



HOW WELL ARE EQUIPMENT REPLACEMENT PRIORITIZATION SCORES FOLLOWED? WRHA AS A CASE STUDY

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INTRODUCTION

Healthcare organizations around the world are increasingly making use of mathematical models to provide objective analysis of equipment in the inventory for equipment replacement. These models involve Equipment Replacement Priority Scores (ERPS), which are based on providing a numerical score to various criteria, and vary across regions depending on the system [1]. While a lot of studies exist to demonstrate various ways to implement replacement systems [1-3], little is known on how well these systems are followed within organizations. The Winnipeg Regional Health Authority (WRHA) is used as a case study thus, to investigate organization-wide integration.

Choosing what equipment to be replaced in the Winnipeg Region is a multistep process: The Clinical Programs must prioritize equipment in need of replacement individually and generate their Program's equipment priority list. These lists are brought forward to a committee that prioritizes equipment regionally by voting as a group, generating a regional prioritized list. This ranked listing is sent for budgetary approval at this point. An ERPS was implemented to help reduce the subjectivity of the voting process. The prioritization model makes use of the following criteria based on information available in the region's Computerized Maintenance Management System (CMMS): Repair Cost, Age, Reliability, Equipment Function and Failure Consequence [4]. These criteria were given various weights and combined, to produce a final ERPS after normalization up to 100. A higher priority score would indicate a greater urgency for replacement [5]. Equations 1 and 2 below are the calculations employed for the ERPS.

$$\begin{aligned} & \text{Prelim.ERPS} & (1) \\ & = 0.2 * \left(\frac{RCS}{5}\right) + 0.1 * \left(\frac{AS}{6}\right) + 0.5 * \left(\frac{RLS}{5}\right) + 0.1 \\ & * \left(\frac{EFS}{8}\right) + 0.1 * \left(\frac{FCS}{5}\right) \end{aligned}$$

$$\begin{aligned} & \text{Final ERPS} & (2) \\ & = [(\text{Prelim.ERPS} - \text{min})/(\text{max} - \text{min})] * 100 \end{aligned}$$

ERPS = Equipment Replacement Priority Score
RCS = Repair Cost Score
AS = Age Score
RLS = Reliability Score
EFS = Equipment Function Score
FCS = Failure Consequence Score
Min = Minimum possible prelim. ERPS
Max = Maximum possible prelim. ERPS

This paper describes a comparison of the subjective voting method and the objective ERPS method to assess the degree of agreement.

METHODOLOGY

The lists of WRHA prioritized equipment for the fiscal years 2014-2015 and 2015-2016 were obtained for analysis. The list was comprised of: the region's voting priority rank, site, clinical program, areas needing equipment replacement or addition, cost and justification for request. The analysis looked at replacement devices only; net new devices were out of scope.

A list of the inventory complete with their ERPS was generated from the region's CMMS. This list included all the necessary criteria for computing the ERPS with a separate column for the final computation. The ERPS generated was then matched to the exact equipment on the WRHA prioritized equipment list. Since the WRHA prioritized equipment list is already ranked in order of voting priority, the corresponding ERPS are given 2nd rankings

Table 1: 2014-2015 WRHA and ERPS rankings for Specialized Assets. Min, Max & Avg represent the ERPS data.

| Original Voting Rank | Voting Rank (redefined) | Generic Equipment Type | ERPS Score | | | ERPS Rank | | |
|----------------------|-------------------------|------------------------|------------|------|------|-----------|------|------|
| | | | Min. | Max. | Avg. | Min. | Max. | Avg. |
| 2 | 1 | Ventilators | 23 | 88 | 51 | 1 | 1 | 1 |
| 4 | 2 | Patient Monitoring | 14 | 58 | 19 | 6 | 5 | 7 |
| 5 | 3 | Patient Monitoring | 16 | 59 | 30 | 3.5 | 4 | 4 |
| 6 | 4 | Patient Monitoring | 12 | 37 | 27 | 9.5 | 6 | 5 |
| 7 | 5 | Patient Monitoring | 14 | 14 | 14 | 6 | 8.5 | 8 |
| 10 | 6 | Patient Monitoring | 14 | 66 | 36 | 6 | 3 | 3 |
| 13 | 7 | Fetal Monitors | 16 | 73 | 45 | 3.5 | 2 | 2 |
| 18 | 8 | Bladder Scanner | 10 | 10 | 10 | 11 | 12 | 11 |
| 27 | 9 | Camera Tower | 8 | 11 | 9.5 | 12 | 11 | 12 |
| 29 | 10 | Sleep Lab Equipment | 12 | 14 | 13 | 9.5 | 8.5 | 9.5 |
| 34 | 11 | Common Supplies | 18 | 31 | 21 | 2 | 7 | 6 |
| 39 | 12 | Mobile X-Ray | 13 | 13 | 13 | 8 | 10 | 9.5 |

based on their ERPS (ERPS ranks). Not all equipment requested through the annual prioritization process is intended to replace an existing asset in the CMMS inventory. In these cases, an ERPS cannot be generated as the scoring system was designed to prioritize asset replacement based on their service history. The ranks obtained through the voting process had to be redefined to remove those assets with no ERPS (i.e. "Voting Rank (redefined)").

