Examining the Impact of Traffic on Shot Attempts in Ice Hockey: NHL Regular Season and Playoffs

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Abstract

In ice hockey, traffic in front of the net during a shot attempt (skaters in or near the area between the puck and the posts) may impact the shot outcome. In some cases, traffic may impede the goaltender's ability to see the puck, possibly increasing the probability of a goal. In other cases, traffic may prevent the puck from even reaching the goal. In this paper, we use puck and player tracking data from the National Hockey League to determine the number of skaters creating traffic and examine the relationship between traffic and shot outcomes.

Keywords: ice hockey, analytics, traffic, shot attempts, NHL

1 Introduction

Shot quality in ice hockey is influenced by many factors including distance, angle, and preceding events [22] [19] [24]. One often-discussed but less precisely quantified factor is *traffic*, which we define as the presence of skaters in or near the *shooting lane*: a triangular area between the puck and the posts ("near" is defined precisely in Section 4). Traffic is widely believed to be a key factor in scoring chances but its effects are nuanced and to this point have not been studied in detail. In this paper, using puck and player tracking (PPT) data from the National Hockey League (NHL), we examine the impact of traffic on shot outcomes.

In our initial exploration of traffic and its relationship to shot outcomes for this paper, we observed that traffic levels were strongly correlated with shot location. Specifically, when grouping shot attempts by traffic level (N) and computing average distance and angle within each group, we found a strong positive correlation between N and shot distance ($r = 0.94$) and a moderate negative correlation between N and shot angle ($r = -0.64$). This indicates that shot attempts with more traffic tend to be taken from farther away and towards the center of the ice. Because traffic is correlated with shot location, any attempt to measure the impact of traffic must first control for the confounding effects of shot location. To do this, we group similar shot attempts together by dividing the offensive zone into regions based on distance and angle, as shown in Figure 1 (see Section 5 for details on how these regions are defined). We then examine how traffic impacts shot outcomes within each region.

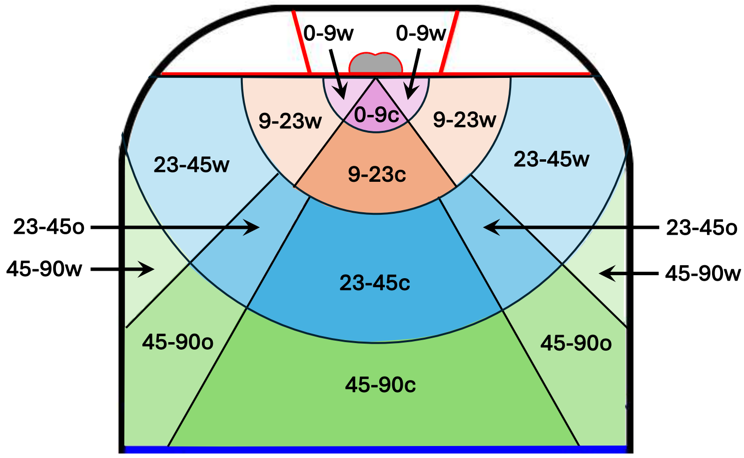

Fig. 1 Shot location regions used to control for distance and angle in traffic analysis.

Each region is labelled with their distance range in feet and their orientation: "c" represents center-angle shot attempts, "o" represents off-center shot attempts (which are only included in the larger distance regions), and "w" represents wide-angle shot attempts. Figure 2 shows the relationship between traffic and goals for each region, illustrating the number of goals (y-axis) by traffic level within each of ten distance-angle regions (x-axis), ordered by distance and then angle. This figure highlights how analyzing traffic can reveal new insights about shot attempts. For example, in all close-range regions (within 23 ft), the number of goals scored with no traffic exceeds the combined total of goals scored with traffic. While this figure doesn't show how many shot attempts are in each traffic-region group (we explore that in Section 6), it provides a preview of the types of patterns we examine.

One reason for the high number of goals from close range may be the limits of human reaction time. Prior research suggests that the fastest male humans have an average reaction time of 0.22 seconds [4], which means a 70 mph shot attempt would need to be at least 23 feet away for the goaltender to react in time. Across all regions, the highest number of goals occurs

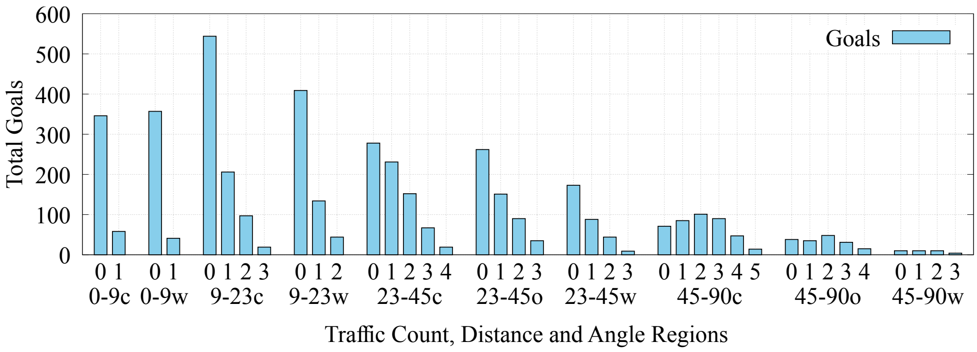

Fig. 2 Goals scored across traffic levels and location regions.

