

SYSTEM DYNAMICS MODELING TO UNDERSTAND THE IMPACT OF COVID-19 ON INDIAN ECONOMY

Dr. Anuja Shukla*
Dr. Neha Tomer**
Preeti Singh***

ABSTRACT

COVID-19 has led to a severe health crisis. This sudden and wide impact of corona virus has brought the global economy to its knees. The virus has spread across the world through the chain of transmission. In India, the first case of COVID-19 was reported in the month of February 2020 and has spread drastically within past four months. As a preventive measure, the government announced complete lockdown in the month of March 2020 to stop this pandemic situation in India (Suri, April 30, 2020). This invisible virus has compelled many business organizations to shutdown their respective activities and to follow social distancing norms. The outbreak of COVID-19 has disrupted the Chinese economy first and then it led to affect global economy. This paper models the impact of COVID-19 on Indian economy (Sansa, 2020). The researcher shows the impact using System Dynamics modeling approach. The causal loop diagram was used to explain the causality of series of events. The results show that the strategy of shutdown/lockdown tends to increase the unemployment and ultimately causes negative impact on Indian Economy. In order to revive economy, we recommend, that the focus to be shifted on the factors such as new startups, Government relief funds, development of COVID-19 vaccine, generating employment and better health care facilities to reduce the spread of COVID-19 and strengthen Indian economy.

Keywords: COVID-19, Indian economy, Employment, Lockdown, System Dynamics, Causal loop, Stockflow

* **Subject Matter Expert, upGrad**

** **Assistant Professor, SBM, Noida International University**

*** **M.Phil. Scholar, SBM, Noida International University**

1. INTRODUCTION

Coronavirus emerged as potential threat in December 2019 at Wuhan city of China. Since then, the virus has been drastically spreading across the globe. At the first, almost 2, 00,000 cases are recorded worldwide due to this virus and are on continuous rise (Fernandes, 2020; Gern, & Mösle, 2020; Ozili & Arun, 2020). Many countries are not equipped to face challenges faced by Covid-19, including the developed ones. It is quite uncertain when the emergency may arise as more people are getting affected due to virus day by day. Not only China most of the countries like Europe, America, Italy, Turkey and India are also suffering from this pandemic situation (Acikgoz & Gunay, 2020; Arturo & Ruiz, 2020; Nuhu, 2020). WHO has also declared this pandemic as an emergency at an international level. This pandemic situation has made the whole world strongly connected as the impact of the virus go way beyond mortality. Governments across the world are taking the necessary measures to sustain their economies (Ruiz Estrada, 2020- B).

The lockdown was declared in four phases by government of India: Phase 1 Lockdown (25 march to 14th April), Phase 2 Lockdown (15th April to 3rd May), Phase 3 Lockdown (4th may to 17th may), and Phase 4 Lockdown (18th may to 31st may). Phase 1 and 2 were declared as complete lockdown but phase 3 and 4 some relaxations to movement were granted. These four phases of lockdown led to reduced supply and demand of goods except daily essential items (Inoue & Todo, 2020). Overall economy was impacted as millions of people unfortunately lost their jobs across the globe. The phase one lockdown was a complete lockdown leading to shutdown of the schools, colleges, universities, production houses, markets, business and corporate offices. During phase 1 lockdown period, no relaxations were provided by both central and state governments. Due to sudden shutdown of businesses, people started losing jobs and thousands of people migrated out of major Indian cities to reach their native places (Ruiz, 2020-A). Many companies are announcing the layoffs, shutting down and revising estimates due to change in consumer's buying behavior and simultaneous shortage of supply (S. M. & Sengupta, 2020; Gupta, 2020). As a result, global financial markets fell sharply leading to volatility of financial crisis along with health crisis (Wiki, June 17, 2020)

This paper makes an attempt to develop an understanding of the current situation and tries to model the impact of Covid-19, Lockdown and Unemployment using System dynamics modeling (Forrester, 1994). As the world is interconnected, this model proposes to create a self-regenerating system that can help the economy to recover. The paper has been organized into five sections. First section covers the introduction to the study. The relevant literature reviews are organized in second section. The third section covers research methodology. The fourth section discusses the model using system dynamics approach. The fifth and the final section cover conclusion, suggestions and recommendations.

