Research on Cost Control of Mobile Project Procurement Based on Improved SEIRS Model

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Abstract. Cost control in procurement is critical for the mobile manufacturing industry, where rising costs of raw materials and components pose significant challenges. To address this, we developed an improved SEIRS epidemic model to study cost control propagation among contract units in mobile projects. Simulation results, based on evaluations from 12 experts, show that infected contract units maintain stable inventories and high infectivity, spreading cost issues to other units. Individual measures are insufficient to resolve these issues, leading to increasing procurement costs. Effective strategies include strengthening supplier management, enhancing procurement personnel's cost control skills, improving organizational structures and processes, establishing clear assessment indicators, and enhancing cost discrepancy detection. This research expands the application of the SEIRS model, providing new insights and scientific tools for cost control in mobile manufacturing projects.
Keywords：Cost control, Procurement management, SEIRS model, Mobile manufacturing, Contract chain analysis

1 Introduction

Cost control is crucial for business success, particularly in procurement, which focuses on optimizing management to save costs and improve efficiency. Effective procurement cost control is key to gaining a competitive edge and has drawn attention from businesses worldwide. Studies show that focusing on procurement cost control can significantly reduce supply chain costs [1]. In mobile manufacturing, procurement costs, including raw materials and components, can exceed 60% of total costs. With the rapid advancement of electronic information technology, the mobile communication industry faces intense competition, leading to more complex and valuable procurement projects [2] Consumer electronics procurement must also adapt to trends like short product lifecycles and changing consumer behavior [3].

Research on procurement cost control involves various methods, including target costing, total cost of ownership (TCO), activity-based costing, and supply chain-based management. These methods aim to enhance material classification, supplier selection,

and coordination to reduce costs. However, traditional supply chain approaches often overlook the dynamic and multifaceted nature of procurement cost control, treating it as a static process rather than a real-time one influenced by multiple factors and risks.

This study proposes using epidemic models to rethink procurement st control, as the diffusion of procurement cost risks is similar to the spread of infectious diseases. Procurement projects are inherently vulnerable to cost risks that can spread through the supply chain [4-5]. To address this, the study develops an improved SEIRS model to analyze the diffusion of procurement cost risks in mobile projects, providing solutions for predicting and controlling these risks effectively.

The research introduces the SEIRS model's application to procurement projects in the mobile manufacturing industry, filling a gap in existing literature by addressing unique challenges and risks. By using this model, the study aims to offer a more accurate and comprehensive approach for managing procurement costs, helping mobile manufacturing companies make informed decisions to control their expenses.

2   Data, Method, and Modeling

2.1   Data and Variables

This article is based on interviews conducted with 12 experts through face-to-face or telephone conversations. From table 1, the interview results were subsequently compiled and summarized. Some of the experts are from X Company's mobile project procurement department, and they possess a deep understanding of the entire process of mobile project procurement and contract management. The other experts were financial management specialists invited from external companies, and they have extensive knowledge of procurement cost control. The evaluation focuses on three key evaluation points: purchase contract signing, purchase contract execution, and p Purchase contract closure. Each evaluation point was assigned a score ranging from 1 to 9 to assess its level of importance.

Table 1. Evaluation of X Company's Procurement Cost Control Based on Contract Chain

Evaluation Criteria	Evaluation Content	Evaluation Method
1 Purchase Contract Signing		
1.1 Purchase plan development	To ensure the integration of the existing inventory levels and purchase requests from relevant departments, the procurement department should conduct a comprehensive balance and develop the procurement plan (annual, quarterly, or monthly)	Rigorous planning Comprehensive planning Scientific planning
1.2 Supplier selection	For procurement that requires a bidding process, the company should verify whether the procurement department follows relevant laws, regulations, and internal policies to implement the bidding process. This includes defining the scope, standards, procedures, and evaluation rules for the	Qualification level Equipment level Technical level Management level

	bidding process. Other departments such as the legal department and finance department should be involved in the evaluation or supervision of the bidding process	
1.3 Contract signing	The content of the procurement contract should include quality, quantity, price, transportation, payment, insurance, dispute resolution methods, and breach of contract responsibilities.	Standardized contracts
2 Purchase Contract Execution		
2.1 Contract tracking	Has the management of the procurement process been strengthened? Are the contract execution status tracked according to the agreed-upon contract amount? Have written reports been issued regarding any abnormal situations that may affect production and financial funds, along with proposed solutions?	Personnel experience Management capability
2.2 Contract acceptance	Check if the company's warehouse management personnel prepare the warehouse entry documents based on acceptance records, purchase requests, purchase contracts, and arrival notifications. The warehouse entry documents should be confirmed in writing by the purchasing personnel, warehouse management personnel, and other relevant individuals.	Contract compliance rate On-time completion rate
2.3 Contract payment	Is there a regular reconciliation of purchase transactions with suppliers through written communication? In case of discrepancies identified during reconciliation, have both the finance department and the procurement department jointly investigated the reasons for the discrepancies and taken appropriate follow-up measures?	Timely payments
3 Purchase Contract Closure		
3.1 Supervision of procurement contracts	Checking whether the company's audit, disciplinary inspection, and other relevant departments conduct regular procurement oversight as required, including generating written reports and providing updates to relevant management personnel.	Financial auditing

