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Mitigating Vulnerability of Adolescent Girls via Innovative Usage of Digital Technologies: Insights from a Field Trial

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ABSTRACT

Adolescents and young adults, between the ages of 10 to 24, comprise approximately 30 percent of India's population. These youths, 365 million strong, will shape the future of the nation. Although the Government of India has been spending enormous amount of money in a relentless manner over decades and the current cohorts of youth are healthier and better educated than ever before, the fact of the matter is, vulnerabilities still persist for adolescent girls (World Bank, 2014). We argue in this paper that vulnerability of adolescent girls cannot be dealt with by executing verticals programmes in Education, Health, Nutrition and Protection in isolation rather it needs to be handled by running these programmes in a converged manner. The comprehensive reports and analysis of data across these domains would provide a 360-degree view of individual girls, predicting their potential vulnerability well ahead of time, thereby enabling the stakeholders to intervene and prevent untoward incidents like child marriage, child labour, child pregnancy, and trafficking among others. Furthermore, insights generated from analysing the data from the field can be used to identify the areas of improvement for the programme as applicable to decision makers at different levels of societal structure starting with villages to blocks to districts. This paper describes a digital solution called G-Power that comprehensively addresses the above challenges, and shares insights from a field trial carried out in two districts of West Bengal in India.

Keywords: *mobility, social welfare, vulnerability assessment*

INTRODUCTION

Holistic care of individuals has become a primary focus of social welfare departments in government (India, 2010), especially in developing countries. Advances in digital (social, mobile, analytics and cloud) technology coupled with the penetration of mobiles in the rural areas have become instrumental in realizing the holistic care service delivery model.

To provide holistic care, it is essential that the services belonging to an individual's verticals, like Education, Protection, Health and Nutrition (EPHN) are tracked together as opposed to in silos (India, 2014) so that a comprehensive picture of an individual's status can be generated. A 360-degree view of an individual's condition helps to identify the right steps needed to fix the problems if any. Usually the outcome of care for an individual depends on an intricate balance of support from multiple verticals, and as a result, it is of utmost importance to consider an individual as a whole and look at him/her from multiple lenses. That is exactly why the convergence model of service delivery encompassing Education, Protection, Health and Nutrition needs to be followed at any cost.

The traditional method of pen and paper-based survey, due to its cost of deployment and the lack of ability to scale, has been a major roadblock in delivering holistic care services. In addition, the cost associated with the collection and storage of huge volume of data, the impact of data loss during transmission, and the complexity of analysis have also been deterrents for the same. With the advent of digital revolution, new strides in cloud computing, and the increase in reach and acceptance of mobile technology among the masses, the cost of delivering a holistic care solution at scale has become manageable and hence the solution has become feasible now.

A smart phone and a mobile app with the provision of storing data in the cloud have helped in dramatic reduction of time and material cost. G-Power is an application aimed at providing holistic care to the adolescent girls (between the ages of 10 and 19), who have a unique set of problems not addressed comprehensively so far by any solution that we are aware of.

In this paper, we discuss the above challenges, the solutions to addressing them, and the insights generated from the field deployments in two districts of West Bengal, India.

RELATED WORK

Agents as model of monitoring as well as delivery of social welfare services have been used in various government and non-government projects. The Anganwadi model has been successful in India where Anganwadi workers act as a bridge between various government schemes and programmes on one hand, and the mothers and children as the beneficiary of these services on the other hand.

Similar other initiatives involving use of intermediate agents as service facilitators for agriculture in India and as national land care facilitators in Australia are being rolled out.

NGO's like Child In Need Institute (CINI) have been leveraging intermediate agents for delivering services as well as for monitoring these services. The approach of using the intermediate agents for delivering services could not be scaled with the use of pen and paper. This is exactly where the use of digital technology comes in.

PROBLEM DEFINITION

Compartmentalised care over decades in Education, Protection, Health and Nutrition has not provided the desired benefits. The major challenges in providing holistic care in the current situation are the following:

1. **Siloed Approach**

   Holistic care can be provided when all the verticals, such as, Health, Nutrition, Education, Finance and Protection are tracked together and a composite picture of the individual's status is generated.

