Monitoring Claim Processing Duration Using Statistical Quality Control

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Abstract: ***Statistical quality control is an important tool used widely at service provision fields to monitor the overall operation. The significant application of the SPC analysis elements to the operation will make the process more reliable and stable. An important SPC tool is the control charts, which can be used to detect changes in production processes and service delivery with a statistical level of confidence. The study introduces the philosophy and types of control charts, design and performance issues, and provides a review of control chart application in monitoring. Primarily, Shewhart control charts have been described in monitoring clinical services performance, with examples found in duration in which cancer patients were served and infections rate of spreading. It has also been used in monitoring the process of data collection in epidemiologic studies. Most applications describe charting outcome variables, but more examples of control charts applied to input variables are needed. Production systems are the identification of the best statistical model for the common cause of variability, grouping of data, selection of type of control chart, the cost of false alarms and lack of signals and difficulty identifying the special causes when a change is signaled. Nevertheless, carefully constructed control charts are powerful methods in monitoring.***

Keywords: Statistical Quality Control, Control Charts, Claim Forms

1. Introduction

The National Social Security Fund (NSSF) is a friendly service organization which exists for public good. It offers social protection to all Kenyan workers. The NSSF register members, receive their contributions, manage funds of scheme, process and ultimately pay out benefits to eligible members or dependents within a certain period. The NSSF act no.45 of 2013 was assented to on 24th December 2013 and commenced on 10thJanuary 2014 thereby transforming NSSF from a provident fund to a pension scheme to which every Kenyan with income shall contribute a percentage of his/her gross earning so as to be guaranteed compensation of permanent disability, assistance to needy dependents in case of death and a monthly life pension, upon retirement. Thus the Act establishes two funds; pension fund and the provident fund to provide for contribution to and payments of benefits out funds.

The NSSF service charter provide a defined time frame for different claims that is; age benefit-15 days, emigration benefit-8 days, invalidity benefit-20 days, survivors benefit-28 days, withdrawal benefit-15 days and funeral grant-1 day. For claim to be processed to maturity it goes through many processes namely; receiving, capturing, checking, authorization and payment. The data is analyzed to provide information about the claims processing duration at NSSF and to provide information and illustrate procedures for the establishment of a quality control program that could be used by NSSF. Over the years many claims have been processed without reference to the actual duration as provided by the service charter. In theory it is possible to improve the service by narrowing down the claim processing duration, but if the processing duration as provided by the service charter is not observed then the provided claim duration by the charter is of little use, unless some means of control and regulation are exerted.

With the data on different claims duration, it is possible to develop a quality control program based on a thorough understanding of claim processing duration. Quality control uses measures in monitoring a process, SPC being most applied, SPC is a field of quality control that consist of collecting, analyzing and interpreting data, establishment standards and comparison of performance, deviation verification, to use in activities of improvement and quality control of product and services. It also involves inspecting a random sample of output from a process and deciding whether the process is producing products and services with characteristics that fall under a predetermined range. Other than SPC which is a statistical technique for measuring and improving the quality of processes, other techniques include; sampling plans, experimental design, variation reduction, process capability analysis and process improvement plan. The consistent, aggressive and committed use of SPC to bring all processes under control, recognize and eliminate special causes of variation and identify the capability of all operations is what makes it relevant in this case.SPC also prevent defects by applying statistical methods to control the process. The preferred method being use of control charts. SQC provides a means whereby NSSF can derive maximum benefit from controlling and adhering to the defined claim processing duration in the charter. This basic concept is applicable whether a claim takes short time or long time.

Inherent statistical analysis is the ability to make estimates of population parameters from sample statistics and to associate with these estimates of the probability of being in error. Using SQC procedures, a claim processing duration can be investigated to determine the range in values that one can expect under existing conditions. The information obtained can be used to judge whether the claims are capable of being processed and maturing within the predetermined time period as provided by the charter.

