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MS984 Data Analytics in Practice

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# **Data Science and Saving Cost of UK Defence**

## **Executive** **Summary**

This project aims to use data science to save costs of Defence. Three main points are presented to help improve the efficiency of the ministry and save the budget namely:

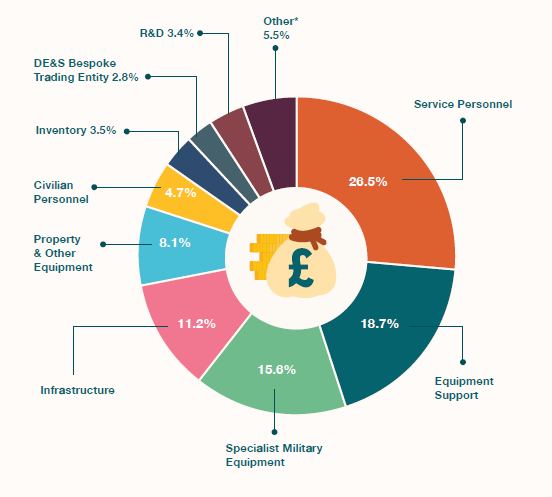
* Predictive analytics for the personnel aspect
  + Using the machine learning to classify personnel to match with a job from the data of past assessments, characteristics of job and personnel. Moreover, machine learning is also used to predict how many personnel for new job or project and putting the optimisation model to allocate job for suitable under constraints.
* Predictive analytics tools for equipment maintenance
  + Using the sensor technology to collect data of using equipment and applying machine learning to detect the performance of equipment and preparing maintenance for only needed.
* Training and health performance improvement using machine learning
  + Using machine learning to detect the pattern of soldiers’ health to search for the proper training and health programme.

From these ideas, the last one seems to be a potential quick win because there is not much thing to prepare before launching the programme. However, applying machine learning for equipment maintenance might have the highest potential for cost saving which can be seen the result in a short time. For saving cost for personnel area, although it is hard to see the good result suddenly, in the future, it can be show powerful ability to reduce costs of military.

## **Introduction**

UK military budget is roughly around 36.6 billion pounds in 2017/18 fiscal year. Though it is a huge amount of money, it is still not enough for all the projects Defence aspired to do. To handle the limited financial resource, efficiency improvement to increase output, and cost saving projects must be realized.  The aim of this report is to introduce ideas to generate cost saving for Defence by using data science techniques and tools.

Figure 1: Defence Expenditure in 2017/18   
(Ministry of Defence, 2018)



First, cost breakdown of military budget is reviewed (figure 1). It reveals that the two biggest portions of the budget go to personnel service and equipment expenses, 20.5% and 18.7% respectively. The huge percentage of these two is an opportunity for huge saving as well. Accordingly, this report proposes 3 ideas for efficiency improvement and cost saving related to these expenses which in the areas of personnel to task allocation, workforce planning and allocation, personnel training program and personnel health performance improvement, and equipment maintenance.

## **Predictively analytics for personnel aspect**

The budget of military’s service personnel is the biggest portion; it gives a promising possibility to decrease expense in this area rather than trying to save cost from other small portions. With the number of personnel in Defence, it needs to investigate that they are suitable for the job or not using machine learning to help the finding and assign personnel to job. Moreover, it also helps to find and allocate workforce.

#### Technical approach:

First, applying machine learning to assign personnel to jobs or tasks. By applying analytics tools to the data of personnel’s performance assessment and their profile to identify common characteristics, background, qualification, and skills that make some personnel did well and some showed poor performance on a certain job. This information provides insight for job requirement, identifying keys elements needed in personnel for a job. Moreover, applying predictive analytics tool to the data will help predict if new personnel or recruit is fitted for the job.

Predictive analytics also help in workforce prediction and optimisation. It can be used to predict how many staffs needed in the new project based on past data. The system predicts how many personnel needed for a job to be success from the data of past successful project or job: what was the job, type of job, how many workforces were there, length of the job, and other data.

Furthermore, the information of job requirements and number of personnel needed can be together with optimisation tools to find optimal personnel to job allocation. By using the data as objective function and constraints to find the suitable number of personnel, skills, characteristic of job and people.

#### Change and cost saving:

The expectation from using machine learning is human resource management, putting the right person for the right job. Rather than using HR’s experience and gut feeling, data help identifies job requirement and predict and assign suitable personnel for the job. This leads to increasing of higher efficiency. When personnel do the job which they are familiar with or be an expert of the job, they perform well with high efficiency, more job can be done using the same or even less amount of personnel. Here is where it can save cost from personnel service. Furthermore, less personnel needed in the workplace leads to less recruitment activity, and also less expense on this.

Another change and saving come from the fact that these activities: job requirement identification, job assignment and workforce planning are done in a fast and almost automated manner using machine learning. It creates less work than manual analysis and planning. Hence, less HR personnel needed, and the cost is saved.

