Preliminary study on prediction-driven munitions supply mode based on big data

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Abstract. The application of big data in military logistics has made great leap in the way of supporting forces and aiding in operational decision-making. This paper introduces a new munitions supply mode—prediction-driven munitions supply based on big data. By monitoring the various sources of munitions consumption data and order data, leveraging the processing technologies, the prediction-driven munitions supply can realize the munitions requirement prediction, and based on the result of the prediction, the munitions managers and logistic supporting organizations can suggest supporting decisions, which leads to the realization of supply ammunition well in advance of shortages happen.

1. Introduction
The munitions supply is to provide the correct type and quantity of munitions to the force as responsively as possible. Munitions supply involves some essential actions which include forecasting, requisition and distribution. However, due to the technology development, the common strategy adopted in ammunition supply process has long been a user’s demand-pulling mode which means the forces dominant the munitions requesting process. When a unit is aware of the shortage of munitions, it begins to request the munitions from the munitions information systems or by other means, and the munitions manager responsible would check if this requisition is reasonable and can be satisfied, if the answer is yes, then, the munitions will be distributed to the requesting unit. Therefore, a supply process is completed. The process is depicted in figure 1. However, it is a passive supply mode which can result in many problems, such as mal-requisition by units, and higher cost and risk due to expedited delivery of munitions in urgent situations. In order to respond the users' demand more quickly, accurately and robustly, the paper introduces a prediction-driven munitions supply mode based on big data, by monitoring the collected consumption data and order data, the munitions manager can find the shortage trend in advance, and by big data processing, the munitions manager can realize the munitions requirement forecasting; and based on this forecasting result, supply and resupply decisions can be made to prevent shortage happening. The process is depicted in figure 2.
2. Characteristics of prediction-driven munitions supply mode based on big data

2.1. Predictability
In prediction-driven munitions supply mode, munitions managers at various military echelons can forecast the munitions shortage trend of a certain unit based on historical consumption data and requirement orders data and after making judgment, find the right time to distribute munitions. With this historical data, a munitions manager is able to use some algorithm model to create a demand forecast, allowing them to make supply decisions quickly.

2.2. Accuracy
Big data system can process enormous volume of data from the variety of sources and different types, and can mine valuable data especially the data associated with predictions of future trends and modes with so fast and processing velocity accurately.[1] By leveraging new technologies, such as AI, machine learning and in-depth analysis of data mining, big data system can discover the new laws in munitions supply process, and apply it for military decision-makers and planners to make the right decision on the battlefield.

2.3. Agility
In Prediction-driven munitions supply mode, by predicting the munitions shortage far earlier than the units be aware of it, munitions managers can better control the tempo of munitions supply, that means there is enough time for munitions managers to plan and execute the munitions operations and control the tempo to distribute, and it will give them much freedom to choose the right time, right place to distribute munitions in accordance with the battlefield tempo and situation.
2.4. High cost-effectiveness
In users' demand-pulling munitions supply mode, there will be much higher cost on expedited shipping order and labor in the supply chain which happens frequently.[2] However, the prediction-driven munitions supply mode can tackle this problem, and it will not only reduce the human error on requesting process, but also result in the savings in transportation cost and labor cost.

3. Framework of prediction-driven munitions supply system based on big data
Big data can be understand as the new generation of data analysis and system framework in mining valuable data that can be supportive to decision-making from the enormous data with a definite time.[3] The framework of prediction-driven munitions supply system based on big data as shown by figure 3, and it contains six parts including data collecting, data monitoring, data processing, requirement prediction, requirement evaluation and supply decision.

Figure 3. Process of prediction-driven munitions supply based on big data
3.1. Data monitoring and data collecting
There are different types and sources of munitions consumption data which include the historical data, real-time data, training and exercising data, testing data, foreign military data, and depots data etc. Some are from the units, some are from organizations which are responsible for collecting data, and some are even from manufacturers, all of which are to be monitored by munitions managers at various echelons in accordance with their authority. Units' munitions consumption data are dynamic and changes frequently while the historical data is more or less static. Changing detections can be useful for identifying changes in data pattern that can be used for future analysis and prediction. Usually, a data change range threshold is defined, if the parameters signify the threshold level, it will provide an early warning, indicating that a supply operation has to be planned.

3.2. Big data processing system
The big data processing system is the core to realize the prediction-driven munitions supply. By storing the data, and mining and analysing the useful data, the system begins to predict the munitions requirement.

3.2.1. Data storage. For the variety of data collecting from different sources, there must be a storage system to store them. Nowadays, the storage methods are usually comprised of documentary systems, database, data warehouse, message system, internal storage system and etc. [4] The traditional storage strategy is to use an integrated database to store data. However, in order to ensure the security of military data, a distributed storage strategy can be adopted. In this system, distributed data warehouses will be the main storage method. By using data warehouse technologies, all the qualified users, including the using units, munitions managers, logistics management organizations, data management organizations and even manufacturers can visit data warehouses, and log in data, manage them and maintain them. [5]

3.2.2. Data analytic. Big data are dependent on data mining.[6]Mining data from the distributed data warehouses and finding the useful and potential valuable data and the trend, then leveraging mature technologies to do the analysis, including the association rules analysis, clustering analysis, trend prediction, sequential analysis, visualized analysis.[7]It is actually a dynamic analysis, which can adapt to the ever changing situations. By integrating the mathematical statistics, machine learning, data mining and patterns identification, and based on pre-processing and exploratory analysis of munitions data, and combine with the characteristics of munitions supply, new models can be established, by which planners can use to make new plans.

3.2.3. Requirement prediction. Munitions requirement prediction is the core function of prediction-driven munitions supply system based on big data which comprises of various munitions consumption model and simulations, by leveraging the data from the variety of source, the big data system can quickly find a right models to calculate the consumptions and the consumption rate, and predict that on a certain condition, how long the munitions on-hand will be used to exceed over the security threshold and need to replenish. After this diagnosis, munitions managers can leverage the new models to calculate how much munitions should be sent to the users at right time. This enables the supply mode shift from the traditional user's demand-pulling supply mode to the new prediction-driven supply mode, thus fulfill the munitions distribution goal that supply the right quantity and type munitions at the right time and place.

3.3. Requirement evaluation and supply decision
The value of prediction-driven munitions supply mode embodies in its applications, especially in the decision-making aids. The data gain from the data processing system can be charted of graphed out, the munitions manager can easily find which units are in need of supply. But before the munitions managers make the supply decision, an evaluation should be conducted on the
requirement prediction. During the evaluation, a common sense judgment is also made to ensure that at a certain consumption rate, the unit needs to be supplied at some point of time, and the quantity of munitions the system calculated is appropriate. After that, he can put this information on the battlefield situational picture, helping the commander to gain the understanding of logistics support, and making the right decision on operational command and control.

Only by the coordination of the above six aspects, can the military realize the prediction-driven munitions supply mode.

4. Conclusion
The ideal supply goal that the military wants to achieve is to supply the unit at the right time, right place with the right type and right quantity. With pursuing this goal, military has made big leap in logistic support with big data. With the deepening of the theory and application of big data, it is foreseeable that in the near future the prediction-driven munitions supply mode based on big data can make breakthrough in military materiel supply mode, which can greatly improve the efficiency in munitions distribution.

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