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Construction of a Multi-objective Dynamic Decision-making Model under Information Uncertainty in Public Health Events

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Abstract

For existing Multi-objective decision models, a Multi-objective dynamic decision model under information uncertainty in public health events is constructed and a DAG directed acyclic graph of public health event decisions is made in the context of public health events. At the same time, the model was validated and tested with a COVID-19 epidemic event as an example. The validation found that the solution of active prevention and control while enhancing macroscopic resource deployment is the solution that achieves the most optimal Multi-objective utility with good epidemic control, low economic expenditure and short recovery time, and the conclusion is also consistent with the actual situation of the epidemic. Finally, the conclusions and our country's performance in such events are synthesized to explore the unique charm and superiority of the socialist system with Chinese characteristics, and to further enhance our theoretical, road, and institutional confidence in socialism with Chinese characteristics.

Keywords

Public Health Events; Multi-objective Decision Making; DAG Directed Acyclic Graph; Socialism with Chinese Characteristics.

1. Background

The outbreak of the COVID-19 epidemic at the end of 2019 brought a huge impact on society. The Decision-making level in China gave full play to the superiority of the system of socialism with Chinese characteristics, and all departments and industries did what they were ordered to do and what they were forbidden to do. The further spread of the epidemic was effectively curbed. The series of prevention and control measures have been highly recognized by the World Health Organization and many countries, but there are still many unjustified criticisms of our prevention and control policies. Professor Burkle of Harvard University has argued that the Chinese government is behaving like a dictatorial government and that the series of measures taken are not helpful to the prevention and control of the epidemic, but will lead to the worsening of the epidemic and global epidemic. In response to the unreasonable attacks by individual scholars on China's epidemic prevention and control initiatives and the slanderous smears against China's socialist system, Chinese academics must refute and counter these irresponsible attacks through scientific theories and academic analysis.

This study will explore the construction of a Multi-objective dynamic Decision-making model and a DAG directed acyclic diagram of the Decision-making scheme under the environment of information uncertainty in the context of prevention and control of public health events, so as to investigate how China achieves the Multi-objective effects of good epidemic control, low economic expenditure, and short recovery time in public health events, and thus also discover how the socialist system with Chinese characteristics created by the Party and people after more than 90 years of struggle The superior features and the unique charm of the socialist system with Chinese characteristics, which is different from the western capitalist system. Multi-objective Decision Scenario Analysis for the COVID-19 Outbreak Case.

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2. Multi-objective Decision Scenario Analysis for the COVID-19 Outbreak Case

2.1. Construction of DAG Directed Acyclic Graphs for the COVID-19 Epidemic Model

Firstly, the influencing factors of each decision in the COVID-19 epidemic event are determined, and the specific node descriptions and states are shown in Table 1. Then the correlations between these nodes are established according to the cause-effect relationship to obtain the decision model of the COVID-19 epidemic.

Table 1. Description of the nodes of the Multi-objective decision model for the COVID-19 epidemic

Category	Node Name	Lettering	Classification	Impact Nodes
Decision context nodes	Epidemic situation	B_1	SevereB_1^1 ,Slight B_1^2	M_1, C_1
	Government Execution	B_2	With force B_2^1, without force B_2^2	M_1, O_3
Decision selection nodes	Epidemic Control Level	M_1	Light M_1^1, Intermediate M_1^2, Advanced M_1^3	C_1,O_2,O_3
	Macro Resourcing	M_2	Active deployment of M_2^1, not active deployment of M_2^2	O_1 , O_2
Decision Process Nodes	Resource constraints	C_1	C_1^1 appears, C_1^2does not appear	M_2 , O_1
Decision target nodes	Outbreak recovery time	O_1	Short-term O_1^1, medium-term O_1^2, long-term O_1^3	V_1
	Economic Expenditure	O_2	lessO_2^1, moderate O_2^1, more O_2^3	V_2
	Patient Casualties	O_3	Good O_3^1, Bad O_3^2	V_3
Decision utility node	Time consumption	V_1	Short-term V_1^1, medium-term V_1^2, long-term V_1^3	
	Economic consumption	V_2	lessV_2^1, moderate V_2^2, more V_2^3	
	Personnel consumption	V_3	Good V_3^1, Bad V_3^2	

2.2. Probability of Each Node of the COVID-19 Epidemic Decision Model

The probabilities of the relevant nodes in the decision model of the COVID-19 epidemic were determined by the expert scoring method. Since the background prior probabilities are related to the actual situation of the COVID-19 epidemic, the two background node probabilities are assigned according to the background of the COVID-19 epidemic, and the subjective decision probabilities such as the decision selection node are the mean probabilities, and the other probabilities of the conditional probabilities C_1 , O_1 , O_2, and O_3 resulting from the decision selection nodes M_1,M_2 are as follows.

