International Journal of Social Science Research and Review

http://ijssrr.com
editor@ijssrr.com
Volume 5, Issue 9
September, 2022
Pages: 284 -301

The Role of the Cosimpol Simulator in Mediating Dialogue for the COVID-19 Pandemic

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http://dx.doi.org/10.47814/ijssrr.v5i9.499

Abstract

The COVID-19 pandemic has created widespread turbulence. We have witnessed how the lockdowns in South Africa negatively impacted the economy, resulting in unemployment and loss of livelihoods. Various sectors, including the education and tourism sectors, have been severely impacted and we are now seeing the myriad economic and social issues that are coming to the fore. It is clear that we are faced with a complex, messy situation, characterised by multiple stakeholders who hold diverse mental models and perspectives. The main aim of this paper is to draw lessons for consideration by policy-makers in South Africa dealing with the pandemic, by understanding how the CoSimPol simulator model can be used in mediating dialogue for the COVID-19 pandemic. The model caters for multiple factors including bed capacity, hospital care, use of Personal Protective Equipment and non-pharmaceutical interventions such as social distancing. From a conflict and peace perspective, a key contribution of this paper is to demonstrate how models such as CoSimPol may be applied not only for predictive capacity in formulating policy, but more significantly ought to be used as transitional objects for dialogue between contending parties and positions.

Keywords: *COVID-19; Policy; Dialogue; Stakeholder Management; Complexity; Systems Thinking; South Africa*

Introduction

Our lives have been dramatically affected by the COVID-19 pandemic. We are faced with immense volatility, uncertainty, complexity and ambiguity (VUCA), and life as we know it has been majorly disrupted [1, 2, 3]. Lives have been lost, and many economies and businesses have suffered and even closed down. On the individual level, many have battled with the multiple effects that the lockdown has had on their very being –both personally and professionally [1, 4, 5, 6, 7, 8]. The diverse effects will be felt for many years to come and, as time progresses, more will become visible [9, 10, 11]. The pandemic laid bare our fragility and the limitations of civilization and economic systems [12].

We need to be cognisant that policies that government have had to rapidly put in place to deal with the short-term crisis may result in unintended consequences, and we could see impacts in areas, which were perhaps not even conceived of in the beginning. We have, for example, witnessed the negative consequences of physical distancing on the economy and the labour force [13]. It is therefore critical that efforts be made to bring diverse stakeholders together to engage in dialogue and co-create, as they try to formulate a common path in the midst of an uncertain future.

We are also able to see the dynamic nature of the pandemic, and how it becomes difficult to predict or forecast what will happen. Different countries were at different stages, with some already having experienced the peak, while others were having to face a third, fourth or even fifth wave, and perhaps again find themselves forced to resort to hard lockdowns [14, 6]. Some countries have experienced protests as individuals have challenged the policy decisions that have been made by their governments. The South African government, therefore, needs to be proactive in avoiding further tensions and possible unrest, which have the potential to destabilise the country. Putting in place appropriate interventions is however challenging given the immense uncertainty, unpredictability, and limited information, and the fact that the science of the epidemic is unknown.

Governments across the world had to introduce various measures to curb the spread of the virus [15]. Typical measures included "isolation, quarantine, social distancing, and community containment measures" [16: pg. 1549, 17]. The South African context is complex and characterised by high levels of poverty, unemployment and inequalities, which unfortunately further exacerbate the situation. African governments had to ensure that there was sufficient testing, contact tracing and also the ability to effect lockdowns, and restrictions pertaining to work and travel [13]. South Africa, like many other countries, responded by implementing a strict lockdown towards end March 2020, with the main aim of preparing the healthcare system and slowing the infection rate [15]. Key factors in South Africa's fight included: ensuring that there were enough facilities and beds; training and capacity development for medical personnel; adequate Personal Protective Equipment (PPE) and medical supplies; and developing awareness campaigns for communities [16].

The country went through various levels of lockdown. There were numerous warnings that citizens should not become complacent as we may see a rise in infections again. It was thus paramount that citizens had to heed the calls to be responsible by ensuring frequent hand washing, wearing of masks, maintaining physical distancing, and sanitising. Mehtar et al. [13: pg. e881] argue that "as lockdowns and physical distancing measures are eased, proactive surveillance, case detection, and contact tracing with isolation will be required to prevent a dramatic resurgence of COVID-19 cases". The African context does, however, make popular interventions such as handwashing and physical distancing challenging due to poverty, overcrowding and poor healthcare [13].

The main aim of this paper is to draw lessons for policy makers in South Africa to consider in dealing with the pandemic, by understanding how the CoSimPol simulator can be used in mediating dialogue for the COVID-19 pandemic. We briefly present the simulation model, which was designed using system dynamics methodologies, and which can be used by policy makers in South Africa to run various scenarios and present different options for dealing with the pandemic. The systems and complexity lens is used then as a framework for policy makers to become aware of the multiple, dynamic factors that create complexity, and which require agility, adaptability and resilience, thus necessitating dialogue to mediate the many valid, diverse perspectives.

The Cosimpol Simulator

The pandemic can be thought of broadly as being non-linear and we also see how a minor change can result in systemic reactions, and also how there is uncertainty on how changes in one part of the system evolve or affect other parts [18, 19]. It is clear that we are faced with a complex, messy situation, characterised by multiple stakeholders, who hold diverse mental models and perspectives [4, 20 21, 22, 19 8]. There are many variables and unknowns, and policy decisions cannot easily be made as a result of the immense complexity and diverse values and perspectives that characterise the handling of the pandemic.

We are faced with a 'wicked problem' [23, 5, 24, 25] where it is difficult to define the very problem. We need to acknowledge the multiple dimensions of the problem, which include "health, economic, social and environmental perspectives" [25: pg. 5].

A simplistic approach, assuming predictability and simple linear stages, is bound to fail. Agerfalk [1: pg. 203] reminds us that we are "scholars in many disciplines around the world… collaborating in a "war" against an invisible enemy". We, thus, contribute by presenting a simulation model, CoSimPol COVID-19, which was designed using system dynamics methodologies, and which can be used by policy makers in South Africa to run various scenarios, and present different options in dealing with the pandemic.

We do not aim to present solutions based on simple cause-and-effect thinking, but rather outline critical aspects which need to be considered by those in leadership who need to navigate the complexity, to lead the country through the pandemic. It is important to bear in mind that these diverse factors interact in multiple complex ways to create outcomes, and often result in unintended consequences which may only become manifest at a later stage.

