Reorganization and Optimization of Import and Export Inspection and Quarantine Processes under Comprehensive Quarantine

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Abstract: Although the current sampling inspection and quarantine efficiency, there are still prevention and control of security risks. Therefore, the existing process is reorganized and optimized, and a comprehensive quarantine strategy is proposed from a theoretical point of view. The results show safety and efficiency problems in the sampling inspection process. The full inspection before reorganization and optimization is also safer than the sampling inspection, but the time consumption will increase correspondingly. Besides, the process is difficult to judge the epidemic products accurately. Compared with the full inspection and sampling inspection after reorganization and optimization, the full inspection takes more time. However, compared with the full inspection and sampling inspection before optimization, it takes less time. It can be seen that the reorganized and optimized process can be safe and efficient in the quarantine part.

Keywords: Comprehensive quarantine; Import and export inspection and quarantine; Process reengineering; Process optimization; Anylogic simulation

1 INTRODUCTION

Although the domestic epidemic is generally at a low level of fluctuation, the global epidemic is still high [10]. The current and even future need to solve the problem is to ensure the safety of imports and export, as well as the existence of efficiency [3, 5, 11, 12]. It cannot ensure the efficiency and safety of imported products from the epidemic at the source [4, 8]. There is an unavoidable safety delay in such measures [16]. The high risk of transmission and the short validity period that can maintain safety require dynamic adjustments to optimize current policies [9]. Therefore, controlling the importation of epidemics at source is the most direct measure to ensure safety and efficiency.

Currently, it has been found that contemporary quarantine for epidemic detection is associated with conflicting laboratory and inspection site capacities [7]. Changing sampling methods to improve safety has improved inspection efficiency, but inspection quarantine remains lax [14]. The increase in such imported epidemics was only significantly reduced when 100% full inspection measures were implemented [6]. The reason for the excellent harvest results is that the epidemic prevention and control process is within control [1]. It would be challenging to implement a 100% proportion of the process for quarantine only [15]. Therefore, this paper

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reorganizes and optimizes the process and uses a 100% total quarantine strategy for epidemic prevention and control.

The idea of 100% full inspection has been used in practice for a long time, mainly in the airport and station security checks [2, 13]. In this paper, the idea of 100% full inspection is used for the first time in cargo inspection and quarantine research. And the four cases are sampling inspection under the basic process, full inspection under the basic process, sampling inspection after process reorganization and optimization, and full inspection after process reorganization and optimization. Of course, there are different options for process optimization and reorganization.

2 THEORETICAL BASIS

2.1 Parameter setting and assumption description

We set parameters for the sampling and full inspection of the basic process (Tab 1). The assumptions are: (1) The total number of products entering different methods is the same. (2) The sampling and full inspection of the basic process can trace the time of the historical data and determine the corresponding values and parameters. (3) The process inspection and quarantine process, the product is no early arrival and late arrival, are punctual.

Table 1: This caption has one line so it is centered

Symbol	Illustration
N	Number of products transported for import and export
K	Number of transported products for import and export
q_i	Number of process links demanded
F_o	Time of entry process inspection
F_1	Time of labor spent
F_2	Product transportation time coefficient
F_m	Time of leaving the process inspection
d_{ij}	Distance between process (i, j)
Q_{ij}	Product capacity between processes (i, j)
Q	Maximum capacity of product transportation
p_1	Price per unit of fuel during transportation
p	The unit price of the quarantine product
t_{ik}	**k** the time of arrival of the product in the process **i**
t_{i0}	Time of product departure for inspection and quarantine
λ	Quarantine coefficient
x_{ijk}	When the product k departs from process **i** to process **j**; for other cases
y_{ik}	When the demand of process **i** is satisfied by product **k**; for other cases

2.2 Model building

Analyze the impact of transportation time, inspection and quarantine time, and arrival time on process reorganization and optimization problems under full inspection, and construct an optimization problem model to minimize time.

