



Office of the Auditor General / Bureau du vérificateur général

DETERMINATION OF SAMPLING REQUIREMENTS

FOR AUDITS OF PAYROLL ACCURACY

2010

DÉTERMINATION DES EXIGENCES D'ÉCHANTILLONNAGE

POUR LES VÉRIFICATIONS DE LA PRÉCISION DE LA PAIE

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EXECUTIVE SUMMARY

Background

The Determination of Sampling Requirements for Audits of Payroll Accuracy was added to the Auditor General's 2010 Audit Plan.

Introduction

The purpose of this report is to provide a sample design framework to support the City in conducting periodic audits of payroll accuracy.

Approach

A number of elements are required to determine the size of the sample that will lead to reliable results. Some of these elements are known while others are estimated. The key elements required to calculate the sample size are listed below. A detailed description is included in the full report.

1. ***Population (N)***: This represents the unit of analysis. The number is generally known.
2. ***Confidence Level (CI)***: Determines how sure one can be that the sample selected is a true representation of the population. Two figures are commonly used; 95% and 99%.
3. ***Margin of Error (MoE)***: It is the plus-or-minus figure usually reported to indicate that results fall within a certain range. This can be specified in advance or generated based on a given sample size.
4. ***Percentage (p)***: This represents the percentage of sample that picks a particular answer. It is an estimated value.
5. ***Sample Size (n)***: This represents the number of records to select.

Based on these inputs a mathematical formula is used to calculate the required sample size. Alternatively, a sample size can be specified and the formula will calculate the margin of error.

Once the sample size is determined, the next stage involves the actual selection of the records to be audited.

Recommendation and Management Response

Recommendation 1:

That the City Treasurer conduct, every three years, an audit of payroll accuracy. As noted in the report, the sample size should be 200 records and a systematic sampling selection approach should be used.

Management Response:

Management agrees with this recommendation.

The first audit will be completed by the end of Q4 2012.

Conclusion

Sample size was determined by taking into consideration several factors as described in this report. We feel that a sample of 200 “direct deposit” records would be sufficient to draw valid conclusions on the accuracy of payroll calculations. A sample of 200 will have a margin of error of plus or minus 4.2 percentage points at a 95% confidence level.

We recommend a systematic sampling selection approach that will yield a sample that is proportional to the percentage “direct deposit” records by employee subgroups as defined by the SAP Payroll system.

Once the audit has been completed a review of the results will be necessary to confirm the representativeness of the sample, apply weighting factors if necessary and re-validate the margin of error based on the actual result of the audit.

Acknowledgement

We wish to express our appreciation for the cooperation and assistance afforded the audit team by management.

RÉSUMÉ

Contexte

La détermination des exigences d'échantillonnage pour les vérifications de la précision de la paie a été ajoutée au Plan de vérification de 2010 du vérificateur général.

Introduction

Le présent rapport vise à fournir un exemple de cadre de conception afin d'appuyer la Ville dans la conduite périodique de vérifications de la précision de la paie.

Approche

Plusieurs éléments sont requis afin de déterminer la taille de l'échantillon qui permettra d'obtenir des résultats fiables. Certains de ces éléments sont connus alors que d'autres sont estimés. La liste des éléments clés requis afin de calculer la taille de l'échantillon est indiquée ci-dessous. Une description détaillée est incluse dans le rapport complet.

1. **Population (N)** : cet élément représente l'unité d'analyse. Le nombre est généralement connu.
2. **Niveau de confiance (CI)** : il détermine le degré de certitude quant au fait que l'échantillon sélectionné est une bonne représentation de la population. Deux nombres sont habituellement utilisés : 95 % et 99 %.
3. **Marge d'erreur (MoE)** : Il s'agit du nombre plus-moins habituellement mentionné pour indiquer que les résultats peuvent se situer dans une certaine échelle. On peut le préciser à l'avance ou bien le générer en fonction de la taille d'un échantillon donné.
4. **Pourcentage (p)** : il représente le pourcentage d'un échantillon qui choisit une réponse en particulier. Il s'agit d'une valeur estimée.
5. **Taille de l'échantillon (n)** : Il représente le nombre de dossiers à sélectionner.

Une formule mathématique est utilisée en fonction de ces données afin de calculer la taille de l'échantillon requise. Sinon, on peut préciser la taille de l'échantillon et la formule calculera la marge d'erreur.