2. Review of Statistical Quality Control

2.1 Statistical Process Control

Statistical Quality Control (SQC) is the term used to describe the set of statistical tools used by quality professionals. SQC can be divided into three broad categories; descriptive statistics, statistical process control and acceptance sampling. Descriptive statistics are used to describe quality characteristics and relationships. They include statistics such as mean, standard deviation, the range and measure of the distribution of data. Statistical Process Control (SPC) involves inspecting a random sample of the output from a process and deciding whether the process is producing products or services with characteristics that fall within a predetermined range.SPC answers the question whether the process is functioning or not.

2.2 Quality Control Charts

A control chart is essentially a graphical display of a measured quality characteristic versus time. The standard assumption justifying the use of the control charts are that the in-control data are independent and normally distributed. (Montogomery, D.C, 2009) Indicates that even slight correlation between data points will adversely affect the performance of most control charts and increase the false alarm incidence rate. Typically, the two horizontal lines called upper control limit (UCL) and the lower control limit (LCL) are plotted on a control chart. If a process is in control, it is expected that nearly all the sample points will fall in a random pattern of points falling within the control limits. In practice, control chart's parameter is estimated using a series of observations or samples when the process is assumed to be in the in-control state. Then the constructed control chart is used to monitor the process and detect possible shifts in the process mean.

2.3 Use of SPC in Service Quality and Data Quality Assurance

Up to date, many researchers have noticed that the trend that service quality improvement has become a necessity in many industries. (Wyckoff, 1984) claimed that SPC is a good method for service managers to monitor service processes, and also helpful for staff to conduct self-improvement. (Palm et al, 1997) also pointed out that SPC would have great possibilities in service industries, such as health care and education, and has already proven to be useful in healthcare industry and service provision sectors. The adoption of SPC into service operations provides a huge opportunity for service quality improvement. However, there are also some obstacles to applying SPC in services such as what to measure and how to measure.

2.4 Use of Quality Control Charts in Non-Manufacturing

According to (Lloyds, 1988), SPC charts have also been applied to other non-manufacturing situations such as tracking stability of engineering measurement processes, examining errors in forecasting and economic modeling. In this manner, statistical process control aims faithfulness to the standards, provides the fitness of the specification that have been determined earlier. It is used to reduce the defected products as much as possible. Statistical process control is powerful collection of problem-solving tools useful in achieving process stability and improving capability through the reduction of variability.

2.5 Use of Quality Control Charts in Monitoring

In (Graham P.L. Mengersen, K. and Morton, A.P, 2003) Morton A.P of Qualsaf health care from Scotland in United Kingdom used SPC in monitoring clinical services performance. He used the control charts to analyze the data that he collected in duration in which patients with cancer were served. He used his findings to ensure that services provision was improved followed by reduction in time consumption and concluded that, SPC charts have potential to provide valuable insight into the impact of changes in structure of services. (J Benneyan, R. Loya and P. Pisek, 1998) Applied the use of SPC to monitor and control infections rate of spreading. They discovered that statistical approach to surveillance analysis is the key to determining occurrences of unexpected event in generic.

2.6 Use of Quality Control Charts in Progress Capability and Variability

For evaluation purposes, control charts have been used to evaluate changes or variations. (Larson and Pierce, 1994) Suggested that quality control charts could be most appropriate statistical tools to control methods of assessing changes. For that, they used SQC methods in assessing the soil quality and due to the same reason Moamenk and Zinck applied the same in assessing soil quality in semi-arid environment of south central Iran. In their research, they constructed histogram to analyze the variations in the data collected and charts to analyze soil organic carbon content bar chart to analyze the available content of phosphorus and soil density. They concluded that control charts can be used in conjunction with geo-statistics to map the spatial variation of land qualities. Control charts have been used in conjunction with other statistical techniques. These are the measures of process capability. According to Dr.W.E Dening capability is measured by the process capability indices CP and CPK, which is computed as the ratio of the specification width to the width of the process and is often used when the process is in control to check the capability of the actual process and performance of the process of duration analyzed.