2. LITERATURE REVIEW

Sulkowski (2020) states that in the wake of COVID-19 virus, individual countries governments are taking necessary actions & making changes for the benefit of their citizen's lives, taking into consideration from the other affected countries experiences. Due to all these actions & decisions, mostly all the types & sectors of enterprises are severally affected. As a result, of which economies of every affected country entering into a phase of recession or stagnation which will be converted into a global recession after sometime if the same situation persists. Carlsson-Szlezak, P., Reeves, M., & Swartz, P. (2020), examines the 3 transmission channels in their study through which the economy of the countries gets infected majorly named as:

Firstly, Financial markets: as the market is going down day by day in this crisis where income & expenditure both falls. Secondly, Consumer expenditure: As the income is lost or low, so the expenditure & consumption pattern of the consumer is decreasing as they consider spending only on

essential items & like to save more for the unpredicted future. Thirdly, Supply chain disruption: As the pandemic puts halt on all the production activities, due to which supply chains got disturbed, which directly impacts the economy of the nation simultaneously with the demand disruption. Abodunrin, Oloye and Adesola (2020) identified major impact of COVID-19 & measures adopted can be felt on the nations economically, socially, politically & human security conditions such as falling of share market & the prices of crude oil globally, hits the travel & tourism industry all over the world, hospitality sector, consumers demand only for essential food items, with the imposing of lockdown restrictions as a preventive measure stops lots of economic & production activities instantly. To overcome from all these situations, governments are taking necessary fiscal measures to save the companies & banks from bankruptcy; a palliative measure has been suggested to reduce the economic hardships. Jaswal and Sharda (2020) explained, as the transmission of the virus is spreading on a very faster pace in every country. To break this chain, many countries has gone under strict lockdown strategy due to which many economic losses has been experienced by the various sectors, only the digital technological industry are in demand these days, as everything has been going on online mode. As we all know this is the global pandemic, so all the counties should respond with a coordinated effort to cope up with this situation.

Muhamad (2020) through the archetypes system analysis, the possible impacts & solutions has been provided. The study has considered 3 subsystems which include: Contagious, healthcare & economy systems, which are interconnected to each other. This COVID-19 virus is so contagious that the development of COVID-19 vaccine is the ultimate solution. Better healthcare facilities needs to be considered by the government which helps to save the lives of human beings. If we respond to the contagious virus very delayed, the consequences will be very adverse on the health of the people & on the economy, as the government has limited funds to support the AD.

Arturo and MEstrada (2020) reported analysis with the help of macroeconomic indicator what will be the effects of this massive pandemic on the world economy in short (1 year) & in the long run (10 years) post COVID-19, whether the world heading towards the recession or depression. Covid-19 Pandemic needs a specific strategy to be tackled (Nyanga et al., 2020). During Pandemic, the ecommerce platforms have become successful due to consumers consciousness (Kalakata, 2021). To prevent from this scenario, an economic expert needs to decide various economic & innovative policies to reduce the damage. Mishra and Kumar (2020) shows the instant shutdown of manufacturing units, falling of financial markets & market disruptions causes economic impact globally. FDI can play an important role to bring back the economic situation under control at some extent with the help of other monetary & fiscal actions. The parents and childrens have undergone extreme stress as a result of pandemic (Shukla, 2020). As the consumer behaviour is changing, it has become important to listen the consumer responses using social media channels (Panwar and Khan, 2020)

Aclkgoz and Gunay (2020), reviewed articles which summarizes the situation & impact of the virus on a small country like Turkey, where this pandemic has been viewed as an economic & political opportunity to develop & indulge in some new ways of living post pandemic, if they tried to control the virus at an early stage, will survive the various sectors, enterprises, which will automatically develop the economy of the Turkey. Gandhi et al. (2021) evaluated performance indicators for technology business incubators in India. Dev and Sengupta (2020) found outbreak of the COVID-19 pandemic has been experienced very late in India, but it shocked the various segments of the economy such as airlines, production units, agricultural, tourism, hospitality, education, MSMEs, financial institutions etc, due to nationwide lockdown imposed by the Prime Minister Narendra Modi government from 25th March 2020 (for almost 60 days) . Pandemic also introduced several HR related challenges (Pandey and Bajaj, 2020). Social distancing has reduced the consumer touch points (Kuma et al., 2020) Due to