$$\min T = T_1 + T_2 + T_3 = F_1 \sum_{j=1}^{N}\sum_{k=1}^{N} x_{0jk} + F_2 \sum_{k=1}^{N}\sum_{i=0}^{N}\sum_{j=0}^{N} d_{ij} x_{ijk} + \lambda \sum_{i=0}^{N}\sum_{j=0}^{N} F_{ij} + \lambda(F_0 + F_m) + \varepsilon_1 \sum_{j=1}^{N} \max\{E_j - t_j, 0\} + \varepsilon_2 \sum_{j=1}^{N} \max\{t_j - L_j, 0\} \tag{1}$$

The following are specific constraints. The maximum capacity during transport is $\sum_{i=1}^{N} q_i y_{ik} \leq Q, \forall K$. Each process is served by more than one transport vehicle about $\sum_{k=1}^{K} y_{ik} \geq 1, \forall i$. One arrival for the same batch of product are $\sum_{i=0}^{N} x_{ijk} = y_{ijk}, \forall j, K$, $\sum_{j=0}^{N} X_{ijk} = y_{ik}, \forall i, K$ .Eliminating sub-loop conditions is $\sum_{i,j \in S \times S} x_{ijk} \leq S-1, S \subseteq \{1,2,...,N\}$. Limiting the transport of products during the transport process is $t_j = t_i + t_{ij}$.

Transportation time is T_1, which consists of labor time and product transportation time.

$$T_1 = F_1 \sum_{j=1}^{N}\sum_{k=1}^{N} x_{0jk} + F_2 \sum_{k=1}^{N}\sum_{i=0}^{N}\sum_{j=0}^{N} d_{ij} x_{ijk} \tag{2}$$

Inspection and quarantine time is T_2 , transported goods for import and export products need to consider the inspection and quarantine time of entering and leaving the process, respectively.

$$T_2 = \lambda \sum_{i=0}^{N}\sum_{j=o}^{N} F_{ij} + \lambda(F_0 + F_m) \tag{3}$$

It indicates that the more quarantine time spent. i.e. $F_{ij} = p_1[\rho_0 + \frac{\rho_m - \rho_0}{Q} Q_{ij}] d_{ij}$. In this formula, ρ_0 is the fuel consumption per unit distance when the capacity is zero. ρ_m is the fuel consumption per unit distance at the maximum capacity. Q_{ij} is the production capacity. F_{ij} is the time of quarantine at the process node (i, j). Therefore, entry inspection time is $F_0 = \sum_{k=1}^{N}\sum_{i=0}^{N} y_{ik} Pq_i (1 - e^{-\partial_1 (t_i^k - t_0^k)})$, leaving inspection time is $F_m = \sum_{k=1}^{K}\sum_{i=0}^{N} y_{ik} PQ_m (1 - e^{-\partial_2 T_i})$. In the two formulas above, ∂_1 is the risk attenuation factor of the product entering the inspection process. ∂_2 is the risk attenuation coefficient of the product leaving the inspection process, and $\partial_1 < \partial_2$. In addition, considering the process demand time is (E_j, L_j). The formula ε_1 is the early arrival process time penalty factor, while ε_2 the time penalty factor for the late arrival process, so the arrival time is

$$T_3 = \varepsilon_1 \sum_{j=1}^{N} \max(E_j - t_j, 0) + \varepsilon_2 \sum_{j=1}^{N} \max\{t_j - L_j, 0\} \tag{4}$$

3 MODEL ANALYSIS

3.1 Sampling under basic process (model 1)

The basic process under the sampling is divided into two types of vertical and horizontal processes, and product inspection and quarantine for an 80% sampling ratio. The vertical process (Fig 1 on the left) runs after the completion of the non-release ratio of 0.23, the release ratio of 0.78, the overall average time of 54.691 hours, and the number of products released of 620**.** The horizontal process (Fig 1 on the right) runs, the proportion of non-release was 0.23, the proportion of releases was 0.77, the number of releases was 613, the number of unqualified products issued by the inspection service prohibited from leaving the country was 187, the overall average time of 20.416 hours. As can be seen, the process type and the overall time-consuming situation are both different. The release ratio does not increase significantly, the proportion of non-release from 0 to 0.23, the average time from 24.02 hours to 40.353 hours. Horizontal sampling process from the quarantine link after processing, after the laboratory quarantine link, the release proportion also showed no significant increase, but the proportion of non-increased release from 0 to 0.11, the average time from 3.155 hours to 4.049 hours.

