**Audit Data Analytics**

**Significant Changes in Spending Behaviours**

1. **Changes by Service Area**

Via the graphs of the service areas in Part 2, we can observe seasonality and several erratic movements in quarterly transaction counts and averages in certain service areas.

While we can observe spikes visually, for automatic consistent detection of spikes, I set a high threshold of 50% for QoQ change in total sum of transaction amounts (total payment volume). This threshold can be adjusted, depending on our needs.

**Spikes**

Service areas and quarters that experienced QoQ changes beyond 50% of the total payment volume of the prior quarter are auto detected and listed below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Service Area | Quarter | transaction\_count | average\_amount | total\_amount | quarterly\_change |
| Adults and Communities | 2015Q4 | 19 | 159.95 | 3,039.03 | 86% |
| Adults and Communities | 2016Q3 | 12 | 34.54 | 414.43 | -89% |
| Assurance | 2015Q2 | 52 | 56.96 | 2,962.10 | 4292% |
| Assurance | 2016Q1 | 29 | 29.29 | 849.28 | -60% |
| Assurance | 2016Q2 | 60 | 158.50 | 9,510.24 | 1020% |
| Assurance | 2016Q3 | 29 | -18.38 | -532.89 | -106% |
| Children's Education & Skills | 2016Q2 | 5 | 95.18 | 475.88 | -94% |
| Children's Education & Skills | 2016Q3 | 4 | 29.55 | 118.18 | -75% |
| Children's Service DSG | 2014Q4 | 32 | 162.93 | 5,213.69 | 71% |
| Children's Service DSG | 2015Q3 | 20 | 138.82 | 2,776.49 | 80% |
| Children's Service DSG | 2015Q4 | 59 | 76.79 | 4,530.62 | 63% |
| Childrens Services | 2014Q3 | 331 | 72.50 | 23,999.07 | -64% |
| Childrens Services | 2014Q4 | 20 | 63.21 | 1,264.11 | -95% |
| Commissioning | 2015Q1 | 29 | 178.95 | 5,189.44 | 51% |
| Commissioning | 2015Q4 | 40 | 215.07 | 8,602.64 | 153% |
| Commissioning | 2016Q3 | 11 | 225.96 | 2,485.54 | -66% |
| Customer Support Group | 2015Q1 | 14 | 1,350.07 | 18,900.97 | 252% |
| Customer Support Group | 2015Q2 | 11 | 3,148.73 | 34,636.00 | 83% |
| Customer Support Group | 2016Q2 | 10 | 2,898.88 | 28,988.78 | 76% |
| Customer Support Group | 2016Q3 | 6 | 1,995.33 | 11,972.00 | -59% |
| Deputy Chief Operating Officer | 2014Q4 | 24 | 35.37 | 848.91 | -51% |
| Governance | 2014Q3 | 3 | 392.32 | 1,176.96 | -91% |
| Governance | 2014Q4 | 1 | 53.94 | 53.94 | -95% |
| Internal Audit & CAFT | 2014Q3 | 7 | 27.56 | 192.95 | -53% |
| NSCSO | 2014Q3 | 2 | 222.75 | 445.50 | 4355% |
| Parking & Infrastructure | 2015Q1 | 1 | 28.43 | 28.43 | -69% |
| Parking & Infrastructure | 2015Q4 | 1 | 159.67 | 159.67 | 462% |
| Parking & Infrastructure | 2016Q2 | 1 | 500.00 | 500.00 | 213% |
| Public Health | 2016Q2 | 1 | 4.55 | 4.55 | -294% |
| Regional Enterprise | 2015Q4 | 1 | 1,645.00 | 1,645.00 | 2642% |
| Regional Enterprise | 2016Q1 | 1 | 60.00 | 60.00 | -96% |
| Regional Enterprise | 2016Q3 | 2 | 56.00 | 112.00 | 87% |
| Street Scene | 2014Q4 | 12 | 110.96 | 1,331.55 | 133% |
| Streetscene | 2015Q1 | 37 | 149.97 | 5,548.83 | 167% |
| Streetscene | 2015Q3 | 72 | 202.90 | 14,608.48 | 421% |
| Streetscene | 2015Q4 | 36 | 149.74 | 5,390.81 | -63% |
| Streetscene | 2016Q2 | 37 | 241.34 | 8,929.61 | 77% |

**Permanent Increases**

Regarding permanent increases, I use the 4-quarter rolling average of total payment volumes. Service areas and quarters whose total payment volumes are 20% higher than the 4-quarter rolling average can be considered witnessing permanent increases. The threshold of 20% can also be adjusted, depending on our needs. Below are the service areas and quarters when permanent increases are noted.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Service Area | Quarter | transaction\_count | total\_amount | average\_amount | rolling\_avg |
| Adults and Communities | 2015Q4 | 19 | 3,039.03 | 159.95 | 1,970.04 |
| Adults and Communities | 2016Q2 | 25 | 3,659.22 | 146.37 | 2,700.66 |
| Assurance | 2015Q3 | 39 | 2,262.28 | 58.01 | 1,349.29 |
| Assurance | 2016Q2 | 60 | 9,510.24 | 158.50 | 3,682.95 |
| Children's Family Services | 2015Q3 | 748 | 6,547.95 | 75.60 | 43,226.06 |
| Children's Service DSG | 2015Q4 | 59 | 4,530.62 | 76.79 | 2,970.27 |
| Children's Service DSG | 2016Q1 | 31 | 4,457.30 | 143.78 | 3,326.92 |
| Commissioning | 2015Q4 | 40 | 8,602.64 | 215.07 | 4,992.56 |
| Commissioning | 2016Q1 | 62 | 8,434.73 | 136.04 | 5,803.88 |
| Customer Support Group | 2016Q2 | 10 | 28,988.78 | 2,898.88 | 19,451.45 |
| Parking & Infrastructure | 2016Q2 | 1 | 500.00 | 500.00 | 195.23 |
| Streetscene | 2015Q3 | 72 | 14,608.48 | 202.90 | 6,259.32 |

1. **Changes by GL Account**

Applying similar logic on GL accounts, I have auto-detected spikes and permanent increases.

Please see the list of 147 spikes attached herein.



Please see attached the list of 45 permanent increases noted.



Stay tuned for the next parts of behavioural clustering and anomaly detection.