the sudden shutdown of all the business activities in the country, lakhs of migrant labors have moved to their native homes. To curb the situation our Indian government has also announced the relief package of worth Rs.2 lakh crores to uplift the Indian economy & to accelerate all the industries who have lost their business during this crisis & a message of "Vocal for Local" & "Atmanirbhar Bharat" has been given as an initiative for startups. As compared to other countries, India's recovery rate is growing, death rate is declining & simultaneously active cases are increasing as the nation is now on the unlocking phase except the containment zones.

Arturo and Ruiz (2020) analyzed the real time economic effect of this contagious disease on 5 different economic markets, East Asia, China, ASEAN, US & European Union. Results of the research indicates the poor performance of GDP of all the 5 markets when the economic wave reached to it final phase due to this Wuhan COVID-19, although in China (Wuhan) is the only place where lockdown has been imposed, all other places activities were going on normally & in US also no lockdown has been announced, so that economic activities can't be affected.

Koirala and Acharya (2020) show how the economy of the country Nepal is highly impacted due this disease. As Nepal is fully dependent country on other countries for its various economic activities. Although many times natural calamities such as earthquakes, floods affected the country, but this contagious disease has very adverse effect on the same. Nepal is very well known for its tourist places, due to this pandemic puts a totally ban on the tourism & hospitality sector which results in the major unemployment in the country. NuhuSansa (2020) conducted a research on the financial markets of China & USA for 25 days to know the accurate impact of COVID-19 by applying the simple regression model. As financial markets plays a very important role in the economy of the country. The result of the model shows that there is a positive significant relationship between the confirmed cases of Covid-19 & all the financial markets of China & USA. So, we need to seriously take some strong actions to control this disease & to boost up our financial markets simultaneously for the health of the overall economy.

Fernandes (2020) explained new type of virus came into existence into the lives of human being which puts every economic activity to human mobility under lockdown, so that we can break the chain of spreading. This is the situation where we all are unknown that when this pandemic comes to an end or by what period (weeks, months, years), we need to be under strict restrictions to prevent from this virus. Same as we can't exactly predict how badly it could affect our global economy, does financial damage, increase in the unemployment level with the declining rate of global GDP & by what extent various policy measures will be beneficial to give a hike to the economy. If it all fails, the chances of facing the biggest threat on the global economy in the last 2 centuries will be more. The situation of crisis that has been arises due to COVID-19, various macroeconomic policies (monetary & fiscal) as a recovery measures needs to be adopted by the developing countries. In a short term, economy can't be stimulated amidst crisis, but we can save the lives of human beings by taking necessary containment & mitigation measures. Simply, we can say that, saving the lives of human can save our future & economy, if there is no population than who will drive the economy of the country or world. Loayza and Pennings (2020)

3. RESEARCH METHODOLOGY

System dynamics modeling was used to model the complex impact of COVID-19 on Indian economy. System dynamics model is used to understand nonlinear behavior of variables by modeling them using feedback process (Sterman, 1992; Forrester, 1994). Systems modeling comprises of two steps, Causal Loop diagram and Stock Flow diagram. The model can be further verified by simulations. As the data for simulation is not yet available, the model only covers CLD (Causal Loop diagram) and Stock Flow Diagram.

4. SYSTEMS MODELLING

4. a. Causal Loop Diagram (CLD)

Making of causal loop diagram is the first step of system dynamics modeling. CLD is a visual representation of the interactive effects of variables. In a CLD model the variables are placed in such a way that shows are circular increasing or reducing behavior. The variables were identified from the literature and industry news (Loayza & Pennings, 2020; Bahri, 2020; Boissay & Rungharoenkitkul, 2020; Gupta, 2020; Rastogi, 2020; Suri, 2020). The causal loop diagram was made using Venzim software. The proposed model is presented in Figure 1 and explained in next section.