3. Methodology

3.1 Control charts

Suppose that a quality characteristic is normally distributed with mean [illegible] and standard deviation σ, where both [illegible] and [illegible] are known, if $x_1, x_2, \dots, x_n$ is a sample of size n, then the average of this sample is

$$\underline{x} = \frac{x_1 + x_2 + \cdots + x_n}{n}$$

In practice μ and [illegible] are usually unknown. Therefore, they must be estimated from preliminary samples or subgroups taken when the process is thought to be in control. Suppose that *m* samples are available, each containing *n* observations on the quality characteristic. Typically, *n* will be small, often either 4,5, or 6. These small sample sizes usually result from construction of rational subgroups. Let $\underline{x}_1, \underline{x}_2, \ldots \underline{x}_m$ be the average of each sample. Then the best estimator of □, the process average, is the grand average

$$\bar{\bar{x}} = \frac{\underline{x}_1 + \underline{x}_2 + \cdots + \underline{x}_m}{m} \qquad 3.1$$

Let $R_1, R_2, \ldots, R_m$ be the ranges of the *m* samples. The average range is

$$\underline{R} = \frac{R_1 + R_2 + \cdots + R_m}{m} \qquad 3.2$$

The control limits for the $\underline{x}$ chart are;

$$\text{UCL} = \bar{\bar{x}} + A_2\underline{R}$$
$$\text{CL} = \bar{\bar{x}}$$
$$\text{LCL} = \bar{\bar{x}} - A_2\underline{R} \qquad 3.3$$

The control limits for the R charts are;

$$\text{UCL} = D_4\underline{R}$$
$$\text{CL} = \underline{R}$$
$$\text{LCL} = D_4\underline{R} \qquad 3.4$$

The values of A_2, D_3, D_4 are tabulated for various values of *n* in statistical tables.

3.2 estimating process capability

Histograms, probability plots, and process capability ratios summarizes the performance of the process. They do not necessarily display the potential capability of the process because they do not address the issue of statistical control, or show systematic patterns in the process output that, if eliminated would reduce the variability in the quality characteristics. Control charts are very effective in this regard. The control chart should be regarded as the primary technique of process capability analysis.

The estimate of C_p is the given by

$$\hat{C}_p = \frac{USL - LSL}{6\hat{\sigma}} \qquad 3.5$$

3.3 The Double Control Limits

3.3.1 Action and Warning limits for $\underline{x}$ chart

Let □ be the process average and □ be the process standard deviation. The Warning limits are constructed such that the chance is only 1 in 20 i.e. 5% that a sample mean will fall outside them.

If $\underline{x} \sim N\left(\mu, \frac{\sigma}{\sqrt{n}}\right)$, we have;

$\frac{k}{\frac{\sigma}{\sqrt{n}}} = 1.96$ from normal tables.

Hence

$$k = 1.96\,\frac{\sigma}{\sqrt{n}}$$

Therefore,

UWL= $\underline{X} + 1.96\,\frac{\sigma}{\sqrt{n}}$

$$\text{LWL} = \underline{x} - 1.96\,\frac{\sigma}{\sqrt{n}} \qquad 3.6$$

Assuming that $\underline{x} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$, we obtain from normal tables that $\frac{k}{\frac{\sigma}{\sqrt{n}}} = 3.09$ this implies that

$$k = \frac{3.09\sigma}{\sqrt{n}}$$

So the action limits are;

$$UAL_{\underline{x}} = \underline{x} + 3.09\frac{\sigma}{\sqrt{n}}$$
$$LAL_{\underline{x}} = \underline{x} - 3.09\frac{\sigma}{\sqrt{n}} \qquad 3.7$$

3.3.2 Action and Warning Limits for R-charts

Suppose that we define process variability to be under statistical control when $Pr[R > k] < 0.1\% = 0.001$

$$Pr[R < k] \geq 0.999$$

This inequality gives the UAL. Now

$$P[R < k] = Pr\left[\frac{R}{\sigma} < \frac{k}{\sigma}\right] \geq 0.999$$

Thus UAL is given by $\frac{k}{\sigma} = r_1$, where r_1 is 99.9% of $\frac{R}{\sigma}$

This implies that

$$k = r_1\sigma$$

therefore

$$UAL = r_1\sigma$$

□ is either specified by the management or is estimated from the sample values by $\hat{□} = \frac{R}{d_2}$.