Conclusion 1: The basic process under the sampling of both inspection and quarantine can lead to an increase in elapsed time.

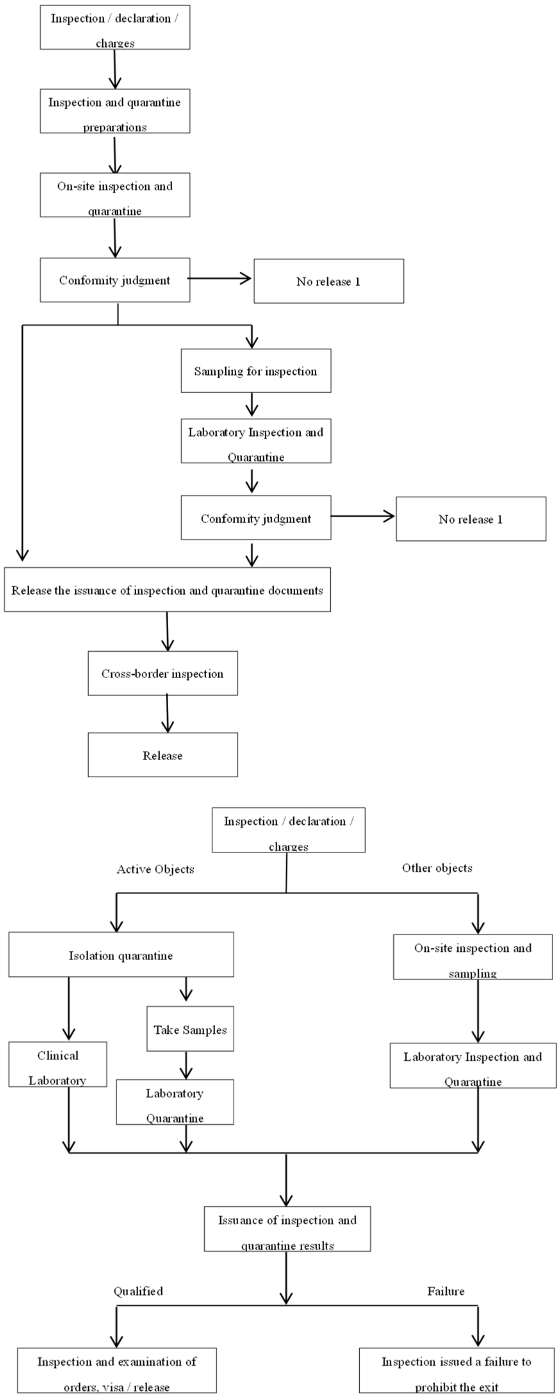

Fig. 1: The process of interoperability between the field and the laboratory (left), the process of distinguishing between movable objects and other objects (right).

3.2 Full inspection under the basic process (model 2)

The full inspection is also divided into two categories, but the product is inspection quarantined for a 100% sampling ratio. The same process simulation results: the vertical process after the completion of the run does not release the proportion of 0.31, the release ratio of 0.69, the overall average time of 67.212 hours, the number of releases 555, the number of non-release 110, the number of non-release 2,135. After the completion of the horizontal process run, the non-release ratio of 0.32, the release ratio of 0.68, the overall average time of 25.972 hours, the number of releases was 541, and the number of unqualified inspections issued by the prohibition of exit 259.

Conclusion 2: The basic process under the full inspection and release of products is difficult to determine from the process whether caused by carrying epidemic germs.

3.3 Sample inspection after process optimization (Model 3)

Figure 2 on the left shows the field inspection and quarantine and laboratory inspection and quarantine reorganization process (hereinafter referred to as "vertical optimization process"), while the right shows Activity and other items detection and quarantine reorganization process (hereinafter referred to as "horizontal optimization process"). Vertical process run after the completion of the non-release ratio of 0.29, the release ratio of 0.71, the overall average time of 26.235 hours, the number of released products 568, the number of non-release one products 96, the number of non-release two products 136.

