

# G-Chart for Predicting Borewell Accidents



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***Timmanna Hatti, a six-year old boy, is trapped in a 160-foot borewell for more than 5 days*** in Sulikeri village of Bagalkot district in Karnataka since the event took place last Sunday.

What is more heart-breaking is the news that the State government is contemplating to stop the rescue operation to extract this little boy on the grounds that the digging work, if continued further, might lead to collapse of the vertical wall created by the side of the borewell within which the innocent little boy, Timmanna, is struggling for his life for the last 5 days.

Until the article was completed, till 2.30 pm Sunday, the final status of the rescue operation was not known.



My prayers are with the millions of people to rescue the boy alive at the earliest time possible and sincerely pray to the God to give the little boy just another chance.

The increasing number of borewell accidents, especially involving little children, across India in

the recent past prompted me to conduct a preliminary study of borewell accidents across India in the last 8-9 years.

## ***Objective :***

The main objective of this study was to find out the possible causes of such accidents and to explore if it is possible to predict such adverse events based on the adverse event data available as of date.

To my dismay, the study has revealed a lot of uncomfortable facts including the pathetic situation of the rural children, the total carelessness of the borewell contractors & farmers, the possible main causes of such deadly accidents, etc.

In the end, the study uses G-chart for possible prediction of next such an adverse event based on Geometric distribution probabilities.

## ***Data Collection:***

Newspaper articles and Google search of borewell accidents in the last 10 years resulted in a total of 34 borewell incidents since 2006. The actual number of incidents may be more since many incidents go unreported. Table -1 shows the list of borewell cases reported between 2006 and 2014.

SI No	STATE	No of Borewell Accidents ( 2006 -2014 Aug)
1	Maharashtra	2
2	Gujarat	6
3	Karnataka	3
4	Assam	1
5	Tamil Nadu	6
6	Rajasthan	4
7	Haryana	6
8	Mathya Pradesh	2
9	Utthara Pradesh	2
10	Andhra Pradesh	2
	<b>Total</b>	<b>34</b>

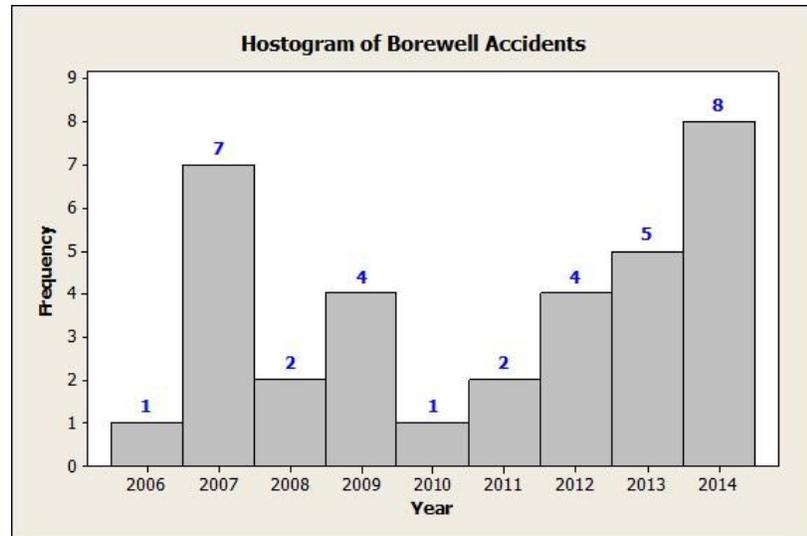
Year	No of Borewell Accidents (2006-2014 Aug)	Percentage
2006	1	3
2007	7	20
2008	2	6
2009	4	12
2010	1	3
2011	2	6
2012	4	12
2013	5	14
2014	8	24
<b>Total</b>	<b>34</b>	<b>100</b>

**Table -1**

**Analysis of the Data:**

**a) Histogram for Frequency of Occurrence:**

A quick analysis of the Histogram, as in figure -1, reveals that out of 34 reported cases, maximum number of accidents have occurred in the years 2007 and 2014. The age of children trapped in the borewells ranged from 2 years to 9 years. Boys (21) were affected by such accidents more than girl children (13).