2. **Lack of Digital Technology**

   The traditional method of pen and paper survey has been a major roadblock in providing holistic care monitoring. This is not only due to cost and the scale involved, but also because of lack of real time analysis of the collected data. The enormity of data collected and

stored, the intentional mistakes and fraud, the amount of data loss during propagation, together with the cost and complexity of analysis are some of the deterrents for the same.

3. Time Gap

There is a time gap between data gathering, analysis and insight generation for taking corrective actions. By the time actions are determined and are readied for implementation, the ground reality is found to have changed.

4. Inconsistency of Unstructured Data

Even after spending a considerable amount of time in training the agents, it is difficult to get the same consistency and quality in output when data is collected in an unstructured format.

TECHNOLOGY AND BUSINESS CHALLENGES

Even when the latest technology is used, there are a few technological challenges as summarised below:

1. *Local language*: Most of the intermediate workers are trained in the local language and are not very familiar with English.

2. *Data entry*: Entering data in the field by typing free text is a challenge due to time and form factor. Furthermore, it is highly error-prone.

3. *Fraud detection*: Detecting intentional mistakes in data entry by the operator is a challenge.

4. *Dynamic Q&A*: Selecting the next question to be asked in a dynamic manner based on the answer given to the previous question is a challenge.

5. *Intermittent Network Connectivity*: The lack of network connectivity or presence of intermittent network connectivity has been a challenge for applications.

6. *Mapping girls to schemes*: Manually identifying the beneficiary girls and mapping available government schemes to the relevant beneficiaries is currently done in an ad hoc manner and hence is not very accurate.

7. *On-demand report generation*: Customised report generation, and usage of ad hoc queries to fetch data are challenging to cater to sudden analysis.

SOLUTION APPROACH

Improved Data Collection and Analysis in Real Time

GPower improves the data collection process by:

1. Empowering community facilitators (CFs) to "register" beneficiaries on the go through a mobile device.

2. Facilitating survey of EPHN pillars that allows real-time alerts to be generated if any vulnerability is detected.

3. Allowing the CFs to raise a grievance, sharing the information instantly with all the relevant stakeholders and tracking progress on mitigation of the grievance.

4. Generating timely reminders for follow-ups.

Using cloud-based technology, GPower ensures quick transmission of data to centralised servers, which allows real-time data analysis. Its analytics-based functions then process the data to provide instant insights. These insights create a continuous information flow that not only allows tracking of individual cases of vulnerability, but also reveals trends and allows forecast of results.

Table 1: Comparison of existing system with Gpower

Without GPower	With GPower
Government programmes in EPHN areas operate in isolation and are unable to provide services to address the vulnerability of adolescent girls in a comprehensive manner.	Government programmes in EPHN are tracked at the beneficiary level across these four verticals and assessed holistically. GPower drives convergence.
Data is captured in paper forms or registers; is prone to human error; and does not allow effective analysis.	Data is captured electronically with stringent quality checks, and can be aggregated at different levels of granularity.
Data analysis is conducted offline once in several months, and potential problems cannot be forecast.	Data analysis is conducted in real time and hence vulnerability can be detected continuously, and even predicted.
Data is analysed manually, sometimes erroneously and insights are derived at a later stage leading to incorrect inference.	Data is analysed automatically and in an accurate manner; insights are derived in real time leading to correct inferences.
The instances of missed service for a beneficiary are identified manually, after filtering paper records, and can lead to missed follow-ups.	The identification of missed service is automated through electronic processing; reminders generated eliminate missed follow-ups.
There is no provision for generating alerts on the system.	The system provides a simple mechanism for field agents to raise alerts that are shared with all relevant stakeholders.
Counselling of victim and parents happen only after an incident such as detection of malnutrition or school dropout.	Counselling happens well ahead of an untoward incident as real-time data analysis detects trends and predicts instances of vulnerability.