Une fois la taille de l'échantillon déterminée, la prochaine étape porte sur l'actuelle sélection des dossiers à vérifier.

Recommandation et réponse de la direction

Recommandation 1

Que la trésorière municipale mène une vérification de la précision de la paie tous les trois ans. Comme il est mentionné dans le rapport, la taille de l'échantillon devrait être de 200 dossiers et une approche systématique de la sélection de l'échantillon devrait être utilisée.

Réponse de la direction

La direction est d'accord avec cette recommandation.

La première vérification sera terminée d'ici la fin du quatrième trimestre de 2012.

Conclusion

La taille de l'échantillon a été déterminée en fonction de plusieurs facteurs, comme il est décrit dans le présent rapport. Nous pensons qu'un échantillon de 200 dossiers de « dépôt direct » serait suffisant afin de tirer des conclusions valides sur la précision des calculs de la paie. Un échantillon de 200 aura une marge d'erreur de plus ou moins 4,2 points de pourcentage à un niveau de confiance de 95 %.

Nous recommandons une approche systématique de sélection de l'échantillon qui donnera un échantillon proportionnel au pourcentage de « dépôts directs » par sous-groupes d'employés comme il est défini par le système de paie SAP.

Une fois que la vérification aura été achevée, un examen des résultats sera nécessaire afin de confirmer la représentativité de l'échantillon, d'appliquer le facteur de pondération au besoin et de revalider la marge d'erreur en fonction du résultat réel de la vérification.

Remerciements

Nous tenons à remercier la direction pour la coopération et l'assistance accordées à l'équipe de vérification.

1 INTRODUCTION

The Determination of Sampling Requirements for Audits of Payroll Accuracy was added to the Auditor General's 2010 Audit Plan.

The purpose of this report is to provide a sample design framework to support the City in conducting periodic audits of payroll accuracy. This sample framework determines the sample size required to draw a statistically valid sample with a specified margin of error.

Different scenarios are presented for your consideration. The choice of the sample size is primarily a function of the margin of error you are willing to tolerate balanced by the level of effort required to conduct the audit. The methodology to perform the sample selection is also explained.

In addition, this report touches briefly on topics related to projecting the results to the entire population of employees.

2 SAMPLE SIZE DETERMINATION

A number of elements are required to determine the size of the sample that will lead to reliable results. Some of these elements are known while others are estimated. The key elements required to calculate the sample size are listed below. A detailed description is included in the following pages.

1. **Population (N):** This represents the unit of analysis. The number is generally known.
2. **Confidence Level (CI):** Determines how sure one can be that the sample selected is a true representation of the population. Two figures are commonly used; 95% and 99%.
3. **Margin of Error (MoE):** It is the plus-or-minus figure usually reported to indicate that results fall within a certain range. This can be specified in advance or generated based on a given sample size.
4. **Percentage (p):** This represents the percentage of sample that picks a particular answer. It is an estimated value.
5. **Sample Size (n):** This represents the number of records to select.

Based on these inputs a mathematical formula is used to calculate the required sample size. Alternatively, a sample size can be specified and the formula will calculate the margin of error.

2.1 Population (N)

The first step is to define and identify the population that is within the scope of the audit. For the purpose of this report the population is defined as the number of direct deposit payments made to employees. Based on 2009 estimates there were approximately 450,000 direct deposits made. Therefore the population figure used throughout in this report is N=450,000.

A key decision at this stage is to determine the inclusion and exclusion criteria to further define the population. For example a decision could be made to exclude certain groups such as Ottawa Police Service (OPS), Ottawa Public Library (OPL) and Elected Officials (EO) and their staff. This is the approach that was taken in the previous payroll calculation audit.

The mathematics of probability has demonstrated that the size of the population is irrelevant beyond a certain point. This means that if the population does fluctuate over the years or if certain occupational groups are excluded from the study, the optimal sample size to select would not be affected.

2.2 Confidence Level (CI)

The confidence level is expressed as a percentage, and represents how often the true percentage of the population lies within a specified range. (In this case the answer would be YES/NO to the question “Is the payroll calculation accurate?”)

A 95% confidence level means one can be 95% certain; the 99% confidence level means one can be 99% certain. The 95% confidence level is most commonly used. However, in certain situations where we are measuring the accuracy rather than an opinion 99% might be more appropriate. At a 99% confidence level a larger sample would need to be drawn to achieve the same margin of error.