in the 9–23c region with zero traffic. For long-range shot attempts (23+ ft), the relationship becomes more nuanced. Section 6 explores this further, including the impact of traffic based on whether it is dominated by attacking or defending skaters.

Before we can analyze the impact of traffic, we must first reliably detect and augment each shot attempt, including determining its start and end time and using a single location per player to identify who is creating traffic. Based on this work, we offer two methodological contributions for analysts working with PPT data:

- We develop a process to combine shot attempts with precise timestamps by matching official NHL shot data to PPT data. This process uses an inference algorithm to recover shot attempts not originally identified in the PPT data, and augmenting for tips, deflections and timing inaccuracies.
- We create an algorithm that divides the offensive zone into regions that minimize within-region variation in distance and angle, allowing us to study the impact of traffic independently from distance and angle.

For NHL front office staff, coaches, players, and fans, our analysis offers several empirical findings that provide insight into how traffic affects shot outcomes:

- We find that for all regions, increased levels of traffic significantly increases the percentage of shot attempts that are blocked and reduces the chance of a shot attempt resulting in a shot on goal or a goal.
- For long-range shot attempts (45-90 ft), 38% of shot attempts are blocked, compared to 29% for all shot attempts in our dataset. However, among long-range shots on goal, higher levels of traffic are associated with an increased likelihood of a goal.
- For mid-range shot attempts (23-45 ft), when there are more defenders than attackers in the shooting lane, shot attempts that reach the goaltender are significantly more likely to result in goals, suggesting that defensive traffic may unintentionally screen the goaltender or deflect shot attempts in the shooter's favor.

2 Related Work

Traffic Research in Football (Soccer): Traffic-related research in football provides relevant context for this paper. For example, a 2015 study using tracking data from a professional football league (via Prozone, now Stats Perform [23]), found that defender presence in the shooting lane significantly reduced goal likelihood [11]. However, its contribution to the predictive model used in the paper was limited, suggesting that its effect may be confounded by factors like shot location. A 2016 study computed *dangerousity*, the probability of a goal during possession, for 64 Bundesliga games (2014/15). As an input to their model, they proposed a more detailed traffic metric, *shot density*, which incorporates not only the number of players in the lane but also their proximity to the shooter and whether they are attackers or defenders [10]. While the authors did not isolate the effect of shot density in their model of dangerousity, the study provides a valuable framework for analyzing player presence and placement in traffic. However, we currently do not focus on specific placement within the shooting lane as we recognize that different positions in the shooting lane in ice hockey have varying impacts such as being close to the shooter potentially increasing the chance of blocking the shot attempt, while being near the goaltender may enhance the likelihood of obsructing the goaltender's view. These studies highlight how to account for the number and type of players in traffic. However, ice hockey poses unique challenges not present in football, such as faster puck and player movement, the difficulty of tracking and blocking a small, fast-moving puck, a higher degree of physical contact, and a smaller, enclosed playing surface. These factors underscore the necessity for tailored approaches to fully understand how traffic influences shot outcomes in ice hockey.

Related work in football has also examined how defender positioning can unintentionally impair goalkeeping performance. Using virtual reality to simulate free-kick scenarios, López-Valenciano *et al.* [12] found that defensive walls, though intended to reduce scoring, can actually hinder a goalkeeper's reaction by occluding their view of the ball. This raises an interesting parallel for ice hockey, where skaters in the shooting lane may likewise reduce goaltender effectiveness by unintentionally obstructing the goaltender's view, a possibility we explore later in our analysis.

Traffic-Related Research in Ice Hockey: A common proxy for traffic in ice hockey is the use of shot types typically associated with traffic such as *tips* and *deflections* [1]. Tips occur when a puck traveling towards the net is redirected via the stick with the goal of changing the puck's direction while not adding momentum to the puck. Deflections occur when a puck traveling towards the net is redirected via the body or skates. While these shot types can signal the presence of traffic, they offer only an indirect measure of its broader impact. One study analyzing NHL power plays during the 2015–16 season took a more expansive approach by manually identifying *screens* through video review, defining them as shot attempts where the goaltender's view was obstructed [15]. The study found that screened shot attempts made up 24.9% of total shot attempts and 21.3% of goals. Although this manual approach enables detailed insights, it lacks scalability and is difficult to evaluate as no comparable data points exist in league-wide datasets. More recently, the NHL introduced an "Opportunity Analysis" model designed to evaluate the quality and context of each shot attempt [2]. This model incorporates variables such as player positioning, shot type, and game situation, as well as counts of attacking and defending skaters within fixed distances of the shot cone (the area between the puck and the net), as well as a flag for "Possible Goalie Vision Block". However, the model's outputs are not available on a per-shot basis and the impact of these traffic-related variables are not reported, making it difficult to assess their influence on shot outcomes.

