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Improvement of a System for Modelling and Analysing Attrition at the IRS

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The views expressed are those of the authors and not the official position of the Internal Revenue Service

Abstract. Years of tight federal budget authority has forced the Internal Revenue Service (IRS) to defer modernization and maintenance to cover salaries. During that same time, between 4,600 and 6,100 full-time permanent employees have left the IRS annually. Since labor costs represent 75% of total resources, and congressional appropriations rules forbid the IRS from transferring funding between budget categories such as taxpayer service and enforcement, if the IRS can predict the number of departures they can properly allocate funding between personal and critical unfunded requirements. This paper presents an analysis of methods used to project attrition at the IRS. The methods are elicited through interviews, then their accuracy is measured by comparison to historical data. The average percentage of the fiscal year worked before departing is also considered. Ultimately, this paper provides recommendations that could allow the IRS to redistribute $16 million per year for strategic planning purposes.

Background

According to the 2017 IRS Data book, during Fiscal Year (FY) 2017 the Internal Revenue Service (IRS) collected more than $3.4 trillion in taxes. This represents most of the funding of the United States Federal Government according to the Center for Budget and Policy Priorities. To complete this task, the IRS's operating expenses come from money annually appropriated from Congress as part of their Annual Appropriations process.

Each year, the IRS's Chief Financial Office (CFO) is responsible for distributing annually appropriated money. Due to the Restructuring and Reform Act of 1998, the IRS is run as a series of separate Business Units (BU) divided along strategic objectives. In accordance with Federal Appropriations Law, such as the Consolidated Appropriations Act of 2018, the CFO must allocate money to specific appropriations, called Funds within the IRS. These are Taxpayer Service, Operations Support and Business Systems Modernization (BSM), and Enforcement. Each Fund is further subdivided into nine to fourteen Financial Plans. Each Business Unit might have employees that work in multiple Financial Plans. It takes Congressional approval to transfer funding between Funds, which is difficult to accomplish. Additionally, according to representatives of several Business Units, each Business Unit is reluctant to have funds taken away to be transferred to another Business Unit (Skopic, 2018 and Sheehan, 2018). This means that the CFO must initially estimate the funding required by each Business Unit as accurately as possible (Shamsie, 2018).

The amount of money the IRS receives from Congress has been steadily decreasing since 2010 according to the Center for Budget and Policy Priorities and former IRS Commissioner John Koskinen. Labor represents the costliest line-item in the IRS' annual budget, representing 75% of the total cost according to the Continuing Resolution Status Reports prepared by the CFO (Brown, 2018 and Hildebrand, 2018). However, attrition at the IRS is very high, staying above 6.2% per year since 2006 with very limited options for replacing people who leave (Koskinen, 2016). The IRS has lost more than a quarter of its enforcement staff since 2010. For this reason, accurately estimating attrition represents the best way for the IRS to free up funding, invest in unfunded requirements, and align with the IRS' and Treasuries Strategic Plans and the President's Management Agenda.

Objectives

The requirements elicitation process with our project Sponsor resulted in one primary goal with several minor goals. Our primary goal is to compare the various methods used in the IRS to estimate attrition and suggest process improvements. Additional lower priority goals include discovering the average percentage of the fiscal year that employees in each Fund and Financial Plan work before leaving the IRS, the sensitivity of the attrition rate to various factors, and evaluating the truth of the IRS truism "One third of annual attrition occurs in the first quarter of the fiscal year". The average percentage of the fiscal year that employees in each Fund and Financial Plan work before leaving the IRS is referred to as the Loss Factor. This is relevant to determine the average cost savings of departing employees. The methods are elicited through interviews from five IRS business units. This paper then analyzes each method by comparison to historical data over a thirteen year period. The findings reveal organizational process improvements that will enable the IRS to redistribute approximately 16 million dollars per year earlier in the year for unfunded requirements.

