A workforce planning model to estimate future staffing requirements and placements

by

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Executive Summary

Workforce planning is a systematic process that aids in the identification of gaps between the current workforce and the future human resource requirements. The workforce of a company is seen as an asset and thus having the right person at the right time at the right place, improves the human capital of a company. With the implementation of an effective workforce planning tool, future human resource requirements can be forecasted. A company with a high turnover usually expects their workforce to change on a regular basis, but this way neither the manager nor the company budget will be surprised by this change.

Table of Contents

Table of Appendices

List of Figures

List of Tables

1. Introduction

1.1 Background

Staff turnover is the rate at which employees leave an organisation and are subsequently replaced by new employees. A high staff turnover rate therefore implies that employees exit their positions at a rather high rate. Staff turnover rates are influenced by various factors including work environment, salary etc. Turnover includes all the employees who have resigned as well as those who have been discharged. Turnover rates differ significantly among industries as shown in a survey done in the United States of America in 2006 where an average employee turnover rate of 15% was observed in the manufacturing industry and an average as high as 56% in the restaurant industry (Ingram, n.d.).

Workers' willingness to persevere in a stressful work environment while being underpaid is extremely low. Telesales is an example of low-skilled, repetitive and stressful work that includes a significant amount of customer contact at a trivial pay. It is these criteria that resulted in telesales and customer services representatives forming part of the top ten occupations with the highest turnover rates. (Gerencher, 2005)

Selling goods or services to aggravated customers is strong incentive for people to be on the lookout for better opportunities. According to an article in *The Wall Street Journal* (Gerencher, 2005) the demand for sales professionals is high and thus there are numerous opportunities with the possibility of a better work environment.

There are various steps that can be taken in order to reduce the turnover rate within any organisation (Zaibak, 2010). One of these steps in particular suggests the optimization of the recruitment process. With an understanding of the desired criteria of in this case a Telesales agent, the recruitment process can immediately start with the filtering and elimination of applicants who are not expected to adapt to the environment. A strong orientation and training program allows the employer to manage expectations and the new employees to adapt to the new environment. It also creates an opportunity for great employer-employee relationships.

In order to optimize the recruitment process, a lead time has to be allowed in order to filter through applications to find the right individual for the position. Currently most companies only realize that there is a vacancy when the letter of resignation is received or the final warning has lead to a discharge. It is then often too late to filter through applications and find the right candidates to fill the vacancies. This is exactly the case within the Telesales department of a well known insurance company.

1.2 Project Aim

The aim of this project is to aid the company in identifying trends in the historical movements as well as future requirements of human resources, with the hopes of optimizing the recruitment process in order to forecast future demands and allow a sufficient lead time for the recruitment process to start. After the identification of the trends, the aim is to respond in a way that will ensure the right people in the right place at the right time.

1.3 Project Scope

The scope of this project includes the identification and application of an appropriate model to aid in workforce planning in the Telesales department of the company, with the hopes of implementing this model at the end of 2012. A complete workforce plan includes an action plan that determines how positions will be filled, in this case the model will give some insight on the estimated amount of new recruits, promotions or transfers to fill the forecasted vacancies.

1.4 Deliverables

The desired outcome of the Workforce Planning Project includes the following deliverables:

A. Provide a means of determining the amount of opening positions to fill in the Telesales department with a sufficient lead time.
B. The outcome specified in point A, should be summarised and shown in a graph in order to easily see whether there is an increase or decrease in the workforce for a specific position or grade.

2. Literature Review

The analysis of the trends in a manpower system plays a significant part in the planned economic development of an organization. Manpower planning is highly dependant on the unpredictable human behaviour as well as the social environment in which the system functions. These trends can be better understood with the help of probabilistic and stochastic models.

With an effective Workforce Planning (WFP) tool in place, the right people with the right skills will be in the right place at the right time. By implementing this planning tool, a company can allow themselves an approximate lead time in order to recruit the right person for the opening position.

Although Workforce planning depends on the specific needs of a company, the aim of a Workforce planning tool remains the same. According to an electronic publication of the *Workforce Planning and Succession Manual* (Workinfo.com, 2010), the aim of WFP is to allow human resource decisions to be aligned with the budgetary resources, mission statement, strategic plan and desired staff competencies in a specific company.

The nationwide statistics from the United States Office of Personnel Management (Personnel Cabinet Governmental Services, n.d.) has shown that 30.9% of general staff, 52.7% of senior personnel, such as Managing Directors and Supervisors, and approximately 65% of Senior Executives will retire in the next five years. Similar statistics from the National Institute of Population and Social Security Research (NIPSSR) has shown that 16.2% of the Japanese population was at retirement age (65 years) or older in 1998. They estimate that this figure will increase to 27.4% in 2025 and 32.3% in 2050 (Oishi and Oshio, 2004). Similar research done by the Statistical Communiqué of China's Aging Development (Wenting, 2011) has shown that 12.5% of China's population was over the age of 60 in 2009 and they estimate this figure to reach 25% in 2030. Research done by Statistics South Africa (Weaving, 2011) has shown that approximately 9.75 million South African will retire within the next 25 years. Workforce planning allows managers to expect and plan for this change, rather than being surprised by it.

There are a few issues that need to be resolved before WFP can effectively be implemented. The workforce plan needs sufficient financial support as every decision made has a cost implication, for example training, adequate qualifications etc. It should also be ensured that before any decisions are made, the impact on all stakeholders is taken into account. Lastly, sufficient training should be done to ensure that the desired effect is achieved with the Workforce plan (Tutor2u, n.d.).

There are various tools available to aid in the implementation of WFP. These tools include Microsoft Excel and various mathematical techniques. The steps to follow in a Workforce plan however do not depend on the tool or technique used. There are five basic steps that can serve as a guideline (Raj, 2009):

1. The reason for undertaking a Workforce plan should be clearly defined.
2. All information regarding the demand for future human resources should be gathered.
3. A plan of action should be developed in order to decide how the human resource gaps will be filled for the future demand. This can be done by internal or external recruiting.
4. Implementation of this action plan
5. The plan has to continually be evaluated to ensure that it is the best possible solution.

For the purpose of this project, the focus will primarily be on step two, as this is the part of the process where a model will be implemented to forecast the total amount of human resources required. After the amount of openings is determined, the model will estimate the manner in which these openings will be filled.

According to research done by Mason (2006a), forecasting techniques can be used to understand future data trends of a business. A business's human resource data trends can thus provide insight into the business and aid in the forecasting of future human resource requirements.

Forecasting techniques can be categorized into two major categories, namely quantitative and qualitative methods. Quantitative methods are based on algorithms that vary in the level of difficulty, where qualitative methods are based on well-informed guessing, judgement and opinions (Mason, 2006a). Because this project aims to optimize the human input as far as possible, the main focus from here on will be on quantitative forecasting methods.

Quantitative methods can be split into time-series methods and explanatory methods (Mason, 2006a). Time-series methods solely focus on historical data patterns and using those patterns to forecast future pattern trends. Explanatory methods on the other hand take in to account how and why a trend exists in the data, for example if there was a profound increase in the workforce for 2011 due to an expansion, an explanatory method will take that into account when forecasting for 2012 and will nor simply follow the trend for the years to come.

Time-series methods are seen as quite straightforward but particularly accurate over the short term. These straightforward time-series methods include moving range models, exponential smoothing etc. In the case of moving range models the forecast is based on the average of the last “x” number of periods, for example the workforce demand for the next month is the average of the workforce of the past year, given that a 12-month moving average is a suitable number. Thus with moving average methods, all data points contribute the same amount when forecasting. Smoothing on the other hand, places more importance on the latest data. Thus if there is a trend in the data and the latest data is used to make up the largest part of the data, the trend will more likely be reflected in the forecast (Mason, 2006a). Single exponential smoothing can be expressed using the following equation:

Equation 1: Exponential Smoothing

$$F_{t+1} = \alpha D_t + (1 - \alpha) F_t$$

where: D_t is the actual employee headcount
F_t is the forecasted human resource requirement
α is the weighting factor, ranging between 0 and 1
t is the current time period

The smoothed value then becomes the human resource forecast for the time period $t + 1$ (Arsham, 1994). Both of these time-series techniques can be implemented by with the use of Microsoft Excel. (Mason, 2006a).

Regression analysis is the most popular method in explanatory forecasting, which forms part of econometrics (Mason, 2006b). Regression analysis is a method used to determine the link between two or more occurrences (Dizikes, 2010). Human resource levels can thus be plotted on a graph and the line that best suite the distribution can then be used in forecasting future human resource requirements. Regression analysis can also be implemented with the use of Microsoft Excel. To appropriately implement regression analysis, the forecast or model construction has to be thoroughly thought trough and the results have to be interpreted with the right amount of care (Mason, 2006b).

More complex time-series techniques include ARIMA (Autoregressive integrated moving average) models, otherwise known as Box-Jenkins models. These models can cope with data influenced by trends and seasonality. As described above, ARMA (Autoregressive Moving-Average) models are not suitable for data that contains trends. Time-series data that contains a trend does not have a fixed mean, where ARMA models are only suitable for time-series data with a fixed mean and variance. ARIMA models remove the trends in the data by differencing the time series. The differencing is incorporated into the ARMA models to create ARIMA models. These models are expressed as ARIMA(p,d,q), where p is the Autoregressive part, q is the Moving-Average part and d is the differencing applied (Trinity College Dublin, n.d.). The advantage of forecasting with ARIMA models is that there are various statistical analysis packages available to aid in the process of selecting the best fitting model for the data. These software packages include MATLAB, SAS and XLSTAT (a Microsoft Excel add-in). All of these packages require a licence which could be costly to a company, however the investment could be worth it as forecasting techniques are not only used for prediction but also for explanation. Understanding the trends and seasonality in your company's data, can provide a better understanding of the underlying health of the company (Mason, 2006a).

A stochastic process can be described as a sequence of events that are generated by probabilistic laws. These events occur randomly over time, but are governed by certain statistical and probabilistic rules. A stochastic process can also be used to forecast time-series data (Real Options Valuation, n.d.). According to the research done by Setlhare (2007), various stochastic models have been used in manpower planning; these models can be broadly classified into two types:

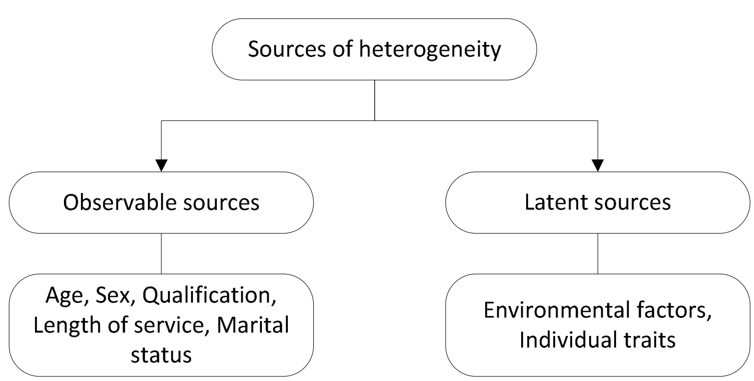
1. Markov Chain models
2. Renewal Models

All of these models assume that members in a system are classified into hierarchical grades that are mutually exclusive and exhaustive, meaning that a member can only be in one grade at any given time. Members can move between these grades due to promotion, resignation, retirement, discharge etc. Given that the sizes of the grades are not fixed, the state of the system can be presented with the vector $X(t) = [X_1(t), X_2(t), \dots X_n(t)]$ at any given time. Where $X_i(t)$ represents the number of members in the ith grade at time t. This type of system behaviour can be described by a Markov chain.

Renewal models on the other hand apply to systems where the grade size is fixed due to the budget or the amount of work to be done. Thus recruitment or promotion can only occur due to vacancies caused by leaving or expansion (Setlhare, 2007).

The research done by Setlhare (2007) has shown that these stochastic models highly depend on homogeneous groups of individuals. This is impossible in practice as human behaviour is highly unpredictable and the environment is very volatile. Thus to incorporate population heterogeneity into a workforce planning model, it was suggested to divide the sources of heterogeneity into two subgroups (see figure 1), namely the observable sources and latent sources. Latent sources are impossible to observe but definitely has an effect on the key parameters of the model.

Figure 1: Summary of heterogeneity



Before a forecasting technique can be selected, there are six criteria that need to be taken into account (Putra, 2009).