#### Additional benefit:

The additional benefit is about personnel satisfaction in their job. Personnel who have been assigned to the job that suits them and they can perform well, would have higher morale, higher job satisfaction, and less stress and mental issues.

## **Predictive analytics tools for equipment maintenance**

As the equipment expense is the 2nd biggest cost, some saving could be generated from equipment failure prediction and prevention. By applying predictive analytics to equipment’s performances and conditions data, which is monitored by sensor technology, equipment’s failures and quality issues could be predicted and prevented. Accordingly, equipment reliability is increased, while equipment maintenance and inventory cost are lower.

#### Technical approach:

First, data of equipment’ working performances and conditions are collected using sensors technology. Sensors such as vibration sensor, fault sensor, corrosive damaged sensor, and crack detection sensor. Together with IoT (Internet of Things) technology, data are transmitted to the platform for computing. Then, the predictive model is run to determine when and where failure is likely to occur by detecting any anomalies, performance gaps and failure patterns from the data.

#### Changes and cost saving:

There are many changes in maintenance operations which result in cost saving. First, periodic maintenance is replaced by condition-based maintenance which is implemented when equipment inspection and part change are actually needed. This help increases equipment availability, eliminate unnecessary inspections and part change which also save maintenance and spare part cost.

Moreover, the ability to predict failure helps in better purchasing plan, when to purchase equipment part and how many to purchase. Therefore, inventory is lower, less sunk cost, and warehouse and storage cost.

Lastly, the predictive analytics tool help avoids catastrophic failures which results in the whole system breakdown rather than just one component. The cost of system restoration is usually a lot more than fixing one component. Moreover, this type of failure also shortens lifetime of the equipment. Again, avoiding the failure means cost saving from new equipment.

#### Additional benefits:

An additional benefit of predictive analytics tool is that it provides a safer working condition to equipment user or operator from using more reliable equipment.

Another benefit is that collected data provides a better understanding of equipment’s performance and efficiency. In turn, it helps in better purchasing, invest more in high-performance ones and less in poor performance ones.

#### Challenges:

The main challenge comes from converting and managing a variety of sensors signals to data, before processing and mining the data.

## **Training and health performance improvement using machine learning**

Employing machine learning to soldier’s health and physiological performance data could help improve military training program to be more effective and cost efficient. By applying machine learning to detect patterns and abnormalities to soldier’s data, response to training is revealed together with health issue or gap. Accordingly, training and health care program could be adjusted to better suit the soldiers to raise their performance.

#### Technical approach:

Health and Physiological data of soldiers during training are drawn using wearable sensors which are worn by soldiers during training. Data such as movement pattern, running speed, ground contact, energy expenditure, body temperature, heart rate, blood pressure and other parameters are collected and processed using machine learning algorithm to detect the patterns or abnormalities of performance, and predict soldiers’ performance whether it’s fit for deployment.

#### Changes and cost saving:

The patterns between different type of training or training conditions and soldiers’ health and physiological performance overtime show result of training. It tells how effective the training program is, whether it’s sufficient, or which type of training yields the best outcome. Accordingly, training programs are adjusted in order to gain the highest performance rate.

Moreover, soldiers’ performance and training condition could be used to predict the soldier’s readiness in deployment in some demanding terrains and environments. Therefore, soldiers whose health are best fit for the deployment environment are assigned to the job based on data rather than planner’s experience and judgement. The main benefit of this is in reducing the risk of operation failure due to lacking physical abilities, which also reducing wasted investment. Moreover, the deployment allocation task is also more efficient with help of machine learning tool.

In term of cost saving, all these changes might not directly yield saving, but they improve training and operation efficiency. Furthermore, it also avoids unbeneficial investment in poor training and healthcare program, and unfit job allocation. Hence, it increases return on investment, maximize money put into the training program and deployment.

#### Additional benefits:

Lastly, anomalies found soldiers’ performance indicates health issue or performance gap. The realization indicates not only soldiers’ readiness for deployment, but also pin points the problem and allows personalized training program for soldiers to improve their conditions.

## Conclusion:

In conclusion, data analytics and advanced technology ease military work in term of management their military’s capabilities including cost saving. Data analytics techniques can be used to save cost of personnel and equipment expense. The technology can help military to detect the useful patterns from the data to determine strategies in order to decrease costs. Not only saving costs, but data analysis techniques also improve working efficiency and safety for personnel. Among proposed projects, the most promising in term of quick win would be training and health performance improvement using machine learning. Implement this does not much of preparing and planning time as the wearable sensors are available in the consumer market at cheap cost. Gathering data and applying data analytics tools does not take long. For the highest possibility in term of potential saving, equipment maintenance sounds most promising as it directly yields actual saving while others result in higher efficiency. Even though saving cost for personnel area seems to be difficult to decrease costs in short term, in long term, the cost saving of this area will be empirical results.

## Reference

Ministry of Defence. (2018). *UK Defence in Numbers*. North Wales: Ministry of Defence UK.