The perceptions of the public are critical to ensuring that citizens change their behaviour to comply with state-enforced recommended public health protocols (Amir Singh, 2020). "Some countries are investing in low-cost preventive measures to improve physical distancing, such as stopping international travel, reducing the number of people at religious and social gatherings, and universal masking using non-medical cloth masks for the community. Other measures could focus on protecting older people, allowing individuals restricted working hours for income generation, information campaigns for personal hygiene, physical distancing, and handwashing" [13: pg. e882].

We are, however, reminded by Angeli and Montefusco [18] that achieving behaviour change is complex and impacted by cultural habits. Corburn et al. [9] also highlight the harsh realities of a developmental context, for example, for those in informal settlements who are having to fight the pandemic under challenging conditions, where basic services are non-existent; there are complexities in adhering to measures such as handwashing. The pandemic has also resulted in vulnerable populations, such as the poor and older adults, being more severely impacted [26].

The CoSimPol model is based on a series of non-linear mathematical equations common in dynamic systems [4, 27, 28, 29, 21, 30, 8, 31, 32]. The model can be calibrated for different country settings, as well as localities. It allows users to examine and change assumptions, and also mediate between different scientific positions as increased knowledge about COVID-19 becomes available. The model also caters for multiple factors including bed capacity, hospital care, and non-pharmaceutical interventions (NPI) such as social distancing, and use of PPE.

The model also considers the user to explore immunity levels, the impact of co-morbidities, and different vulnerabilities of infected patients, e.g. those who recover without hospitalisation, those that recover through hospitalisation without critical care, and those that recover through hospitalisation with critical care. CoSimPol also enables insight into when infections will peak and the estimated number of deaths likely.

CoSimPol is significant in that it allows for the generation of valuable data for different contexts, to enable policy insights and decisions. We thus have a user-friendly model that acknowledges the diverse perspectives that exist and is able to develop further understanding of the multiple dynamics at play. The model contributes to policy formulation and is a mechanism to enhance pandemic resilience. From a conflict and peace perspective, a key contribution is to demonstrate how models such as CoSimPol may be applied not only for predictive capacity in formulating policy, but more significantly ought to be used as transitional objects for dialogue between contending parties and positions. They, thus, become tools for navigating social complexity and in mediating social policy options.

This section briefly presents an overview of the CoSimPol simulator to acquaint the reader with the model and its key components that inform the study. The more technical aspects of the model are presented elsewhere.

Figure 1 below is a stock-flow diagram, a core tool in the system dynamics methodology. A stock-flow diagram shows the key accumulations in the stocks and the major physical or decision-making policies that are represented in the flow. Figure 1 represents the main chain of the epidemic model that draws on standard epidemiological SEIR model formulations. However, it is enhanced in CoSimPol to represent the new knowledge of COVID-19 as and when it becomes available. One example of this is that an earlier version of CoSimPol did not have the losing infectiousness flow, a phenomenon that only became more prominent much later in the trajectory of the epidemic.

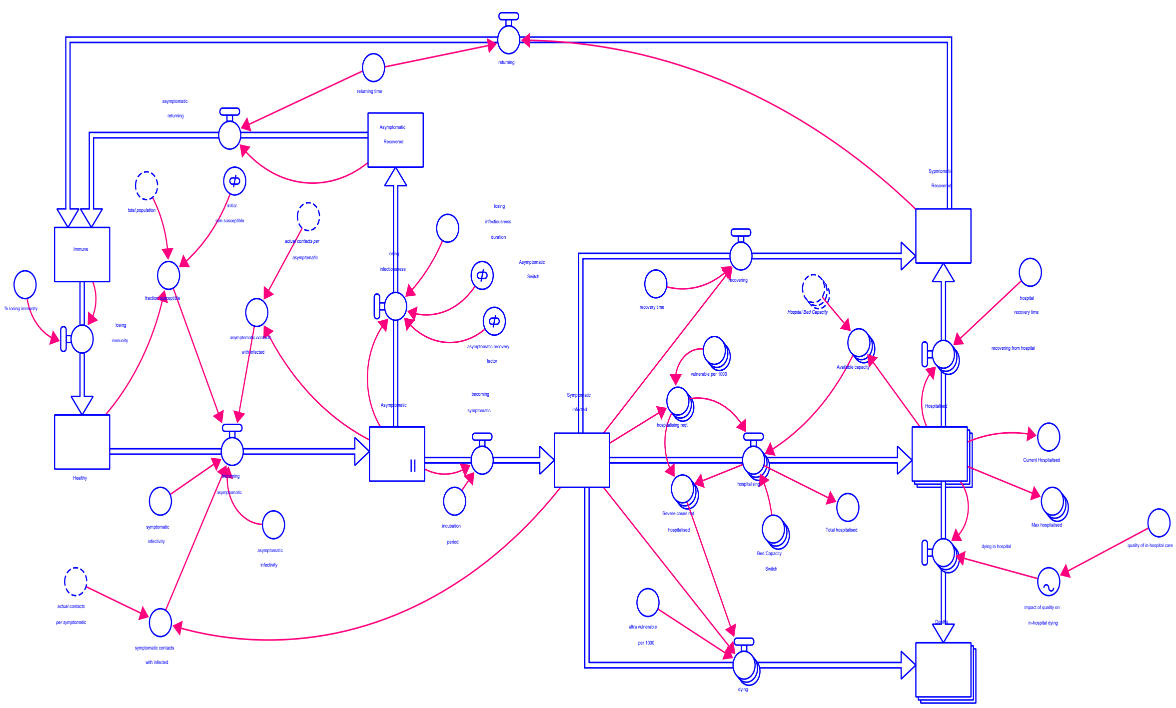


Figure 1: Stock-flow Diagram

CoSimPol is flexible both at the level of the system’s structure as shown in the stock-flow diagram, and in the policy parameters, as will be shown later in the interface. At the level of structure, one example of this flexibility is the stock of people with immunity. Scientifically this is still rather unknown. It was initially thought that once someone has become infected, they will be immune to being infected again. Serological tests show the anti-bodies that will identify such people. However, some studies have shown that such immunity may not necessarily remain as was originally thought.

International Journal of Social Science Research and Review

Volume 5, Issue 9
September, 2022

When CoSimPol was first created, it was set with none losing immunity because that was the scientific understanding at the time. However, its flexible design is illustrated now, by building in the potential loss of immunity. Instead of a major redesign of CoSimPol we merely have to set the losing immunity parameter appropriately to model this phenomenon to reflect the emerging scientific position.