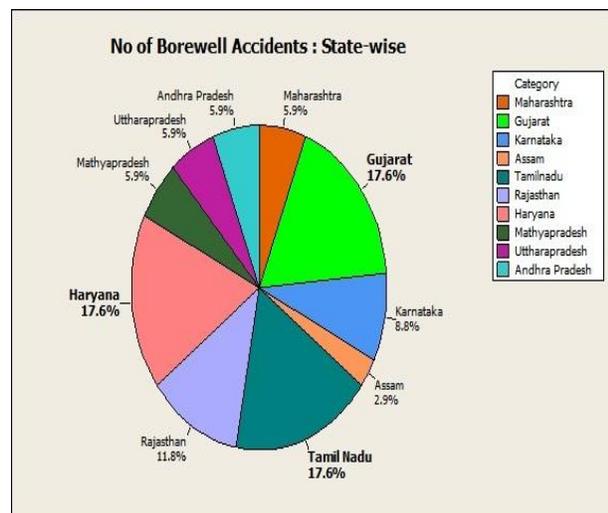


**Figure -1**

What is hurting more, in this modern India, is that more than 70% of the children could not be rescued alive and have died either in the borewell itself or in the hospitals after the rescue. About 20 % of children only have been rescued safe ( i.e 7 out of 34 children) to the ground. The status of 10% of the cases reported is not known.

**b) Pie Chart for Distribution :**

Analysis of a state-wise Pie chart, as in figure -2, indicates that *Haryana, Gujarat, Tamil Nadu* top the list of the borewell accident states. These three states alone account for more than 50% of the borewell accidents since 2006 until August 2014.



**Figure -2**

**c) Pareto Chart for Vital Causes:**

Analysis of the various causes of these borewell accidents through Pareto Chart, as in figure-3, reveals the following as the vital causes:

1. Children accidentally fall into the open borewell pits while playing in the fields.
2. Abandoned borewell pits not properly closed / sealed.

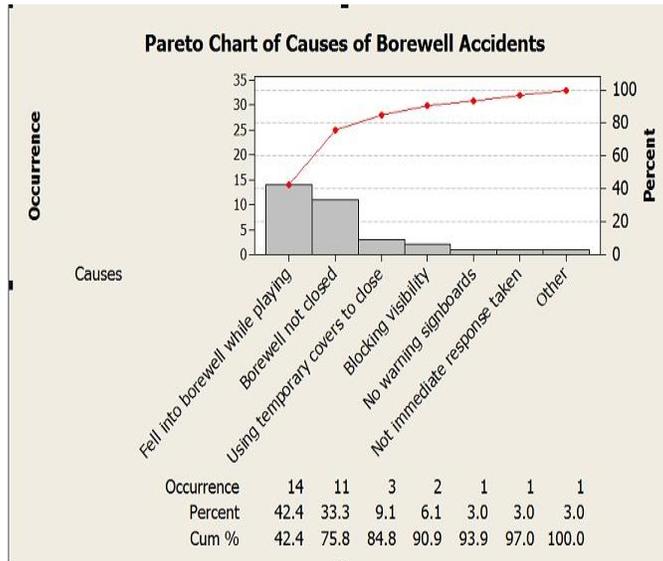


Figure -3

**Control Chart for Rare Adverse Events:**

**a) Geometric Distribution :**

Benneyan's G-chart based on Geometric distribution could be used, instead of the usual P or U charts, to monitor such adverse events as borewell accidents and monitored to see if the borewell accident process follows a random variation within the control limits or shows any noticeable pattern / trend in order to take quick actions to prevent such accidents in future.