Literature

A literature review was initially conducted to inform the questions and structure of the IRS interviews. Unfortunately, there does not appear to be a well-established body of literature that addresses the problem of modeling attrition in a large federal environment. Federal attrition can be influenced by factors in place before hiring, such as hiring employees whose educational backgrounds match their occupational fields (Starks, 2007, 11). In the civilian world, person-to-person career counseling, particularly for new employees also has a significant effect on increasing retention (Elsdon, 1999, 8). This is consistent with the job fit theory that touts the benefits of targeting hiring and socialization programs (Kristof, 1996, 1). However, this literature focuses on the effects of targeting hiring and the perspectives of the job seekers (Neumann, 2016, 1) as opposed to the perspective of an agency with a large existing workforce. Person-organizational fit can predict turnover after two years (O'Reilly et al., 1991), but cannot predict turnover after twenty years. Thus, this research is of little use to the IRS, which is looking to predict all sources of attrition including retirements.

Pitts et al. (2011) suggest using surveys to capture data on overall job satisfaction as a predictive measure of turnover intention. The Federal Human Capital Survey used by Pitts et al. has been replaced with the Federal Employee Viewpoint Survey (FEVS) but many of the questions pertaining to workplace satisfaction factors and organizational/relational factors remain. Due to privacy concerns, the optional nature of the FEVS, and Jung's 2010 finding of a weak or insignificant correlation between organizational turnover and turnover intention, the use of the FEVS was not considered as part of this study, but using the FEVS as a predictive tool could be explored for future research.

Methodology

Our initial task was to gain access to historical attrition data going back through Fiscal Year 2006. This data enabled us to have a baseline with which to compare the accuracy of IRS attrition models.

We then conducted 47 interviews over the course of ten weeks with IRS personnel to reveal workforce attrition models and the attrition forecasting process that have been developed or are under development in several divisions. Some business units had existing planning models that varied in their degree of sophistication and long-term forecasting capability. However, there has not historically been a consistent attrition forecasting methodology in place across all business units. Within each business unit, methods are similarly inconsistent from year-to-year. Our team worked with subject matter experts who explained existing models and contributed knowledge to aid in development of a corporate strategic workforce planning tool. We documented this feedback and created activity diagrams to document and understand this forecasting process. These diagrams were shown to the interviewees for feedback and revision.

We then applied each model to fiscal years 2006-2017 where possible to deduce the accuracy of each model. We investigated what makes some models more or less accurate than others. Finally, we suggested improvements, both in which methods should be used and the overall process, to improve the accuracy of labor funding to the business units.

Due to difficulties getting direct access to the data, all data was received through subordinates of the Sponsor. We obtained biweekly attrition data from each pay period from Fiscal Years 2006-2017. This data contained an abundance of employment information, more than 27,000 data points in total for overall attrition, plus another 28,000 data points related to specific models. As per standard labor projection and modeling practice, all losses that occurred in a pay period were assumed to occur at the last working day of the pay period. Using Excel™, we merged the data sources and added columns to the data to tease out relevant information including the pay period, last date of employment, their worker status, their loss factor, and what Fund they were working under. We then used Tableau™ to pivot and analyze this into a variety of tables and graphs. We exported these tables back to Excel™ and compared the various methods.

Results

During the period under review, the IRS underwent a reorganization which resulted in many employees changing jobs, both internally or externally. For the purposes of this paper, only employees in the IRS category of Permanent, not Seasonal were considered. Additionally, only Pure attrition, which is the IRS label for an employee who leaves the IRS altogether, was considered. This is different from Interplan attrition, which is the IRS label for employees who leave one part of the IRS to go to another. Due to frequent reorganizations, the amount of Interplan attrition remains high, and it is a complicating factor in modeling Pure attrition. In each year of our data, the IRS loses between 4,600 and 6,100 Permanent, Pure, Employees, as shown in Figure 1, which displays attrition by Fund.