Figure 2 below shows the User Interface of CoSimPol. It has seven main tabs in green. These tabs enable the simulator tool to be as transparent as possible, including a representation of the actual model, and the key assumptions behind the model. This enables the user to interrogate and critique the model. Hence, the user does not have to accept anything on faith, but rather understand the paradigm, perspective and assumptions made by the developers. In this way users are able to improve their mental models of the pandemic, the epidemiological fundamentals as well as all of the sociological factors that impact the spread.

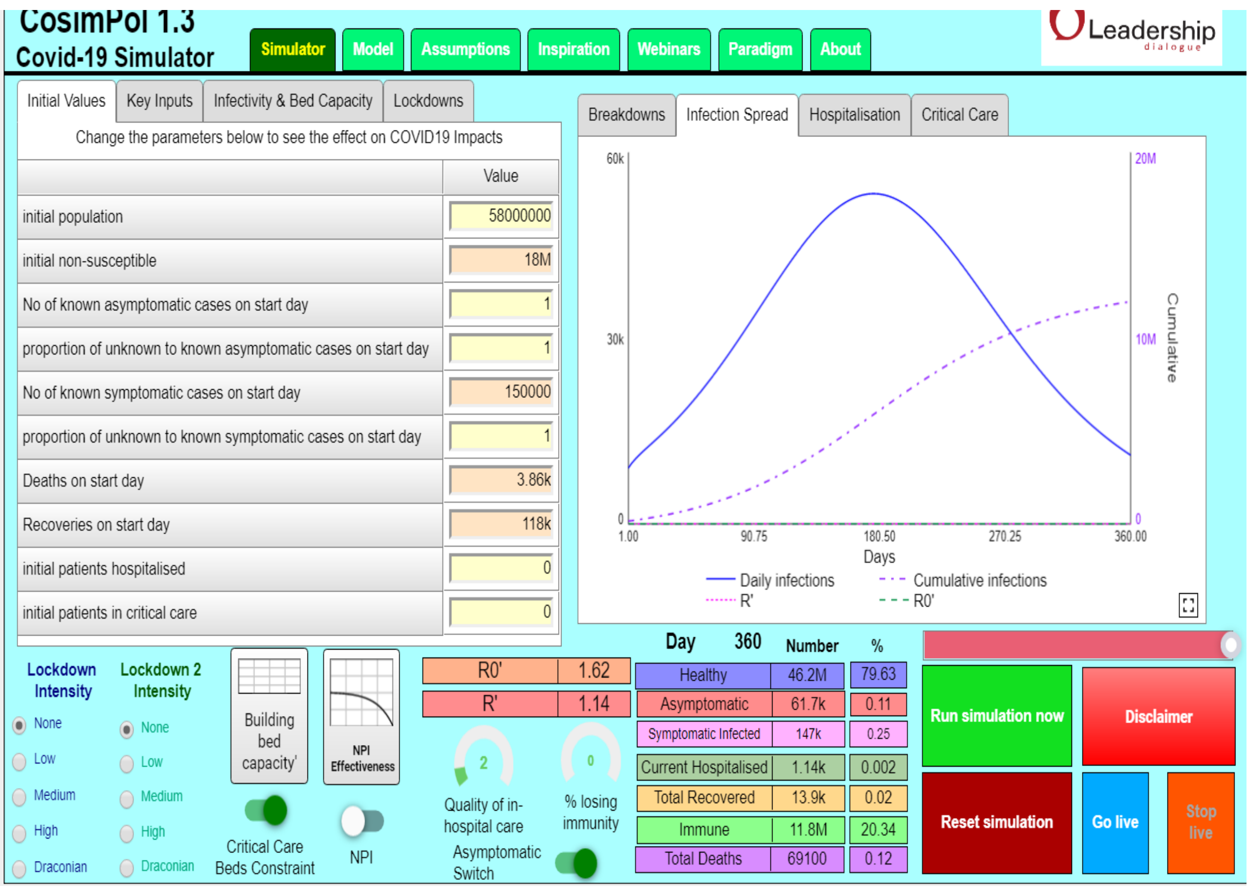


Figure 2: User Interface of CoSimPol

Figure 2 serves as the main dashboard for CoSimPol with a number of input and output devices. We shall now look at these in more detail. There are a set of grey tabs, each of which offers a series of input parameters available to the user. Each of these tabs are shown below.

Figure 3 below shows the first tab which enables the user to input the initial values on day one of the simulation. This gives the user the flexibility to re-initiate the model on any given day as new data is released by the relevant authorities e.g. CDC or NICD of a given country. Many of the extant COVID-19 models begin on the day of the first infection and work from there. CoSimPol can begin on *any* day.

Initial Values | Key Inputs | Infectivity & Bed Capacity | Lockdowns

Change the parameters below to see the effect on COVID19 Impacts

	Value
initial population	58000000
initial non-susceptible	18M
No of known asymptomatic cases on start day	1
proportion of unknown to known asymptomatic cases on start day	1
No of known symptomatic cases on start day	150000
proportion of unknown to known symptomatic cases on start day	1
Deaths on start day	3.86k
Recoveries on start day	118k
initial patients hospitalised	0
initial patients in critical care	0

Figure 3: First Tab – Initial Values

Figure 4 below illustrates the tab that enables the user to enter key epidemiological factors such as incubation times and other important durations related to the spread of the disease.

Initial Values | Key Inputs | Infectivity & Bed Capacity | Lockdowns

Change the parameters below to see the effect on COVID19 Impacts

	Value
incubation period	7
recovery time	14
vulnerable per 1000[Hospital]	1
vulnerable per 1000[Critical Care]	0.05
ultra vulnerable per 1000	0.002
hospital recovery time	14
asymptomatic recovery factor	0.5
losing infectiousness duration	10

Figure 4: Key Inputs for Epidemiological Factors

Figure 5 below shows the input panel for the infectivity values (representing the virulence) and sociological factors that underpin the R0 value. In addition, it is here that the user specifies the normal hospital bed and critical care bed capacities.