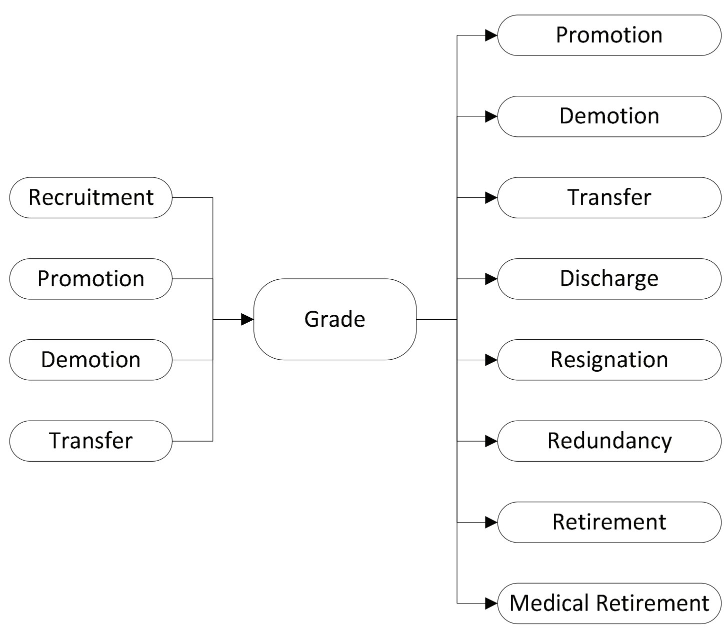
1. The cost associated with the development of a forecasting model has to be compared with the potential gains that will result from its use
2. The complexity of the relationships that are being forecasted.
3. The amount of accuracy that is desired.
4. The minimum level of error that will be tolerated.
5. The amount of available data has to be taken into account, as the various techniques vary in the amount of data they require.

3. Methodology

3.1 Introduction

Following from the literature study, Markov Chain models can aid in workforce planning (Setlhare, 2007). In Markov Chain models the manpower system is graded into hierarchical, mutually exclusive and exhaustive grades, this implies that each member of the system can only be in one grade at any given time. Members of the system move between grades due to promotion, demotion or due to transfer to or from another department. Members of the system can also move out of the system due to discharge, resignation, retirement or medical retirement. The movement of the staff members between grades or system states can be seen in Figure 2 below:

Figure 2: Staff movement between grades



3.1.1 Recruitment

The sizes of the various grades, responding to the expansion, promotion, demotion, transfer and various other exit methods, are usually maintained by the recruitment process. Factors that will influence the recruitment process is whether vacancies are filled as and when they occur or if the company waits for a certain amount of vacancies to accumulate before starting to fill these vacancies in order to minimise cost. Recruitment can be made by the organisation itself or the company may make use of an external recruitment agency (Setlhare, 2007). A recognised problem in the recruitment process of various organisations is the inability to fill all vacancies due to the lack of suitable candidates with sufficient qualifications and experience. This is where a workforce planning tool will prove useful when vacancies can be forecasted to allow a sufficient lead time in the recruitment process.

3.1.2 Promotion and demotion

Lower grade openings are usually filled through a recruitment process and higher grade openings are filled through promotions. Promotions reduce the chance that valuable and efficient employees will leave the company (Setlhare, 2007).

Promotion can be based on any one of the following terms (Setlhare, 2007):

i. The most senior employee in the grade is promoted. The sole criterion for this type of promotion is length of service and can thus be controlled by management.
ii. Random promotion, where management has full freedom to promote an employee of their choice.
iii. An employee that is efficient and has completed the minimum length of service is promoted. The sole criterion of this type of promotion is performance.

Demotion due to lack of performance, can result in the increased headcount of a lower grade and a vacancy in the higher grade from which the demotion occurred. Demotions will however not be regarded as a method of filling a position.

3.1.3 Transfer

Transfer from another department into the studied department can be handled similar to promotions, except that the staff member is not moving into a grade from the next lower grade. The staff member is entering the system state from the outside.

Transfer from the department being studied to another department can be handled as wastage and will be discussed in more detail below.

3.1.4 Wastages

The reasons for an employee to leave the company can now be classified into the following cases (Setlhare, 2007):

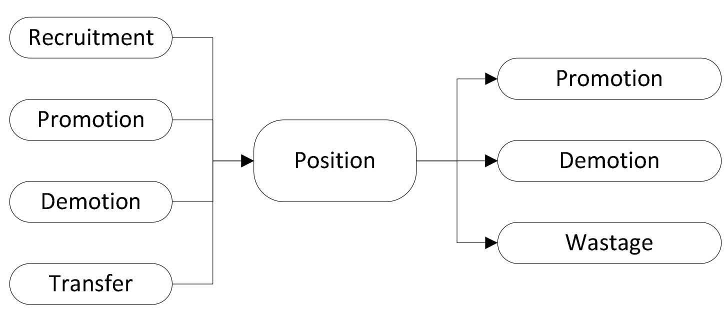
i. Discharge
ii. Resignation
iii. Redundancy
iv. Transfer to another department
v. Retirement
vi. Medical retirement

Reasons (i) to (iv) can be viewed as unnatural reasons for leaving an organisation and normally occurs due to internal structure. Internal structure can be explained in terms of lack of promotion prospects, job dissatisfaction etc. Reasons (v) and (vi) can be viewed as natural reasons for leaving an organisation. Wastage rates can now be classified into three different categories:

i. Internal structure turnover rate
ii. Retirement rate
iii. Medical retirement rate

For the purpose of workforce planning at this specific insurance company, the retirement and medical retirement rate can be assumed to be very small and can thus be omitted. This is due to the fact that the staff members at the insurance company are on average in their mid twenties and it is highly unlikely that an individual will remain at the company until he/she retires. Medical retirement is the early retirement due to a disability or any other medical condition, making it impossible to continue working. Due to the non-hazardous extent of the work in Telesales, the medical retirement rate is very low and can also be omitted for the purpose of this project. Retirement and medical retirement can be treated as extremes, thus provision will be made in the case that retirement or medical retirement occurs.

Figure 3: Consolidated staff movement between grades



In Figure 3 above the consolidated staff movements can now be seen, where wastages consists of discharge, resignation and transfer to another department.

Due to the fact that the sizes of the various grades are not fixed because of the fluctuation in the work load, the system states can be represented by a vector $N(t) = (N_1(t), N_2(t), \ldots, N_n(t))$, where $N_i(t)$ represents the number of staff members in the ith grade at any time t. The goal of a workforce planning tool will be to control the expected number of staff members in the various grades by recruitment control. This will allow an appropriate lead time in recruiting the right candidate to be at the right place at the right time.

Staff training is directly proportional to the performance and efficiency of the staff members and becomes even more effective when it is considered as promotion criteria. The training period is a very important aspect to take into consideration when establishing a sufficient lead time, as there are two staff members in one staff role for the duration of the training period. The insurance company has a performance based salary structure, which makes efficiency and performance a driving factor for all systems in the company.

3.2 Markov Chains in workforce planning

The model developed by Setlhare (2007) will be adapted to aid in the workforce planning project at the insurance company. This is an extension of a Markov Chain model in a manpower system with promotions due to efficiency and seniority.

As mentioned previously vacancies in any grade is filled by means of promotion, demotion, transfers or by a new appointment. This model places specific emphasis on promotion based on length of service and promotion based on the performance of a specific individual. The models developed require the following notation and assumptions in order to apply it to a manpower system.

3.2.1 Notation

The following notation is adapted and slightly extended from the notation used by Setlhare (2007):

Let $t = 1,2, \dots, T$; t being the time window in 3 month periods.

$i, j = 1,2, \dots, n$; representing the system states or various grades within the department, with the total number of grades being n.

$N_j\ (t)$: Number of staff members in grade j at the beginning of time window t.

$P_{ij}(t)$: The probability that a staff member in grade i at the beginning of time window t is in grade j in at the beginning of time window $(t + 1)$.

$R_j(t)$: Number of new recruits to grade j during time window t.

$T_j(t)$: Number of staff members transferred into the department to grade j during time window t.

$w_j(t)$: Wastage factor as a proportion of staff members in grade j.

e_{ij}^{p}: Proportion of vacancies filled by staff members promoted from grade i to j, $(i < j)$.

e_j^{r}: Proportion of vacancies filled by newly recruited staff to grade j.

e_{ji}^{d}: Proportion of vacancies filled by staff members transferred into the department to grade j.

3.2.2 Assumptions

The following assumptions are adapted and slightly extended from the assumptions made by Setlhare (2007):

1. The various grades are mutually exclusive.
2. The existing staff structure is known, $N_j(1)$, and the staff requirements for the future periods, $N_j(t)$, are assumed to be known and dependant on the workload.
3. The expected strength of the employees at any grade j at time $t = 1,2,3, \dots, T$ is known.
4. $w_j(t)$, the wastage factor for any grade j is known at time t, $t = 1,2,3, \dots, T$.
5. Promotion from grade i to j is allowed under the terms of both seniority and performance.
6. Promotions are only allowed to a grade from the next lower grade.

3.2.3 Application of Markov Chains in workforce planning

With the assumption that the organization satisfies all the above assumptions under Markovian assumptions, we can determine the number of staff members in grade *j* at time $t + 1$ with Equation 2 below

Equation 2

$$N_j(t+1) = \sum_{i=1}^{n} P_{ij}\,(t) N_i(t) + R_j(t) + T_j(t); \quad \forall j = 1,2, \dots, n$$

This implies that the staff members in grade *j* at time $(t + 1)$ is the sum of the staff members staying in grade j, the staff members coming from various grades to grade *j* through either promotion or demotion, new recruits into grade *j* and staff members transferred to grade *j* from another department during the time period $(t; t + 1)$. The fact that a staff member will stay in the same grade, move to another grade through either promotion or demotion or leave the system as wastage leads to Equation 3

Equation 3

$$\sum_{j=1}^{n} P_{ij}(t) + w_i(t) = 1; \quad \forall i = 1,2, \dots, n$$

As promotions and demotions are only allowed to the next higher grade or the next lower grade respectively, Equation 2 and Equation 3 become

Equation 4

$$N_j(t+1) = P_{(j-1)j}(t)N_{j-1}(t) + P_{jj}(t)N_j(t) + P_{(j+1)j}(t)N_{j+1}(t) + R_j(t) + T_j(t); \quad \forall j = 1,2,\dots,n$$

Equation 5

$$P_{j(j-1)}(t) + P_{jj}(t) + P_{j(j+1)}(t) + w_j(t) = 1; \quad \forall j = 1,2,\dots,n$$

$$where\ P_{jj}(t) = 1 - P_{j(j-1)}(t) - P_{j(j+1)}(t) - w_j(t); \quad \forall j = 1,2,\dots,n$$

Substituting Equation 5 into Equation 4 leads to Equation 6 below

$$N_j(t+1) = P_{(j-1)j}(t)N_{j-1}(t) + \left(1 - P_{j(j-1)}(t) - P_{j(j+1)}(t) - w_j(t)\right)N_j(t) + P_{(j+1)j}(t)N_{j+1}(t) + R_j(t) + T_j(t)$$

Equation 6

$$N_j(t+1) = N_j(t) + P_{(j-1)j}(t)N_{j-1}(t) + P_{(j+1)j}(t)N_{j+1}(t) - P_{j(j-1)}(t)N_j(t) - P_{j(j+1)}(t)N_j(t) - w_j(t)N_j(t) + R_j(t) + T_j(t); \quad \forall j = 1,2,\dots,n$$

with $P_{(j-1)j}(t) = 0$ for $j = 1$ as there are no promotions to the lowest grade;

$P_{j(j+1)}(t) = 0$ for $j = n$ as there are no promotions from the highest grade;

$P_{j(j-1)}(t) = 0$ for $j = 1$ as there are no demotions from the lowest grade;

$P_{(j+1)j}(t) = 0$ for $j = n$ as there are no demotions to the highest grade

Therefore the total number of promotions, recruitments and transfers are obtained from Equation 6 as

Equation 7

$$P_{(j-1)j}(t)N_{j-1}(t) + R_j(t) + T_j(t) \\ = N_j(t+1) - N_j(t) - P_{(j+1)j}(t)N_{j+1}(t) + P_{j(j-1)}(t)N_j(t) + P_{j(j+1)}(t)N_j(t) \\ + w_j(t)N_j(t) = N_j'(t); \qquad \forall j = 1,2,\dots,n$$

where $N_j'(t)$ is the total vacancies in grade j that need to be filled during time window t to satisfy the manpower requirement for time window $t+1$.

