Forecasting of indirect consumables for a Job Shop

M. Shakeel, S. Khan and W. A. Khan
Faculty of Mechanical Engineering, G.I.K Institute of Engineering Sciences and Technology, Topi 23640, Swabi, KPK, Pakistan

E-mail: gme1510@giki.edu.pk, gme1512@giki.edu.pk, wasim@giki.edu.pk

Abstract. A job shop has an arrangement where similar machines (Direct consumables) are grouped together and use indirect consumables to produce a product. The indirect consumables include hack saw blades, emery paper, painting brush etc. The job shop is serving various orders at a particular time for the optimal operation of job shop. Forecasting is required to predict the demand of direct and indirect consumables in a job shop. Forecasting is also needed to manage lead time, optimize inventory cost and stock outs. The objective of this research is to obtain the forecast for indirect consumables. The paper shows how job shop can manage their indirect consumables more accurately by establishing a new technique of forecasting. This results in profitable use of job shop by multiple users.

1. Introduction
The objective of forecasting is to satisfy the need of users of the job shop efficiently by providing them all the direct and indirect consumables required. The main objective proposed in this research is to develop a forecasting method for the selected indirect consumables that are used in a job shop in order to determine the demand quantity for the ordering. If the forecasting estimates are not predicted, the figure may appear to be prone to errors. [1] Therefore in order to make it error free and more precise, forecasting is done so that their order to the supplier is appropriate in term of quantity and delivery time. Appropriate ordering results in good lead time management, inventory cost and stock outs.

Direct consumables include machines and usually the demand rises as the number of orders increases in a job shop [1-2]. Indirect consumables are the materials required for these machines to be used by the users. These materials play a supporting role in performing manufacturing processes. The demand of indirect consumables must be specified as they may cause hurdles during operation of machine tools while executing an order. Several methods for forecasting the use of indirect consumables are available.[3] Quantitative techniques are employed for forecasting of indirect consumables. The forecasting can be time-series forecasts or they may be based on other associative models. Time series data must be identified by the forecaster. These behaviors may show pattern or random variation. [3-5]

In this study the quantitative techniques weighted average and exponential smoothing were employed to express new technique to reduce the error due to limited data for analysis.

2. Proposed methodology
The methodology used is to first get the previous data from a job shop. The data used was for a period of 4 months. The estimated value of the indirect consumable was calculated through feedback from stakeholders. The forecast was estimated using averaging, weighted average and exponential smoothing (with different values of alpha) [3-4]. The results are presented in Table1, the difference...
between the actual value and the exponential smoothing decreases as the value of alpha increases but there is still a large difference. A new method is introduced whereby the weighted average and exponential smoothing are combined together. For this new method the formula is, Forecasted value = Weighted average + \alpha (Actual-Weighted average). The results are listed in the figure below. The results show a big difference in the traditional exponential method vs the new method. The results are presented in Table 1.

| Items                  | Actual number | Estimated number | Average | Weighted Average | ES 0.1 | ES 0.2 | ES 0.3 | ES 0.4 | ES 0.5 | ES 0.6 |
|------------------------|---------------|------------------|---------|------------------|--------|--------|--------|--------|--------|--------|
| Hack Saw blades        | 1000          | 1200             | 1100    | 1080             | 1180   | 1160   | 1140   | 1120   | 1100   | 1080   |
| Fine emery paper       | 24            | 32               | 28      | 27.2             | 31.2   | 30.4   | 29.6   | 28.8   | 28     | 27.2   |
| Coarse emery paper     | 24            | 32               | 28      | 27.2             | 31.2   | 30.4   | 29.6   | 28.8   | 28     | 27.2   |
| Painting brush         | 20            | 14               | 17      | 17.6             | 14.6   | 15.2   | 15.8   | 16.4   | 17     | 17.6   |
| Welding rods           | 5             | 8                | 6.5     | 6.2              | 7.7    | 7.4    | 7.1    | 6.8    | 6.5    | 6.2    |
| Aluminium rods         | 0.5           | 2                | 1.25    | 1.1              | 1.85   | 1.7    | 1.55   | 1.4    | 1.25   | 1.1    |
| Copper Rods            | 0.5           | 2                | 1.25    | 1.1              | 1.85   | 1.7    | 1.55   | 1.4    | 1.25   | 1.1    |
| Brass Rods             | 0.5           | 2                | 1.25    | 1.1              | 1.85   | 1.7    | 1.55   | 1.4    | 1.25   | 1.1    |
| Mild steel rods        | 1             | 3                | 2       | 1.8              | 2.8    | 2.6    | 2.4    | 2.2    | 2      | 1.8    |
| Gas cylinders          | 1             | 1                | 1       | 1                | 1      | 1      | 1      | 1      | 1      | 1      |
| Kerosine oil           | 20            | 20               | 20      | 20               | 20     | 20     | 20     | 20     | 20     | 20     |
| Mobile oil             | 60            | 60               | 60      | 60               | 60     | 60     | 60     | 60     | 60     | 60     |
| Soluble oil            | 40            | 40               | 40      | 40               | 40     | 40     | 40     | 40     | 40     | 40     |
| Cotton rag             | 40            | 50               | 45      | 44               | 49     | 48     | 47     | 46     | 45     | 44     |
| Shoes                  | 55            | 55               | 55      | 55               | 55     | 55     | 55     | 55     | 55     | 55     |
| Coats                  | 55            | 55               | 55      | 55               | 55     | 55     | 55     | 55     | 55     | 55     |
| Goggles                | 40            | 40               | 40      | 40               | 40     | 40     | 40     | 40     | 40     | 40     |
| Lathe tools            | 20            | 21               | 20.5    | 20.4             | 20.9   | 20.8   | 20.7   | 20.6   | 20.5   | 20.4   |
| End mill cutters       | 5             | 7                | 6       | 5.8              | 6.8    | 6.6    | 6.4    | 6.2    | 6      | 5.8    |
| Gear module            | 2             | 3                | 2.5     | 2.4              | 2.9    | 2.8    | 2.7    | 2.6    | 2.5    | 2.4    |

