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Dynamic Forecasting in Emergency Communications: A Modern Approach to Aligning Staffing with Real Demand

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Abstract

Emergency communication centres face unique operational pressures when staffing models fail to reflect true call demand. Traditional static staffing assumes uniform workload across time, yet emergency call patterns fluctuate daily, weekly, monthly, and seasonally. At Calgary 911 (C911), these mismatches resulted in inefficiencies, heightened employee strain, and unpredictable service levels. In response, C911 implemented a dynamic forecasting system built on complementary long-term and short-term predictive models. These forecasts feed into Erlang C calculations and are refined further with operational constraints, producing accurate, actionable staffing requirements. This article explores the development and implementation of this system, highlighting insights gained, lessons learned, and the operational advantages of data-driven staffing. The approach demonstrates how modern forecasting strengthens emergency communication operations and improves the alignment between workload and workforce.

Introduction

Emergency communication centres exist at the heart of public safety systems. Their work is immediate, unpredictable, and essential. A sudden surge in calls can mean the difference between smooth response and delayed service during moments of crisis. Despite this reality, many centres, including Calgary 911, historically relied on static staffing models. Static staffing models assume that a single staffing baseline applied throughout the year would adequately provide coverage for every hour of every day throughout each season. At C911, it became clear that this assumption did not reflect operational reality.

Daily rhythms, weekend differences, seasonal cycles, and large-scale events all create shifting call patterns. Overnight call volumes are often far lower than daytime volumes. Weekends behave differently than weekdays. Summer months consistently bring heavier demands than winter months. Even more importantly, certain periods—such as New Year's Eve, severe weather events, or shifts in technology—trigger unpredictable spikes that require immediate operational adaptation.

It became clear that to protect both service levels and employee wellbeing, C911 needed a staffing approach driven by real demand rather than long-standing assumptions. The constant tension between perceived and reported staffing adequacy underscored a deeper need: a clear, data-driven understanding of workload. Without such insight, even well-designed schedules risked misalignment.

A desire to reimagine and innovate propelled the centre toward modern forecasting approaches. Recognizing the limitations of static models, Calgary 911 set out to build a dynamic system that could forecast demand, adapt to change, and translate predictions into meaningful staffing outputs.

Understanding Why Static Staffing Falls Short

Analysis of historical call volumes revealed a pattern of systematic variation. Calls tapered off during the early morning hours and increased dramatically during daytime peaks. Weekend traffic consistently differed from weekday traffic, reflecting distinct community activity patterns. Seasonal differences were even more pronounced; winter months produced fewer calls overall, while summer months—driven in part by the Calgary Stampede and increased outdoor activity—produced heavy, sustained surges.

These variations are often easily visible in retrospective data, but they are not reflected in static staffing models. A single baseline number that is expected to cover all circumstances will result in predictable inefficiencies. During low-demand periods, a centre will be overstaffed, an expensive mismatch during times of workforce strain and miss opportunities for intentional continuous training or other staff-focused initiatives. During

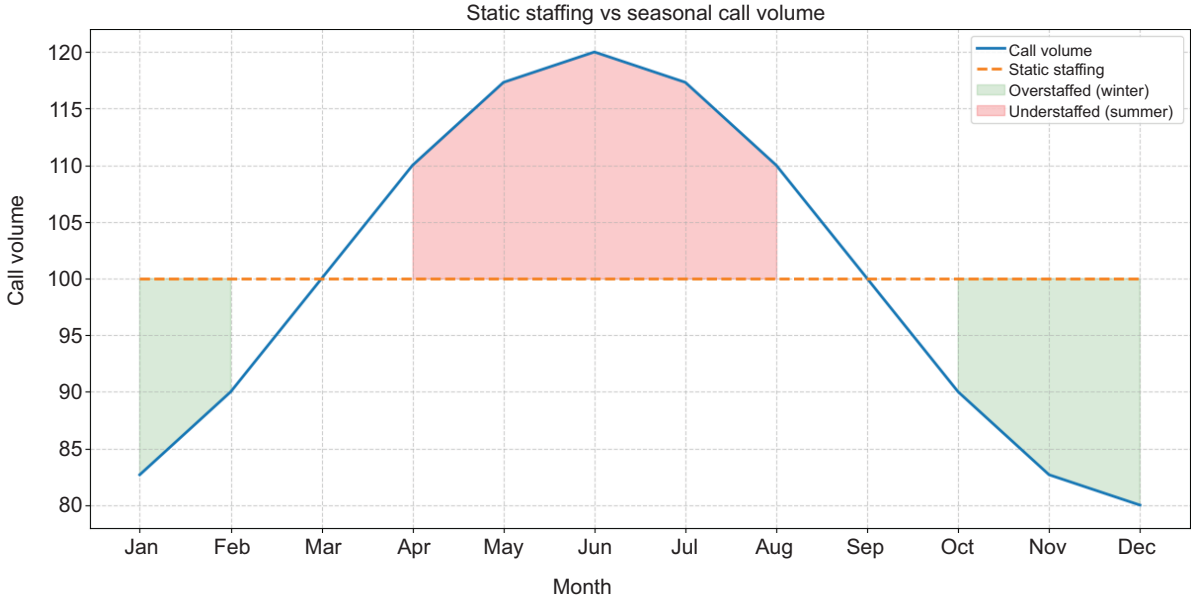

Figure 1. Seasonal and daily variation in call volume.