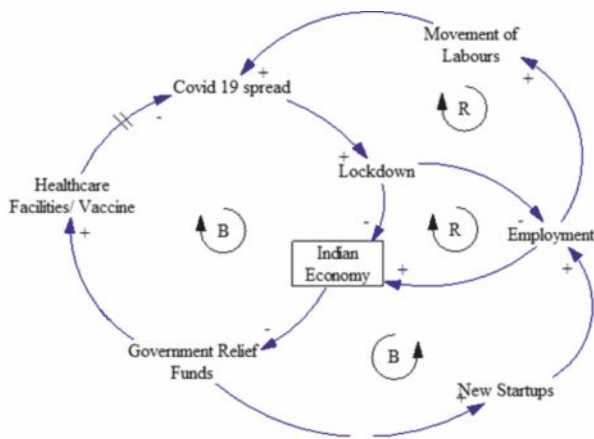


Figure1. Causal Loop Diagram showing Impact on Indian economy

Explanation: There are two loops in (Figure 1) which are explained as under:

1. Reinforcing Loop: Reinforcing loop is a loop that contains variables which keeps on repeating (reinforcing) the phenomenon. In the above diagram there are two reinforcing loops (represented by R in Figure 1):

A. Reinforcing Loop 1: The increase in COVID-19 spread will increase the Lockdown across the country. The increase in lockdown will reduce the employment. Employment is positively linked to Indian economy. Therefore, reduction in employment will further add to negative impact on Indian economy. If this process will continue to repeat itself, hence it is a reinforcing loop.

B. Reinforcing Loop 2: The increase in COVID-19 spread will increase the Lockdown across the country. The increase in lockdown will reduce the employment. As the employment will reduce, there will be movement of workers in search of job or to their respective home states. This movement will increase the spread of COVID-19. Thus a reinforcement loop will come into action.

2. Balancing Loop

Balancing loop consists of variables which decreases the impact of phenomenon. In the given diagram there are two balancing loops (represented by B in Figure 1) which are explained as under:

A. Balancing Loop 1: As the COVID-19 increases its spread, the country was put under lockdown. Due to lockdown the Indian economy suffered with huge losses. Lockdown negatively impacts Indian Economy. As there is downfall in economy, Government releases more funds to cover up.

With several funding, we can have better healthcare facilities and the possibility of Vaccine development. When the vaccine will develop, the impact of corona virus will automatically reduce. Thus, it is a balancing loop.

B. Balancing Loop 2: The second balancing loop represents the impact of labor movement. Spread of COVID-19 led to increase in lock down to two months. Lock down reduced Indian economy growth. Reduction in economy led to increase in funds release by government. E.g. Promotion of MSME for UP government. With these funds, new start-ups will begin. Due to this, employment will generate. As employment will increase, the growth of Indian economy will start. Thus, it is a balancing loop.

4. b. Stock Flow Diagram

Stock flow diagram represents the inflows (increasing variables that add to stock) and outflows (decreasing variables that reduce stock). Stock flow diagram is shown in (Figure 2). Stock flow diagram is made using Stella software. Based on CLD model, a stock flow model is developed. The left side of the model shows those variables which increases the stock. The right side of the model shows those variables which reduces the stock. Employment, Startups, COVID-19 Vaccine, Government relief funds will increase the stock, i.e. Indian Economy. Lockdown and spread of COVID-19 will reduce the growth of Indian economy.