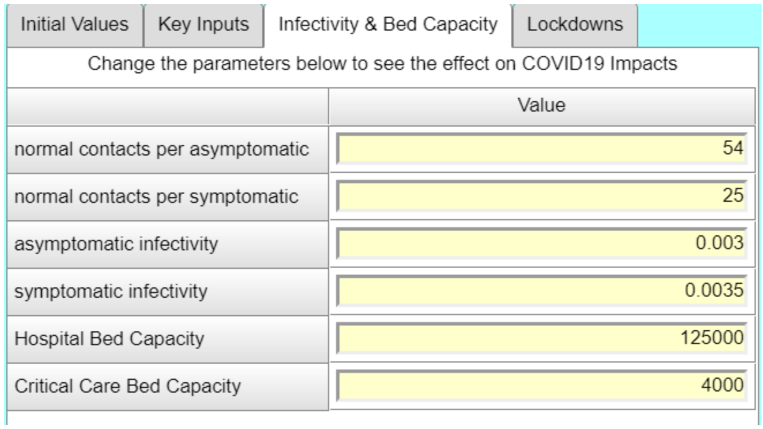


Figure 5: Infectivity, Sociological Factors and Hospital Capacities

Figure 6 below enables inputs around possible lockdowns. In the current version of CoSimPol, there is a possibility to model up to two lockdowns. These inputs allow the user to specify when the lockdowns begin and end, and their respective durations.

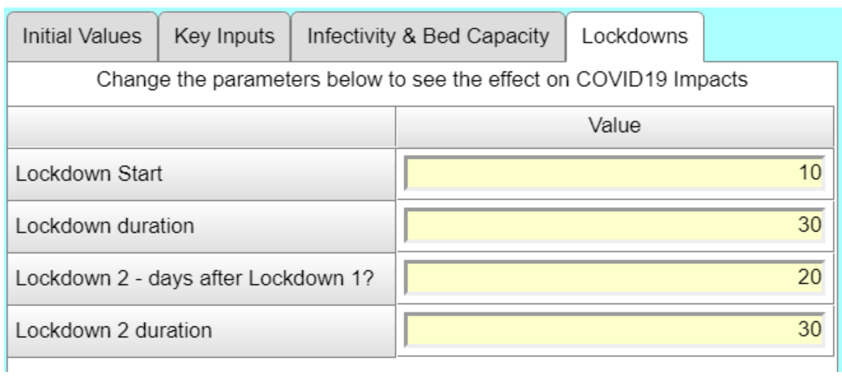


Figure 6: Inputs around Possible Lockdowns

Figure 7 below shows that the simulator allows one to select four different intensities of lockdowns for each of the lockdowns. These in turn affect the severity of the economic and social impact on people's lives.

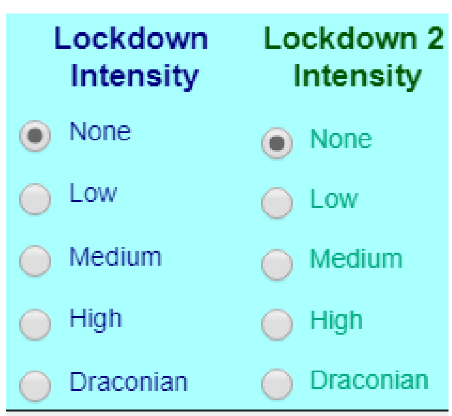


Figure 7: Four Different Intensities of Lockdowns

Figure 8 below shows additional input devices. The ‘critical-care bed’ switch turns on capacity constraints on critical beds. The ‘non-pharmaceutical interventions’ (NPI) switch allows the user to model the impact without NPI and with NPI. In the early days of the epidemic the focus was on lockdowns, and less on NPI. At present, there is a much bigger emphasis on NPI. The ‘Asymptomatic switch’ enables the user to run the model, whether or not there is a significant loss of infectiousness by asymptomatic patients.

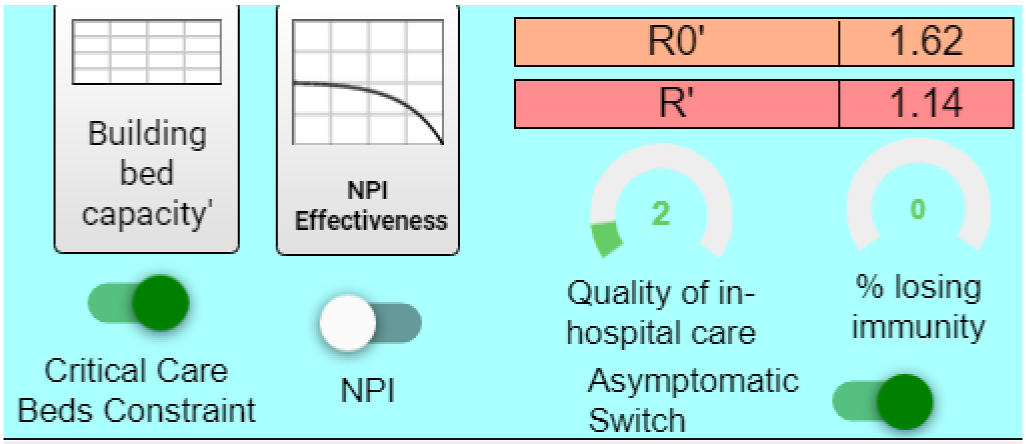


Figure 8: Additional Input Devices

There are also four tabs with graphs and output devices as shown below.

Figure 9 below shows the trajectory of each of the key stocks, representing the quantities of people at different stages of the epidemic over time.

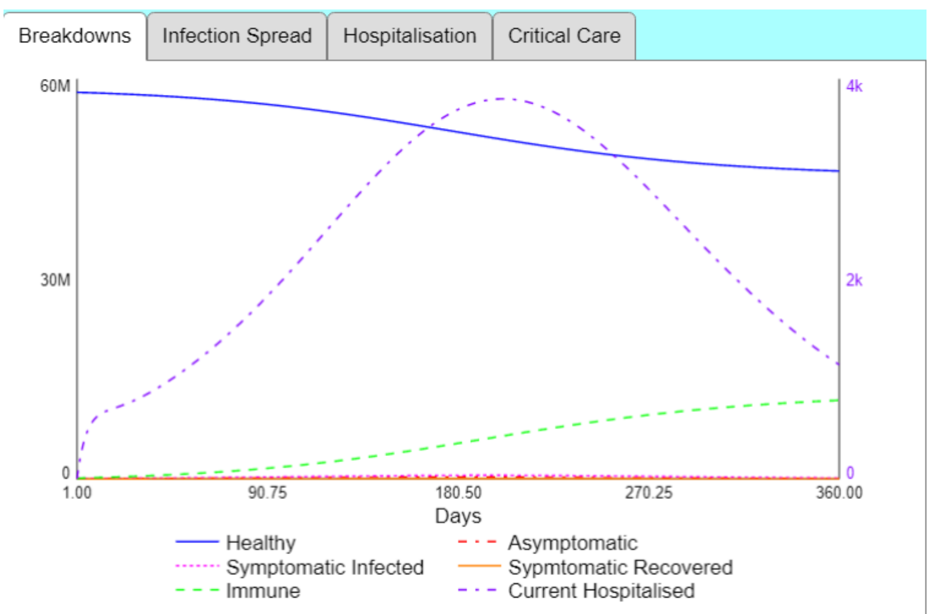


Figure 9: Trajectory of Each of the Key Stocks

Figure 10 below shows the infection spread over time. It identifies both the daily infections and the cumulative infections, together with the R0 and R numbers. R0 represent the reproduction number at the start of the simulation. R represents how the reproduction number changes over time as the simulation proceeds and the different interventions such as lockdowns, NPI etc. are modelled.