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Table 2. Probability of resource shortage

Epidemic situation B_1	Epidemic control level M_1	Shortage of resources C_1	
		C_1^1 does not appear	C_1^2 appears
Slightly B_1^1	Advanced M_1^1	0	100%
Slightly B_1^1	Intermediate M_1^2	50%	50%
Slightly B_1^1	Light grade M_1^3	90%	10%
Serious B_1^2	Advanced M_2^1	0	100%
Serious B_1^2	Intermediate M_2^2	0	100%
Serious B_1^2	Light grade M_1^3	0	100%

Table 3. Probability distribution of outbreak recovery time

Shortage of resources C_1	Government macro deployment M_2	Recovery time		
		Short-term O_1^1	medium-term O_1^2	long-term O_1^3
C_1^2 appears	Active deployment of M_2^1	20%	70%	10%
C_1^2 appears	No active deployment of M_2^2	0	10%	90%
C_1^1 does not appear	Active deployment of M_2^1	100%	0	0
C_1^1 does not appear	No active deployment of M_2^2	100%	0	0

Table 4. Economic expenditure probability distribution

Epidemic control level M_1	Government macro deployment M_2	Economic expenditure situation O_2		
		less O_2^1	moderate O_2^1	more O_2^3
Advanced M_1^3	Active deployment of M_2^1	0	0	100%
Advanced M_1^3	Not active deployment of M_2^2	0	50%	50%
Intermediate M_1^2	Active deployment of M_2^1	0	50%	50%
Intermediate M_1^2	Not active deployment of M_2^2	0	100%	0
Light M_1^1	Active deployment of M_2^1	70%	50%	0
Light M_1^1	Not active deployment of M_2^2	100%	0	0

Table 5. Probability distribution of patient casualties

Government Execution B_2	Epidemic control level M_1	Patient Casualty O_3	
		Bad O_3^2	Good O_3^1
With force B_2^1	Advanced M_1^3	0	100%
With force B_2^1	Intermediate M_1^2	40%	60%
With force B_2^1	Light M_1^1	60%	40%
Without force B_2^2	Advanced M_1^3	20%	80%
Without force B_2^2	Intermediate M_1^2	60%	40%
Without force B_2^2	Light M_1^1	90%	10%

Table 6. Benefit node weight assignment

Effectiveness Node	Effectiveness Status		
Time consumption V_1	Long-term	Medium-term	Short-term
	V_1^3	V_1^2	V_1^1
	-50	-30	-10
Economic consumption V_2	more	moderate	less
	V_2^3	V_2^2	V_2^1
	-40	-30	-20
Personnel consumption V_3	Bad		Good
	V_3^2		V_3^1
	-80		-10

3. Epidemic Decision Model

The utility values of all value nodes are the final quantitative results of the decision model for the COVID-19 epidemic, and the goal of the model solution is to find the solution with the lowest utility consumption $\sum_{n=1}^{3} V_n$. In the context of the COVID-19 epidemic, $B_1^1 = 100\%$ because COVID-19 pneumonia is known to be a serious infectious disease before the decision is made. Regarding the government execution nodal variable, both unitary and federal state structures are subject to insufficient government execution, even if, as in the case of China, a representative of the unitary state, there is still a situation in which the director of the Huanggang Health Commission does not act at the beginning of the epidemic and the prevention and control of Harbin is not in place, so government execution does not occur at 100%, so $B_2^1 = 60\%$ is taken, and the two prior probabilities are not affected by the the impact of the decision.

3.1. Solving the Epidemic Decision Model

The utility of each decision option can be quantified using equation (1).

$$V(S_i) = \sum_{j=1}^{n} \sum_{k=1}^{q^j} W_j^k * P(O_j = O_j^k | S_i B) \tag{1}$$

Table 7. Three Scheme comparing

Epidemic control level	Macro Resourcing	Three types of benefits			Total benefits	Representing countries
		Time	Economy	People		
Advanced	Active deployment	-4.6	-6.7	-5.2	-16.5	CHN,KOR
Advanced	Not active deployment	-8	-5.8	-5.2	-19.0	FRA,JPN
Intermediate	Active deployment	-4.6	-5.8	-14,5	-25	VIE,CUB
Intermediate	Not active deployment	-8	-5	-14.5	-27.5	MAS,IND
Light	Active deployment	-4.6	-4.3	-20.1	-29.1	
Light	Not active deployment	-8	-3.3	-20.1	-31.5	HUN,NOR

At the same time, in order to better compare and analyze countries, we first sorted out the epidemic prevention and control policies of major countries in the world in the COVID-19

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epidemic, and calculated the time consumption benefit, economic consumption benefit and personnel consumption benefit, and obtained the comprehensive program benefits as shown in Table 7.

3.2. Conclusions of the Outbreak Decision Model

Combining the above analysis and the comprehensive benefits in Table 7 shows that in this COVID-19 epidemic, the government can minimize the impact of the epidemic to the greatest extent by actively carrying out epidemic prevention and control, by doing what it should do, and by deploying the resources of the whole society. And the reality of this COVID-19 epidemic reflects that conclusion.