SOCIAL MOBILE ANALYTICS AND CLOUD

Hierarchical Social Networking

With the tablets and mobile phone the CF's do social networking among themselves and with their supervisors about various issues. The uniqueness of the approach is that unlike in traditional social network, everyone cannot communicate with everyone on a peer-to-peer basis rather one can communicate certain types of messages like grievances or

concerns with their supervisors only, and certain other types of messages, such as questions about their work with their peers only. Similarly, the supervisors will be able to share best practices with all the workers under their supervision while sharing status of problem resolution only with their peers.

Mobility

The solution is portable across various mobile and tablet models with different form factors. Being developed in android it is easier to deploy across various devices supported by the android platform.

Insightful Analytics

Analytics happens in two places: (1) at the edge (mobile device itself) and (2) at the centre (cloud). The edge analytics is usually lightweight and used for quick decisions while the analytics done in the cloud is more intense where correlations are done across millions of records, insights derived, alerts generated for various stakeholders, and reports generated for planning purposes.

Using Cloud to Create Convergence

From the CF's Android tablet, the data is transferred to a remote centralised server on the cloud. This data is then used for real-time problem monitoring and mined for insights. GPower architecture is shown in Figure 1.

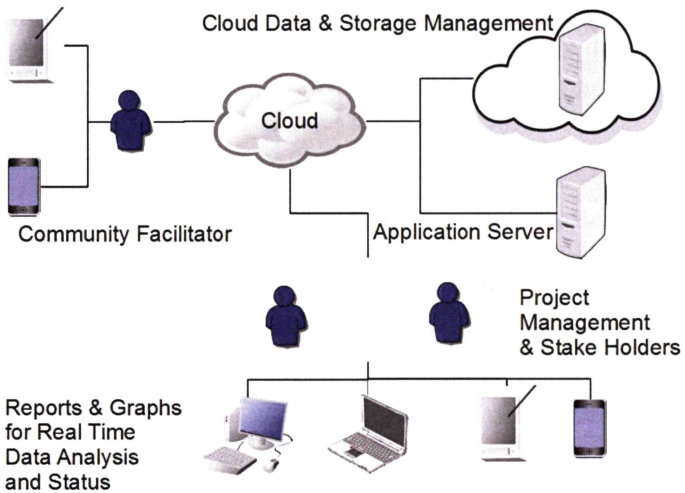

Figure 1: GPower Architecture

PROBLEM RESOLUTION APPROACH

The technological and operational challenges faced were resolved by taking the following steps:

1. *Local language*: The application is architected such that the language-dependent part is clearly separated from the language-independent part. For the language-dependent part, it uses the local language support provided by Android platform.

2. *Data entry*: The number of text to type was reduced to minimum without sacrificing the consistency and quality the app was trying to address.

3. *Fraud detection*: When the data was entered into the tab, the GPS location of the device was used to locate the services availed by the beneficiary girls and the location of home of the beneficiary girls.

4. *Ease of use*: The GPower app has been designed in such a way that the required data entry places are shown only when it is required.

5. *Intermittent network connectivity*: Due to the remote areas of the operability of the app, offline mode of data entry was designed, without compromising any of the features mentioned above. The data is stored in the app in offline mode and whenever connectivity is available it is transmitted to the cloud server.

6. *Smart visualisation*: The GPS feature was utilised to plot accurately the location of resources inside a particular village.

7. *On-demand report generation*: The data stored in the cloud in a RDBMS could be used to generate dynamic reports.

8. *Scalability*: The design of the app using cloud storage and cloud API enabled scalability in a seamless manner.

9. *Smart database*: A secondary graph database Orient DB was used to store dynamic information about the beneficiary girls and to create their profile. This would be used to identify and then query features about the girl or women in future.

TECHNOLOGY DETAILS

Use of Expert System for Rules Engine on Android

"CLIPS" is an open source expert system library with JNI (Java Native Interface) support for integration with Android. In GPower, we create a knowledge base by getting answers to 32 questions and rules are written to identify the vulnerability based on those questions. Each question has two to five choices. The choices have weightage between 1 and 5. The vulnerability formula is given below:

$$VI = \frac{\sum_{n=1}^{32}(Q_n)}{n}$$

Where Q_1, Q_2, $Q_3 \ldots Q_n$ are answers; VI is vulnerability index.