3   Variables

The spread of procurement cost among contract units exhibits an incubation period. The impact of procurement cost in one unit on its associated units does not immediately result in significant cost deviations. It is only when the procurement cost becomes uncontrollable that it receives considerable attention and control measures are taken. Therefore, this article aims to establish an SEIRS infectious disease model with an incubation period to study the propagation patterns of procurement cost control among contract units in mobile projects. In the SEIRS model, the contract units in the system can be classified into four types: susceptible individuals (S), exposed individuals (E), infected individuals (I), and recovered individuals (R).

In the context of procurement cost control in mobile project systems, S represents healthy contract units that have not experienced any cost control issues. E represents

affected contract units where the actual procurement cost differs within a reasonable range from the planned cost, indicating no cause for concern. I represents affected contract units where the deviation between the actual and planned procurement costs reaches a low alert level or higher. R represents contract units that have been effectively corrected through the efforts of multiple stakeholders, including the mobile project suppliers, or terminated contract units.

4   Methodology

To facilitate calculations, let's assume that the contract units belonging to the same contract have equal contract amounts. The contract amounts (HTE) for chip procurement contract units, display procurement contract units, metal structural component procurement contract units, packaging material procurement contract units, and OEM production contract units are (196, 63, 50.75, 8, 20) hundred million yuan, respectively. These five contract units will be referred to as C1, C2, C3, C4, and C5. The parameters within brackets represent the possible infection states between any two contract units, while a dash indicates no direct relationship in one step. Based on discussions with the expert team and the actual implementation of the CL project, during time period A, the investment deviation alarm statuses for the five contract units are mild alarm, no alarm, no alarm, no alarm, and moderate alarm, respectively. The corresponding specific infection parameter values related to these five contract units can be seen in the bracketed section.Furthermore, after evaluation by the expert group and for the convenience of studying the correction control of deviation in procurement contract units, it is assumed that susceptible contract units, latent contract units, infected contract units, and immune contract units all exist at the initial moment.

The evaluation of contract unit resilience focuses on the contractor's own execution capability and coordination ability. Following the quality capacity evaluation index system, this study constructs a corresponding evaluation index system for contract unit resilience, which includes the contractor's basic resilience and coordination ability. The contractor's basic resilience encompasses two aspects: comprehensive capabilities and contract performance capabilities. The coordination ability of the contractor regarding the contract unit includes two modules: work coordination and communication abilities, and conflict coordination mechanisms.

5   Results

Based on the given weight information, we can calculate the first-level indicator information for the resilience of the procurement contract units in the mobile project:
S=(0.708，0.864，0.263，0.752，0.814，0.193，3.0465)

So, based on the calculations above, we can determine that the resistance level of the mobile project procurement contract unit is 6.68.

Using the evaluated parameter values, according to formula, the predicted value for the second stage of the infectious disease model equation system is:

$$\begin{cases} S(2) = 337.75 - 0.82 * 193 - 0.618 * 63 - 0.137 * 50.75 - 0.346 * 8 - 1 * 20 \\ E(2) = 0.75 \\ I(2) = 0.82 * 193 + 0.618 * 63 + 0.346 * 8 + 1 * 20 \\ R(2) = S(2) - E(2) - I(2) \end{cases}$$

According to the principle, during the sixth period, procurement cost control reaches a stable state, as shown in Figure 1. This stability occurs when the cure rate is 0.67, effectively controlling latent contract units and preventing cost deviations from worsening. In other words, latent contract units do not turn into diseased units, and the cure rate of already diseased units stabilizes. These diseased units will continue to infect susceptible units, causing latent units to disappear. Although diseased units are suppressed, this does not fundamentally solve the procurement cost control issue. This situation expands the challenges of controlling project procurement costs, necessitating stronger interventions.