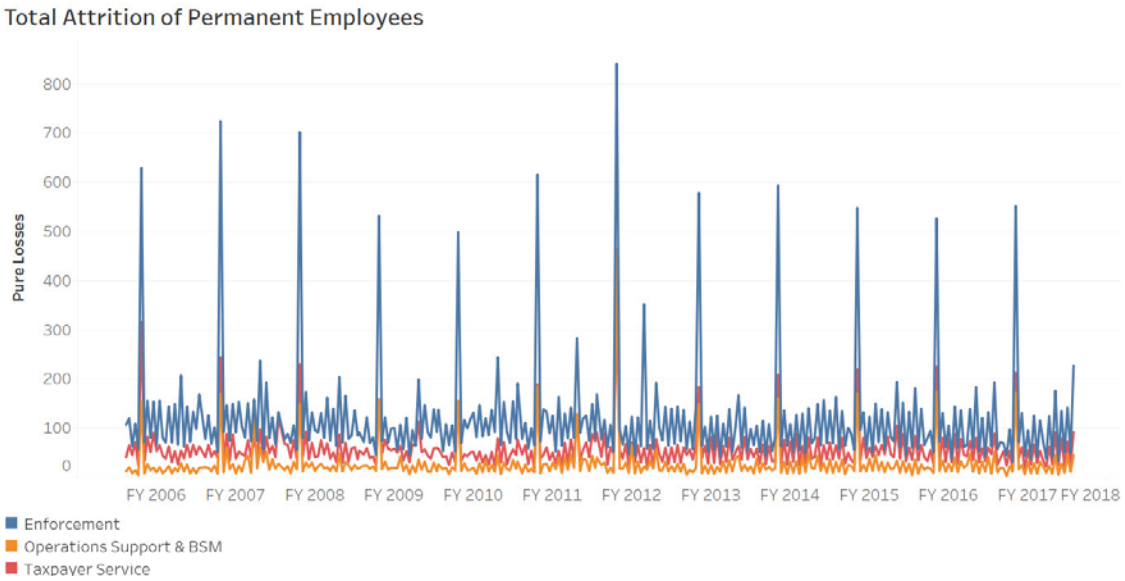

Figure 1: Attrition at the IRS has ranged between 4,600 and 6,100 employees per fiscal year.

Lower Priority Goals: Data analysis also enabled the estimation of future Loss Factors based on the calculated historical average. The Financial Planning and Analysis Team in the CFO had estimated that on average, the CFO saves about 50% of the labor costs of each departure. The team analyzed the results by all categories used by the CFO and discovered that the actual percentage of the FY worked by employees prior to departing ranges from 40.8% to 68.13% of costs, with an overall average of 52.29%.

The team also evaluated the veracity of the IRS truism "One third of annual attrition occurs in the first quarter of the fiscal year". After estimating a probability density function and then a cumulative distribution based on Figure 1, the team confirmed that the statement is valid for the period of FY 2006-2017.

Method Descriptions: Table 1 lists the attrition methods revealed in the interviews. The benefit of the "% of Year Loss Factor" method is that since most attrition occurs early in the fiscal year projections made towards the end of the fiscal year will be highly accurate. However, this accuracy comes at the price of its usefulness. This method, while useful to specific Business Units towards the end of the fiscal year, does not enable the CFO to distribute funds to the Business Units in a proactive and accurate way. This method does not enable the IRS to fund other requirements and it increases the potential for inefficiency and waste since labor funding must be allocated earlier in the process. For these reasons, this method is not directly compared to the others and this paper recommends using it for projections that involve significant hindsight only.

The model from the Research, Applied Analytics, and Statistics (RAAS) business unit uses logistic regression to calculate the probability of retirements or resignations at the employee level and rolls these up into the Fund and Functional Area categories required by the CFO. Because this regression is calculated at the individual employee level, its accuracy will be consistent regardless of organizational structure. This analysis includes factors based on the type of employee (permanent, seasonal, etc), employee-factors such as veteran status and age, and economic factors such as the household sales in the county of employment and the local

Woods & Poole Economics Wealth Index. Their forecast includes estimates of attrition projected forward one, three, and five-years. Since this model was completed in FY 2015, only two years of data can be produced for accuracy analysis.

Previous Attrition	The team uses last year's attrition data and estimates that it will be the same for the upcoming year.
Previous Attrition + 0.5%	The team uses last year's attrition data, increases the count by a small buffer (0.5%) and reports that for the upcoming year.
Previous Attrition 5- year Average	The team uses a running average from the last 5 years to estimate the attrition in the upcoming year.
Lower of Previous Attrition in past two years	The team uses the lower of the attrition rates from the last two years as the estimate for the attrition in the upcoming year.
Previous Attrition 3- year Average	The team uses a running average from the last 3 years to estimate the attrition in the upcoming year.
Previous Attrition 2- year Average	The team uses a running average from the last 2 years to estimate the attrition in the upcoming year.
% of Year Loss Factor	Relying on the fact that some attrition projections from some Business Units are not required until most of the fiscal year has already passed, this method uses five-year average historical probability distribution functions to estimate what % of total fiscal year attrition occurs in the remaining pay periods, then estimates total attrition by multiplying current attrition by the resulting factor.
RAAS Model	A model created by the Research, Applied Analytics, and Statistics (RAAS) business unit, this model is a logistic regression on the individual level created from fiscal years 2011-2015.