API Gateway on Cloud for Seamless Integration

API (Application Protocol Interface) is used as a means of providing service to the android client devices. The data transfer from android clients to server is done by calling various services which exposes API end points or URL, through the API gateway as shown in Figure 2.

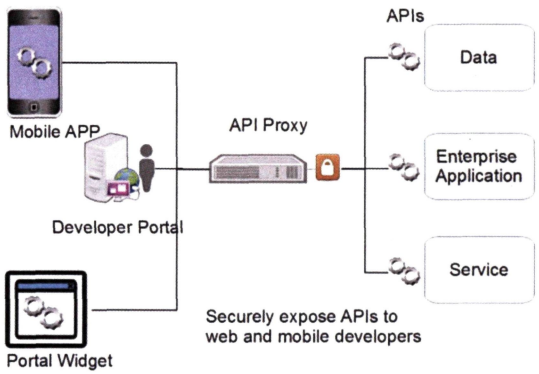

Figure 2: API Gateway Architecture

Offline Data Storage Mechanism in Android using SQLite

Due to the remote area of operations of CF there was a need for a mechanism of storage of data in the android client when the connectivity was not there with the API gateway via Internet. SQLite was used to store the data of the applications. When connectivity was available the data was transferred automatically to the server.

Dynamic Excel Reports

Macros were written to make dynamic excel reports. These are interactive and would fetch data on demand from the server via internet. The data is encrypted and decrypted while being exchanged from the server. Thus, the reports require internet availability to function and are as per application software by itself.

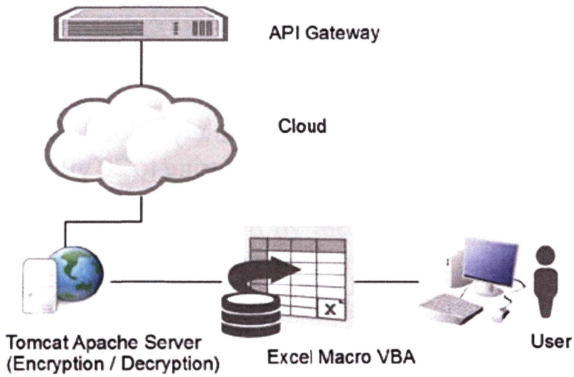

Figure 3: Dynamic Excel Report Architecture

VULNERABILITY INDEX (VI)

Vulnerability index is calculated in the range of 1 to 5, with 1 being the worst. For every girl, a VI is generated for each vertical and a consolidated VI across all the four verticals is also generated. The colour code for each question response for VI is shown below.

Table 2: Vulnerability Index (VI) Score by Colour

VI Score	Colour Code
1 < Score <= 2	Red
2 < Score <=4	Yellow
4 < Score <=5	Green

The reports are generated and aggregated at different levels, such as, village, Gram Panchayat, Block and District level. The most vulnerable girls can be easily identified and highlighted.

It is also possible to visualise the vulnerability trend of a particular girl based on the survey done to generate insight. The issues of the girls and their current status and the mitigation steps taken by the CF can also be seen.

FIELD DEPLOYMENT AND SYSTEM EVALUATION

Deployment Setup

In two districts of West Bengal, namely "South 24 Parganas" and "Murshidabad", GPower was launched catering to 20 villages. Four Tablet PC's were given to four community facilitators with provision of 2G data connectivity.

The CF's were to use the tablets to register family members including the target girl child's data as part of base lining of data. These baseline data were to be used later for comparison to identify the status of various vulnerability indicators across the EPHN verticals. Once the base lining was completed, the CF's performed the survey in the form of questions of the target girls every month, to record their status and the data was used to compute the vulnerability index (VI) of the girls. VI is presented in a visually identifiable manner in real time. Thus, a real life dynamic and complex family issue like child abuse is recorded in a structured format and the raw data is processed to generate a meaningful report within hours.

