Mission Zero

A pandemic poses a special challenge to the society and an even greater challenge to the authorities that have been democratically elected by the society. The authorities face ruthless criticism for their failures and little appreciation for their successes . A specific challenge faced by authorities is lack of co-ordination with its own citizens . Global co-ordination is considered the best way to tackle a pandemic, the first step towards such an approach would be where citizens started co-operating with their own elected governments. This particular game explores an approach where the user is placed in the authoritative position to tackle the pandemic and take the necessary steps keeping in mind the economical and health consequences of taking the measures . The game hopes to instil a sense of responsibility and help in incorporating the importance of complying to government directives in these critical times.

The game also hopes to intuitively explain some common concepts in handling of an epidemic. The user realises how flattening the curve can help reduce deaths, how lockdowns even at a great economic price can be useful in the longer run and how little investments in basic hygiene could go a long way (distribution of face masks and installation of sanitisation stations) . We hope the following game and its progress can

help people move towards healthier habits with the ultimate goal of eradicating the pandemic.

The player starts with a budget and is given the following controls: he can increase hospital capacity; increase testing capacity; install sanitisation stations; distribute face masks and make crucial investments to revive economic growth . The player starts with a fixed budget and spends accordingly to control the epidemic . The user must keep the number of deaths within a respectable target and also make sure that a certain economic growth is achieved to move on to the next level .

The game fulfils the solution requirements in following manner:-

1. The game encourages the player's desirable behaviour such as - staying at home, sanitization and wearing masks.

The mechanism of the game is such that the number of cases rise alarmingly when there is no / partial lockdown, and comparatively lesser in case of total lockdown which instils in the mind of player to stay at home no matter what.

Sanitization at various places is one of the key controls the player has by investing some amount of money. Taking this measure would decrease the number of infections. Another control the player has is distribution of masks which has a similar effect.

All these measures when taken by the player at right times would significantly change the aftereffects of the pandemic and he/she would realise its importance.

Moreover, at the end of a level, a graph would be shown to the player which would depict the rise of total cases and deaths with time based on measures taken by him

With this, the player would also be able to understand the situation nicely and appreciate the efforts taken by the government in such a situation. He would realise the importance of following the guidelines given by the government.

2. The game would have a feature of 'Compete online' through which the players could play online with each other. A timer would be set for 15 minutes and a random city with same pandemic situation would be given to each player. Each player would be assigned same money initially. The objective would be to improve the situation without compromising the economy and having minimum number of deaths possible.

At the end, the players would be ranked on the basis of economy, appropriate measures taken at right time and fatalities.

3. The game has various levels in it varying in terms of difficulty. 'Medal of Honour' would be given at the successful completion of each level. The next level would give the player a higher position (promotion). The player would take the positions from

governor (first level) to the president (last level). The lesser number of deaths in a level, the more money the player would get after completion of the level. There would be certain values for deaths, economy, masks distributed and number of sanitization machines installed , which on surpassing would give the player bonus points in the form of powerups. With the help of powerups , the capacities of hospitals could be increased at lower investments, vaccine could be developed quickly and other such benefits would be available.

4. The game doesn't ask any detail of the user other than his username. So, no question of privacy loss.

5. We don't see any possibility of cheating in this game as of now.

6. For playing this game, only an android phone is required.

7. The game by default begins with instructions to the player in a simple language with visual clues , when the player opens it for the very first time. There are only few controls which are to be used by clicking on the corresponding icon of the measure or by clicking on the corresponding building (e.g. Hospital building for increasing hospital capacity). There is also an 'instructions' option in the main menu to review the same whenever needed.

It could be played by anyone who could understand simple English and is familiar with android phones.

8. The game would have a good animation for the player's delight. The game would begin with story told to the player through animation.

Once a level is successfully completed, the player would get more money for the next level , powerups , promotion , different city for next level etc. This would give him a sense of joy and accomplishment.

Also, the 'compete online' feature would allow the player to play along with friends and enjoy.