Table 1: A list of attrition modeling methods used at the IRS

Error Rates: Applying each method to actual attrition values from FY 2006-2017 resulted in accuracy values as shown in Figure 2. While the 8-year average Linear Regression method showed the lowest median and average error rate, it is not a method usable by most BUs. As stated in the Overview section, attrition at the IRS is divided into both Funds and Financial Plans. While some of these subcategories are large, with greater than 1,000 losses each year, most subcategories are small, with less than 10 losses each year. These small categories are subject to frequent reorganizations, which means a linear regression method wouldn't work for them. The BUs with in the largest subcategory also have employees in small subcategories, and so couldn't categorically use a linear regression method either. However, the RAAS model calculates attrition likelihood at the individual employee level and is indifferent to reorganizations.

Because the RAAS model is a logistic regression based on data through 2015, only two years of error calculations are available. To have a more direct comparison, the data points for the years 2016 and 2017 appear in Figure 2 in blue while the other data points appear in orange. Considering only the years 2016 and 2017, the RAAS model has the second lowest error rate behind the linear regression model that's based on the previous 8-year average. However, the

linear regression methods are used by only one business unit whose employees are in a specific funding subcategory. Due to frequent reorganizations, the linear regression methods are not usable by most business units. For these reasons, when considering recommendations for the IRS, the team chose to focus in interviews on the RAAS model.

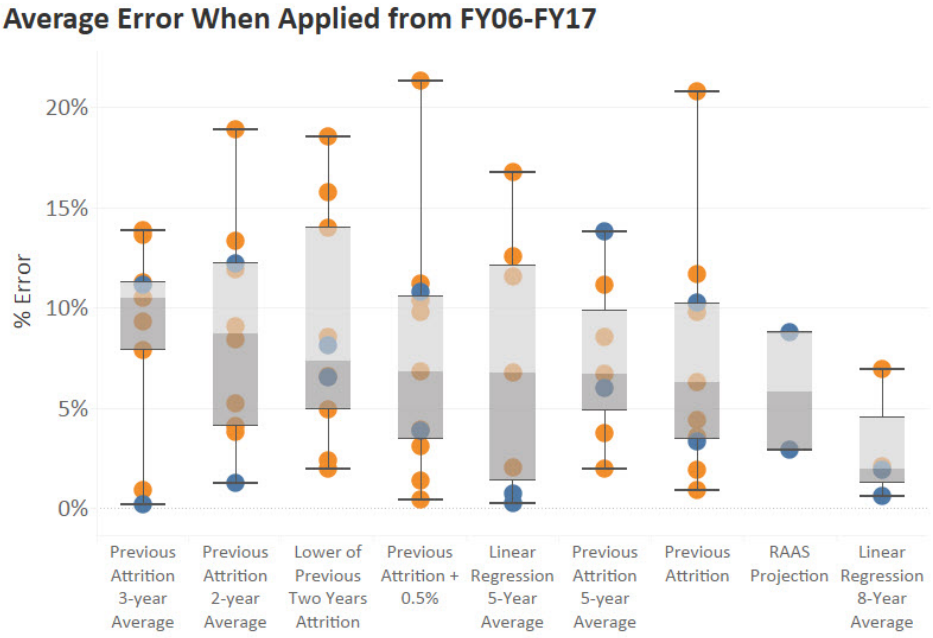

Figure 2: The RAAS method and Linear Regression 8-year average show the lowest error rates. The years 2016 and 2017 appear in blue, all others in orange.

Findings from the Interviews: Interviewing IRS personnel and diagramming the attrition modeling process revealed detailed attrition modeling processes, a sample of which from The Small Business and Self Employed (SB/SE) business unit is shown in Figure 3. It also revealed differing motivations of the CFO compared to the Business Units. The CFO must estimate attrition in the first half of the fiscal year and then provide that data to the IRS's Budget Formulation team. The Business Units provide initial estimations to the CFO, but can update these estimates towards the end of the fiscal year. The CFO is motivated to underestimate the amount of attrition as part of a risk management strategy to mitigate the risk of having to transfer money from other Funds. The BUs, however, are incentivized to underestimate funding by a greater amount. This is because the BUs do not run the risk of the money being taken away by the CFO for other parts of the IRS until towards the end of the fiscal year. Dramatically under-estimating the amount of attrition means that the BUs gain additional funding if funding is spent prior to year-end. The lack of accountability of which method of estimating attrition works better under which circumstances also prejudices the results in favor of the Business Units at the expense of the CFO, as the CFO typically agrees with the Business Unit's corrections to their initial attrition estimates.

