of changes on the simulation model of the system. This is also time efficient and cost efficient. Greatest disadvantage of this methodology is that in this method, all the inferences about the actual system are based upon some artificial copy of the system. However, if that model has been designed with care and has been analysed accurately, it is an effective method of analysing any system.

Monte Carlo simulation method

Monte Carlo (MC) method of simulation is a technique based on the use of random numbers and probability statistics to investigate problems. This is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. A simulation can typically involve large number of iterations (in thousands or millions) of the model, a task that is only practical using computers. Thus, use of Monte Carlo method to model physical problems allows us to examine more complex systems than we otherwise can. In addition, use of random numbers eliminates any chance of subjective judgment on the part of investigator. Thus with Monte Carlo technique, a large system can be designed using random numbers, and that data can be used to describe the system as a whole.

Random seed value

The seed is a number that initializes the selection of numbers by a random number generator. Given the same seed, a random number generator will generate the same series of random numbers each time a simulation is run. So it is suggested to use different seed values during different simulations, so that random nature of the simulation technique can be maintained.

Simulation software @Risk

In the simulation when a beneficiary reaches the facility her characteristics at each station is decided using risk-discrete function with the construct in @RISK as follows:

Riskdiscrete *({outcome 1, outcome 2… outcome n}, {$p_1, p_2 \ldots p_n$})*

If a particular beneficiary is having a certain characteristic of delivery case, then it will pass through those processes only and corresponding costs will occur for that patient. For this purpose, nested "If-Then-Else" structure has been used. For example, if a beneficiary arrives, it will be checked in OPD (Clinical investigation) as described in the flowchart, to determine whether this is a low risk delivery case, or high risk case or whether sonography is required or there is still time and the beneficiary is required to wait or still there is time and she is sent back. For this purpose, function used is

RiskDiscrete ({0, 1, 2}, {p_0, p_1, p_2}).

Here, 0 indicates there is still time, come later, 1 indicates low risk case, no sonography required, that is normal delivery case and 2 indicates high risk case, sonography is required. As per the cost matrix, at this stage, cost is zero for all beneficiaries. Then a value is assigned to the beneficiary using simulation. For example, if this beneficiary is assigned a value 2, she becomes a high risk case, and sonography will be required. Now this patient will reach to Sonography station. Here the function used will be ***RiskDiscrete ({0, 1}, {0.83, 0.17})***, where *0* indicates normal delivery case and *1* indicates Caesarean, here probabilities have been used using the above mentioned probability matrix. At this stage the cost of this process is Rs.150 as provided in cost matrix. Once this beneficiary is assigned value 1, it is a caesarean case. So it will be sent to caesarean investigation section. There function used is ***RiskDiscrete ({0, 1, 2}, {p_0, p_1, p_2})***, where *0* indicates blood transfusion is not required, *1* indicates blood transfusion is required and in-house blood is available and *2* indicates blood transfusion is required and in-house blood is to be outsourced. If the beneficiary is assigned a value *0*, then cost is Rs.150, else cost is Rs.1150 using function ***IF (AT11=0,150,150+1000)***. In case the beneficiary is assigned the value 0 which indicates that blood transfusion is not required and only routine investigation will happen. After this she will be shifted to operation theatre for which the cost is Rs.5000. After operation, the mother and the child will be kept for observation for 1 hour. For this there is no cost assigned. During this observation mother and child can experience two states: (i) no post operation complications, or (ii) post operation complications. This is assigned to patient using function ***RiskDiscrete ({0, 1}, {0.95, 0.05})***, where 0 indicates no complication and 1 indicates post-operation complication. No-complication outcome does not have any costs as the mother and child will be sent to ward for 3 to 5 days stay since this case is a caesarean case. The ward stay duration in case of a normal delivery is on the average 2 days.

In case there are post-operation complications, child might have two states, NICU or no NICU again using **RiskDiscrete** function. In case of NICU the cost is Rs. 1000 else it is zero. At the end of simulation a case all these costs will be added to obtain the total cost for the beneficiary. We add fixed cost of Food, Dai and Transport to obtain the final total cost.

Using @RISK we run the simulation model with 100 iterations and 5000 simulations, each time using a different random seed value. Here 100 iterations denote 100 patients and the whole system of 100 patients are simulated 5000 times, thus giving us distribution of average costs.