Following is a picture which depicts how the game would look like while playing:-
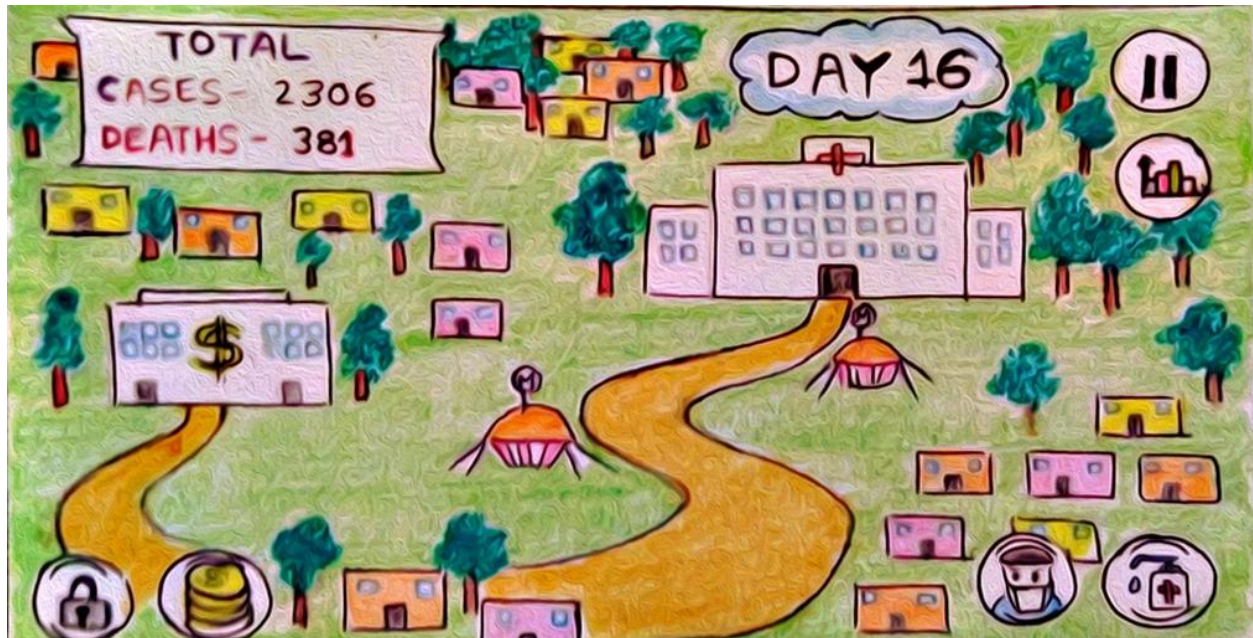
On the top left of the player's mobile screen, the total positive cases and total deaths are shown as of the day mentioned on top right. The player could easily pause the game whenever needed, by touching on the icon on topmost right.

Below that is an icon touching on which the player could see the rise in the number of positive cases and deaths with time in the form of a graph.

 At the leftmost bottom , an icon of lock is visible. It is a control for choosing lockdown state – complete ; partial ; no lockdown. Presently shown in the picture is a situation of complete lockdown in a city.

On the right of lockdown control icon is the funds icon (shown by stack of coins). The player could see the money available and take actions based on it.

 At the right corner there are controls for distributing masks and installing sanitization centres.

For controlling the hospital capacities and making economic investments , the player would have to touch the corresponding buildings as shown in the image. On the right , the biggest building is the hospital and on the left , the building with a dollar sign is the economy centre.

Other small buildings are houses and shops surrounded by tretree

Following are the ways in which the different parameters vary with time at the back end in this game :-

I(t) - number of new infections at time t
H(t) - number of people that need to be hospitalised at time t.
D(t) - number of new deaths at time t.
T(t) - number of positive tests at time t
Ct   - testing capacity
Ch - hospital capacity
tr   - Recovery period

P0 - initial population
V0 - initial economic value

Note - since each of these represents new cases, the actual number of infections in an interval, etc.. can be obtained by taking the area under the curve within that interval

H(t) represents the number of fatal cases and is directly proportional to the number of active cases

$$H(t) = R_0 \int_{t-t_r}^{t} (I(t) - D(t) - T(t))dt$$

R0 here is a fixed constant it is the ratio of fatal cases to total cases.

D(t) in this game is determined by the shortage of hospital capacity

$$D(t) = \begin{cases} H(t) - C_H & if \quad H(t) > C_H \\ 0 & else \end{cases}$$

I(t) here is proportional to both the number of currently infected cases and the ratio of unaffected population to the total population

$$I(t) = R(\int_{t-t_r}^{t} (I(t) - D(t) - T(t))dt) \frac{P_0 - \int_0^t I(t)dt}{P_0}$$

The value of R here can be changed by installation of sanitisation stations, distribution of masks and enforcing a partial or complete lockdown.

T(t) here is proportional to the ratio of active cases to the unscreened population (those who have neither died, tested positive or been hospitalized) and the square of testing capacity (we choose square here as testing is not purely random and surely factors such as contact tracing give an advantage)

$$T(t) = \frac{\int_{t-t_r}^{t} I(t)}{P_0 - \int_0^t (H(t) + T(t))dt}(C_T)^2$$

Note - H(t) includes both people who have died and the people who have been hospitalized.

For economic value, we have a sigmoid relationship between investment and value, such a relationship is chosen as it is realistic to how initial investment can bring great change but as we go higher a certain stall is experienced. The economic value here is also proportional to the square of the ratio of the remaining population to the initial population.

$$V(t) = 2 * \frac{1}{1 + e^{-x/10000}} * \left(\frac{P_0 - \int_0^t D(t)dt}{P_0} \right)^2 * V_0$$

Tax is collected and added to the player s' purse in frequent intervals, tax collected is directly proportional to the value at the time it is collected.

$$Tax(t) = V(t) * r$$

All these integrals are difficult to compute by hand but after giving a statement for the initial values from 0 to Tr (recovery time), they can be approximated using Reimann sum. We have chosen continuous functions instead of discrete integer functions for representing days as that allows for greater flexibility and more command in the hand of the user as he can change states at any time.

Note : A C++ file containing code and an executable file is attached along with this document which is a raw C++ implementation of how the player would get outputs based on the inputs given. It is a prototype of the game. The real game would have a graphical user interface with touch controls.

Thank you