Assuming that demotions are not seen as a method of filling vacancies, the proportion of vacancies filled by promotions, recruitment and transfers can now be expressed as

Equation 8

$$e_j^r = 1 - e_{(j-1)j}^p - e_j^t$$

From Equation 7 and Equation 8 the total number of promotions, recruitments and transfers can be determined with

Equation 9: Number of promotions

$$P_{(j-1)j}(t)N_{j-1}(t) = \left(1 - e_j^r - e_j^t\right)N_j'(t); \quad \forall j = 2,3,\dots,n$$

Equation 10: Number of recruits

$$R_j(t) = \left(1 - e_{(j-1)j}^p - e_j^t\right)N_j'(t); \quad \forall j = 1,2,\dots.n$$

with $e_{(j-1)j}^p = 0$ for $j = 1$ as there are no promotions to the lowest grade

Equation 11: Number of transfers

$$T_j(t) = \left(1 - e_{(j-1)j}^p - e_j^r\right)N_j'(t); \quad \forall j = 1,2,\dots,n$$

with $e_{(j-1)j}^p = 0$ for $j = 1$ as there are no promotions to the lowest grade.

Now the total amount of vacancies in grade j at time t can be forecasted with Equation 7 and Equation 9, Equation 10 and Equation 11 can be used to determine the amount of promotions, transfers and new recruits to satisfy the manpower requirement for time window $t+1$.

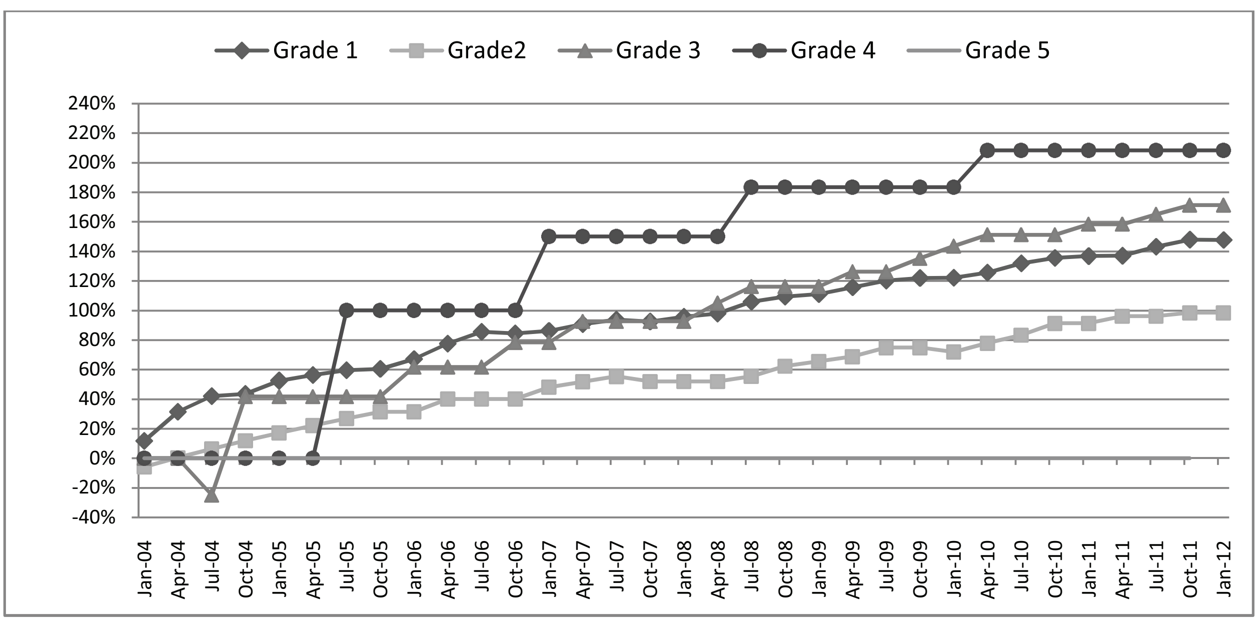
4. Numerical Illustration

4.1 Case study

Within the particular insurance company there are five hierarchical grades, with the highest grade being grade five, consisting of the Head of Department, then grade four, the General Managers, grade three, Managers, grade two, Team Leaders, each with a team of Team Members that represents the lowest grade, grade one. The Team Members represent the bulk of the Telesales department and also reflects a clear representation of the high turnover rate. The employee turnover data is available on a monthly basis, for the purpose of this project the data is grouped by quarter to allow a minimum lead time of three months.

With $i, j = 1,2,3,4,5$, the data pertaining to the notation stated in the previous section can be seen in the respective appendices. Time window t consists of a quarterly period starting at the beginning of the month in the first column and first row to the beginning of the month in the following row.

Figure 4: Cumulative proportion of staff growth in grade j



From Figure 4 it is evident that the company has been expanding from 2004 and that the company is still expanding. The amount of positions is directly proportional to the workload within a specific time period, thus company expansion can be attributed to increased workload. It is also evident from Figure 4 that it can be said with certainty that the grade sizes for grade 1 to 3 are not maintained, the grade size for grade 4 is maintained for a period of between 18 to 24 months. This has to be taken into account when observing the trends in the historical data. Grade 5 can be seen as a maintained grade size.

In the previous section, it was established that the total amount of vacancies in grade j that has to be filled during time window t to satisfy the manpower requirement in time window $t+1$, can be forecasted with Equation 7 (p.19). The manner in which these vacancies are filled will be predicted by looking at the average proportion in which previous vacancies were filled by either promotions, new recruits or transfers from other departments. These average proportions can be determined with the following equations. The total number of vacancies filled by promotions, transfers and new recruits can be obtained from the respective appendices pertaining to the information on a specific grade.

Equation 12: Average proportion of vacancies in grade j filled by promotions

$$\bar{e}^{p}_{(j-1)j} = \frac{\sum Vacancies\ filled\ by\ promotions\ in\ grade\ j}{\sum Vacancies\ filled\ \ in\ grade\ j}; \quad \forall j = 2,3,4,5$$

Equation 13: Average proportion of vacancies in grade j filled by transfers

$$\bar{e}^{t}_{j} = \frac{\sum Vacancies\ filled\ by\ transfers\ in\ grade\ j}{\sum Vacancies\ filled\ \ in\ grade\ j}; \quad \forall j = 1,2,3,4,5$$

Equation 14: Average proportion of vacancies in grade j filled by recruits

$$\bar{e}^{r}_{j} = \frac{\sum Vacancies\ filled\ by\ recruits\ in\ grade\ j}{\sum Vacancies\ filled\ \ in\ grade\ j}; \quad \forall j = 1,2,3,4,5$$

The data and results for the forecasted number of vacancies to be filled during time window t, as well as the manner in which these vacancies are filled is expressed for each grade individually.

4.1.1 Grade 5: Head of Department

Due to the extremely low probability of a wastage or demotion from grade 5, the wastage factor $w_5(t)$ as well as the demotion probability $P_{54}(t)$ is assumed to be constant and determined by calculating the average over the time period $t = 1,2,3, \dots ,34$. Thus for the forecast of the amount of vacancies to be filled in grade 5 during time t

$$w_5(t) = 0.00;\ \forall t = 1,2,3, \dots , T$$

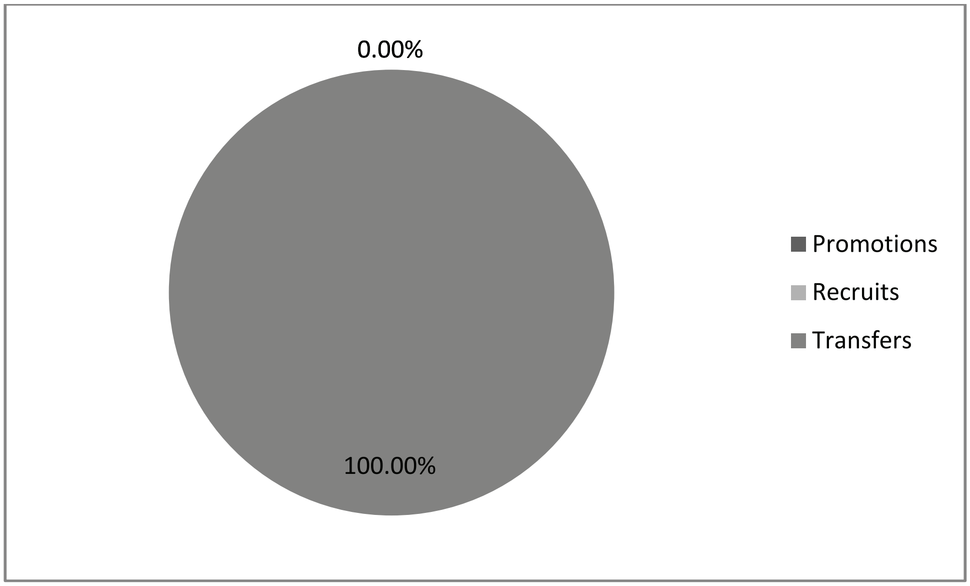
$$P_{54}(t) = 0.0294;\ \forall t = 1,2,3, \dots , T$$

The reason for the non-zero value of the demotion probability is due to the occurrence of a demotion in the fourth quarter of 2008. From Equation 7 the forecasted number of vacancies in grade 5 becomes

$$N_5'(t) = N_5(t+1) - N_5(t) + P_{54}(t)N_5(t) + w_5(t)N_5(t)$$

Making use of the data in Appendix E and the values for $w_5(t)$ and $P_{54}(t)$ as stated above, the results for the forecasted number of vacancies are calculated and shown in Table 1. The average proportions in which future vacancies will be filled as calculated with Equation 12, Equation 13 and Equation 14 are summarized in Figure 5.

Figure 5: Proportion of vacancies in grade 5 filled by promotions, transfers or new recruits



From Figure 5 it is evident that all future vacancies in grade 5 will be filled by transfers. Due to the low representation of vacancies in the historical data, the proportions in Figure 5 will only be used for the purpose of this project. It is recommended that candidates from grade 4 as well as candidates from other departments are considered for the filling of future vacancies. Making use of the proportions as shown in Figure 5, the number of forecasted vacancies filled by promotions or transfers can be calculated with Equation 7 (p.19) as it becomes

$$N_5'(t) = P_{45}(t)N_4(t) + T_5(t)$$

Where

$$P_{45}(t)N_4(t) = \bar{e}_{45}^{p} N_5'(t); \quad \forall t = 1,2,3,\dots,T$$

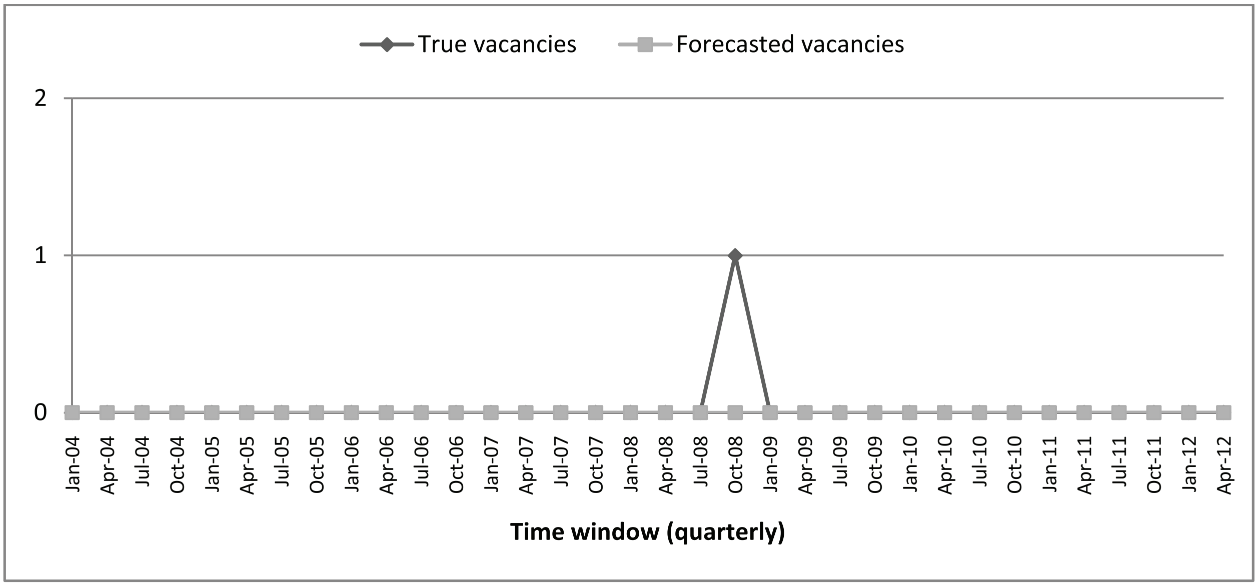
$$T_5(t) = \bar{e}_5^{t} N_5'(t); \quad \forall t = 1,2,3,\dots,T$$

All results are summarized in Table 1

Table 1: True vacancies vs. forecasted vacancies for grade 5

Time window	t	True vacancies filled	Forecasted vacancies $(N'_5(t))$	Forecasted promotions $(P_{45}(t)N_4(t))$	Forecasted transfers $(T_5(t))$
Jan-04	1	0	0	0	0
Apr-04	2	0	0	0	0
Jul-04	3	0	0	0	0
Oct-04	4	0	0	0	0
Jan-05	5	0	0	0	0
Apr-05	6	0	0	0	0
Jul-05	7	0	0	0	0
Oct-05	8	0	0	0	0
Jan-06	9	0	0	0	0
Apr-06	10	0	0	0	0
Jul-06	11	0	0	0	0
Oct-06	12	0	0	0	0
Jan-07	13	0	0	0	0
Apr-07	14	0	0	0	0
Jul-07	15	0	0	0	0
Oct-07	16	0	0	0	0
Jan-08	17	0	0	0	0
Apr-08	18	0	0	0	0
Jul-08	19	0	0	0	0
Oct-08	20	1	0	0	0
Jan-09	21	0	0	0	0
Apr-09	22	0	0	0	0
Jul-09	23	0	0	0	0
Oct-09	24	0	0	0	0
Jan-10	25	0	0	0	0
Apr-10	26	0	0	0	0
Jul-10	27	0	0	0	0
Oct-10	28	0	0	0	0
Jan-11	29	0	0	0	0
Apr-11	30	0	0	0	0
Jul-11	31	0	0	0	0
Oct-11	32	0	0	0	0
Jan-12	33	0	0	0	0
Apr-12	34	0	0	0	0

Figure 6: The total amount of vacancies filled in grade 5 vs. the forecasted amount of vacancies for grade 5 during time window t



In Figure 6 above, the actual vacancies filled in grade 5 is compared to the forecasted vacancies in grade 5 during time window t. The reason for the sporadic vacancy not represented by the forecast during the fourth quarter of 2008 is due to the low representation of vacancies in grade 5, resulting in the model not picking up the low demotion probability. The forecasted vacancies for grade 5 to be filled in period t can thus be assumed to solely depend on the manpower requirements for the time window $t + 1$.