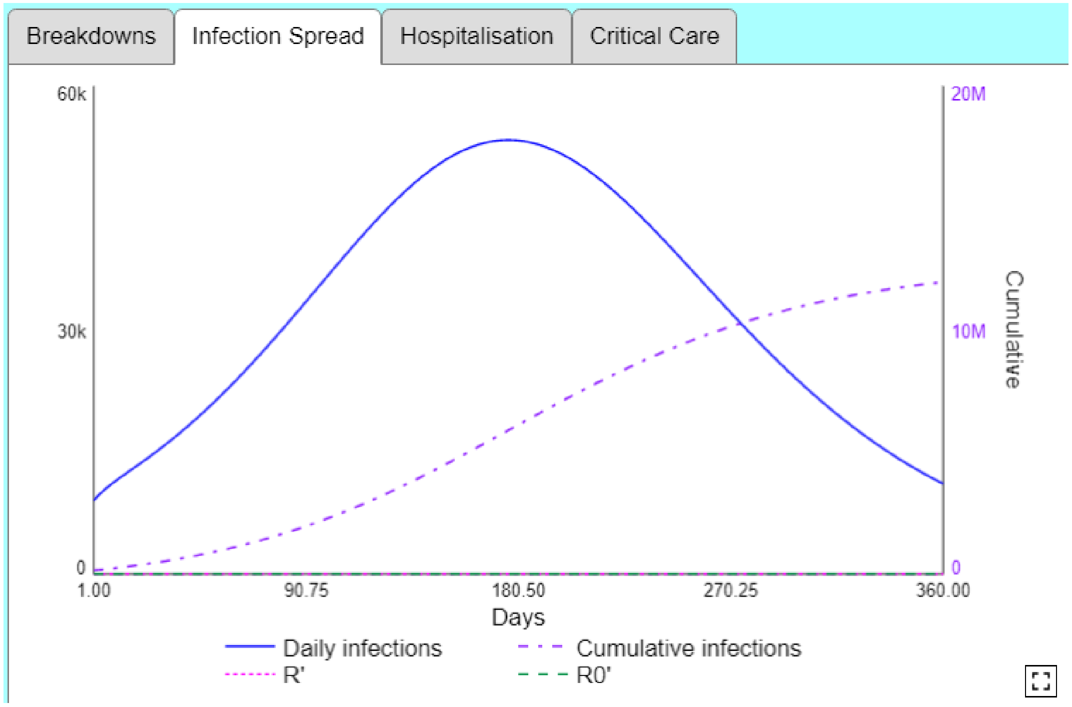


Figure 10: Infection Spread over Time

Figure 11 below shows the graphs over time for hospitalisation demand, actual hospitalization and capacity with regard to normal hospital beds.

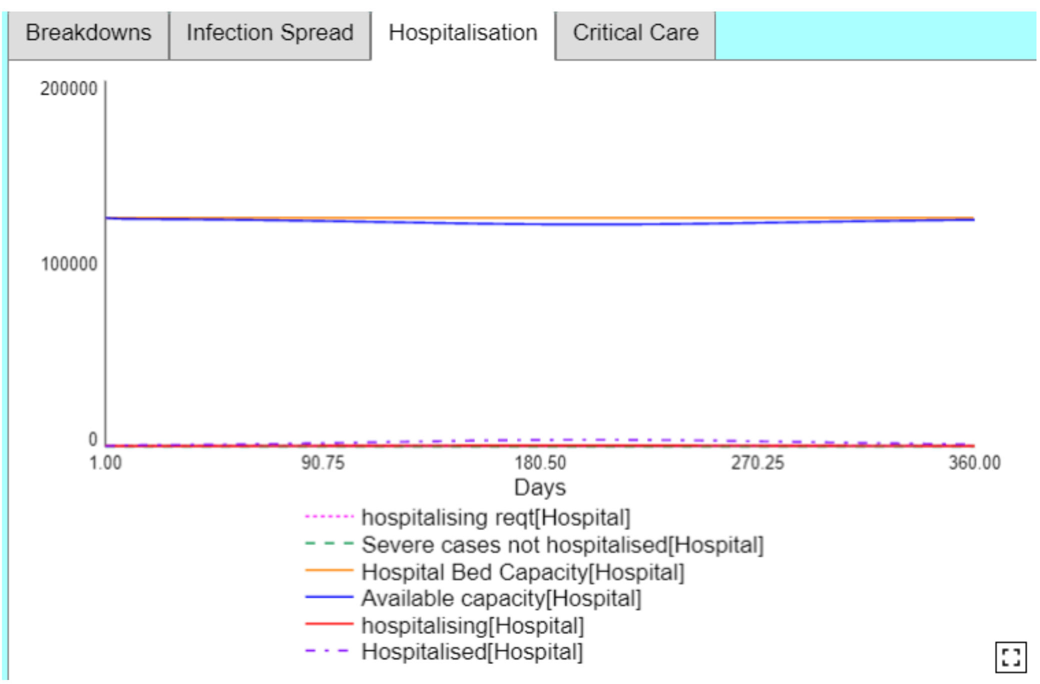


Figure 11: Graphs over time for Normal Hospital Bed Capacity

Figure 12 below is similar to Figure 11 but it reflects critical care beds, demand and capacity.