CI	z-value
90%	1.65
91%	1.70
92%	1.75
93%	1.81
94%	1.88
95%	1.96
96%	2.06
97%	2.17
98%	2.33
99%	2.58

The theory behind the confidence level is based on the concept of a standard normal distribution. To use the confidence level in the mathematical formula, the confidence level must be converted to a Z-score by using a Z-score table.

2.3 Margin of Error (MoE)

The margin of error is the plus-or-minus figure usually reported. For example, if we choose a margin of error of 5 as being acceptable and 80% percent of the sample shows the payroll calculation as being accurate then we can say with certainty that if we had audited the full population between 75% (80-5) and 85% (80+5) of the calculations would have been accurate.

When we put the confidence level and the margin of error together, we can say that the accuracy rate of payroll calculations will be between the values of 75% and 85% 95% of the time (or 19 times out of 20).

Generally the margin of error decreases as the sample size increases, however the relationship is not linear and there are diminishing returns. At a certain level a large increase in the sample size has a marginal effect on the margin of error.

2.4 Percentage (p)

Typically, when determining the sample size needed for a given level of sampling accuracy one must use the worst case percentage (50%). This percentage is used to determine a general level of accuracy for a sample already defined.

For example if 99% of the sample selected turns out to be "Accurate" and 1% are "Inaccurate," the chances of error are remote, irrespective of the sample size. However, if the percentages are 51% and 49% respectively the chances of error are much greater. It is easier to be sure of extreme answers than ones in the middle.

Although using $p = 0.50$ to obtain a sample that is big enough to ensure precision is commonly used it doesn't prevent us from using a different estimate, especially when taking into account the results of the past audit. For the purpose of a Payroll Audit using $p = 0.90$ would be justifiable.

2.5 Sample Size (n)

The sample is essentially a subset of the population that will serve as the reference group for drawing inference about the full population.

Ideally the larger the sample size, the more certain we can be that the payroll calculations are accurate and that the findings reflect the population. However the cost and effort required to conduct the audit must be taken into consideration.

As stated earlier, for a given confidence level, the larger the sample size, the smaller the margin of error but doubling the sample size does not cut the margin of error in half.

2.6 Sample Calculation Formula

Generally, there are two ways to calculate the optimal sample size as shown below.

2.6.1 Sample size is unknown:

The objective is to determine the optimal sample size and requires assumption on the margin of error one is willing to tolerate i.e., 3%, 5%, 7% etc. The formula is:

$$n = \frac{z^2 \times p(1-p)}{moe^2}$$

2.6.2 Sample size chosen:

The objective is to estimate a potential sample size prior i.e., 100, 200 or 300 and to determine what the resulting margin of error will be. The formula is:

$$MOE = (1.96) \sqrt{\frac{p(1-p)}{n-1}}$$

In both formulas:

n = Required sample size

z = Confidence level at standard value (1.96 for 95%)

p = Estimated percentage (accuracy)

moe = Margin of error

2.7 Scenarios

The following tables present a comparison of two different scenarios based on a combination of several variables. The choice of a sample will ultimately depend on the level of effort you are willing to spend on conducting an audit. However, it is evident from the table that beyond 400 there is not much to be gained. Also it would be desirable to have a margin of error in the neighborhood of 4.

We recommend selecting a sample size of 200 records of direct deposits. Recommendation is highlighted in grey.

2.7.1 Scenario 1 – 95% CI & 90%

Sample Size	Confidence Level	Estimated Percentage	Margin of Error
100	95%	0.9	5.9
200	95%	0.9	4.2
300	95%	0.9	3.4
400	95%	0.9	2.9
500	95%	0.9	2.6
600	95%	0.9	2.4
1000	95%	0.9	1.9

2.7.2 Scenario 2 – 99% CI & 90%

Sample Size	Confidence Level	Estimated Percentage	Margin of Error
100	99%	0.9	7.8
200	99%	0.9	5.5
300	99%	0.9	4.5
400	99%	0.9	3.9
500	99%	0.9	3.5
600	99%	0.9	3.2
1000	99%	0.9	2.4

3 SAMPLE SELECTION

With the sample size determined (n=200), we now know the associated margin of error (+ or - 4.2) at the 95% confidence level. The next stage involves the actual selection of the records to be audited.