Due to the number of individual pieces of equipment, a system for examining equipment groups needed to be established. For example, more than one ventilator could be getting replaced at a time but those ventilators might be regionally prioritized together instead of separately. Hence, all those ventilators would receive the same voting priority rank. Even though they might all have the same voting priority rank, the individual ventilators are still used differently and have different conditions affecting them. They all break down at different times, have different number of repairs, and may be different ages. Therefore, their ERPS will be different between them. With differing ERPS within an equipment group, analysis becomes a little more challenging.

For the purposes of this analysis, the minimum, average and maximum ERPS were used to understand the relationship between the two methods. Table 1 above shows a sample of

the rank comparison in raw data for the 2014-2015 fiscal year.

A direct rank comparison plot was done for both fiscal years. Individual assessment of ranked assets was done to obtain more insight into the differences from both methods.

RESULTS

Based on information for both 2014-2015 and 2015-2016 fiscal years, individual plots Figure 1 and Figure 2, were created. 12 and 11 generic device types were analyzed in both fiscal years respectively. Visually, it appears that there is increasing agreement between both methods from 2014-15 to 2015-16. To gain more perspective, the ERPS of the entire asset inventory was plotted against the ERPS of the regionally prioritized equipment in Figure 3 below. It revealed that some high scored ERPS equipment were not being prioritized by the region and that the majority of replacement items brought forward by the clinical Programs were low scored ERPS in the score range of 21 - 30.

DISCUSSION AND CONCLUSION

Examining the constructed figures above, it is seen that from the 2014-2015 to the 2015-2016 fiscal year, there seems to be better agreement between the two methods. This does not imply that one method is getting equal to the other but simply showing that the order with which items are being ranked, are similar. Ideally, a match on the 45-degree line across the plots would indicate perfect agreement. This data does not indicate that the ERPS is dictating the voting process of the region, but does demonstrate increasing alignment. Further data for future years would need to be gathered to determine if the trend continues. While certain pieces of equipment possess high ERPS, they have been ranked low by the WRHA voting committee. This can be seen in Figure 2 where an item ranked 2nd using ERPS is ranked 10th using WRHA voting. Conversely, an asset ranked low by ERPS was ranked high by the voting committee. This was because the voting committee favored decisions on the support status, clinical capability and age of assets.

Examining Figure 3, it is evident that only 2 out of 6 high priority items in the range of 81-90 were prioritized through the voting process.