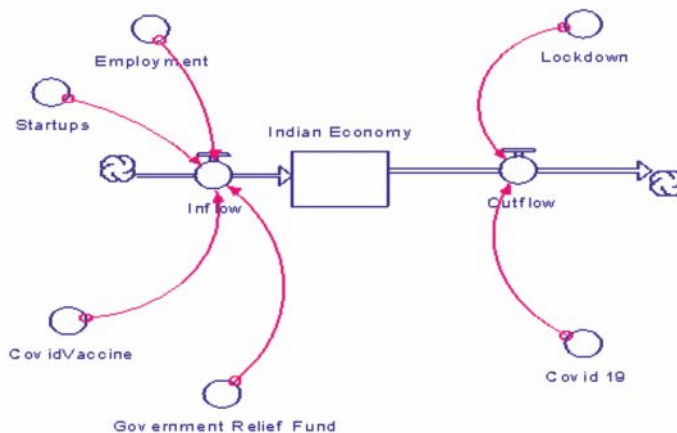


Figure2. Stock flow representing inflow and outflow for Indian Economy

5. CONCLUSION, SUGGESTIONS AND RECOMMENDATIONS

This paper aims to present a holistic view to impact of COVID-19 on Indian economy. The causal loop diagram clearly explains the endogenous and exogenous factors that lead to increase in Coronavirus spread and reduction in growth of economy through reinforcing loops. The balancing loops represent the factors responsible for reducing COVID-19 and hence increasing the Indian economy growth. The Government and citizens of India should try to increase the strength of balancing loop, so that, the economy could be recovered from loss.

The stock flow diagram clearly shows the inflow and outflow variables. The inflow variables will increase the stock i.e. growth of Indian economy. The outflow will reduce the growth of Indian economy (Rastogi, 2020). Therefore, we should focus on increasing the inflows to maintain the growth of economy. Employment, Startups, COVID-19 Vaccine, Government relief funds will increase the stock, i.e. Indian Economy. The outflows, namely Lockdown and spread of COVID-19 will reduce the

growth of Indian economy. Mishra et al. (2021a, 2021b) proposed the impact of new technologies on consumers, hence future studies may focus on evaluating the impact of COVID-19 driven usage of technology and impacts on economy. Consumers adopt technology such as mobile payments for grocery shopping (Shukla and Sharma, 2018) and the consumer generated word of mouth impacts online hotel booking (Shukla and Mishra, 2021). ICT has influenced the usage of technology and thus paved way for women entrepreneurs (Shukla et al., 2021), Thus future studies must evaluate how the technology impacts economy since covid-19 has led increase in technology usage.

REFERENCES

- Abodunrin, O., Oloye, G., & Adesola, B. (2020). Coronavirus pandemic and its implication on global economy. *International Journal of Arts, Languages and Business Studies*, 4.
- AÇIKGÖZ, Ö., & GÜNAY, A. (2020). The early impact of the Covid-19 pandemic on the global and Turkish economy. *Turkish journal of medical sciences*, 50(SI-1), 520-526.
- Bahri, M. (2020). The nexus impacts of the Covid-19: A qualitative perspective.
- Boissay, F., & Rungcharoenkitkul, P. (2020). Macroeconomic effects of Covid-19: an early review (No. 7). Bank for International Settlements.
- Carlsson-Szlezak, P., Reeves, M., & Swartz, P. (2020). What coronavirus could mean for the global economy. *Harvard Business Review*, 3.
- Dev, S. M., & Sengupta, R. (2020). Covid-19: Impact on the Indian economy. *Indira Gandhi Institute of Development Research, Mumbai April*.
- Fernandes, N. (2020). Economic effects of coronavirus outbreak (COVID-19) on the world economy. SSRN 3557504.
- Forrester, J. W. (1994). System dynamics, systems thinking, and soft OR. *System dynamics review*, 10(2,3), 245-256.
- Gandhi, V., Syed, A. A., & Jain, S. K. (2021). A study of performance indicators of Technology Business Incubators (TBIs) in India. *Management Dynamics*, 21(1), 14-23.
- Gern, K. J., & Möhle, S. (2020). The impact of the COVID-19 pandemic on the global economy: Survey-based evidence from free zones (No. 139). *Kiel Policy Brief*.
- Gupta, A. (2020, May 19). Coronavirus (COVID-19) And Indian Economy - Coronavirus (COVID-19) - India.
- Inoue, H., & Todo, Y. (2020). The propagation of the economic impact through supply chains: The case of a mega-city lockdown against the spread of COVID-19. Available at SSRN 3564898.
- Jaswal, N. (2020). COVID 19–IMPACT ON PUBLIC HEALTH AND ECONOMY OF THE NATION. *Purakala with ISSN 0971-2143 is an UGC CARE Journal*, 31(12), 346-350.
- Kalakata, A. (2021). Flipkart: Driving Ecommerce During COVID-19. *Management Dynamics*, 21(1), 07-13.
- Kumar, H., Pillai, S. V., & Vipin, H. (2020). Impact of Age and Social Distancing on COVID-19 Epidemic in India. *Management Dynamics*, 20(2), 18-29.
- Loayza, N. V., & Pennings, S. (2020). Macroeconomic policy in the time of COVID-19: A primer for developing countries.