4.1.2 Grade 4: General Manager

Due to the extremely low probability of a wastage or demotion from grade 4, the wastage factor $w_4(t)$ as well as the demotion probability $P_{43}(t)$ is assumed to be constant and determined by calculating the average over the time period $t = 1,2,3,\dots,34$. Thus for the forecast of the amount of vacancies to be filled in grade 4 during time t

$$w_4(t) = 0.00;\ \forall t = 1,2,3,\dots,T$$

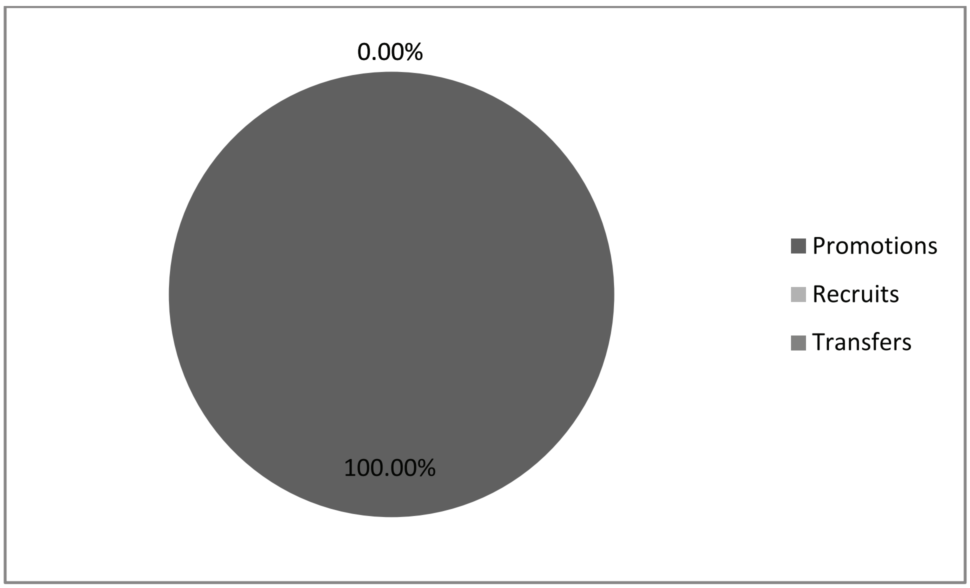
$$P_{43}(t) = 0.00;\ \forall t = 1,2,3,\dots,T$$

From Equation 7 the forecasted amount of vacancies in grade 4 becomes

$$N_4'(t) = N_4(t+1) - N_4(t) - P_{54}(t)N_5(t) + P_{43}(t)N_4(t) + P_{45}(t)N_4(t) + w_4(t)N_4(t)$$

Making use of the values shown in Table 1 for $P_{45}(t)N_4(t)$, the data in Appendix D and the values for $w_4(t)$ and $P_{43}(t)$ as stated above, the results for the forecasted number of vacancies are calculated and shown in Table 2. The average proportions in which future vacancies will be filled as calculated with Equation 12, Equation 13 and Equation 14 are summarized in Figure 7.

Figure 7: Proportion of vacancies in grade 4 filled by promotions, transfers or new recruits



From Figure 7 it is evident that the all vacancies in grade 4 will be filled by promotions. This result will only be used for the purposes of this project due to the low representation of vacancies in the historical data. It is recommended that candidates from grade 3 as well as candidates from other departments are considered for the filling of future vacancies. Making use of the proportions as shown in Figure 7, the number of forecasted vacancies filled by promotions or transfers can be calculated with Equation 7 (p.19) as it becomes

$$N_4'(t) = P_{34}(t)N_3(t) + T_4(t)$$

Where

$$P_{34}(t)N_3(t) = \bar{e}_{34}^{p} N'_4(t); \quad \forall t = 1,2,3, \dots, T$$

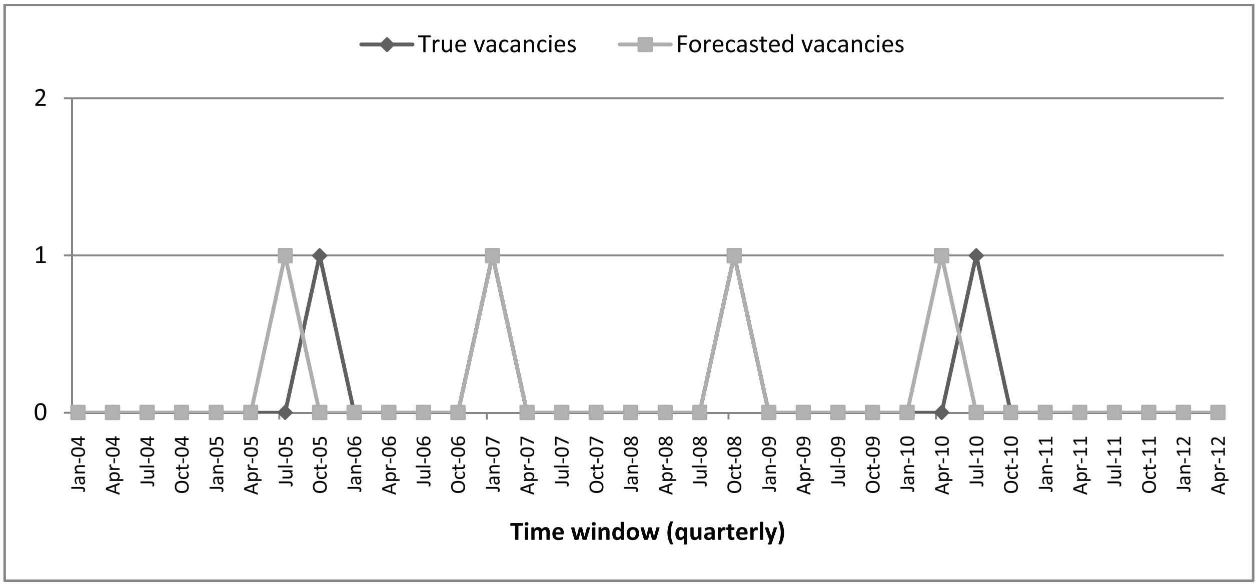
$$T_4(t) = \bar{e}_4^{t} N'_4(t); \quad \forall t = 1,2,3, \dots, T$$

All results are summarized in Table 2.

Table 2: True vacancies vs. forecasted vacancies for grade 4

Time window	t	True vacancies filled	Forecasted vacancies ($N'_4(t)$)	Forecasted promotions ($P_{34}(t)N_3(t)$)	Forecasted transfers ($T_4(t)$)
Jan-04	1	0	0	0	0
Apr-04	2	0	0	0	0
Jul-04	3	0	0	0	0
Oct-04	4	0	0	0	0
Jan-05	5	0	0	0	0
Apr-05	6	0	0	0	0
Jul-05	7	0	1	1	0
Oct-05	8	1	0	0	0
Jan-06	9	0	0	0	0
Apr-06	10	0	0	0	0
Jul-06	11	0	0	0	0
Oct-06	12	0	0	0	0
Jan-07	13	1	1	1	0
Apr-07	14	0	0	0	0
Jul-07	15	0	0	0	0
Oct-07	16	0	0	0	0
Jan-08	17	0	0	0	0
Apr-08	18	0	0	0	0
Jul-08	19	0	0	0	0
Oct-08	20	1	1	1	0
Jan-09	21	0	0	0	0
Apr-09	22	0	0	0	0
Jul-09	23	0	0	0	0
Oct-09	24	0	0	0	0
Jan-10	25	0	0	0	0
Apr-10	26	0	1	1	0
Jul-10	27	1	0	0	0
Oct-10	28	0	0	0	0
Jan-11	29	0	0	0	0
Apr-11	30	0	0	0	0
Jul-11	31	0	0	0	0
Oct-11	32	0	0	0	0
Jan-12	33	0	0	0	0
Apr-12	34	0	0	0	0

Figure 8: The total amount of vacancies filled in grade 4 vs. the forecasted amount of vacancies for grade 4 during time window t



In Figure 8 above, the actual vacancies filled in grade 4 is compared to the forecasted vacancies to be filled in grade 4. These two distributions are very close and it is also evident that the vacancies filled in the last quarter of 2005 and the third quarter of 2010 could have been forecasted with an effective lead time of 3 months.

4.1.3 Grade 3: Manager

Due to the low probability of a wastage or demotion from grade 3, the wastage factor $w_3(t)$ as well as the demotion probability $P_{32}(t)$ is assumed to be constant and determined by calculating the average over the time period $t = 1,2,3, \dots ,34$. Thus for the forecast of the amount of vacancies to be filled in grade 3 during time t

$$w_3(t) = 0.0216;\ \forall t = 1,2,3, \dots , T$$

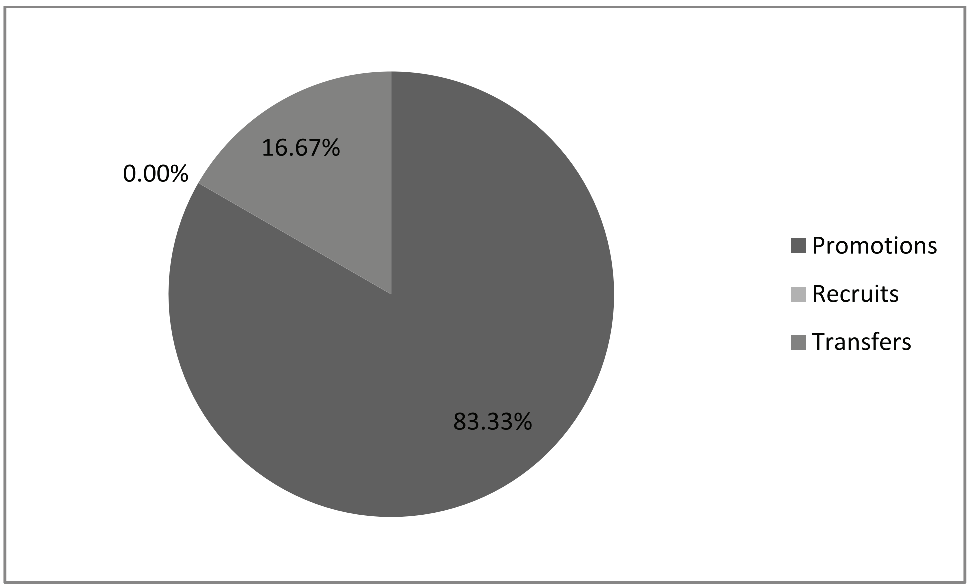
$$P_{32}(t) = 0.0059;\ \forall t = 1,2,3, \dots , T$$

From Equation 7 the forecasted amount of vacancies in grade 3 becomes

$$N_3'(t) = N_3(t+1) - N_3(t) - P_{43}(t)N_4(t) + P_{32}(t)N_3(t) + P_{34}(t)N_3(t) + w_3(t)N_3(t)$$

Making use of the values shown in Table 2 for $P_{34}(t)N_3(t)$, the data in Appendix C and the values for $w_3(t)$ and $P_{32}(t)$ as stated above, the results for the forecasted number of vacancies are calculated and shown in Table 3. The average proportions in which future vacancies will be filled as calculated with Equation 12, Equation 13 and Equation 14 are summarized in Figure 9.