The services availed by the girls are also recorded in the system. This information is used to do cause and analysis of greater vulnerability identified in particular geographical region. The mobile application running in the tablet has features like automated task reminders like pending monthly surveys and follow up issues. The girls' family members registered whose age became inside the target range of 10-19 years during the course of the project was automatically queued as pending monthly survey.

IDENTIFICATION OF THE MOST VULNERABLE GIRLS

Table 3: Top five vulnerable girls from baseline survey

Family Member ID	Baseline Average VI
Fm1	1.75
Fm2	2.3125
Fm3	2.3125
Fm4	2.3125
Fm5	2.34375

Table 3 shows the five most vulnerable girls based on their baseline survey data. The average Vulnerability Index was calculated on the response of 32 questions.

Mitigation Actions

Detailed analysis of the answers obtained in the survey is done, issues are identified and recorded by the CF. The steps taken by the CF for mitigation of the issues, if any, are identified based on the Childs Right Information Sheet that contains the government schemes a child is entitled to. If any additional mitigation steps are required, the CF is notified. Detailed analysis from the survey shows lack of toilet facility and lack of regular availability of free text books and school uniform deter students from going to school, making them vulnerable.

August 2014 Survey showing category wise distribution of VI.

Table 4: Shows district wise comparison of VI

Aug 14 VI	District		
VI Types	Murshidabad	South 24	Grand Total
1-2	0%	0%	0%
2-3	9%	7%	8%
3-4	91%	92%	92%
4-5	0%	1%	1%
Grand Total	100%	100%	100%

Table 4 shows that the distribution of VI in two districts by vulnerability type in percentage. Note that less than 10% of the girls belonged to type 2-3 were more vulnerable compared to those in types 3-4 and 4-5. These girls became the prime target for close tracking and just-in-time intervention to prevent untoward incidents from happening to them.

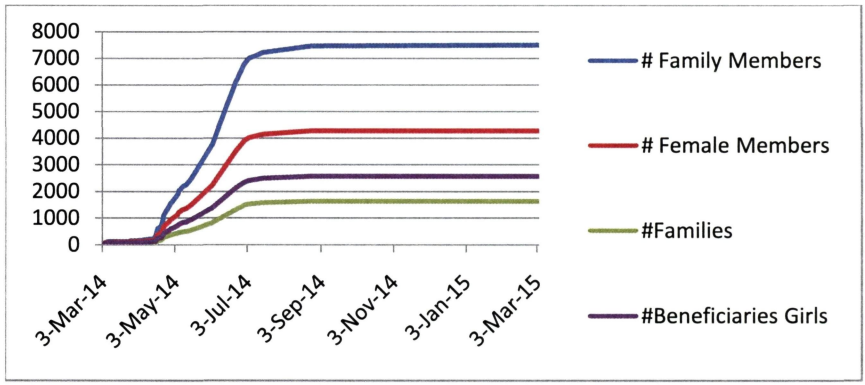

Figure 4: The progress of type of registration in one year

As shown in Figure 4 the blue line represents the total number of family members registered, from March 2014 to March 2015, a period of one year. Amongst them the number of female members registered is represented by the red line. The green line represents the number of families comprising these registrations whereas the number of beneficiary girls between the ages of 9 and 19 is represented by the purple line.

Table 5: Average VI score of parameters between two districts (The better value is shown in*)

	EDUCATION	Murshidabad	South 24
ea4	Fees taken by school	4.27	4.99 (*)
ea6	Toilet facility in school	3.56	4.82(*)
pa3	Number of children	3.65 (*)	2.50
pa4	Parents' education	2.61	3.10 (*)
pa8	Living environment	4.23	4.93 (*)
pa9	Family environment	4.46	4.93 (*)
pa11	Social /religious pressure	4.27	4.94 (*)
ha2	SRH knowledge	2.20(*)	1.64
ha5	Safe motherhood	2.96	3.91 (*)
na1	Anaemia knowledge	2.27 (*)	1.63
na2	Iron and folic acid and de-worming consumption	3.36 (*)	2.87
na4	Mid-day meal quality/quantity	3.61	4.45 (*)

Baseline March 2014 data comparison of two districts

The table above shows that ha2 and na1 are the worst performing parameters in the two districts as their average VI scores is the lowest among all the parameters. In addition, it is clear that the girls in the district of Murshidabad were slightly better off compared to those of South 24 in these two parameters.