In the geometric distribution, we count the number of opportunities before or until the defect (adverse event) occurs. In this case, we count the

number of days between events, i.e the borewell accidents, that were observed / reported. One key assumption made was, when counting the number of days between the events, that the number of accidents per day was fairly constant.

Minitab®, a leading statistical software, has been used to analyze the data using G-chart for the analysis of such adverse rare events as borewell accidents. The figure-4 below shows the geometric probability distribution of days between such rare events for a  $p=0.01$

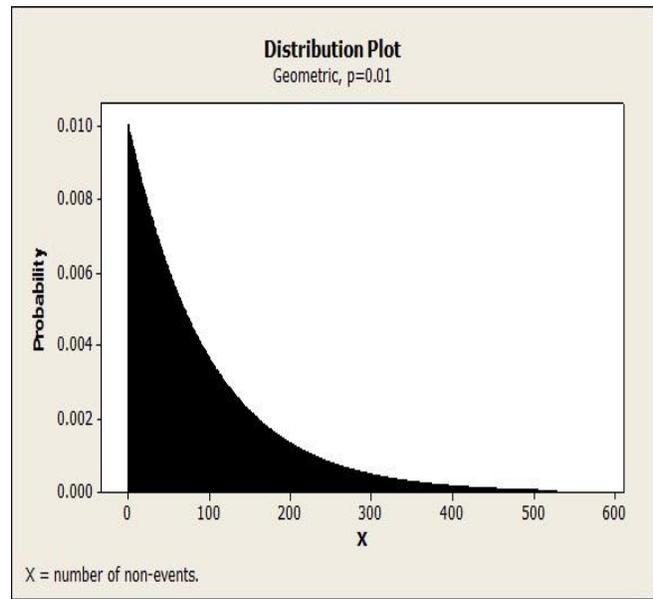


Figure -4

**b) G- Chart for Prediction of Next Accident:**

The observations in the G-chart, as in figure-5, below for the "Date Between Events", although within the UCL and LCL, a cluster of observations below the center line (mean) after the 28th observation and until the 34th observation (latest event) indicates /detects an unusually high rate of occurrences of adverse events (borewell accidents).

This process did not show any "out of control situation" as it passed all the 3 default tests set in the Minitab® and also passed the Benneyan's test.

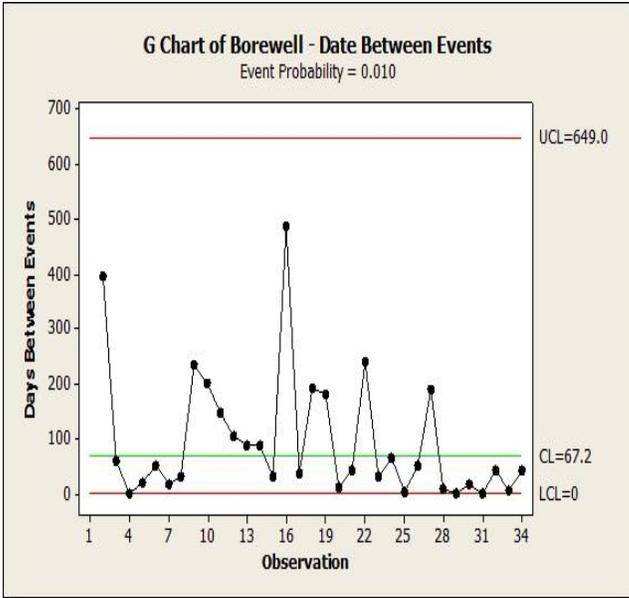
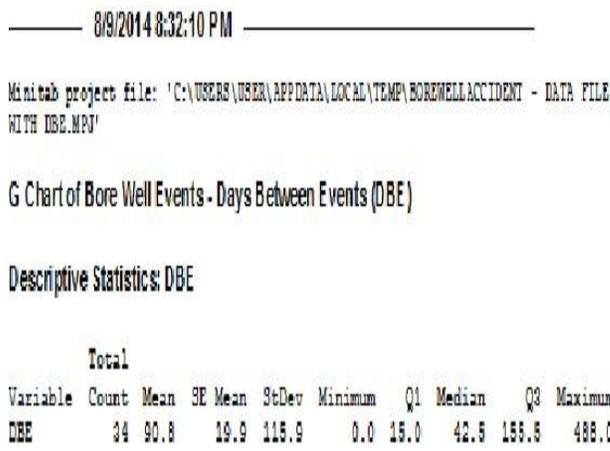