3.1 Representativeness of the Sample

Taking a true random sample of 200 records is based on the assumption that the population is homogeneous. Although the population is made up of all direct deposits from the City of Ottawa there are in reality several factors that should be considered when selecting the sample. For example, some employees are full time vs. part time, belong to different unions, etc.

Sampling bias occurs when records selected for a sample over-represent or under-represent the population attributes that are related to the characteristics of payroll calculations.

Ideally the population needs to be divided into subpopulations (strata) and random samples are taken of each stratum. Weights can be applied to the data to further adjust representativeness of the sample versus the population.

The proposed approach to sample selection is called systematic sampling.

3.2 Systematic Sampling

The target population (direct deposits) is sorted according to an ordering scheme. The cases to be pulled for audit are then selected at regular intervals through that ordered list.

Systematic sampling involves a random start and then proceeds with the selection of every nth record from that starting point. The nth record is obtained by taking the population size then dividing it by the sample size selected/obtained (N/n). For example in this case we would select every 2,250th record (450,000/200).

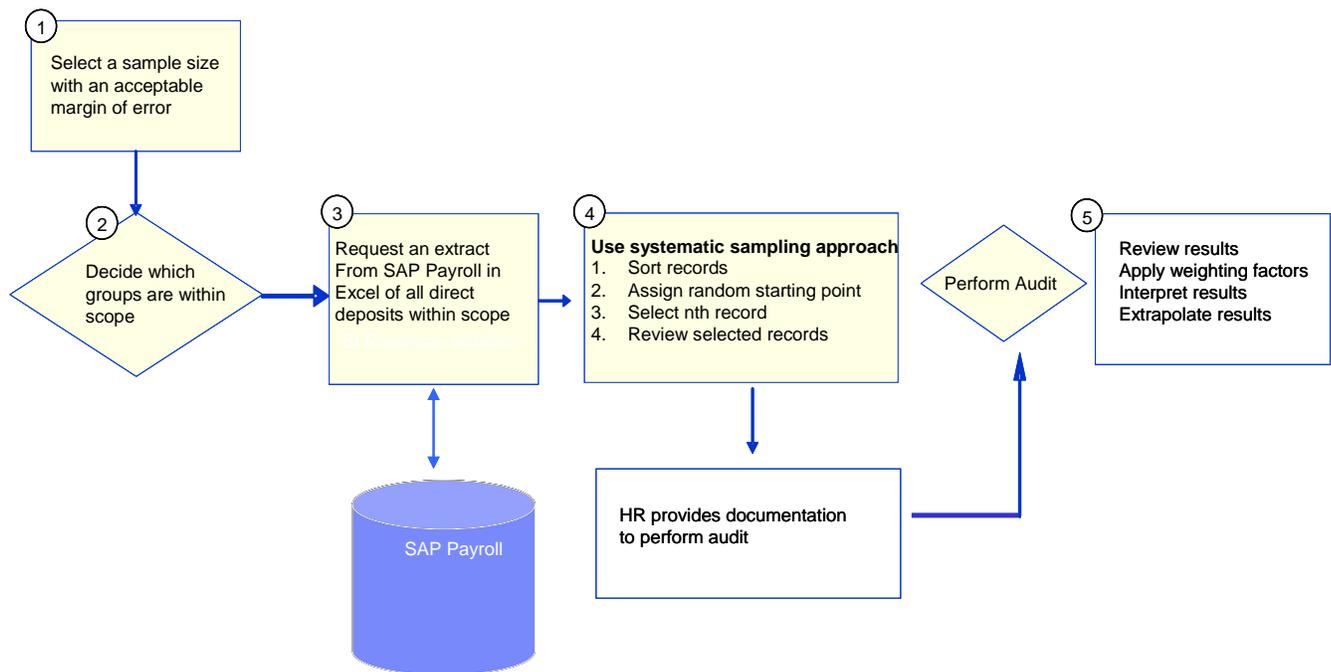
It is important that the starting point is randomly chosen and not the first in the list. A simple Microsoft Excel formula using the “rand” function can be used to determine the random starting point.

There should be a visual check of each record selected to ensure that the record is not an exception or a very uncommon occurrence. Although unlikely, a random selection process could pick a record that, based on its inherent characteristics, would simply not be an efficient use of resources if it were audited.

The benefits of this sampling approach is that it is easy to implement and especially useful for efficient sampling from large database of records. The stratification is achieved by sorting the records with the fields that are meaningful in differentiating between the various groups of employees.