- Mishra, A., & Shukla, A. (2020, December), Psychological Determinants of Consumer's Usage, Satisfaction, and Word-of-Mouth Recommendations Toward Smart Voice Assistants. In International Working Conference on Transfer and Diffusion of IT (pp. 274-283). Springer, Cham.
- Mishra, A., Shukla, A., & Sharma, S. K. (2021a). Psychological determinants of users' adoption and word-of-mouth recommendations of smart voice assistants. *International Journal of Information Management*, 102413. (A* category + scopus)
- Mishra, A., Shukla, A., Rana, N. P., & Dwivedi, Y. K. (2021b). From "touch" to a "multisensory" experience: The impact of technology interface and product type on consumer responses. *Psychology & Marketing*, 38(3), 385-396. ('A' category + scopus)
- Mishra, M. K. (2020). The World after COVID-19 and its impact on Global Economy.
- Nyanga, T., Zirima, H., & Mashavira, N. (2020). Withering COVID 19 Storm: Survival Strategies Employed by Informal Traders in Masvingo Urban, Zimbabwe. *Management Dynamics*, 20(1), 01-09.
- Ozili, P. K., & Arun, T. (2020). Spillover of COVID-19: impact on the Global Economy. SSRN 3562570.
- Pandey, S., & Bajaj, R. (2020). A Study on Upcoming Global Human Resource Challenges and Concerns during COVID-19 Outbreak. *Management Dynamics*, 20(1), 10-17.
- Panwar, T., & Khan, K. (2020). Social Listening: A Strategy to Bond with the New Age Customers. *Management Dynamics*, 20(2), 1-5.
- Rastogi, A. S. (2020, May 20). The New Normal: Analysis of COVID-19 Impact on the Indian Economy.
- Ruiz Estrada, M. A. (2020, A). COVID-19: Economic Recession or Depression? Available at SSRN 3575881. Koirala, J., & Acharya, S. (2020). Impact of Novel Corona Virus (COVID-19 or 2019-nCoV) on Nepalese Economy. Available at SSRN 3560638.
- Ruiz Estrada, M. A. (2020, B). Economic Waves: The Effect of the Wuhan COVID-19 On the World Economy (2019-2020). Available at SSRN 3545758.
- Sansa, N. A. (2020). The Impact of the COVID-19 on the Financial Markets: Evidence from China and USA. *Electronic Research Journal of Social Sciences and Humanities*, 2.
- Shukla, A. (2020). Impact of Technology on Child Psychology During COVID-19. *Management Dynamics*, 20(2), 6-9.
- Shukla, A., & Mishra, A. (2021). Effects of Visual Information and Argument Concreteness on Purchase Intention of Consumers Towards Online Hotel Booking. *Vision*, 09722629211038069. ('C' category + scopus)
- Shukla, A., & Sharma, S.K. (2018), Evaluating Consumer's Adoption of Mobile Technology for Grocery Shopping: An Application of Technology Acceptance Model, *Vision– The Journal of Business Perspective*, SAGE publication, 22(2), 185-198, ISSN 0972-2629. (C category + Scopus)
- Shukla, A., Kushwah, P., Jain, E. and Sharma, S.K. (2021), Role of ICT in emancipation of digital entrepreneurship among new generation women, *Journal of Enterprising Communities: People and Places in the Global Economy*, <https://doi.org/10.1108/JEC-04-2020-0071> (C Category + Scopus)
- Sterman, J. D. (1992). System dynamics modelling for project management.
- Su kowski, . (2020). Covid-19 pandemic; recession, virtual revolution leading to de-globalization? *Journal of Intercultural Management*, 12(1), 1-11.
- Suri, I. S. (April, 30, 2020). Impact of COVID 19 on Indian Economy and Road Ahead for Corporate Sector.