Figure 9: Proportion of vacancies in grade 3 filled by promotions, transfers or new recruits



From Figure 9 above it is evident that 83.33% of vacancies in grade 3 are filled by promotions from the next lower grade and the remaining 16,67% is filled by transfers from other departments. New recruits are thus not allowed into grade 3. Making use of the proportions as shown in Figure 9, the number of forecasted vacancies filled by promotions or transfers can be calculated with Equation 7 (p.19) as it becomes

$$N_3'(t) = P_{23}(t)N_2(t) + T_3(t)$$

Where

$$P_{23}(t)N_2(t) = \bar{e}_{23}^{p} N_3'(t); \quad \forall t = 1,2,3,\dots,T$$

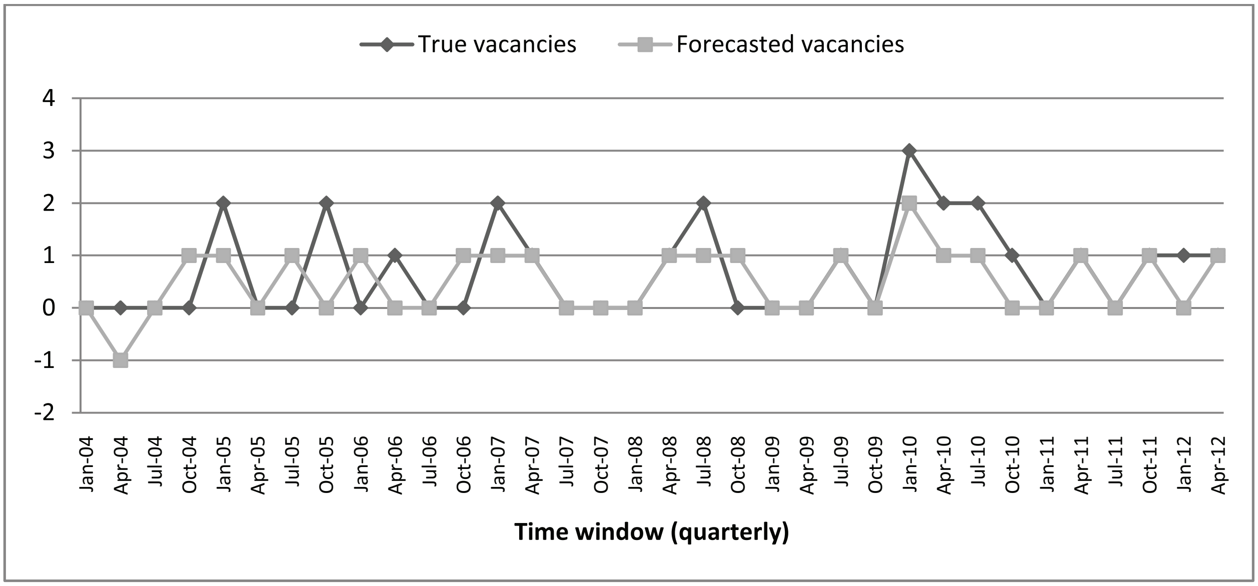
$$T_3(t) = \bar{e}_3^{t} N_3'(t); \quad \forall t = 1,2,3,\dots,T$$

All results are summarized in Table 3.

Table 3: True vacancies vs. forecasted vacancies for grade 3

Time window	t	True vacancies filled	Forecasted vacancies ($N_3'(t)$)	Forecasted promotions ($P_{23}(t)N_2(t)$)	Forecasted transfers ($T_3(t)$)
Jan-04	1	0	0	0	0
Apr-04	2	0	-1	-1	0
Jul-04	3	0	0	0	0
Oct-04	4	0	1	1	0
Jan-05	5	2	1	1	0
Apr-05	6	0	0	0	0
Jul-05	7	0	1	1	0
Oct-05	8	2	0	0	0
Jan-06	9	0	1	1	0
Apr-06	10	1	0	0	0
Jul-06	11	0	0	0	0
Oct-06	12	0	1	1	0
Jan-07	13	2	1	1	0
Apr-07	14	1	1	1	0
Jul-07	15	0	0	0	0
Oct-07	16	0	0	0	0
Jan-08	17	0	0	0	0
Apr-08	18	1	1	1	0
Jul-08	19	2	1	1	0
Oct-08	20	0	1	1	0
Jan-09	21	0	0	0	0
Apr-09	22	0	0	0	0
Jul-09	23	1	1	1	0
Oct-09	24	0	0	0	0
Jan-10	25	3	2	2	0
Apr-10	26	2	1	1	0
Jul-10	27	2	1	1	0
Oct-10	28	1	0	0	0
Jan-11	29	0	0	0	0
Apr-11	30	1	1	1	0
Jul-11	31	0	0	0	0
Oct-11	32	1	1	1	0
Jan-12	33	1	0	0	0
Apr-12	34	1	1	1	0

Figure 10: The total amount of vacancies filled in grade 3 vs. the forecasted amount of vacancies for grade 3 during time window t



In Figure 10 above, the actual vacancies filled in grade 3 is compared to the forecasted vacancies for grade 3. These two distributions are very close. The forecasted number of vacancies to be filled during time t appears to be lower than the true number of vacancies filled. This is assumed to not be an issue as the company will consider more candidates than the forecasted amount of vacancies in order to select the right person. Thus there will be a buffer, should the actual vacancies be higher than the forecasted vacancies.

4.1.4 Grade 2: Team Leader

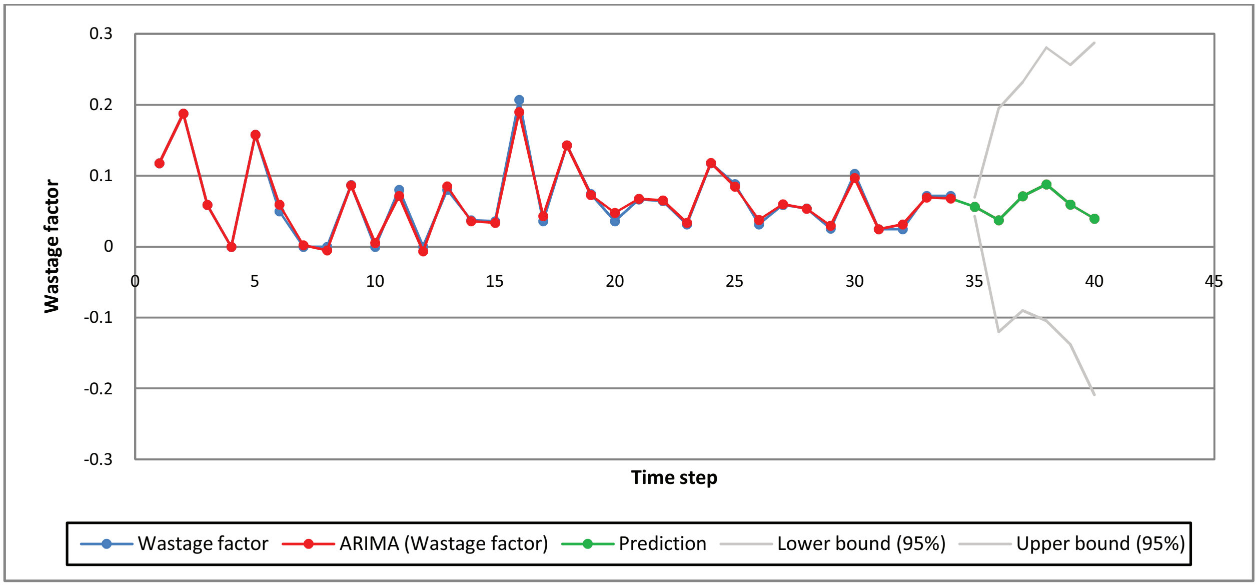
Due to the high probability of wastage and demotion in grade 2, the wastage factor, $w_2(t)$ and demotion probability, $P_{21}(t)$ cannot be assumed to be constant for all values of t. These variables will be forecasted with ARIMA (Autoregressive Integrated Moving Average) models, due to the fact that there is no obvious regression trend in the data. There are various software packages that can aid in selecting the best ARIMA model for a particular data set. These packages include MATLAB, SAS and XLSTAT. Making use of a combination of MATLAB and XLSTAT the best models were selected in MATLAB and the forecasted values were calculated in

XLSTAT for both variables. The best fitting model for the grade 2 wastage factor is an $ARIMA(1,1,4)^4(1,1,4)$ model, that provides for the seasonality in the data. The best fitting model for the demotion probability from grade 2 to grade 1 is an $ARIMA(5,1,1)$ model. The forecasted values calculated in XLSTAT are summarized in Table 4 as well as the size of the error between the real and forecasted values. Figure 11 and Figure 12 illustrates these values graphically.

Table 4: Forecasted wastage factor and demotion probability with ARIMA for grade 2

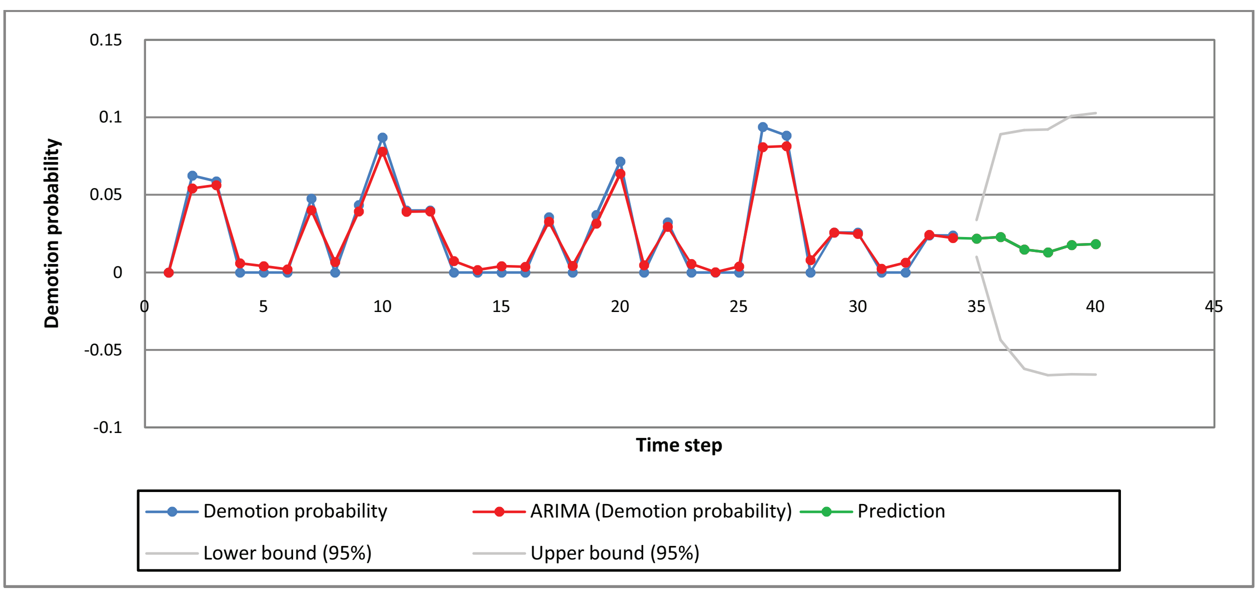
	Wastage factor			Demotion probability		
t	$w_2(t)$	**ARIMA** $(w_2(t))$	**Error**	$P_{21}(t)$	**ARIMA** $(P_{21}(t))$	**Error**
1	0.118	0.118	0.000	0.000	0.000	0.000
2	0.188	0.188	0.000	0.063	0.054	0.008
3	0.059	0.059	0.000	0.059	0.056	0.003
4	0.000	0.000	0.000	0.000	0.006	-0.006
5	0.158	0.158	0.000	0.000	0.004	-0.004
6	0.050	0.059	-0.009	0.000	0.002	-0.002
7	0.000	0.002	-0.002	0.048	0.040	0.007
8	0.000	-0.005	0.005	0.000	0.007	-0.007
9	0.087	0.086	0.001	0.043	0.039	0.004
10	0.000	0.005	-0.005	0.087	0.078	0.009
11	0.080	0.071	0.009	0.040	0.039	0.001
12	0.000	-0.006	0.006	0.040	0.039	0.001
13	0.080	0.085	-0.005	0.000	0.007	-0.007
14	0.037	0.036	0.001	0.000	0.002	-0.002
15	0.036	0.034	0.002	0.000	0.004	-0.004
16	0.207	0.190	0.017	0.000	0.004	-0.004
17	0.036	0.043	-0.008	0.036	0.033	0.003
18	0.143	0.143	0.000	0.000	0.004	-0.004
19	0.074	0.073	0.001	0.037	0.031	0.006
20	0.036	0.048	-0.012	0.071	0.064	0.008
21	0.067	0.068	-0.001	0.000	0.005	-0.005
22	0.065	0.065	-0.001	0.032	0.029	0.003
23	0.031	0.034	-0.002	0.000	0.006	-0.006
24	0.118	0.118	0.000	0.000	0.000	0.000
25	0.088	0.084	0.004	0.000	0.004	-0.004
26	0.031	0.038	-0.006	0.094	0.081	0.013
27	0.059	0.060	-0.001	0.088	0.081	0.007
28	0.054	0.053	0.001	0.000	0.008	-0.008
29	0.026	0.030	-0.004	0.026	0.026	0.000
30	0.103	0.097	0.006	0.026	0.025	0.001
31	0.024	0.025	0.000	0.000	0.002	-0.002
32	0.024	0.031	-0.007	0.000	0.006	-0.006
33	0.071	0.069	0.002	0.024	0.024	-0.001
34	0.071	0.068	0.003	0.024	0.022	0.002

Figure 11: True wastage factor in grade 2 vs. the forecasted wastage factor for grade 2



From Figure 11 it is evident that the forecasted distribution is very close to the real data and the $ARIMA(1,1,4)^4(1,1,4)$ model is thus a perfect fit in order to predict future wastage factors.