The UWL is obtained similarly by considering the inequality

$$Pr[R > k] \leq 0.05$$
$$Pr[R < k] \geq 0.95$$
$$Pr\left[\frac{R}{\sigma} < \frac{k}{\sigma}\right] \geq 0.95$$
$$\frac{k}{\sigma} = r_0, k = r_0\sigma \qquad 3.8$$

Where r_0 is 95% value of $\frac{R}{\sigma}$, therefore; $UWL = r_0\sigma$. If □ is unknown then it is estimated by $\frac{R}{d_2}$.

The LAL and LWL are both taken to be zero.

3.4 Sampling Strategy

The method used was stratified sampling method. This is because there were different claim forms; withdrawal and age benefit, survivors' benefits, invalidity benefit, emigration benefit and funeral grant claim form. The research contained withdrawal and age benefit claim form in which were the commonest types of claim forms. In our study we included two strata which consisted of withdrawal and age benefit claim forms. This is because they were the most popular types of claims. In the first stratum we had withdrawal benefit claim forms and in the second age benefit claim forms.

Systematic sampling method was used to select claim forms from each month and included in the sample for each stratum (N_1) and (N_2). Proportionate technique was employed to determine the number of claim forms from each stratum to give the required sample size.

3.5 Sample Size Determination

The data which was used in this study was obtained from secondary sources. The time frame for processing claim was randomly picked from the target population then duration in days taken to full processing recorded. In the study, stratified sampling method was used and thus proportionate method was applied on the strata to obtain the sample size: The number of elements selected from stratum, n_i was given by the expression $n_i = n \times P_i$ where, $P_i = \frac{N_i}{N}$, $N_i$is the sizes of the stratum, N the total number of claim forms, n is the required sample.