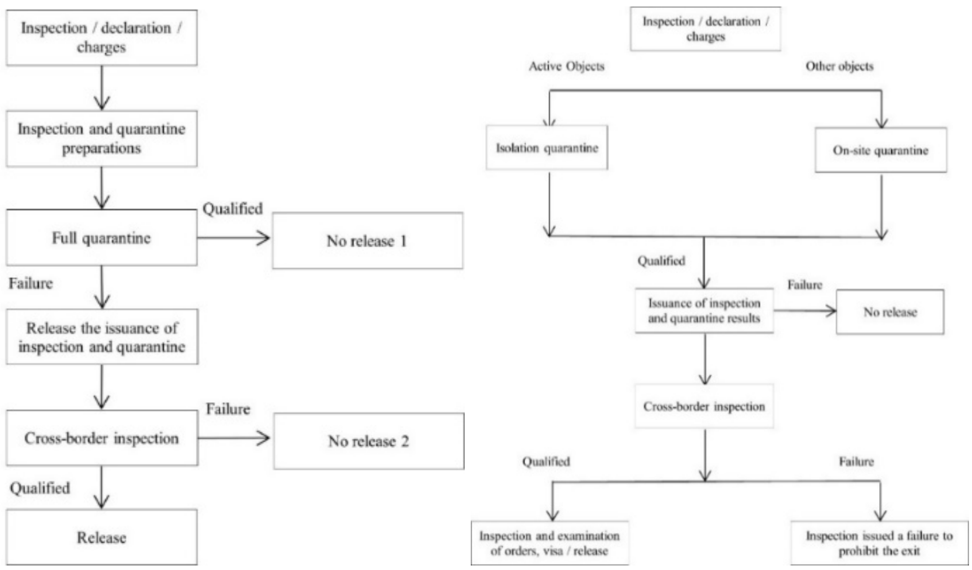

Fig. 2. Field inspection and quarantine and laboratory inspection and quarantine reorganization process (left),activity and other items inspection and quarantine reorganization process (right)

After the completion of the horizontal process run non-release ratio of 0.17, release ratio of 0.83, not to release 63, the number of prosecution review orders released was 667, the number of prosecution issued unqualified prohibited products 70, the overall average time of 21.646 hours.

Conclusion 3: The restructured and optimized sampling takes less time, but the safety issues in terms of release ratio are prominent.

3.4 Full inspection after process optimization (Model 4)

Reorganization and optimization of the full inspection are also divided into two categories of a full vertical inspection and a full horizontal inspection, product quarantine for a 100% sampling ratio. The vertical process run after the completion of the non-release ratio of 0.33, release ratio of 0.68, the overall average time of 30.991 hours, the number of released products 540, the number of non-release one products 125, the number of non-release two products 135. After the completion of the horizontal process run non-release ratio of 0.19, the release ratio of 0.81, the number of 649 released, the number of unqualified products issued by the inspection service is prohibited from leaving the country is 77, the overall average time of 25.365 hours, not released 63.

Conclusion 4: Process optimization of the full inspection process, although there is a release ratio, most of the results of the inspection part.

4 COMPARISON MODEL ANALYSIS

4.1 Comparative analysis of model 1 and model 2

A comparison of the basic process under the sampling process and the basic process under the full inspection process, found the following: First, the basic process under the full inspection is only the results of the enlarged presentation, and not to shorten the time to improve the proportion of non-release. Second, the basic process of full inspection still exists under the release ratio, which may have the number of releases of inspection links, will cause interference with the quarantine link judgment.

Conclusion 5: The basic process under the full inspection compared to sampling security, taking at least 5 hours to increase the maximum 13 hours, and quarantine efficiency by the process itself.

4.2 Comparative analysis of model 1 and model 3

Compare the sampling process under the basic process and the process optimization of the sampling process, found the following: First, the reorganization and optimization, the vertical process in the proportion of release, the proportion of non-release, and the overall average time have been improved, and the same analysis of the horizontal process is the opposite result. Second, the reorganization and optimization, the vertical process only a full quarantine link once to get the proportion of quarantine not released. But time-consuming, the vertical process is more efficient.