Figure 12: True demotion probability in grade 2 vs. the forecasted demotion probability for grade 2



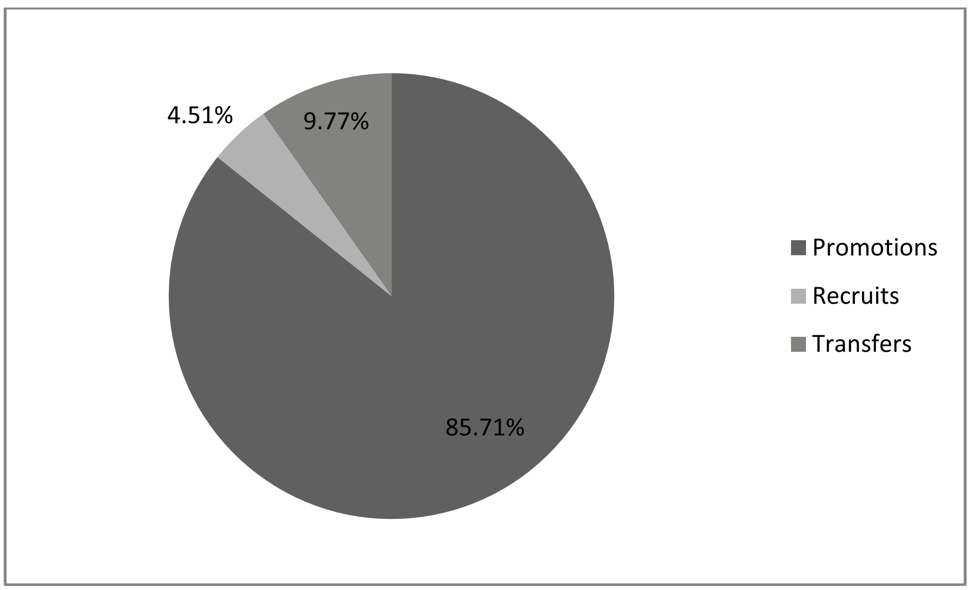
From Figure 12 it is evident that the forecasted distribution is very close to the real data with an average error size of 0 and a standard deviation of as low as 0.0053.

From Equation 7 the forecasted amount of vacancies in grade 2 becomes

$$N_2'(t) = N_2(t+1) - N_2(t) - P_{32}(t)N_3(t) + P_{21}(t)N_j(t) + P_{23}(t)N_2(t) + w_2(t)N_2(t)$$

Making use of the values shown in Table 3 for $P_{23}(t)N_2(t)$, the data in Appendix B and the ARIMA values for $w_2(t)$ and $P_{21}(t)$ from Table 4, the results for the forecasted number of vacancies are calculated and shown in Table 5. The average proportions in which future vacancies will be filled as calculated with Equation 12, Equation 13 and Equation 14 are summarized in Figure 13.

Figure 13: Proportion of vacancies in grade 2 filled by promotions, transfers or new recruits



From Figure 13 it is evident that the majority, 85.71%, of vacancies in grade 2 are filled by promotions from the next lower grade, 9.77% by transfers from other departments and 4.51% of vacancies are filled by new recruits. Making use of the proportions as shown in Figure 13, the number of forecasted vacancies filled by promotions, transfers or new recruits can be calculated with Equation 7 (p.19) as it becomes

$$N_2'(t) = P_{12}(t)N_1(t) + R_2(t) + T_2(t)$$

Where

$$P_{12}(t)N_1(t) = \bar{e}_{12}^{p} N_2'(t); \quad \forall t = 1,2,3, \dots, T$$

$$R_2(t) = \bar{e}_2^{r} N_2'(t); \quad \forall t = 1,2,3, \dots, T$$

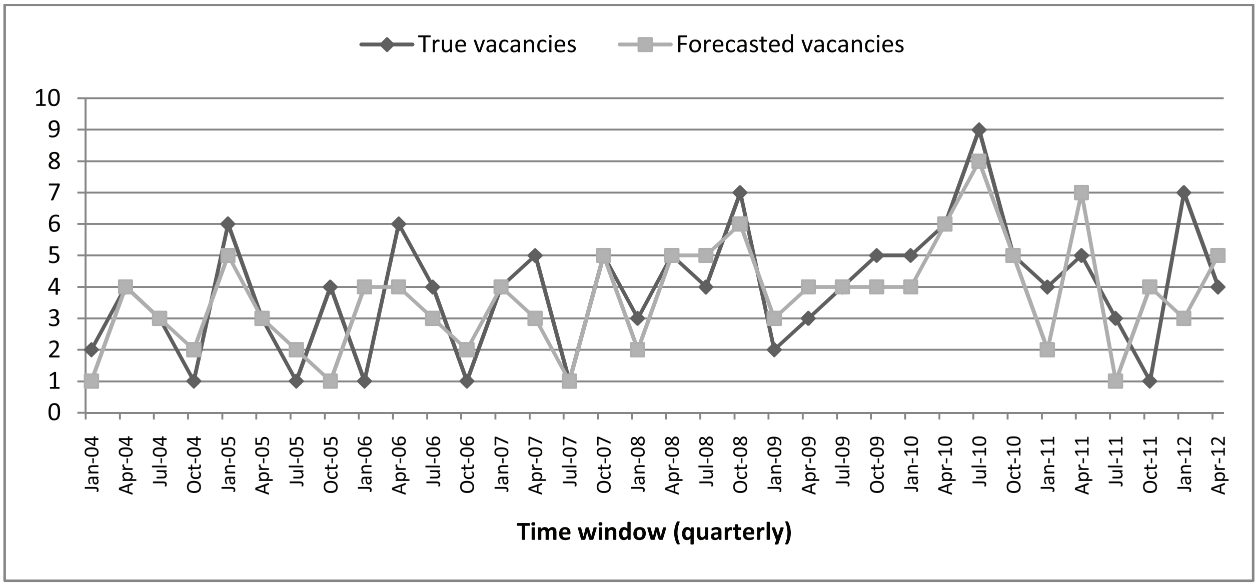
$$T_2(t) = \bar{e}_2^{t} N_2'(t); \quad \forall t = 1,2,3, \dots, T$$

All results are summarized in Table 5.

Table 5: True vacancies vs. forecasted vacancies for grade 2

Time window	t	True vacancies filled	Forecasted vacancies ($N_2'(t)$)	Forecasted promotions ($P_{12}(t)N_1(t)$)	Forecasted new recruits ($R_2(t)$)	Forecasted transfers ($T_2(t)$)
Jan-04	1	2	1	1	0	0
Apr-04	2	4	4	3	0	0
Jul-04	3	3	3	3	0	0
Oct-04	4	1	2	2	0	0
Jan-05	5	6	5	4	0	0
Apr-05	6	3	3	3	0	0
Jul-05	7	1	2	2	0	0
Oct-05	8	4	1	1	0	0
Jan-06	9	1	4	3	0	0
Apr-06	10	6	4	3	0	0
Jul-06	11	4	3	3	0	0
Oct-06	12	1	2	2	0	0
Jan-07	13	4	4	3	0	0
Apr-07	14	5	3	3	0	0
Jul-07	15	1	1	1	0	0
Oct-07	16	5	5	4	0	0
Jan-08	17	3	2	2	0	0
Apr-08	18	5	5	4	0	0
Jul-08	19	4	5	4	0	0
Oct-08	20	7	6	5	0	1
Jan-09	21	2	3	3	0	0
Apr-09	22	3	4	3	0	0
Jul-09	23	4	4	3	0	0
Oct-09	24	5	4	3	0	0
Jan-10	25	5	4	3	0	0
Apr-10	26	6	6	5	0	1
Jul-10	27	9	8	7	0	1
Oct-10	28	5	5	4	0	0
Jan-11	29	4	2	2	0	0
Apr-11	30	5	7	6	0	1
Jul-11	31	3	1	1	0	0
Oct-11	32	1	4	3	0	0
Jan-12	33	7	3	3	0	0
Apr-12	34	4	5	4	0	0

Figure 14: The total amount of vacancies filled in grade 2 vs. the forecasted amount of vacancies for grade 2 during time window t



In Figure 14 above, the actual vacancies filled in grade 2 is compared to the forecasted vacancies for grade 2. These two distributions are very close with an average number of four vacancies and a standard deviation of two vacancies for both distributions.

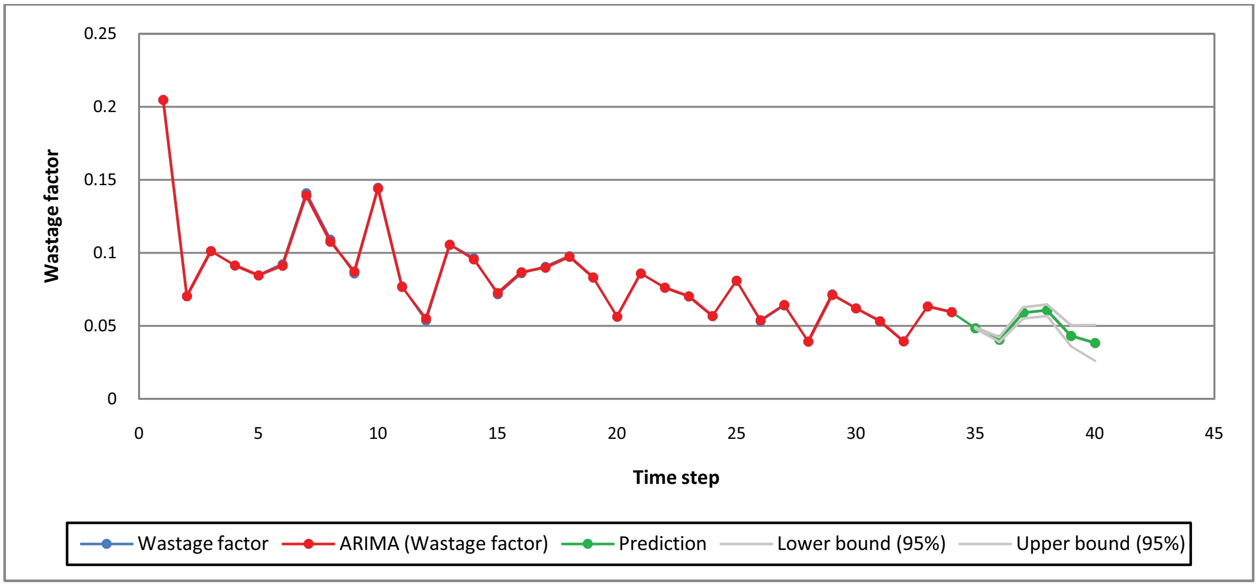
4.1.5 Grade 1: Team Member

Due to the high probability of wastage in grade 1, the wastage factor, $w_1(t)$ cannot be assumed to be constant for all values of t. This variable can also be forecasted with an ARIMA model. The best fitting model for the wastage factor in grade 1 ,was determined in XLSTAT, as an $ARIMA(1,1,2)^4(1,1,2)$ model that provides for the seasonality in the data. The forecasted values calculated in XLSTAT are summarized in Table 6, as well as the error size between the real and forecasted values. Figure 15 provides a graphical representation of this data. There is no demotion probability for grade 1 as no demotion can occur from the lowest grade.