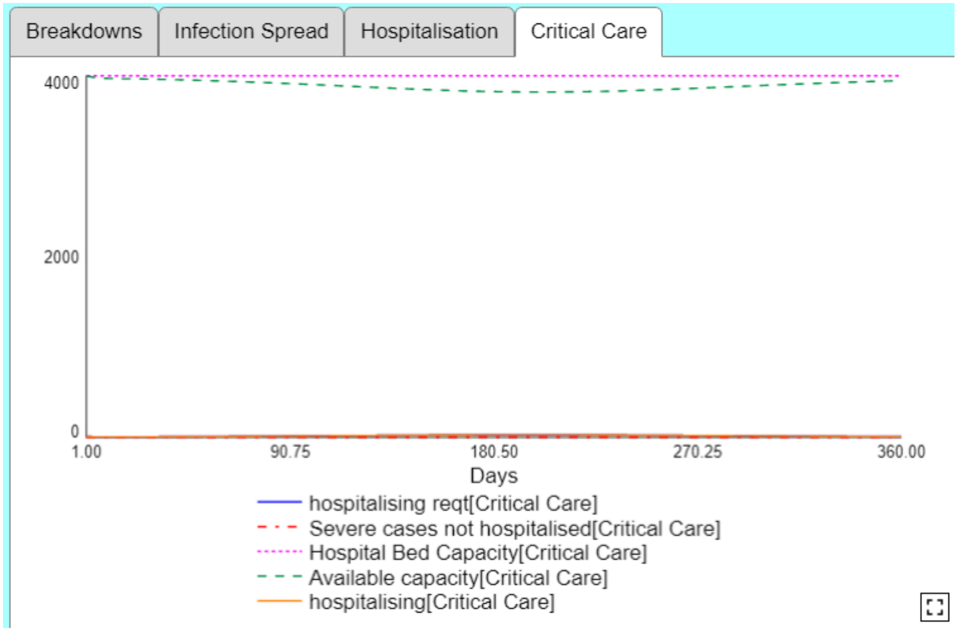


Figure 12: Graphs over time for Critical Care Bed Capacity

Figure 13 below shows the actual and % values in each of the stocks as the simulation proceeds.

Day 360	Number	%
Healthy	46.2M	79.63
Asymptomatic	61.7k	0.11
Symptomatic Infected	147k	0.25
Current Hospitalised	1.14k	0.002
Total Recovered	13.9k	0.02
Immune	11.8M	20.34
Total Deaths	69100	0.12

Figure 13: Dynamic Values of the Key Stocks in the Model

Figure 14 below provides the user with the underlying perspective and a description of what CoSimPol is. It also has a section that shows the latest features updates as the model is improved and new releases are published.

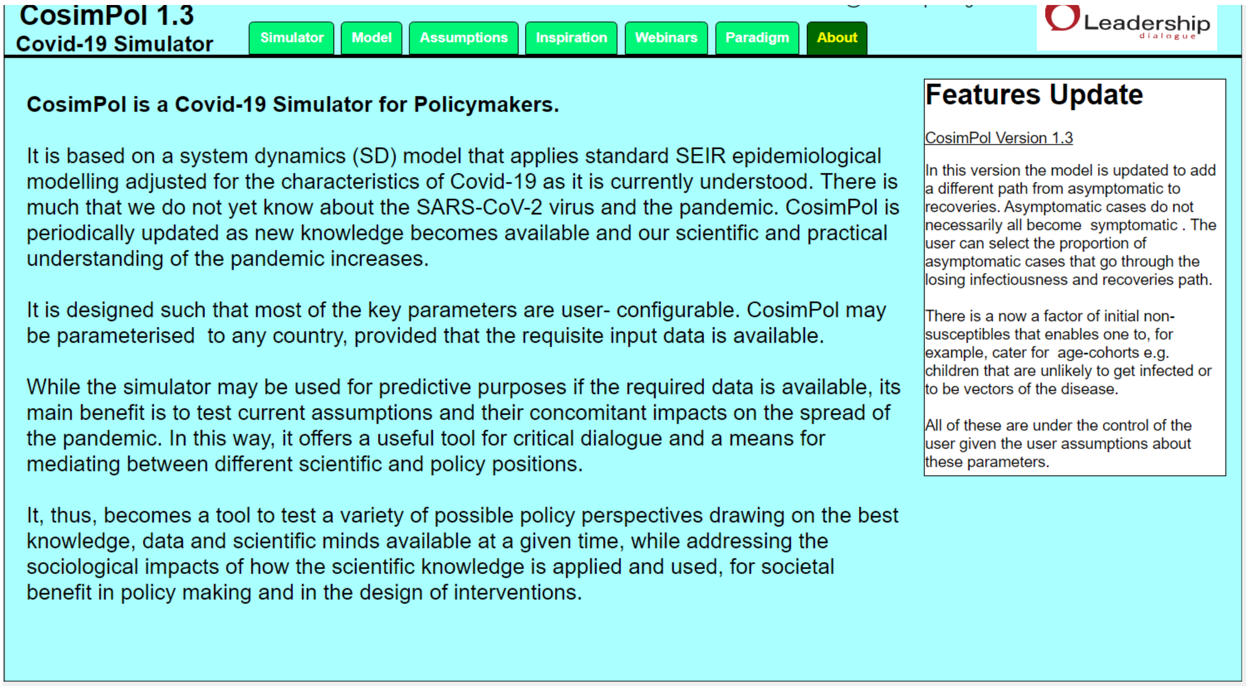
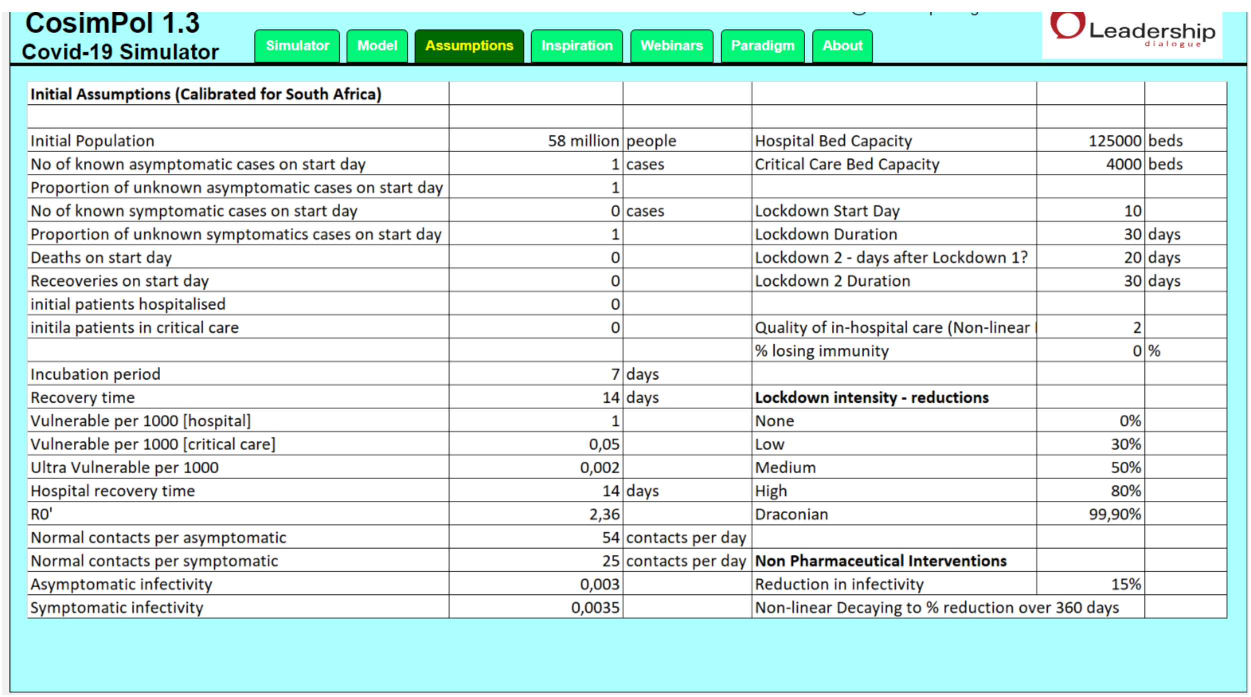