To effectively correct procurement cost control, the most critical parts must be addressed. Analysis of the prediction results indicates a significant turning point in the second period, showing poor control in the first period, failing to suppress the deviations of diseased units and their secondary impacts. Therefore, efforts should focus on the diseased contract units heavily affected by cost control issues. Based on this observation, it is hypothesized that correcting the procurement cost of the mobile chip contract unit and returning it to the susceptible group will improve control. The predicted results after this correction are shown in Figure 2.

Figure 2 shows that after correcting the chip contract unit's cost deviation, the project's investment deviation impact and cumulative effect significantly improve, avoiding widespread deviations. The trend indicates a decrease in diseased units and an increase in susceptible units. Over time, only the metal structure component contract unit will have a controlled investment deviation, meaning no outbreak of deviation issues, without needing complete eradication.
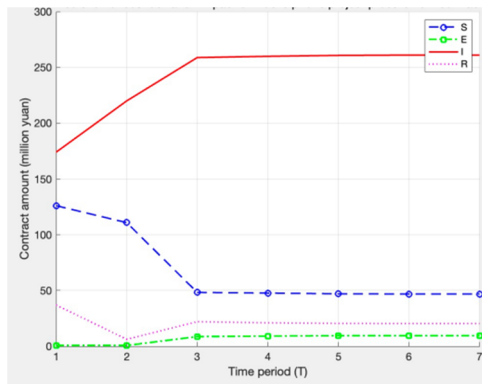

Fig. 1. Forecasting the Impact of Procurement Contract Cost Deviations in the Mobile Phone Chip Procurement
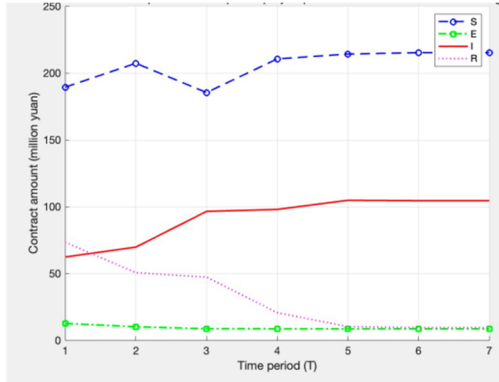
Fig. 2. Forecasting the Impact of Procurement Contract Cost Deviations in the Mobile Project after Correcting the Chip Procurement Contract Unit
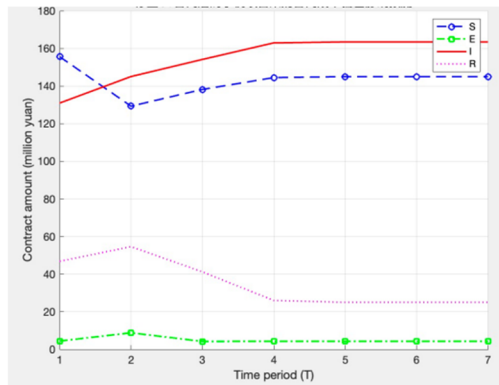

Fig. 3. Impact of Correcting Metal Structure Component Procurement Contract Unit on Forecasting of Procurement Contract Cost Deviations in the Mobile Project
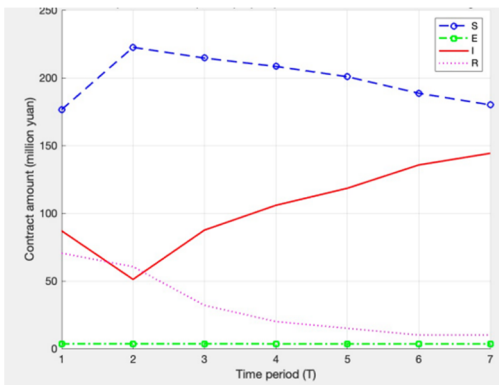

Fig. 4. Impact of Correcting All Sources of Infection on Forecasting of Procurement Contract Cost Deviations in the Mobile Project

According to Figures 3 and 4, correcting the investment deviation in the metal structure component procurement contract only slightly alleviates the project investment deviations due to the significant impact of the chip procurement contract's deviations, where the recovery rate is lower than its infectivity. After effectively correcting all sources of infection, project investment deviations are significantly controlled, but the display procurement contract unit becomes infected with a recovery rate insufficient to surpass the infectivity of the metal structure component. Thus, the metal structure component procurement contract remains in a deviation state while other contract units stay healthy and controlled. It is recommended to prioritize correcting the chip procurement contract, and if resources allow, simultaneously correct the complete assembly contract. Alternatively, with limited resources, first control the chip procurement contract and then improve the recovery rate to achieve significant control effects and support the project's procurement cost control objectives.