4. Results and Analysis

4.1 Test of Normality

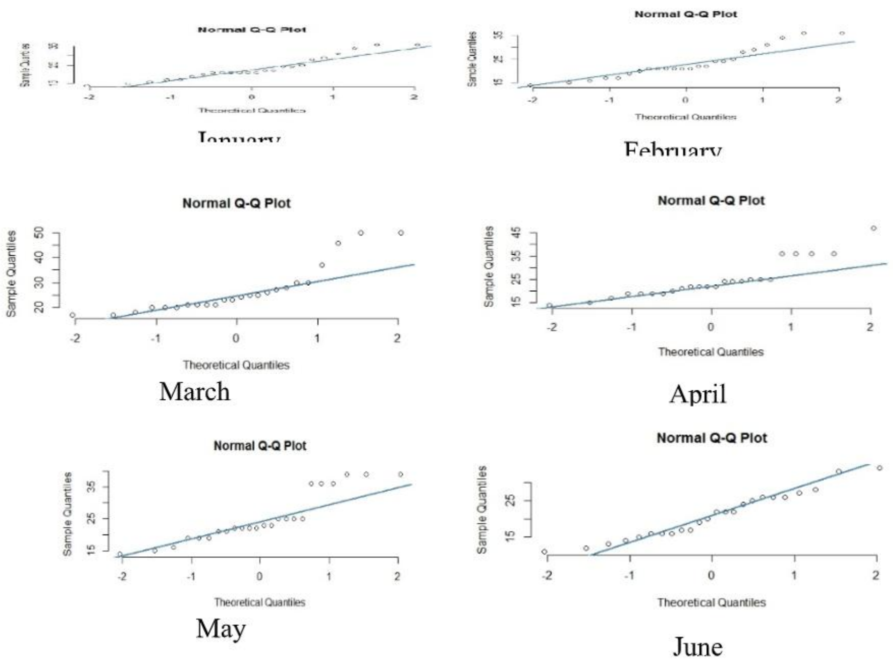

Figure 4.1: QQ plots for Age Benefit Claim Forms

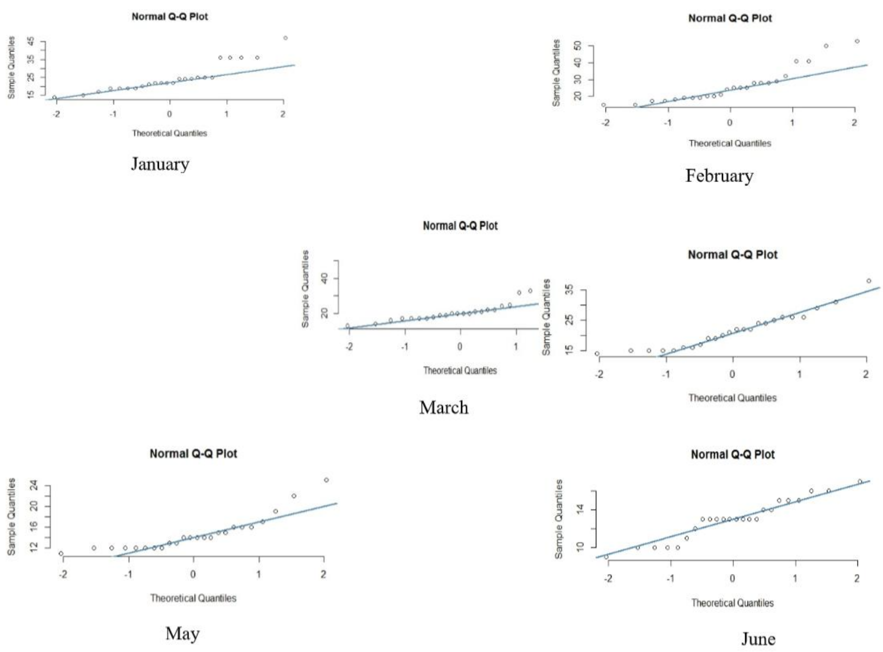

Figure 4.2: QQ plots for Withdrawal Benefit Claim Forms

For data to be assumed to be normal, its points must fall in a straight line, but from the figures above it is clear that most of the points do not lie in the line. Hence the data is non-normal.

4.2 Control Charts

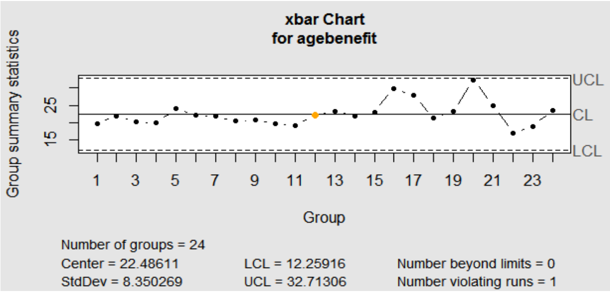

Figure 4.3: X-bar Chart for Age Benefit Claim Forms

From figure 4.3, it is evident that the process is in control. This is shown by all points lying between the control limits. It is evident that there is variability in the samples as different months take different values.