Figure 14: Underlying perspectives and description of CosimPol

Figure 15 below shows all of the key assumptions that may be critiqued by the user. As more knowledge about the virus and the epidemic unfolds, these assumptions may be changed to better reflect the emerging reality.



Initial Assumptions (Calibrated for South Africa)					
Initial Population	58 million	people	Hospital Bed Capacity	125000	beds
No of known asymptomatic cases on start day	1	cases	Critical Care Bed Capacity	4000	beds
Proportion of unknown asymptomatic cases on start day	1				
No of known symptomatic cases on start day	0	cases	Lockdown Start Day	10	
Proportion of unknown symptomatics cases on start day	1		Lockdown Duration	30	days
Deaths on start day	0		Lockdown 2 - days after Lockdown 1?	20	days
Receoveries on start day	0		Lockdown 2 Duration	30	days
initial patients hospitalised	0				
initila patients in critical care	0		Quality of in-hospital care (Non-linear	2	
			% losing immunity	0	%
Incubation period	7	days			
Recovery time	14	days	**Lockdown intensity - reductions**		
Vulnerable per 1000 [hospital]	1		None	0%	
Vulnerable per 1000 [critical care]	0,05		Low	30%	
Ultra Vulnerable per 1000	0,002		Medium	50%	
Hospital recovery time	14	days	High	80%	
R0'	2,36		Draconian	99,90%	
Normal contacts per asymptomatic	54	contacts per day			
Normal contacts per symptomatic	25	contacts per day	**Non Pharmaceutical Interventions**		
Asymptomatic infectivity	0,003		Reduction in infectivity	15%	
Symptomatic infectivity	0,0035		Non-linear Decaying to % reduction over 360 days		

Figure 15: Key assumptions

Implications of Simulation Model for Policy Decision-Making and Dialogue

We have all observed how the pandemic resulted in "economic and social burden" [15: pg. 7]. The strict lockdown in South Africa negatively impacted the economy, resulting in unemployment and loss of livelihoods in many sectors [1, 29, 15]. Various sectors, including the education [33] and tourism sectors [34, 35], have been severely impacted, and we are seeing the myriad economic and social issues that are now coming to the fore [4]. This has triggered tension and conflict between government and various stakeholders, including the private sector, scientists, and ordinary citizens [10]. Dialogue is therefore required to mediate these diverse perspectives and ensure the continued development of joint initiatives with early intervention and responsiveness.

Angeli and Montefusco [18] point to how COVID-19 can result in a situation where saving lives in the short term may come at a cost to well-being, social order, and the economy. Hynes et al. [19: pg. 183] also remind us that "the radical uncertainty associated with complex systems makes it impossible to predict where the next crisis will come from; nevertheless, this should not stop us learning the lessons of the past to prepare a systemic response for the future". We must therefore engage in learning from lessons regarding the pandemic and its illustration of system interactions and complexity [25, 36].

Through the simulation model that was presented earlier we have highlighted, in a systemic manner, some of the key factors that contribute to high levels of complexity. Such factors will be important for policy decision-makers to consider when formulating and assessing policy in relation to COVID-19. As Petrie and Peters (24: pg. 134] note, "an ignorance of wicked problems and system complexity by policy-makers, planners, and politicians have contributed to an unsustainable healthcare system and a misunderstanding of how to appropriately address the foundational determinants of health".

Policy decision-making in relation to the COVID-19 pandemic is especially challenging [18]. McBryde et al. [30] highlight that models in the COVID-19 pandemic are of great value in informing policy decisions but Allen et al. [4: pg. 4) remind us that "effective policy must address each and every dimension of this pandemic and do so early and decisively while also earning public confidence in order to ensure cooperation and compliance". We are thus encouraged to promote flexibility and high levels of adaptability which will allow the system to respond to the emergence of new issues [18, 28, 24].

The public health crisis that we were faced with requires governments to speedily respond by formulating effective and proportionate policy actions [18]. Acknowledging the complexity of the system will be critical in understanding the need for diverse stakeholders to be afforded the opportunity to share their multiple perspectives early, which could influence the rate of engagement and adoption of policy [28, 37, 24, 31]. Foss [29] emphasises how crucial this is to avoid biased decision-making, especially when faced with high levels of uncertainty and ill-structured problems, such as COVID-19. Petrie and Peters [24] thus argue that policymakers should strive for emergent decision-making that takes into consideration the complexities of the situation.

Health systems globally, and more especially in South Africa, have been tested and require us to introspect and examine our levels of responsiveness [24, 38]. The pandemic has illustrated how critical the state of our healthcare systems is in the fight against COVID-19 [38, 13, 39, 26]. Policy-makers need to consider that, while the fairly young population may have resulted in the death rate being low in Africa, there is cause for concern when considering "the high prevalence of HIV, tuberculosis, hypertension, and diabetes coupled with weak healthcare systems in Africa" [13: pg. e882].

We need to be proactive in identifying challenges to the critical healthcare sector, while remembering that healthcare delivery is dynamic [4]. The pandemic has seen progress in some respects, with increased tele and video consultations, as well as self-management [14]. We have also come to be highly appreciative of the role of healthcare personnel and much has been said about the importance of

PPE, training, infection prevention and control, and strengthening of the various levels of the healthcare system [14]. Further, there have been calls for women to be more involved in the various stages of public healthcare management and public policy [12, 39].