Figure -5

While the descriptive statistics given below indicate a Mean of 90.8 days as the mean "days between events", the G-chart, based on geometric distribution, which is more apt for studying the distribution of adverse events, indicates a Mean (CL) of only 67.2 days as "days between events".

**c) Descriptive and Cumulative Probability Distribution :**



**Cumulative Distribution Function**

Geometric with p = 0.01

x	P( X <= x )
0	0.010000
395	0.981313
16	0.157057
0	0.010000
20	0.190272
51	0.407034
17	0.165486
31	0.275020
235	0.906695
201	0.868687
147	0.774052
104	0.651907
88	0.591180
89	0.595268
33	0.289447
488	0.992661
38	0.324271
194	0.859116
181	0.839452
12	0.122479
43	0.357388
241	0.912155
32	0.282269
66	0.490014
4	0.049010
51	0.407034
190	0.853336
9	0.095618
1	0.019500
18	0.173831
0	0.010000
44	0.363815
6	0.067935
42	0.350897

\* NOTE \* X = number of non-events.

Notes :

This means, the probability of next bore well event happening in X= DBE of 31 days or less = 0.275020 = 27.5% appx. based on Geometric distr.

This means, the probability of next bore well event happening in X= DBE of 104 days or less = 0.651907 = 65% appx. based on Geometric distr.

This means, the probability of next bore well event happening in X= DBE of 181 days or less = 0.839452 = 84% appx. based on Geometric distr.

This means, the probability of next bore well event happening in X= DBE of 488 days or less = 0.992661 = 99% appx. based on Geometric distr.

**Possible Predictions / Conclusions :**

*From the above Geometric probability distribution (p=0.01) of days between events of such rare events as borewell accidents, one can reasonably predict / detect a next borewell accident any of the States included in the above study, especially in the states of **Haryana, Tamil Nadu, Gujarat, Rajasthan, and Karnataka.***

*We can state our possible predictions or conclusions as below with the assumption that the sample size and the Gage R&R / Measurement errors of event data reported and collected are adequate and within the allowable limits.*

*Probability of next borewell event happening in 31 days or less = 0.275020 = 27.5% appx.*

*Probability of next borewell event happening in 104 days or less = 0.651907 = 65% appx.*

*Probability of next borewell event happening in 181 days or less = 0.839452 = 84% appx.*

*Probability of next borewell event happening in 488 days or less = 0.992661 = 99% appx.*

The purpose of this study would be fulfilled if *enough preventive actions, before the possibility of occurrence next such an adverse event within next 6 months ( $p > 80\%$ ), like sealing of all open borewells across India, especially in the above 5 states*, are taken up on war-footing basis either by NGOs or Govt.officials to prevent many innocent children from dying while playing.

#### **About the Author:**

The author, Ondiappan Arivazhagan "Ari", is a Honors Graduate in Civil / Structural Engineering from University of Madras.He is a certified PMP, PMI-SP, PMI-RMP from PMI, USA. He is also a Master Black Belt in Lean Six Sigma and has done Business Analytics from IIM, Bangalore. He has 30 years of professional global project management experience in various countries around the World and has almost 14 years of teaching / training experience in project management and Lean Six Sigma .He is the Founder-CEO of International Institute of Project Management (IIPM), Chennai and can be reached at [askari@iipmchennai.com](mailto:askari@iipmchennai.com)