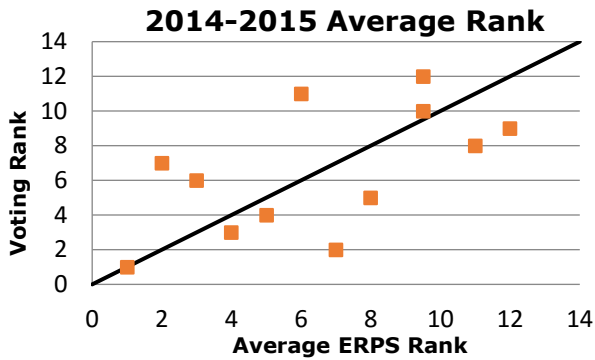


Figure 1 - 2014/2015 Rank Comparisons

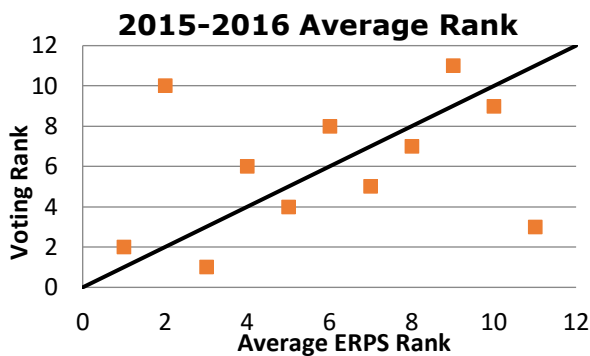


Figure 2 - 2015/2016 Rank Comparison

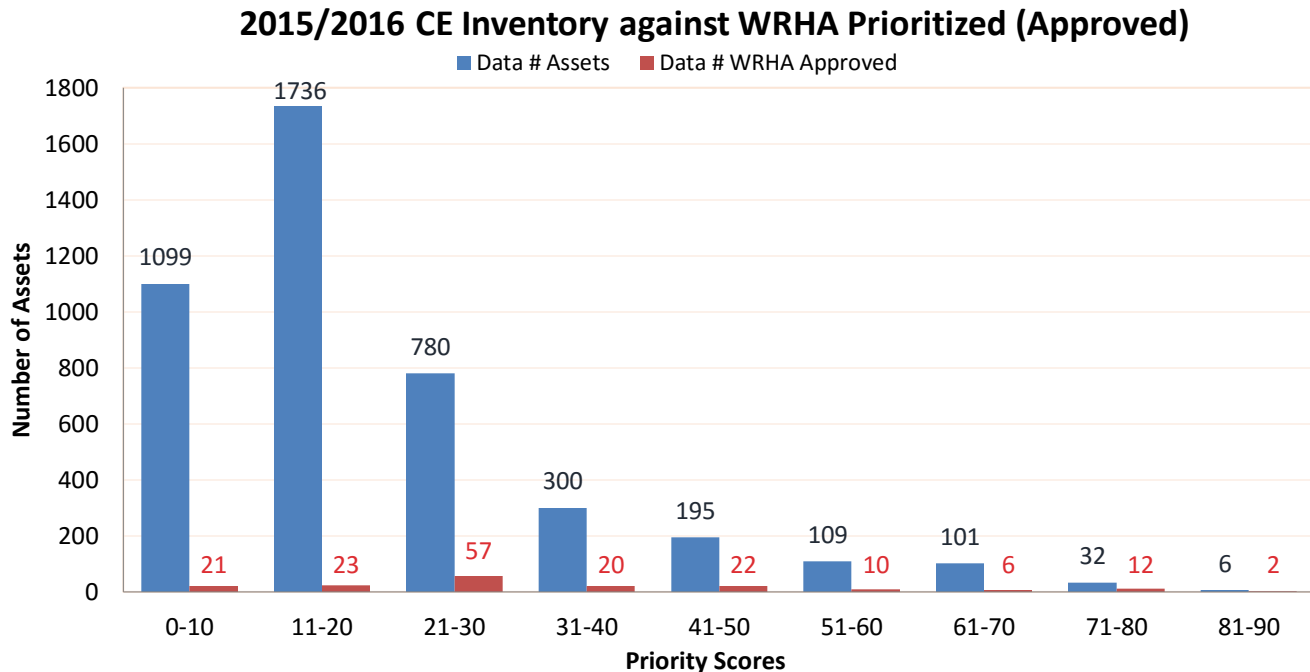


Figure 3 - 2015/2016 CE Inventory vs ERPS of Prioritized Assets

+ Lower priority devices in this paper account for devices with scores below 30.

There are a lot of high priority assets in the 61-80 ranged that were not prioritized as well. We can see however that the bulk of prioritization (57 assets) occurred for the ERPS range of the 21-30 which is low. This begs 2 questions:

- Are the high scored ERPS assets being considered for replacement at all? If yes, why are they not being prioritized?
- Why are low scored ERPS assets being prioritized over highly scored assets regionally?

To answer these questions, an initial list of all pieces of equipment brought forward by the different clinical programs (all un-prioritized) by the region was obtained. This list was used to cross-examine both high and low ERPS ranked assets to determine exactly what the missing (un-prioritized) assets are, then consult the above-mentioned list to answer both questions posed above.

Are the High ERPS scored Items Being Considered for Replacement?

Upon examination of the assets with high ERPS scores that were **not** prioritized, it was determined that the highly-scored assets in the range of 81 – 90 were: 2 patient monitoring systems for the Critical Care Program, a pacemaker for the Surgery program and a ventilator for the Allied Health program. These were cross matched with the list of un-prioritized assets brought forward by the clinical programs and came back without a match suggesting that they are not being considered. To ensure that this conclusion wasn't premature, an analysis of the high priority assets in the range of 71 – 80 was conducted. Only 3 out of the 20 un-prioritized items were successfully matched. This solidifies the conclusion that the highly-scored assets were **not** being voted highly for replacement and should be further investigated.

Why are Lower Scored Assets Being Prioritized Higher?

Still using the same un-prioritized list brought forward, it was observed that the regionally prioritized high priority assets in the range of 81 – 90 were defibrillators. Defibrillators also happened to have been

prioritized in the ranges of 71 – 80 and 21 – 30. This was because of a replacement plan to replace defibrillators regardless of their priority scoring. This is a contributing factor to the large discrepancy in regional prioritization being skewed to the lower priority scores. The defibrillators accounted for 77% of the +lower priority devices while some ventilators accounted for 23%.

Conclusively, this analysis suggests that factors such as Support Status, Clinical Capability and age are more heavily weighted during the voting and not considered in the ERPS score. This analysis will help further enhance the ERPS scoring system, and future work will be conducted to include factors such as Support Status and Clinical Capability in our automated ERPS scoring system. However, the automated system presents some challenges of its own with regards to updating support statuses. Due to the large number of assets in our database, entering this data individually would be quite tasking. Processes are being implemented to have support status data more reliable in the CMMS.

Therefore, the above changes would allow for ERPS to be more closely followed by Clinical Programs. Further related cases need to be analyzed for improved knowledge to better guide health management organizations.

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