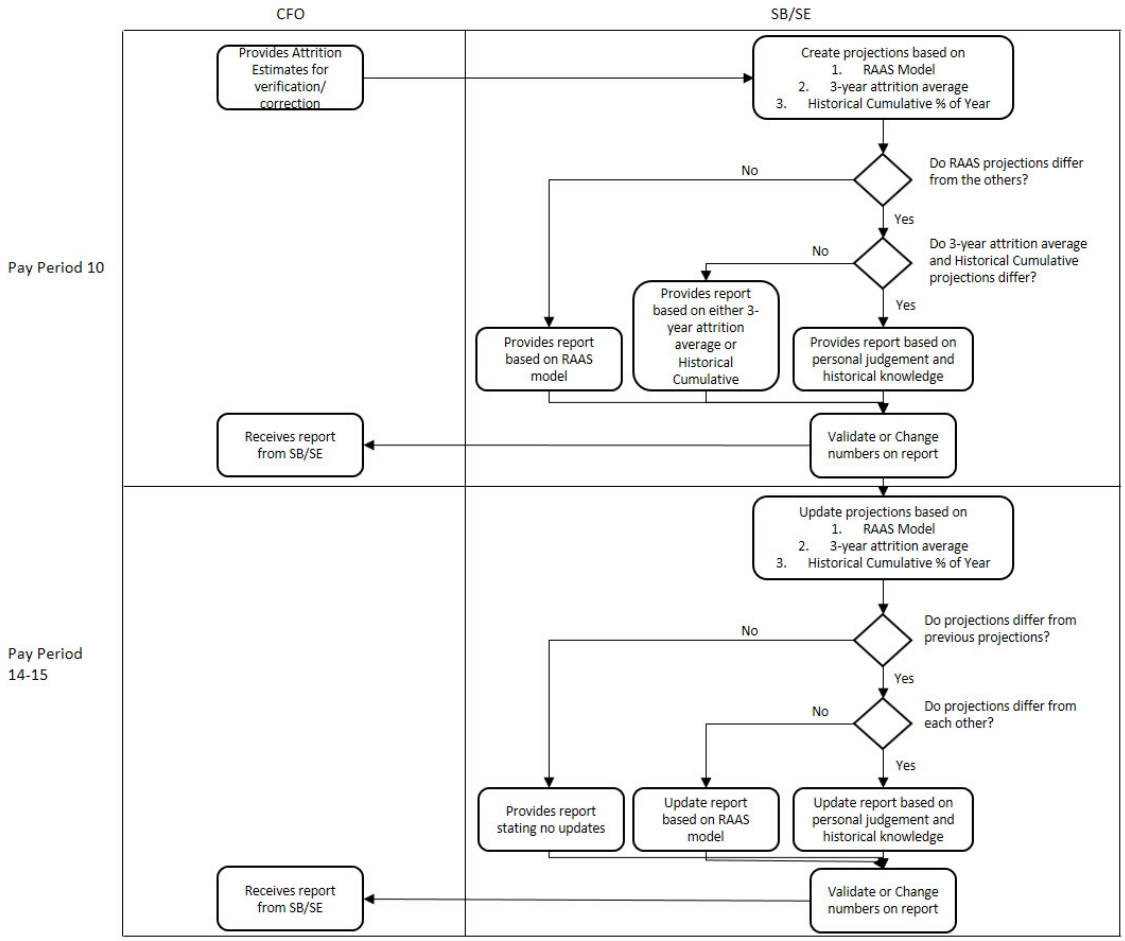

Figure 3: Typical Attrition Modeling process at SB/SE

Interviews with the Business Units indicate widespread skepticism about the RAAS attrition model. Reasons given for this include:

1. The fact that the model can only begin on odd pay periods, when some fiscal years begin on even pay periods.
2. The model must be specifically requested from RAAS, adding extra time and effort to the typical work process.
3. The report predicts attrition for the next year, 3 years out, and 5 years out, and the 5-year predictions are notoriously inaccurate.
4. The model does not account for frequent reorganizations
5. The widespread perception is that this model *overestimates* attrition, a situation that could leave parts of the IRS without necessary funding.
6. The belief that the model does not account for all employees, only technical employees.