Through simulation of procurement cost control under different cure rates, we observed the following results: As the cure rate increases, the procurement costs of A Company's mobile project contract units are effectively controlled, and the spread effect is suppressed. Infected contract units are gradually controlled, and particularly at a cure rate of 0.5, the spread impact is eliminated. Ultimately, the procurement cost control of the chip contract unit is completely eradicated, and the entire project's contract units reach a stable state. All units remain healthy, achieving effective prediction and control of investment deviations, thus ensuring A Company's mobile project procurement cost control objectives.

The above simulation predicted the impact of investment deviation spread in the original state. To further clarify the absolute impact of the increased cure rate, simulations were conducted based on the initial states shown in Figures 5 and 6. The predicted impact of contract unit investment deviations under different cure rates is shown in Figures 7 and 8. The simulation analysis indicates that as the cure rate increases, the spread of procurement cost deviations in the mobile project is significantly suppressed. In-depth analysis reveals that the slight deviations in the complete assembly contract unit and the chip procurement contract unit, caused by the cumulative effect of procurement deviations, are effectively controlled under higher cure rates. Figures 7 and 8 clearly show that the spread of procurement deviations is cured within the first three periods, ensuring the successful achievement of the project's cost control objectives.
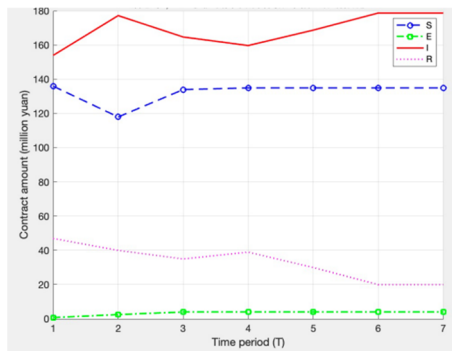

Fig. 5. Impact of Mobile Project Procurement Contract Cost Deviations on Forecasts with Recovery Rate $\gamma=0.3$
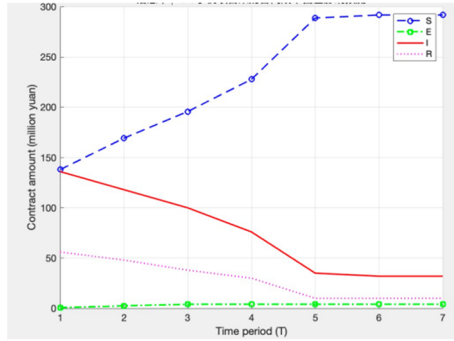
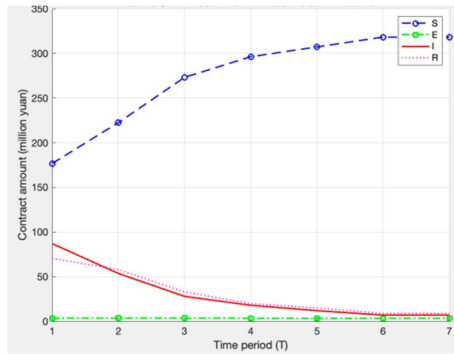**Fig. 6.** Impact of Mobile Project Procurement Contract Cost Deviations on Forecasts with Recovery Rate γ=0.5

Fig. 7. Impact of Procurement Contract Cost Deviations on Forecasts in Alert-Free State with Recovery Rate γ=0.3
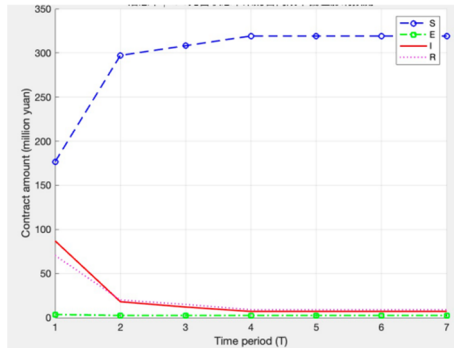

Fig. 8. Impact of Procurement Contract Cost Deviations on Forecasts in Alert-Free State with Recovery Rate γ=0.5

6   Conclusion

This study uses the SEIRS model to understand procurement cost control in mobile phone production, drawing an analogy to virus transmission. Effective supplier management, accurate risk assessment, and comprehensive budgeting are crucial for optimizing procurement processes. Centralizing procurement functions within an organization can streamline processes and improve communication, reducing inefficiencies. Establishing clear, data-supported performance metrics for suppliers and procurement staff is essential for effective cost control. Additionally, developing early warning systems to detect and address cost deviations can significantly enhance procurement outcomes. Implementing these strategies can help organizations improve procurement cost control, mitigate risks, and achieve better financial results.

Acknowledgement

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