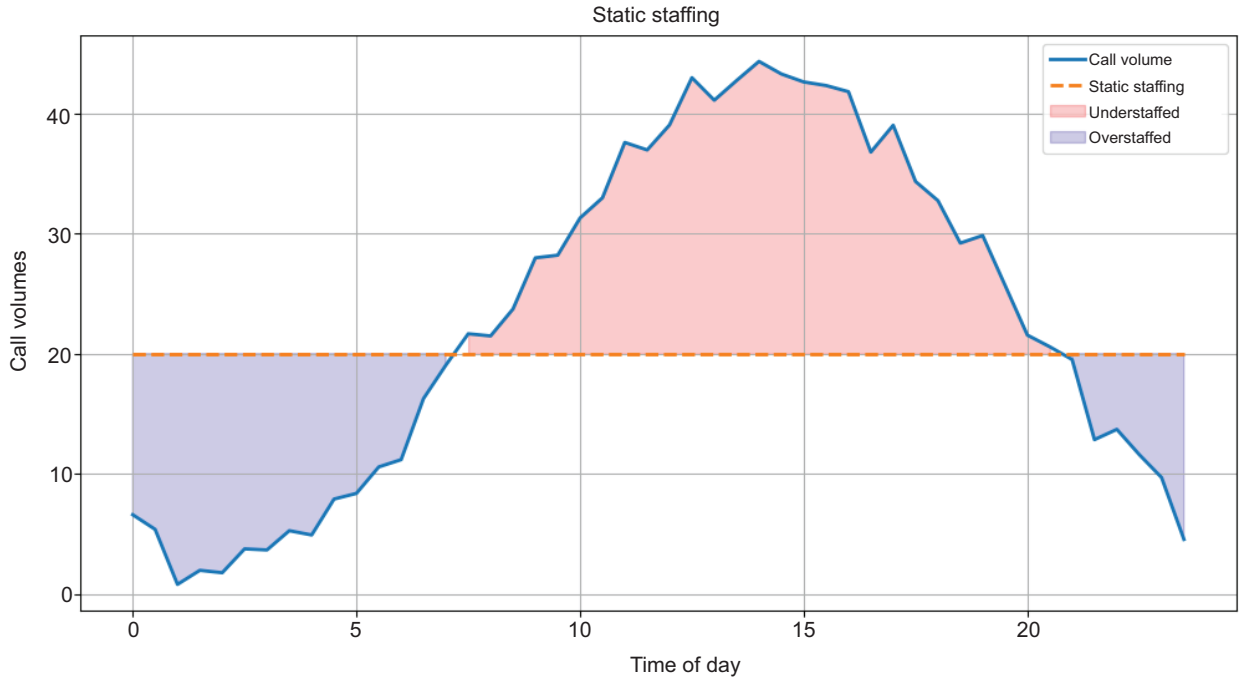

Figure 2. Integration of long-term and short-term forecasting models.

high-demand periods, staffing levels lag behind workload, forcing difficult trade-offs between speed, quality, and employee strain.

These situations also affect morale. During periods of elevated call volume, staff feel pressure and fatigue, particularly when staffing reports imply conditions should be manageable. Conversely, during quieter intervals, staff sometimes experience long stretches of low activity, a different kind of operational inefficiency. These inconsistencies pointed to a common cause: the need for staffing that aligns with what the work actually requires.

Developing a Dynamic Forecasting Framework

From the outset, it was clear that no single predictive model could meet the centre's operational needs. Long-term planning requires steady, reliable projections, while operational scheduling requires highly responsive, frequently updated information. These separate needs led to a dual-model forecasting strategy.

Long-Term Forecasting for Strategic Planning

The long-term forecast, built on statistical time-series models, captures gradual patterns in call volume across months and years. This model supports strategic decisions, including budget planning, hiring cycles, training class sizes, and long-range workforce strategies. Its stability and interpretability were essential, providing leaders with reliable insight into future trends.