In terms of time to recovery, countries that actively deployed materials and pooled social resources were able to recover from the effects of the COVID-19 epidemic relatively quickly. Numerous socialist centralized unitary states such as China, Vietnam, Cuba and individual capitalist countries that implemented a centralized unitary state structure such as South Korea, took full advantage of the superiority and characteristics of their respective systems and successfully shortened the recovery time from the epidemic.

In terms of economic spending, countries with lower levels of prevention and control and no aggressive macro deployment spend less from a short-term economic spending perspective. Countries that adopt higher levels of prevention and control and active macro deployment, such as China and South Korea, have significant economic spending from a short-term perspective in order to deploy resources and alleviate resource constraints. However, as analyzed in the weighting assignment, the economic target, as the easiest of the three epidemic targets to recover losses, has a low weighting, and the overall utility of the program remains high if the appropriate increase in economic spending can shorten the epidemic recovery time and improve the rescue rate, and the overall effect of epidemic prevention and control remains better.

Judging from the rescue and death of people, East Asian cultural circles that emphasize the spirit of collectivism can often act in the collective interest and effectively contain the spread and development of the epidemic in an epidemic, while European and American cultural circles that fall into excessive liberalism often miss the best containment period due to over-emphasis on liberalism, leading to the spread and spread of the epidemic.

From the perspective of the overall epidemic prevention and control effect, a public ownership system as the main body can pool social resources for centralized deployment of resources faster in the event of an epidemic; a communist party as the leader can pool collective consensus faster in the event of an epidemic; short-term economic interests can be temporarily sacrificed to protect people's lives and long-term economic development; a centralized unitary system as the state structure can ensure that all A centralized unitary system as a state structure can ensure that all regions will be able to act on orders and prohibitions in the event of an epidemic, improving administrative efficiency and reducing the waste of resources and time delays caused by administrative friction.

4. Conclusion

For the problem of Multi-objective dynamic decision making in public health events, this paper tries to construct a decision model and make a DAG diagram for public health event decision making. Through this model and DAG diagram, various situations and objectives at the time of public health events can be considered comprehensively, and by analyzing the attributes of each node of the model, the future optimization and improvement of the decision level should be explored.

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From the government execution node of the background node, government execution is a very important exogenous variable in public health events, and if the government execution is low, although various decisions are optimal at a later stage, it will still allow public health events to bring serious losses to society. Therefore, in the future, it is necessary to effectively strengthen the government execution and continuously improve the government administrative capacity.

From the point of view of the epidemic prevention and control level node of the decision selection node, if the safety of people's lives and properties is the most important consideration when we make decisions, when a public health event occurs, the epidemic prevention and control level must be raised quickly, as the Chinese government has shown in this epidemic, through the construction of square cabin hospitals, accelerating the development of detection kits, etc., to achieve the collection, treatment and detection of the epidemic as much as possible Although it will lead to a large amount of economic expenditure, it has positive significance in terms of people's life safety and recovery time from the epidemic. If individual countries in Europe and the United States adopt the means of "mass immunization" and "limited testing", although it will reduce the economic expenditure, but because it will lead to the safety of people's lives at risk, so this kind of decision is not the optimal decision.

From the government macro-deployment node of the decision selection node, when a public health event occurs, in the face of resource scarcity, government decision makers should increase macro-deployment to pool high-quality resources from society to prevent further spread and contagion of the epidemic. In the case of the New Guinea epidemic, for example, countries with active macro-deployment, such as China, recovered from the epidemic relatively quickly, while individual state governments in individual countries, with central and local governments passing the buck to each other, failed to reach the "epidemic inflection point" in the New Guinea epidemic and suffered a huge economic impact.

Combining the above conclusions with China's performance in several public health incidents since the 21st century, we can find that the socialist system with Chinese characteristics, created by the Party and the people after more than 90 years of struggle, has shown a unique charm different from the Western capitalist system with its unique concept and superior features. It is also the theory, road and system we adhere to that have enabled us to face several sudden epidemics under the unified leadership and deployment of the Party Central Committee, with the Party, the government, the military and the people working in unison, and with the East, West, North, South and Central in unison, forming a war "epidemic" in which the Party Central Committee is the commander-in-chief, the areas with serious epidemics are the main battlefield, the hospitals are the main positions, and the areas with less serious epidemics are the rear. "This layout has enabled China to recover more quickly from each epidemic. The 18th Party Congress pointed out that all of us should effectively enhance "theoretical confidence, road confidence and system confidence". Therefore, in the future, we should always adhere to and continuously develop the road of socialism with Chinese characteristics, unswervingly follow the theoretical, road and system confidence of socialism with Chinese characteristics, and build our country into a rich, strong, civilized, democratic and harmonious socialist modernization country as soon as possible.

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