Interviews with the team who created the RAAS model revealed that reasons #1, 5, and 6 are untrue, and reason #3 cannot be evaluated either true or false. The team recommends that the CFO request the model on behalf of the other BUs early in the fiscal year to mitigate the impact

of reason #2. Regarding reason #4, while the RAAS model calculates attrition likelihood at the individual employee level, the system used by the RAAS team does not find out about reorganizations until well after they occur. The team recommends RAAS send out biannual data calls regarding upcoming reorganizations to mitigate this concern.

Even among business units that were in favor of the RAAS model, interviews with them revealed that they tended not to use it. An example of a difference between stated preferences and revealed preferences is SB/SE, as shown in Figure 3. This unit stated that they used the RAAS model each year and relied on it. However, interviews with the head of the team that estimates annual attrition revealed that they typically use the RAAS Model, the 3-Year Attrition Average model, as well as the Historical Cumulative % of Year Model and only use the RAAS model if its answers are in line with the other two models. They tend to, like the other business units, revert to the personal judgement and historical knowledge of IRS analysts. A diagram of this process is shown in Figure 3.

Recommendations

Our recommendation is for the CFO to obtain annual projections from RAAS and to use these projections as the "default" when supplying attrition estimates to the Business Units. Additionally, we believe that RAAS should release one-year projections to the BUs so that the potentially less accurate three- and five-year projections don't cause confusion. Finally, we propose that RAAS should send out bi-annual data calls with requests for information about upcoming reorganizations so that they can increase their knowledge of upcoming reorganizations and include them in their model. Since the Historical Cumulative % of Year method has an accuracy that approaches 1 as the FY nears its end, the team recommends that all BUs switch to this model in the later parts of the fiscal year. While the team's recommendations are to move towards a standardized modeling process, due to the order of magnitude increase in variability experienced by the very small subcategories compared to the large, the team recommends that attrition in these very small subcategories be allowed to be manually estimated.

As shown in Figure 4, the RAAS model has an average error rate that is 2.3% lower than the average of the other applicable methods. If the attrition estimates done by the CFO for FY 2006-2017 could have been improved by that amount, the additional attrition of 107 to 138 individuals would have been accurately predicted. Since the average salary including benefits of an IRS employee is $151,076 this would have enabled the IRS to redistribute $16 million dollars to $21 million dollars each year earlier in the year for unfunded requirements. However, given the variability in the error rates and the overlap in the confidence intervals, more study is warranted.

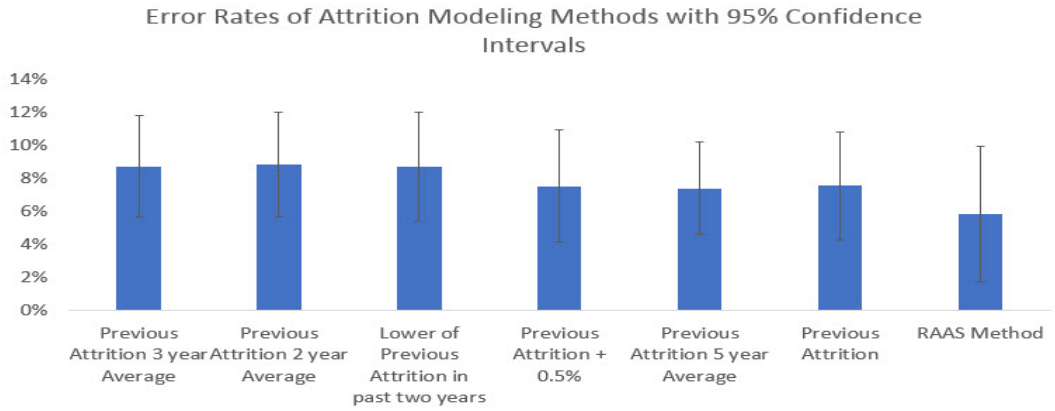

Figure 4: Mean error rates of attrition methods that are applicable to all BUs with a 95% confidence interval

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Biography

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