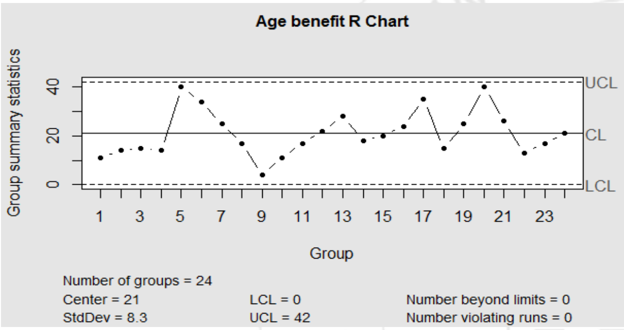

Figure 4.4: R Chart for Age Benefit Claim Forms

In figure 4.4 the plot shows that the process is in control because all the points lie within the specification limits. There is noticeable variation. In order to fully consider a process to be in control, for both X-Bar chart and R-Chart the points must not violate the control rules stated by the analysis. Therefore, the samples from Age Benefit Claim Forms are in control. In Both X-Bar chart and R-Chart, the process is stable because the data appear to be distributed randomly.

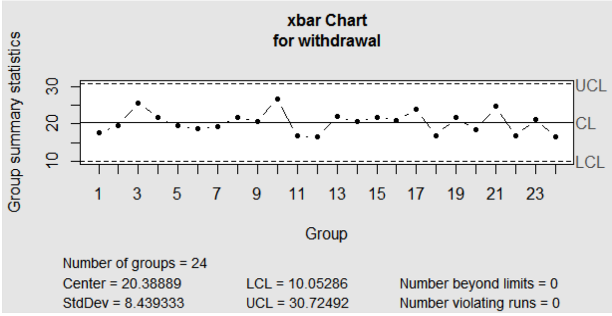

Figure 4.5: A X bar chart for Withdrawal benefit Claim forms

From Figure 4.5, the plot shows that the control process is not violated as is evident by all points lying inside the specification limits. Moreover, there is noticeable variation. In order to conclusively say that the process is in control there is need to draw R-Chart.

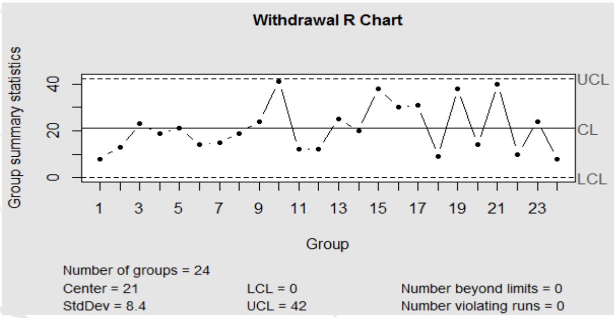

Figure 4.6: R Chart for Withdrawal Benefit Claim Forms

From Figure 4.6 which is showing the R-Chart, it is evident that the process is in control as all points lie within the specification limits. Also in this chart there is presence of Variation. In conclusion, the samples from Withdrawal Benefit Claim Forms are in control and variation is caused by common cause since the data appear to be randomly distributed hence the process is stable.

Generally, the claim processing duration at NSSF Eldoret is statistically stated as being in control. Meaning, even though there exist variations in the duration of the claim processing, the claim processing duration met the control limits stated by the analysis of the data. The process is then said to be in control and stable.

4.3 Control Charts with Double Control Limits

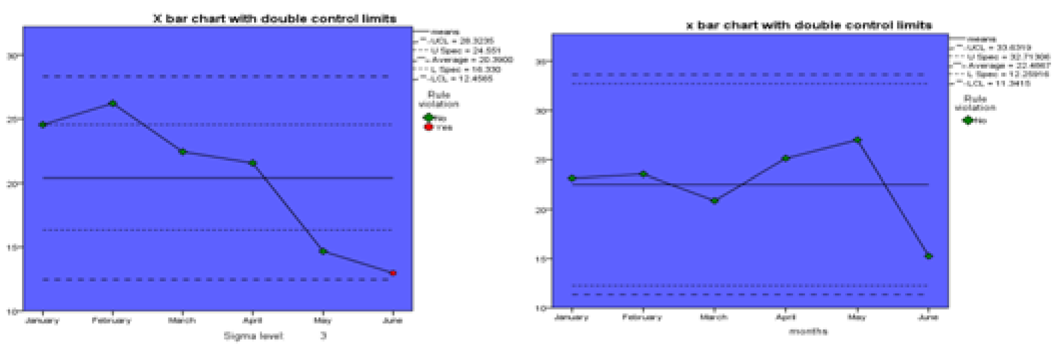

Figure 4.7: X bar charts with Double control limits for Age benefit and Withdrawal Benefit Claim Forms

From the above X-Bar chart, the samples from June have assignable causes of variation. If the sample lies between the warning (L spec &U spec) and action limit (UCL &LCL) there is evidence of assignable causes. However, if they fall outside the actions limits then the process has to be stopped and action should be taken to bring it to control.