Table 1 presents the values for average and weighted average however it requires more data. The proposed methodology is applied at different value of alpha and at alpha 0.6 it is showing very good results as compared with the actual.
Table 2. Forecasting of indirect consumables using proposed methodology

| Items                  | Actual number | Estimated Average | Weighted Average | New ES 0.4 | New ES 0.5 | New ES 0.6 | New ES 0.7 |
|------------------------|---------------|-------------------|------------------|------------|------------|------------|------------|
| Hack Saw blades        | 1000          | 1200              | 1100             | 1080       | 1048       | 1040       | 1032       | 1024       |
| Fine emery paper       | 24            | 32                | 28               | 27.2       | 25.92      | 25.6       | 25.28      | 24.96      |
| Coarse emery paper     | 24            | 32                | 28               | 27.2       | 25.92      | 25.6       | 25.28      | 24.96      |
| Painting brush         | 20            | 14                | 17               | 17.6       | 18.56      | 18.8       | 19.04      | 19.28      |
| Welding rods           | 5             | 8                 | 6.5              | 6.2        | 5.72       | 5.6        | 5.48       | 5.36       |
| Aluminium rods         | 0.5           | 2                 | 1.25             | 1.1        | 0.86       | 0.8        | 0.74       | 0.68       |
| Copper Rods            | 0.5           | 2                 | 1.25             | 1.1        | 0.86       | 0.8        | 0.74       | 0.68       |
| Brass rods             | 0.5           | 2                 | 1.25             | 1.1        | 0.86       | 0.8        | 0.74       | 0.68       |
| Mild steel rods        | 1             | 3                 | 2                | 1.8        | 1.48       | 1.4        | 1.32       | 1.24       |
| Gas cylinders          | 1             | 1                 | 1                | 1          | 1          | 1          | 1          |
| Kerosine oil           | 20            | 20                | 20               | 20         | 20         | 20         | 20         |
| Mobile oil             | 60            | 60                | 60               | 60         | 60         | 60         | 60         |
| Soluble oil            | 40            | 40                | 40               | 40         | 40         | 40         | 40         |
| Cotton rag             | 40            | 50                | 45               | 44         | 42.4       | 42         | 41.6       | 41.2       |
| Shoes                  | 55            | 55                | 55               | 55         | 55         | 55         | 55         |
| Coats                  | 55            | 55                | 55               | 55         | 55         | 55         | 55         |
| Goggles                | 40            | 40                | 40               | 40         | 40         | 40         | 40         |
| Lathe tools            | 20            | 21                | 20.5             | 20.4       | 20.24      | 20.2       | 20.16      | 20.12      |
| End mill cutters       | 5             | 7                 | 6                | 5.8        | 5.48       | 5.4        | 5.32       | 5.24       |
| Gear module            | 2             | 3                 | 2.5              | 2.4        | 2.24       | 2.2        | 2.16       | 2.12       |

3. Results and discussion

Above calculations shows that selection of an appropriate method of forecasting requires availability of past data. Averaging methods can be used when enough data is present. Forecasting using small data for averaging technique may result in large errors. Although exponential smoothing is the method that can be used with small amount of data and gives a good results even if more variables are applied. But the new method introduced gives even better result than traditional exponential smoothing method although it is a derivative of the same method.

Figures 1-8 shows the graphs related to Table 1. Figures 9-15 shows graphs related to Table 2. Figure 16 shows the comparison between actual forecast, forecast using exponential smoothing (alpha=0.4) and forecast using proposed methodology (alpha=0.4).
Figure 1. Forecasting for hack saw blades

Figure 2. Forecasting for emery paper

Figure 3. Forecasting for welding rods

Figure 4. Forecasting for gas welding rods

Figure 5. Forecasting for MS rods

Figure 6. Forecasting for cotton rig

Figure 7. Forecasting for lathe tools

Figure 8. Forecasting for end mill cutter
4. Conclusion
The method proposed can be used for forecasting rather than older methods because it is more accurate. In fact new method is just a derivative of some old techniques together. The results show a
good trend and are comparable at any level. For less critical values any method can be used but for critical problems the proposed method is the solution.

5. References

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