It is important to bear in mind that the local context is critical [18]. Policy-makers should thus avoid a one-size-fits-all approach [24], and be mindful of imposing their views in an autocratic manner. Migone [40: pg. 397] notes: "in some cases, though, like COVID-19, their sheer speed and scale represent critical opportunities for changes in policy-making and overcoming limits to existing policy styles". CoSimPol is specifically designed to negate a one-size-fits all approach, as it enables policy- makers to contextualise the specific situations they face; the model enables fine-grained granularity and may equally be applied in very localised contexts.

There is a need for South Africa to radically upscale its digital infrastructure and to develop digital technology to bolster the healthcare sector [41, 42, 17]. We should also seize this opportunity to focus on developing widespread technological competencies in our educational systems at the various levels. We saw during the lockdown just how real the digital divide is, with some students more agile and responsive to online learning, than others. It is important that our education systems are resilient and flexible [33]. The authors argue that the pandemic accelerated pedagogical trends, and that the innovations which arose during the pandemic may well continue past the pandemic.

Globally, leaders found themselves faced with the multiple complexities related to COVID-19. The political leadership, along with the socioeconomic situation of a country, are quite important to consider [13]. Amir Singh [43] argues for trust and transparency, as well as credibility. Government should use this as an opportunity to strive for profound systems change by promoting transformational leadership to change the country and its institutions. A concomitant need is to strive for servant leadership, whereby the goal is to serve the needs of others, be trustworthy, and not engage in acts which promote the interests of a few.

Leaders in Africa need to be proactive and decisive – many decisions had to be made, including balancing the economy and livelihoods with health, and how best to ensure physical distancing measures. Those in leadership positions need to see the big picture and understand how the different parts interact, due to their interconnectedness. Effort has to be made to move from the current reality to a desired future with capabilities and future-preparedness to handle VUCA. It is also critical that the organisational culture become agile, able to respond to radical change, and that there be opportunities for diverse stakeholders to participate in a meaningful way. There has to be a willingness to collaborate to engage the many legitimate perspectives of the diverse stakeholders [43, 20, 39].

South Africa needs to respond to the pandemic by having a multidisciplinary approach which is transparent and inclusive [43]. It is critical that various stakeholders, including governments, are focused on cooperation and systemic behaviour, and do not fall into a blame-and-shame mindset [18, 22]. Adopting the lens of a 'complex adaptive system' helps us to understand how behaviour emerges through the many complex interactions between the diverse stakeholders [18].

Policy-makers need to be cognisant of the self-organising and emergent properties of complex systems, whereby the emphasis should not be on trying to find permanent solutions but rather on how to influence the system [28]. Policy decisions are impacted by risk and uncertainty [44]. It is therefore important that stakeholders have an opportunity to engage in deep dialogue to actually hear each other's perspectives and learn from one another [28, 20, 22, 45, 6, 46].

There is a need to focus on the short term to help communities deal with the immediate crisis now, but governments should also focus on developing communities' social and economic resilience [9] and help citizens deal with the psychological aspects [10]. Government needs to adopt a systemic mindset, with policies focused on deeper leverage points [25]; this is an opportunity for the government to lift South Africa [47].

The pandemic has illustrated just how connected we are. Bui [48] argues, "this global Covid-19 pandemic can only stop completely when the whole world act together. We need to restore our sustainable world with our mind, heart and hand, and particularly with spirituality, mental models, systems thinking, presencing, and sustainability mentality". We also need to ensure that we are prepared for future health crises, and should thus be engaging at the international level as well and be engaged in cooperative responsibility [14, 6, 22, 19, 12, 39, 49].

Engaging the international community is critical to facilitating the sharing of information and cooperation [39]. Hynes et al. [19: pg. 184] argue that in considering policymaking, "our systems must be designed for resilience, providing them with the capacity for recovery and adaptation regardless of the challenges they may face".

A few examples for how CoSimPol may be applied to mediate diverse perspectives is provided here. In the early stages of the epidemic, the major intervention focus in South Africa and much of the world, with the exception of the Far East, was on restrictions in movement. A key debate at the time was on the type of restrictions that would be appropriate, and how intense they ought to be. Many argued for hard lockdowns while others argued for no lockdown at all, following Sweden's example. These polar positions could have been explored by using CoSimPol to anticipate or predict the impact of different intensities and durations of lockdowns and restrictions on the spread of the infection.

A process of mediated dialogue would have enabled those on different ends of the spectrum to understand the strengths and flaws in their own mental models and in those they disagreed with.

Although CoSimPol did not separate (in principle it could easily do so) the wearing of masks from the NPI, it could have been used to mediate contrasting discourses around the level of NPI that needed to be applied. A further example is that it has long been argued that 'flattening the curve' would not eradicate the virus but would enable public health facilities to be ramped up to deal with the exponential rise in cases and thereby reduce mortality through sufficient health-care capacity in normal and critical-care beds, ventilators etc. It has largely been left unsaid in the public health and popular discourse how complex it is to figure out the actual need for capacity and especially the *timing* of building and ramping up the capacity. CoSimPol specifically allows the modelling of a range of possibilities for the extent and timing of building public-health capacity to deal with such high levels of uncertainty.

A final example is the *spirit* underlying the design of CoSimPol. What we mean by this is that it is not meant to be a tool to represent truth (inasmuch as it relies on rigorous data and parameter selection). Instead, it enables users to explore multiple competing and complementary *perspectives*, based on their mental models and their constructions of reality. This design spirit means that CoSimPol is not meant to be central in the policy-making endeavour. Rather, it is meant as a transitional object [50, 51] to enable surfacing of assumptions, clarifying differing constructions of reality, and holding any one truth lightly towards mutuality, respect, understanding, joint problem solving and action. In the final analysis, this is a more appropriate way to work with and deal with uncertainty at the scientific and technical level, and also at an ethical level in navigating social complexity [52, 53].

Conclusion

The COVID-19 pandemic has created widespread turbulence. We have witnessed how the lockdown and other measures have negatively impacted the economy, resulting in unemployment and loss of livelihoods. This paper has highlighted how complex and messy this situation is, characterised by multiple stakeholders who hold diverse mental models and perspectives.

We have drawn lessons and highlighted implications for policy-makers in South Africa to consider while dealing with the pandemic, by understanding how the CoSimPol simulator can be used in mediating dialogue for the COVID-19 pandemic. The model, based on system dynamics methodologies, presents different options for dealing with the pandemic. This model is significant in that it allows for the generation of valuable data linked with different contexts, to enable policy insights and decisions. The model contributes to policy formulation and a mechanism to enhance pandemic resilience. We thus contribute to the debate on navigating social complexity and in mediating social policy options.

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