In our case, the process is evident to be in control despite the few assignable causes of variation. This is because there is no sample falling outside the action limits.

4.4 Process Capability

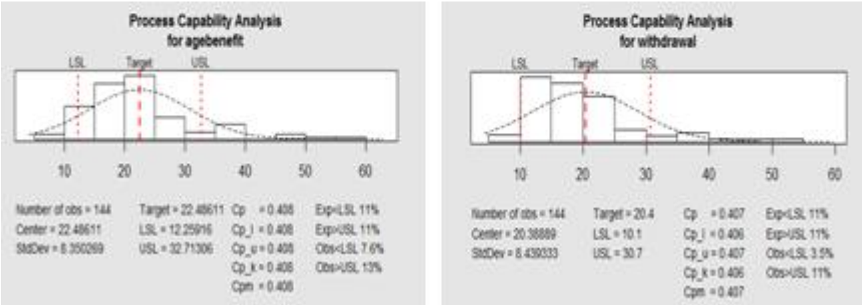

Figure 4.8: Process Capability Analysis for age benefit and Withdrawal Benefit Claim forms

From figure 4.8, the process capability is low since the dispersion in the distribution is high.

5. Conclusion and Recommendation

5.1 Conclusion

NSSF is a friendly service organization which exists for public good. NSSF Eldoret covers the whole of Uasin Gishu County and is a very important service delivery unit; therefore customer needs should be considered and satisfied. It is against this background that this study was carried out to monitor the claim processing duration using statistical quality control methods.

The analysis of the data showed that the claim processing duration of the withdrawal and age benefit claim forms are within the control limits. Control charts with double control limits were subsequently constructed to increase sensitivity and it also showed that the claim processing duration are within the specification limits. Generally, claim processing duration at NSSF Eldoret follows the requirements in the customer service charter.

The X bar chart was identified to be a suitable control chart to depict variations in claim processing duration. The variations are caused by common causes and are predictable and correctable with less effort. When variations are ignored they can easily be inherited in claim processing.

The study also revealed that the process capability is low which may affect the claim processing duration in future. The information is vital for raising the level of awareness among the stakeholders.

The study is useful in setting priorities when improving on customer service delivery. In conclusion, NHIF, insurance agencies, other service delivery units and the main stakeholder (NSSF) would find this research very beneficial.

5.2 Recommendation

Even though the claim processing duration at NSSF Eldoret is in control that is it follows the requirements in the customer service charter, there is also need to improve the process performance of the claim processing duration to make the process more capable. The management together with the staff and its clients should work towards the same.

The management should ensure more human labour in the department of claims so as to speed the initial stages of claim processing as most of the time the forms processing is slowed at the initial stages.

Secondly, as human labour is being increased at the claim processing department, more desk tops should be purchased so that at least each operator has to work on the claim received as well as automate the data capturing screen to help minimize errors in capturing details of clients presented in the form. Wrong capturing of such information is only detected at the authorization stage and always makes the claim forms be rejected back to initial stages, a factor that leads to longer duration in processing of the claims when the final stage is arrived at.

The last issue that should be taken into account is adoption of sophisticated software that can enable clients to access claim forms online and guide them on how to fill it so as to avoid mistakes.

The study made recommendations that further research should be done concerning risk mitigation, resource accountability and learning processes on operational efficiency of NSSF Eldoret since it affects claim processing.

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