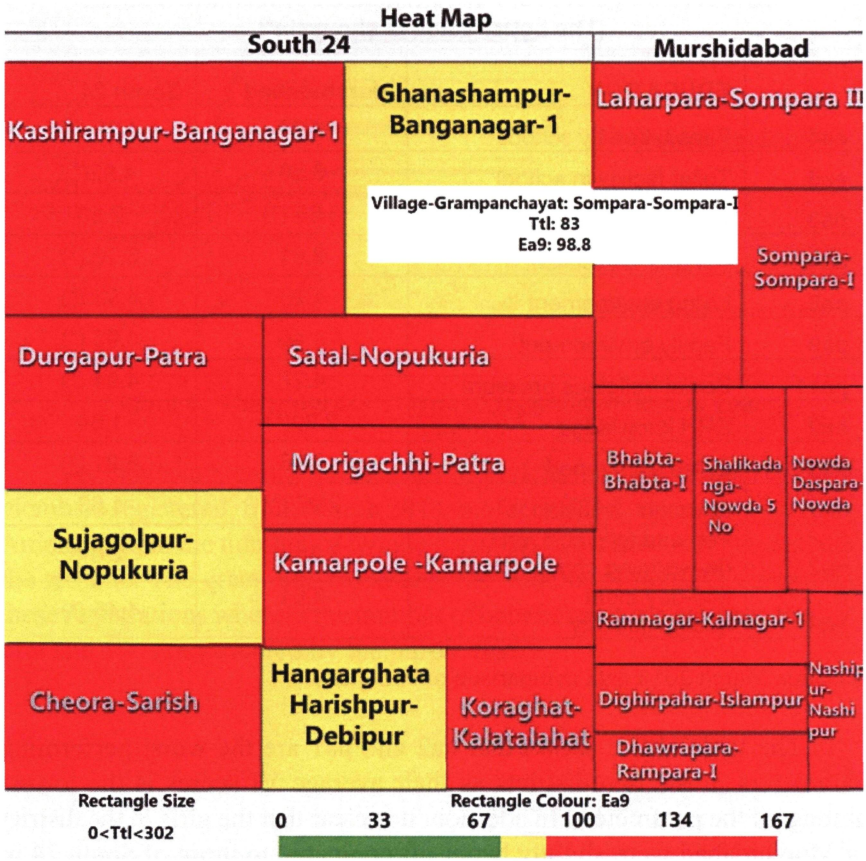

Figure 5: Heat map and geographical distribution of villages by Ea9 parameter with vulnerability score of <= 2