Conclusion 6: Unrelated to the process itself, the efficiency and security of the sampling process need to be improved.

4.3 Comparative analysis of model 1 and model 4

A comparison of the basic process under the random inspection process and process optimization of the full inspection process, found the following: First, the vertical process in the reorganization and optimization of the full inspection of security and efficiency is more secure, the horizontal process in the basic process of random inspection is better. Second, the quarantine part of the reorganization and optimization of the full inspection to ensure safety, but efficiency needs to be improved. However, the time taken to carry out a full inspection has high, and low efficiency varies because of the different processes.

Conclusion 7: The overall security and efficiency of the full inspection and sampling process, although there are differences, the reorganization and optimization of the full inspection can indeed guarantee quarantine security.

4.4 Comparative analysis of model 2 and model 3

A comparison of the basic process under the full inspection process and process optimization of the random inspection process found the following: First, the overall safety of the full inspection process without reorganization and optimization is higher than the optimization of the random inspection, but the efficiency is not high compared. Second, the security of the quarantine part is higher than the optimization of the random inspection, but the efficiency is compared to a high and low.

Conclusion 8: Even without reorganization and optimization, full inspection in the overall process and quarantine link security is higher than the process optimization of random inspection, but the efficiency of the selected process and there are advantages and disadvantages.

4.5 Comparative analysis of model 2 and model 4

Comparing the full inspection process under the basic process and the process optimization of the full inspection process found the following: First, the process optimization of the vertical full inspection process to ensure safety and efficiency. Second, the basic process under the horizontal process can also ensure a certain level of security and efficiency. The release ratio is lower than the latter. In the quarantine part of the process, the basic process under the horizontal full inspection process, relative to the process optimization of the horizontal full inspection process, takes less time. In the horizontal process, you can choose the appropriate full inspection process as needed.

Conclusion 9: The process optimization of the vertical full inspection process can take into account both safety and efficiency.

4.6 Comparative analysis of model 3 and model 4

A comparison of the process optimization of the random inspection and full inspection process found the following: process reorganization and optimization, full inspection compared to random inspection, in the overall process and quarantine part, are able to ensure security but will affect a certain degree of efficiency. It can be seen that the full inspection ensures safety but still takes more time, sacrificing some efficiency.

Conclusion 10: After process reorganization and optimization, the full inspection can ensure safety, but compared to random inspection time of up to 4 hours.

5 CONCLUSIONS AND FINAL THOUGHTS

From the above analysis, it is clear that both the reorganization and optimization of the sampling process before and after the safety and efficiency problems (conclusion 1, 3, 6). Reorganization and optimization before the full inspection than the safety of sampling (conclusion 8), but the time consumption will increase accordingly (conclusion 5), and the process itself is difficult to make an accurate judgment of the epidemic products (conclusion 2). The reorganized versus optimized full and random inspections take more time for the full inspection but spend relatively less time compared to the full and random inspections before optimization (conclusion 10). In addition, most of the reorganization and optimization of the process release ratio for the detection of partial results (conclusion 4) in the quarantine part can have security and efficiency (conclusion 7, 9).

Comprehensive analysis of the above also found that: (1) Sampling reorganization and optimization of the full inspection process after the non-release ratio can reach 10%. (2) The average time spent in an acceptable range, the simulation model can be compatible with a wide range of applications. (3) Both inspection and quarantine are separately and centrally executed. The process has efficiency advantages. (4) The efficiency of the use of technology has nothing to do with the number of processes that lies in the overall efficiency of the process. (5) Cost advantage by the impact of equipment.

On the one hand, a comprehensive quarantine strategy is theoretically proposed, and the theoretical model is combined with the simulation model to further deepen the foundation of theory and practice. Not only that, the processes provide clear options for further reorganization and optimization. On the other hand, from the product perspective, countries are able to control the outbreak at the source, and the government can based on the inspection and quarantine process provide some equipment support. Finally, the implementation of import and export inspection and quarantine is conducive to normal transactions between countries and promotes prosperity. There are certain limitations of the text study, such as legal, political, and diplomatic challenges.

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