Short-Term Forecasting for Operational Agility

By contrast, the short-term forecast is built using machine learning models designed to react quickly to evolving patterns. These models incorporate recent call data, weather events, holidays, and known upcoming events, and routinely achieves 80 percent accuracy at the half-hour level. Their

purpose is pragmatic: to guide scheduling decisions and inform daily resource deployment.

Together, the long-term and short-term forecasts create a flexible forecasting ecosystem that adapts to both predictable and unpredictable changes.

Translating Forecasts into Staffing: The Role of Erlang C

Forecasted call volumes must be translated into actionable staffing requirements. For this purpose, Calgary 911 uses the Erlang C model, a classical queuing theory tool widely used in emergency and commercial call centres.

Erlang C integrates three key variables

1. Expected call arrivals in each interval. In emergency call centers call volumes are highly variable and are driven by real-time events. There is limited ability to reduce staffing without impacting service. Conversely in non-emergency or commercial call centres there are many avenues to reduce call volumes, call back options, alternative contact methods, or redirecting low priority calls. Reducing peak call arrivals, even slightly, can significantly reduce the number of agents required.

2. Average handling time (AHT). AHT is often constrained by procedural and regulatory requirements, leaving emergency contact centres with limited room for reduction. However, a streamlined workflow, improved scripts, and integrated decision support can help shorten the AHT. Non-emergency call centres again have more flexibility to reduce AHT through optimizations in processes or encouraging self-service options. Small reductions in AHT can dramatically reduce staffing needs in Erlang C because the system is sensitive to handling time changes.

3. Target service level. High service level targets in emergency call centres are non-negotiable; dropping the target even slightly is often not an option. Staffing must remain sufficient to meet the performance goals under all expected demand scenarios. Non-emergency call centre service targets can sometimes be adjusted. Whether it be a general reduction or a reduction during peak times, staffing levels can be reduced while still maintaining an acceptable customer experience.

Agents	Agents (no shrinkage applied)	Service level	Occupancy
8	7	14.6%	95.2%
9	8	48.5%	83.3%
10	9	70.4%	74.1%
11.5	10	83.9%	66.7%
12.5	11	91.7%	60.6%
13.5	12	96%	55.6%
15	12	98.2%	51.3%
16	12	99.2%	47.6%
17	12	99.7%	44.4%

Figure 3. Erlang C comparison of short- and long-duration call scenarios.

Erlang C calculates the minimum required number of agents to meet the defined target service level. One of the most import characteristics of Erlang C is its nonlinearity, even small increases in call volume or average handling time can produce disproportionately large increases in the required staffing levels. This behavior is especially relevant in emergency communication environments, where service levels must remain consistently high. Because performance deteriorates quickly when demand rises even slightly, staffing must closely track fluctuations in workload rather than rely on a single baseline number.

From Interval Staffing to FTE Requirements

Erlang C provides interval-based staffing requirements but turning those into annual full-time equivalent (FTE) numbers requires additional steps. These include:

- Converting interval staffing into total workload hours.

- Dividing workload hours by productive hours per employee.

- Applying the shift relief factor (SRF), which accounts for leave, absence, training, and 24/7 coverage requirements.

The shift relief factor accounts for the fact that agents are not available to handle calls for the entire scheduled period. Time away from direct work, due to breaks, meetings, training, or time away from work in general due to sick leave or vacation. The shift relief factor can be applied to the number of agents calculated by Erlang C to ensure enough staff are scheduled to maintain service levels. Essentially, the SRF inflates the raw staffing requirement to better reflect real world availability and ensure continuous coverage.

Maintaining a single continuously staffed position 24/7 365 days requires approximately six to seven employees once all operational realities are considered.

Operationalizing the Forecast: Dashboards and Decision Support

To bring the forecasting system into daily operations, Calgary 911 developed scheduler-facing dashboards that visualize predicted call volume alongside scheduled staffing. Schedulers can instantly identify periods of under- or over-coverage and adjust accordingly. Because the short-term model updates frequently, the displayed information is always current.

This approach fosters consistency and ensures the entire organization—from operations to leadership—works from the same source of truth.

Benefits and Organizational Impacts

The transition to dynamic forecasting has produced significant improvements across Calgary 911.

It has increased scheduling accuracy, informed budgeting, and enhanced evidence-based decision-making. The forecasting system also allows leaders to model hypothetical scenarios, such as changes to AHT, shifts in service level targets, improved wellness strategies, call diversion programs, or adjustments in utilization expectations.

Conclusion

Calgary 911's evolution from static staffing to dynamic forecasting represents a major advancement in emergency communication operations. By integrating predictive analytics, queuing theory, and practical workforce planning, the centre created a responsive, resilient staffing strategy aligned with real demand. This data-driven approach strengthens service reliability, supports employee wellbeing, and provides a forward-looking model for emergency centres across North America and beyond.