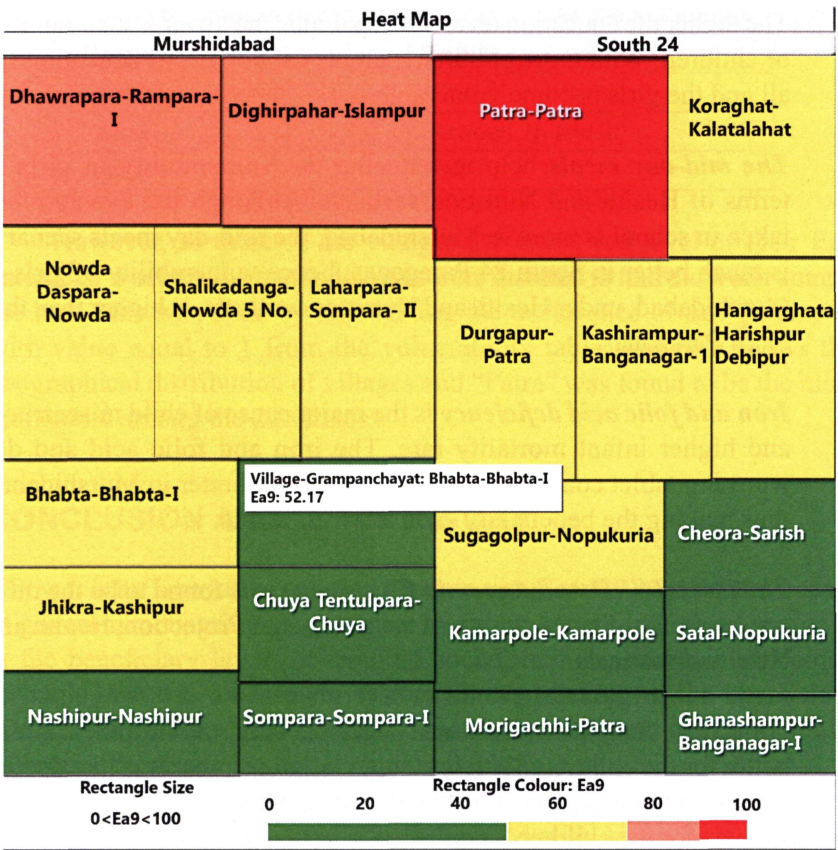

Figure 6: Heat map and geographical distribution of villages by Ea9 parameter with vulnerability score of 1

Insights from the Trial as Shown in Figure 5 and Figure 6

1. The monthly survey designed with 32 questions was found to be time consuming and impractical to implement on a large scale. The number of questions was brought down to five for monthly surveys.

2. The major reason for school dropout among adolescent girls is the lack of proper toilet facilities in school. The presence of better toilet facilities in South 24 Paraganas encourages the girls to attend schools lowering their vulnerability in terms of Education, Health and Nutrition verticals.

3. The higher the education level of the parents; the lower is their number of children. With more children, parents cannot afford education for all and the girls become vulnerable.

4. ***The mid-day meals*** help in reducing the vulnerability of girls in terms of Health and Nutrition verticals. Although the average fees taken in school is more in Murshidabad, the mid-day meals scenario is much better in South 24 Paraganas; hence vulnerability of girls in Murshidabad, under Health and Nutrition verticals, is higher than that of 24 Paraganas.

5. ***Iron and folic acid deficiency*** is the major cause of child miscarriage and higher infant mortality rate. The iron and folic acid and de-worming tablet consumption was found to be better in Murshidabad thus making the beneficiary girls less vulnerable.

6. ***The lack of SRH and Anaemia Knowledge*** was found to be the most serious cause of vulnerability of the girls under Protection, Health and Nutrition verticals.

7. If the ***Socio Religious situation*** is better, the family environment is also better for the children. With less socio religious pressures like dowry, early child marriage custom, relationship between family members, support for the children's education is better. In South 24 Paraganas, the socio religious situation is better; so girls are less vulnerable.

8. ***Detention in a class for more than a year*** (Ea9) was identified as the top most contributor to vulnerability. The aggregate VI resulting from Ea9 was found to be less than or equal to 2 on the vulnerability scale. The details are shown below in the heat map. The colour code is depicted in the table below.

Table 6: Colours of the heat map as shown the in Figure 6

Colour	Ea9 %
Green	< 75
Yellow	Between 75 and 90
Red	> 90

However, as most of the villages are at the red level or their Ea9 parameter was bad, the methodologies were distilled to find the worst among the bad. This was done by aggregating the occurrence of Ea9 parameter with value equal to 1 from the vulnerability table. Figure 6 shows the geographical distribution of villages and "Patra" was found to be the most vulnerable among the 20 villages.

CONCLUSION AND FUTURE WORK

GPower is an innovative solution that can significantly enhance the impact of government flagship programmes by supporting an integrated approach at the beneficiary level. Leveraging social, mobile, analytics and cloud technologies, this assessment system allows tracking of the beneficiary status, and provides real-time data and analysis to spot trends and take corrective measures in a timely, dynamic manner.

In future, the app can also be integrated with wearable devices like smart bands/watches worn by the beneficiary girls to help track those who are the most vulnerable.

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