3.3 Sample Selection

The following chart provides an illustrative view of the sample selection process.



3.3.1 Select a sample size

Scenarios in section 2.7 can be used or another sample size can be determined by using the formula to calculate the sample size.

3.3.2 Decide which groups are within scope

This is a management decision. Groups can be excluded without any impact on the sample size selection.

3.3.3 Request extract from SAP Payroll

For all records in scope an Excel file comprising of these fields should be provided at a minimum. This should provide enough information to select the sample and to trace it back to an individual record that can be audited

SAP Field Name	Description
Pers.No	Personnel number: unique system generated number that identifies the employee. It is created upon hire.
PYAreaIP	Payroll Area: defines the frequency with which an employee is paid and therefore used to group employees in the same payroll cycle. There are currently three payroll cycles, paid up to date, 15 days in arrears and 19 days in arrears.
InPeriod	Pay period in which the event occurred.
PA	Personnel Area: four digits number used to represent the various collective agreements or terms and conditions.
PersonnelAreaText	Personnel Area Text: describes the collective agreement/bargaining unit in text format.
Subarea	Personnel Subarea: represents further breakdowns of the collective agreements; to distinguish different terms and conditions.
P.subareatext	Personnel Sub Area Text: describes the Personnel Subarea in text format
E S	Employee Subgroup: defines the type of employee, i.e., full time continuous, full time temporary, part time continuous, part time temporary, casual, salary, wage.
NameofEEsubgroup	Name of Employee Subgroup: describes the Employee Subgroup in text format

3.3.4 Use systematic sampling approach.

We recommend extracting the data to an Excel spreadsheet; however other tools could achieve the same outcome.

The first step is to sort records in a systematic and logical manner. We would recommend using the *Employee Subgroup* as the primary sort field.

The following table presents the proportion of direct deposits by all Employee subgroups. The third column shows the expected number of records to be chosen by these subgroups.

Employee Subgroups	%	Sample
Continuous FT Salary	50.5%	100
Continuous FT Wage	21.5%	42
Continuous PT Salary	4.5%	10
Continuous PT Wage	12.8%	26
Other (Casual, Co-op Student, Councillors, Hourly, Mayor, Non-Reg Remuneration, Salary, Student, Sum Student Salary, Sum Student Wage, Temp FT Salary, Temp FT Wage, Temp PT Salary, Temp PT Wage)	10.7%	22
Total	100.0%	200

Percentages are from 2009. Categories are as they appear in SAP Payroll.

Secondary sort field would include:

- Pay runs (PYAreaIP) : C1/C8/O2
- Union (Personnel AreaText)
- Date (InPeriod)

The next step is to assign a random starting point using an Excel formula i.e., “RAND()*(450,000-1)+1”. Then the nth (2,250th) record within the sorted list would be selected.

Finally a check of the selected records is required to ensure that they do not represent a special case.

4 REVIEW OF THE RESULTS

Once the audit has been completed a review of results should be undertaken with a focus on how it relates to the overall population.

The systematic sampling should ensure proportional sampling is achieved but based the sample size selected and the nature of the findings some further review may be necessary to truly assess the representativeness of the sample.

Any unavoidable disproportionate representation can be compensated by applying a weighting scheme to the results.

It is the weighting of the data that will support the ultimate inference from the sample to the population of all direct deposits.

Each sample unit would be assigned a weight. Each weighting factor indicates how many direct deposits would, in theory, represent each of the audited records.

Recommendation 1:

That the City Treasurer conduct, every three years, an audit of payroll accuracy. As noted in the report, the sample size should be 200 records and a systematic sampling selection approach should be used.

Management Response:

Management agrees with this recommendation.

The first audit will be completed by the end of Q4 2012.

5 CONCLUSION

Sample size was determined by taking into consideration several factors as described in this report. We feel that a sample of 200 “direct deposit” records would be sufficient to draw valid conclusions on the accuracy of payroll calculations. A sample of 200 will have a margin of error of plus or minus 4.2 percentage points at a 95% confidence level.

We recommend a systematic sampling selection approach that will yield a sample that is proportional to the percentage “direct deposit” records by employee subgroups as defined by the SAP Payroll system.

Once the audit has been completed a review of the results will be necessary to confirm the representativeness of the sample, apply weighting factors if necessary and re-validate the margin of error based on the actual result of the audit.

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