Table 6: Forecasted wastage factor with ARIMA for grade 1

Wastage factor			
t	$w_1(t)$	**ARIMA** $(w_1(t))$	**Error**
1	0.205	0.205	0.000
2	0.070	0.070	0.000
3	0.101	0.101	0.000
4	0.091	0.091	0.000
5	0.085	0.085	0.000
6	0.092	0.091	0.001
7	0.141	0.139	0.001
8	0.109	0.108	0.001
9	0.086	0.087	-0.001
10	0.145	0.144	0.001
11	0.077	0.077	0.000
12	0.054	0.055	-0.001
13	0.105	0.106	0.000
14	0.096	0.095	0.001
15	0.072	0.072	-0.001
16	0.086	0.087	-0.001
17	0.091	0.090	0.001
18	0.098	0.097	0.000
19	0.083	0.083	0.000
20	0.056	0.056	0.000
21	0.086	0.086	0.000
22	0.076	0.076	0.000
23	0.070	0.070	0.000
24	0.057	0.057	0.000
25	0.081	0.081	0.000
26	0.053	0.054	0.000
27	0.064	0.064	0.000
28	0.039	0.039	0.000
29	0.072	0.071	0.000
30	0.062	0.062	0.000
31	0.053	0.053	0.000
32	0.040	0.039	0.000
33	0.063	0.063	0.000
34	0.060	0.059	0.000

Figure 15: True wastage factor in grade 1 vs. the forecasted wastage factor for grade 1

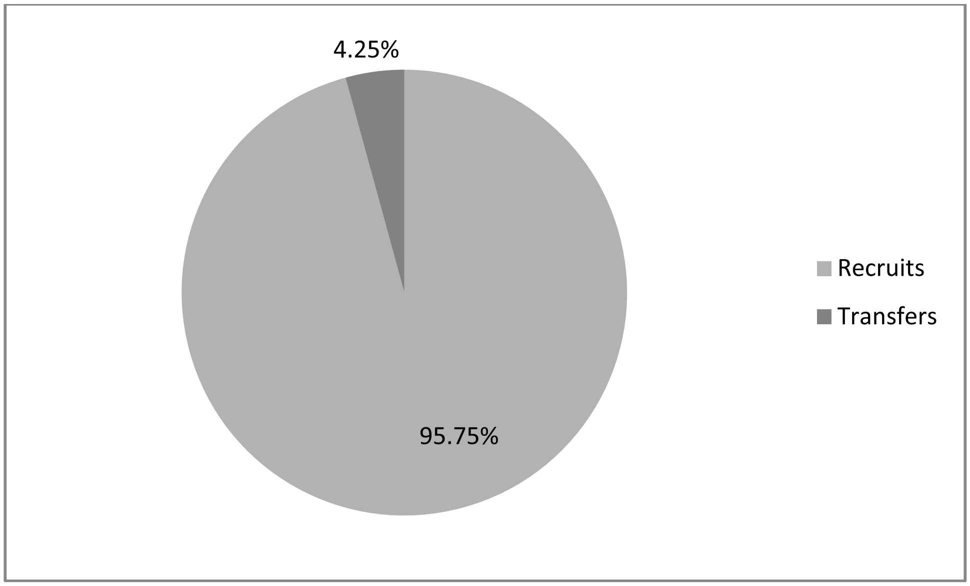


From Figure 15 it is evident that the forecasted distribution is very close to the real data and the $ARIMA(1,1,2)^4(1,1,2)$ model is thus a perfect fit in order to predict future wastage factors. From Equation 7 the forecasted amount of vacancies in grade 1 becomes

$$N_1'(t) = N_1(t+1) - N_1(t) - P_{21}(t)N_2(t) + P_{12}(t)N_1(t) + w_1(t)N_1(t)$$

Making use of the values shown in Table 5 for $P_{12}(t)N_1(t)$, the data in Appendix A and the forecasted values for $w_1(t)$ in Table 6, the results for the forecasted number of vacancies are calculated and shown in Table 7. The average proportions in which future vacancies will be filled as calculated with Equation 12, Equation 13 and Equation 14 are summarized in Figure 16.

Figure 16: Proportion of vacancies in grade 1 filled by promotions, transfers or new recruits



From Figure 16 it is evident that the majority, 95.75%, of vacancies in grade 1 are filled by new recruits and the remaining 4.25% is filled by transfers from other departments. Vacancies in grade 1 can not be filled by promotions from the next lower grade as there is no grade lower. Making use of the proportions as shown in Figure 16, the number of forecasted vacancies filled by transfers or new recruits can be calculated with Equation 7 (p.19) as it becomes

$$N_1'(t) = R_1(t) + T_1(t)$$

Where

$$R_1(t) = \bar{e}_1^r N_1'(t); \quad \forall t = 1,2,3, \dots, T$$

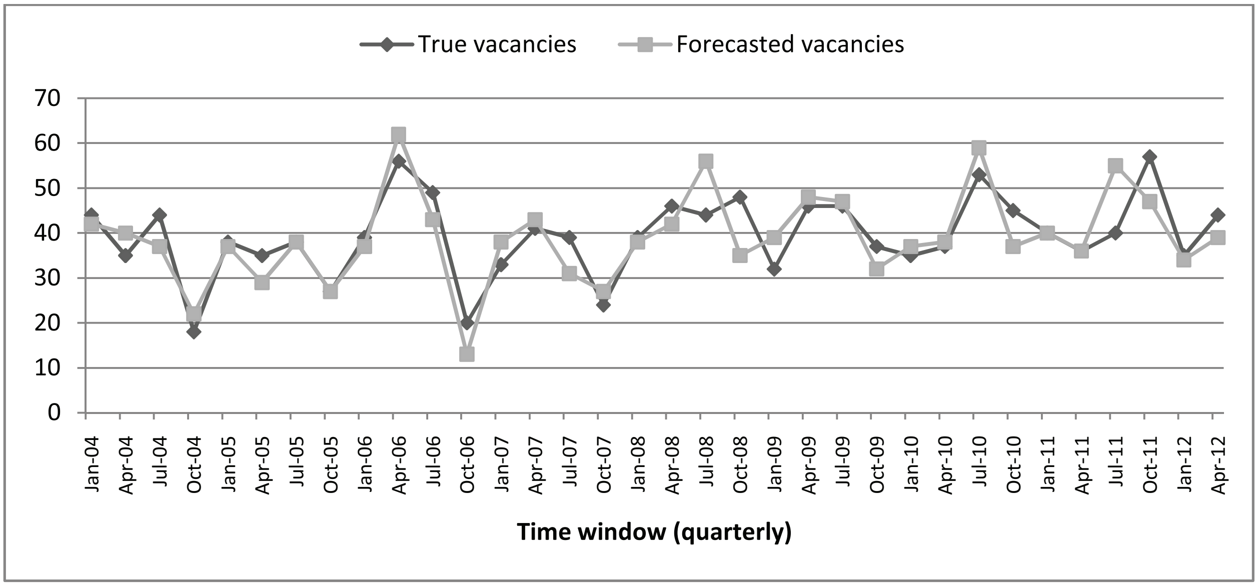
$$T_1(t) = \bar{e}_1^t N_1'(t); \quad \forall t = 1,2,3, \dots, T$$

All results are summarized in Table 7.

Table 7: True vacancies vs. forecasted vacancies for grade 1

Time window	t	True vacancies filled	Forecasted vacancies ($N'_1(t)$)	Forecasted new recruits ($R_1(t)$)	Forecasted transfers ($T_1(t)$)
Jan-04	1	44	42	40	2
Apr-04	2	35	40	38	2
Jul-04	3	44	37	35	2
Oct-04	4	18	22	21	1
Jan-05	5	38	37	35	2
Apr-05	6	35	29	28	1
Jul-05	7	38	38	36	2
Oct-05	8	27	27	26	1
Jan-06	9	39	37	35	2
Apr-06	10	56	62	59	3
Jul-06	11	49	43	41	2
Oct-06	12	20	13	12	1
Jan-07	13	33	38	36	2
Apr-07	14	41	43	41	2
Jul-07	15	39	31	30	1
Oct-07	16	24	27	26	1
Jan-08	17	39	38	36	2
Apr-08	18	46	42	40	2
Jul-08	19	44	56	54	2
Oct-08	20	48	35	34	1
Jan-09	21	32	39	37	2
Apr-09	22	46	48	46	2
Jul-09	23	46	47	45	2
Oct-09	24	37	32	31	1
Jan-10	25	35	37	35	2
Apr-10	26	37	38	36	2
Jul-10	27	53	59	56	3
Oct-10	28	45	37	35	2
Jan-11	29	40	40	38	2
Apr-11	30	36	36	34	2
Jul-11	31	40	55	53	2
Oct-11	32	57	47	45	2
Jan-12	33	35	34	33	1
Apr-12	34	44	39	37	2

Figure 17: The total amount of vacancies filled in grade 1 vs. the forecasted amount of vacancies for grade 1 during time window t



In Figure 17 above, the actual vacancies filled in grade 1 is compared to the forecasted vacancies for grade 1. These two distributions are very close with an average number of 39 vacancies for both distributions. There is a slight difference in the standard deviations as the true vacancy distribution has a standard deviation of 9 vacancies and the forecasted distribution has a standard deviation of 10 vacancies. Thus the forecast provides a high-quality estimate of the number of vacancies to be filled during time window t.

5. Conclusion and Recommendations

After the analysis of the results it can be concluded that the model developed by Setlhare (2007) with the additional application of ARIMA models to forecast the respective variables, can be used in the forecasting of placements to satisfy future human resource requirements. The advantage of this model is its ability to forecast the number of openings for a specific time period with the historical staff turnover as sole input data.

In the case of this particular Telesales department the grade sizes are not maintained and the amount of periods that the model can be used to forecast ahead is dependant on the ability of management to determine future workload. The model solely predicts the amount of vacancies and the manner in which the vacancies will be filled. Thus in order to determine the amount of vacancies to be filled during the fourth quarter of 2012, the human resource requirement for the first quarter in 2013 has to be known.

It should be understood that a forecast will never be exact and can only be used as a guideline. This guideline will however be efficient in allowing the required lead time in order to ensure that the right candidate is selected for the position as soon as the vacancy arises.

Should the model be implemented, it is recommended that the process and underlying data is reviewed at regular intervals to allow for changes in underlying trends and identification of outliers that could materially affect the output.

5.1 Future research

It is important that the company not only give consideration to the number of vacancies to be filled, but also the cost of filling these vacancies. For example, a vacancy filled by promotion will result in an increased salary, where a new recruit will either represent a complete new salary in the case of expansion or merely the replacement of another salary. Cost analysis is of vital important in terms of budgeting for the next time period. Another factor that has an influence on the cost analysis is the salary structure of the company. The company used in this project, makes use of a performance based salary structure and cost analysis on this structure could reveal further factors that should be considered in the recruitment process and suggest refinement to the model. Ideally the company should want to replace one high performing staff member with another.

In the model developed by Setlhare (2007), the only variables taken into account are wastages and demotions as well as the probability that a vacancy can arise due to a promotion to the next higher grade. However, as the composition of the workforce can change continually in terms of age, race, gender etc. these factors can be taken into account when forecasting the resignation rate where a person in their twenties to early thirties might be more likely to resign than someone in their fifties as an example. This could in turn result in a more accurate forecast of the wastage factor as the changing profile of the workforce will be taken into account.

Promotion pressure in terms of the duration of a staff member in a particular grade can also be taken into account. This could aid in the forecasting of a more accurate probability that a staff member will be promoted to the next higher grade.

These are merely suggestions for refinements to a workforce planning model once the value of an effective workforce planning model has been realised and an initial model was successfully implemented. With the implementation of additional variables, the forecast will become more accurate and less dependant on the volatility of the historical data.

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Appendices

Appendix A: Grade 1

Time window	t	Positions	New recruits ($R_1(t)$)	Transfers ($T_1(t)$)	Wastages	Wastage factor ($w_1(t)$)
Jan-04	1	126	44	0	26	0.2058
Apr-04	2	142	34	0	10	0.0704
Jul-04	3	169	43	0	17	0.1004
Oct-04	4	187	18	0	17	0.0907
Jan-05	5	191	37	1	16	0.0839
Apr-05	6	207	35	0	19	0.0916
Jul-05	7	215	37	0	30	0.1393
Oct-05	8	223	27	0	24	0.1078
Jan-06	9	225	38	0	19	0.0846
Apr-06	10	239	54	0	34	0.1421
Jul-06	11	265	48	0	20	0.0755
Oct-06	12	286	19	0	15	0.0524
Jan-07	13	282	32	1	29	0.1027
Apr-07	14	288	41	0	27	0.0939
Jul-07	15	301	39	0	21	0.0698
Oct-07	16	310	24	0	26	0.0840
Jan-08	17	306	38	0	27	0.0882
Apr-08	18	316	45	1	30	0.0949
Jul-08	19	323	41	2	26	0.0806
Oct-08	20	348	46	0	19	0.0545
Jan-09	21	361	32	0	30	0.0832
Apr-09	22	366	43	2	27	0.0737
Jul-09	23	384	40	6	26	0.0677
Oct-09	24	401	36	1	22	0.0549
Jan-10	25	407	34	1	32	0.0786
Apr-10	26	408	33	1	21	0.0514
Jul-10	27	422	43	7	26	0.0616
Oct-10	28	450	45	0	17	0.0378
Jan-11	29	465	38	1	32	0.0688
Apr-11	30	472	34	1	28	0.0594
Jul-11	31	473	34	6	24	0.0507
Oct-11	32	502	36	21	19	0.0379
Jan-12	33	525	31	3	32	0.0609
Apr-12	34	525	41	2	30	0.0571
Jul-12	35	530				
Total			**1260**	**57**		

Appendix B: Grade 2

Time window	t	Positions	Promotions from grade 1 to 2	New recruits ($R_2(t)$)	Transfers ($T_2(t)$)	Wastages	Wastage factor ($w_2(t)$)	Demotions from grade 2 to 1	Demotion probability ($P_{21}(t)$)
Jan-04	1	17	2	0	0	2	0.1200	0	0.0000
Apr-04	2	16	4	0	0	3	0.1915	1	0.0638
Jul-04	3	16	3	0	0	1	0.0612	1	0.0612
Oct-04	4	18	0	0	1	0	0.0000	0	0.0000
Jan-05	5	18	6	0	0	3	0.1636	0	0.0000
Apr-05	6	19	3	0	0	1	0.0517	0	0.0000
Jul-05	7	21	1	0	0	0	0.0000	1	0.0476
Oct-05	8	22	4	0	0	0	0.0000	0	0.0000
Jan-06	9	22	1	0	0	2	0.0896	1	0.0448
Apr-06	10	23	6	0	0	0	0.0000	2	0.0882
Jul-06	11	24	4	0	0	2	0.0822	1	0.0411
Oct-06	12	25	1	0	0	0	0.0000	1	0.0400
Jan-07	13	25	4	0	0	2	0.0800	0	0.0000
Apr-07	14	26	5	0	0	1	0.0380	0	0.0000
Jul-07	15	28	1	0	0	1	0.0357	0	0.0000
Oct-07	16	28	5	0	0	6	0.2118	0	0.0000
Jan-08	17	28	2	1	0	1	0.0361	1	0.0361
Apr-08	18	27	5	0	0	4	0.1463	0	0.0000
Jul-08	19	28	3	0	0	2	0.0723	1	0.0361
Oct-08	20	29	6	0	1	1	0.0345	2	0.0690
Jan-09	21	31	2	0	0	2	0.0645	0	0.0000
Apr-09	22	32	2	0	1	2	0.0632	1	0.0316
Jul-09	23	32	2	0	2	1	0.0309	0	0.0000
Oct-09	24	35	4	0	1	4	0.1154	0	0.0000
Jan-10	25	35	3	0	1	3	0.0857	0	0.0000
Apr-10	26	34	4	2	0	1	0.0294	3	0.0882
Jul-10	27	36	6	0	3	2	0.0561	3	0.0841
Oct-10	28	38	5	0	0	2	0.0526	0	0.0000
Jan-11	29	41	4	0	0	1	0.0244	1	0.0244
Apr-11	30	41	4	1	0	4	0.0976	1	0.0244
Jul-11	31	43	1	0	2	1	0.0234	0	0.0000
Oct-11	32	43	1	0	0	1	0.0234	0	0.0000
Jan-12	33	44	7	0	0	3	0.0682	1	0.0227
Apr-12	34	43	3	0	1	3	0.0692	1	0.0231
Jul-12	35	44							
Total			**114**	**4**	**13**				

Appendix C: Grade 3

Time window	t	Positions	Promotions from grade 2 to 3	New recruits ($R_3(t)$)	Transfers ($T_3(t)$)	Wastages	Wastage factor ($w_3(t)$)	Demotions from grade 3 to 2	Demotion probability ($P_{32}(t)$)
Jan-04	1	4	0	0	0	0	0.0000	0	0.0000
Apr-04	2	4	0	0	0	0	0.0000	0	0.0000
Jul-04	3	3	0	0	0	1	0.3000	0	0.0000
Oct-04	4	3	0	0	0	0	0.0000	0	0.0000
Jan-05	5	4	2	0	0	0	0.0000	0	0.0000
Apr-05	6	5	0	0	0	0	0.0000	0	0.0000
Jul-05	7	5	0	0	0	0	0.0000	0	0.0000
Oct-05	8	5	2	0	0	1	0.2000	0	0.0000
Jan-06	9	5	0	0	0	0	0.0000	0	0.0000
Apr-06	10	6	1	0	0	0	0.0000	0	0.0000
Jul-06	11	6	0	0	0	0	0.0000	0	0.0000
Oct-06	12	6	0	0	0	0	0.0000	0	0.0000
Jan-07	13	7	2	0	0	0	0.0000	0	0.0000
Apr-07	14	7	1	0	0	0	0.0000	0	0.0000
Jul-07	15	8	0	0	0	0	0.0000	0	0.0000
Oct-07	16	8	0	0	0	0	0.0000	0	0.0000
Jan-08	17	8	0	0	0	0	0.0000	0	0.0000
Apr-08	18	8	1	0	0	0	0.0000	0	0.0000
Jul-08	19	9	2	0	0	0	0.0000	1	0.1111
Oct-08	20	10	0	0	0	0	0.0000	0	0.0000
Jan-09	21	10	0	0	0	0	0.0000	0	0.0000
Apr-09	22	10	0	0	0	0	0.0000	0	0.0000
Jul-09	23	10	0	0	1	0	0.0000	0	0.0000
Oct-09	24	11	0	0	0	0	0.0000	0	0.0000
Jan-10	25	11	3	0	0	1	0.0882	1	0.0882
Apr-10	26	13	2	0	0	0	0.0000	0	0.0000
Jul-10	27	13	0	0	2	1	0.0750	0	0.0000
Oct-10	28	14	1	0	0	1	0.0714	0	0.0000
Jan-11	29	14	0	0	0	0	0.0000	0	0.0000
Apr-11	30	14	1	0	0	0	0.0000	0	0.0000
Jul-11	31	15	0	0	0	0	0.0000	0	0.0000
Oct-11	32	15	1	0	0	0	0.0000	0	0.0000
Jan-12	33	17	1	0	0	0	0.0000	0	0.0000
Apr-12	34	17	0	0	1	0	0.0000	0	0.0000
Jul-12	35	18							
Total			**20**	**0**	**4**				
Average							**0.0216**		**0.0059**

Appendix D: Grade 4

Time window	t	Positions	Promotions from grade 3 to 4	New recruits ($R_4(t)$)	Transfers ($T_4(t)$)	Wastages	Wastage factor ($w_4(t)$)	Demotions from grade 4 to 3	Demotion probability ($P_{43}(t)$)
Jan-04	1	1	0	0	0	0	0.0000	0	0.0000
Apr-04	2	1	0	0	0	0	0.0000	0	0.0000
Jul-04	3	1	0	0	0	0	0.0000	0	0.0000
Oct-04	4	1	0	0	0	0	0.0000	0	0.0000
Jan-05	5	1	0	0	0	0	0.0000	0	0.0000
Apr-05	6	1	0	0	0	0	0.0000	0	0.0000
Jul-05	7	1	0	0	0	0	0.0000	0	0.0000
Oct-05	8	2	1	0	0	0	0.0000	0	0.0000
Jan-06	9	2	0	0	0	0	0.0000	0	0.0000
Apr-06	10	2	0	0	0	0	0.0000	0	0.0000
Jul-06	11	2	0	0	0	0	0.0000	0	0.0000
Oct-06	12	2	0	0	0	0	0.0000	0	0.0000
Jan-07	13	2	1	0	0	0	0.0000	0	0.0000
Apr-07	14	3	0	0	0	0	0.0000	0	0.0000
Jul-07	15	3	0	0	0	0	0.0000	0	0.0000
Oct-07	16	3	0	0	0	0	0.0000	0	0.0000
Jan-08	17	3	0	0	0	0	0.0000	0	0.0000
Apr-08	18	3	0	0	0	0	0.0000	0	0.0000
Jul-08	19	3	0	0	0	0	0.0000	0	0.0000
Oct-08	20	3	0	0	0	0	0.0000	0	0.0000
Jan-09	21	4	0	0	0	0	0.0000	0	0.0000
Apr-09	22	4	0	0	0	0	0.0000	0	0.0000
Jul-09	23	4	0	0	0	0	0.0000	0	0.0000
Oct-09	24	4	0	0	0	0	0.0000	0	0.0000
Jan-10	25	4	0	0	0	0	0.0000	0	0.0000
Apr-10	26	4	0	0	0	0	0.0000	0	0.0000
Jul-10	27	5	1	0	0	0	0.0000	0	0.0000
Oct-10	28	5	0	0	0	0	0.0000	0	0.0000
Jan-11	29	5	0	0	0	0	0.0000	0	0.0000
Apr-11	30	5	0	0	0	0	0.0000	0	0.0000
Jul-11	31	5	0	0	0	0	0.0000	0	0.0000
Oct-11	32	5	0	0	0	0	0.0000	0	0.0000
Jan-12	33	5	0	0	0	0	0.0000	0	0.0000
Apr-12	34	5	0	0	0	0	0.0000	0	0.0000
Jul-12	35	5							
Total			**3**	**0**	**0**				
Average							**0.0000**		**0.0000**

Appendix E: Grade 5

Time window	t	Positions	Promotions from grade 4 to 5	New recruits ($R_5(t)$)	Transfers ($T_5(t)$)	Wastages	Wastage factor ($w_5(t)$)	Demotions from grade 5 to 4	Demotion probability ($P_{54}(t)$)
Jan-04	1	1	0	0	0	0	0.0000	0	0.0000
Apr-04	2	1	0	0	0	0	0.0000	0	0.0000
Jul-04	3	1	0	0	0	0	0.0000	0	0.0000
Oct-04	4	1	0	0	0	0	0.0000	0	0.0000
Jan-05	5	1	0	0	0	0	0.0000	0	0.0000
Apr-05	6	1	0	0	0	0	0.0000	0	0.0000
Jul-05	7	1	0	0	0	0	0.0000	0	0.0000
Oct-05	8	1	0	0	0	0	0.0000	0	0.0000
Jan-06	9	1	0	0	0	0	0.0000	0	0.0000
Apr-06	10	1	0	0	0	0	0.0000	0	0.0000
Jul-06	11	1	0	0	0	0	0.0000	0	0.0000
Oct-06	12	1	0	0	0	0	0.0000	0	0.0000
Jan-07	13	1	0	0	0	0	0.0000	0	0.0000
Apr-07	14	1	0	0	0	0	0.0000	0	0.0000
Jul-07	15	1	0	0	0	0	0.0000	0	0.0000
Oct-07	16	1	0	0	0	0	0.0000	0	0.0000
Jan-08	17	1	0	0	0	0	0.0000	0	0.0000
Apr-08	18	1	0	0	0	0	0.0000	0	0.0000
Jul-08	19	1	0	0	0	0	0.0000	0	0.0000
Oct-08	20	1	0	0	1	0	0.0000	1	1.0000
Jan-09	21	1	0	0	0	0	0.0000	0	0.0000
Apr-09	22	1	0	0	0	0	0.0000	0	0.0000
Jul-09	23	1	0	0	0	0	0.0000	0	0.0000
Oct-09	24	1	0	0	0	0	0.0000	0	0.0000
Jan-10	25	1	0	0	0	0	0.0000	0	0.0000
Apr-10	26	1	0	0	0	0	0.0000	0	0.0000
Jul-10	27	1	0	0	0	0	0.0000	0	0.0000
Oct-10	28	1	0	0	0	0	0.0000	0	0.0000
Jan-11	29	1	0	0	0	0	0.0000	0	0.0000
Apr-11	30	1	0	0	0	0	0.0000	0	0.0000
Jul-11	31	1	0	0	0	0	0.0000	0	0.0000
Oct-11	32	1	0	0	0	0	0.0000	0	0.0000
Jan-12	33	1	0	0	0	0	0.0000	0	0.0000
Apr-12	34	1	0	0	0	0	0.0000	0	0.0000
Jul-12	35	1							
Total			**0**	**0**	**1**				
Average							**0.0000**		**0.0294**