3 Determining Shot Timing and Duration

In this section, we describe our process for identifying and augmenting shot attempts, and then determining a shot start and end time in which to determine traffic.

3.1 Identifying Shot Attempts

Each official shot attempt is available from the NHL via their Application Programming Interface (API) [13], but this data is only recorded in whole second granularity using scoreboard time. In contrast, PPT data provides locations every hundredth of a second. Since the puck can travel about 103 feet per second (for a 70 mph shot), the coarse resolution of scoreboard time is insufficient for aligning tracking data with shot attempts. As such, we construct our shot dataset using a combination of *detected shot attempts* based on the NHL's physics-based shot event model applied to PPT data, and *inferred shot attempts* which we derive from puck touch data, which represents the NHL's effort to determine every instance of a player making contact with the puck.

Detected Shot Attempts: The NHL detects shot attempts using the PPT data and an automated, physics-based event classification algorithm that identifies when a player directs the puck toward the net. Detection is extremely difficult and consequently, errors may occur such as passes being misclassified as shot attempts. To improve accuracy, the NHL incorporates a manual shot reviewing process where human reviewers verify and correct PPT shot event data. Unfortunately, even after manual review, discrepancies remain where an official shot attempt is not recognized by the shot detection system or where attributes such as the shooter or shot location differ between sources. To address this, we compare the PPT data with the official NHL API data and infer the timing of undetected shot attempts using puck touch data, as described in the following section.

Inferred Shot Attempts: We identify the timestamps (or release times) of undetected shot attempts in the PPT data by comparing NHL API data and puck touch data. From the NHL API data, we can obtain the scoreboard time, shooter, and shot outcome. To match it with a puck touch, we implemented a matching algorithm, adapted from a method originally developed by the NHL's Research and Development team [14]. This algorithm attempts to match official shot attempts and puck touches by considering the touch's timing, location, and the puck's incoming and outgoing direction and velocity.

3.2 Augmenting Shot Attempts

Potential Start Time Inaccuracies: After these steps, we obtain a dataset of shot attempts with estimated release timestamps. Some timestamps originate from the NHL's physics-based shot detection model, while others are derived from the end of a puck touch. In an attempt to verify and possible improve shot release times, we use techniques from previous work on pass and shot timing corrections [17]. Specifically, we verify that the puck is within four feet of the shooter's location at the moment of release. If not, we adjust the timestamp, which is required for 20.8% of all shot attempts.

Handling Compound Shot Attempts: Tips and deflections occur when a player redirects an incoming puck with their stick, skates, or body. We refer to both the initial play action and the tip or deflection as a *compound shot attempt*. The player who tipped or deflected the puck is credited as the shooter, so the initial play action is not officially recorded as a shot attempt. However, we are interested in the initial play action as the tip or deflection is usually the result of traffic, and the initial play action reflects the traffic leading to the tip or deflection. Thus, we replace tipped and deflected shot attempts with their corresponding initial play actions. First, we identify shot attempts with type "tip" or "deflection" in the NHL API data. For each of these shot attempts, we trace the event back to the initial play action by finding the last recorded puck touch by a teammate of the player who tipped or deflected the shot attempt. We then calculate traffic based on the initial play action while preserving the final shot outcome (e.g., goal, save, block, or miss).

3.3 Results of the Shot Identification and Augmentation Process

In this section, we analyze data from 891 NHL games played during the 2024-25 season, up to February 9, 2024 (the in-season scheduling break for the 4 Nations Face-Off). Later, in Section 8, we repeat this process for that season's playoffs (the 2025 playoffs) and compare the results. We define a shot attempt as *matched* if it is either detected by the NHL's shot classification algorithm or inferred from puck touch data. After excluding games where fewer than 50% of official shot attempts were matched, 870 games remain in our dataset. Across these games, there were 103,948 official shot attempts, with a total of 80,473 detected shot attempts, 12,887 inferred shot attempts, and 10,588 shot attempts for which we were unable to determine a timestamp. The remaining 870 games in our dataset had at least 75% of the official shot attempts matched, and more than half of the games have 90% or more matched. We examined the unmatched shot attempts, but missing data (e.g., location) limited analysis. Table 1 summarizes the shot-matching results.

Table 1 Summary of shot identification and matching process for 870 regular season games in dataset.

Matching Stage	Shot Count	Percentage
Total official shot attempts in dataset, after removal of some games	103,948	100.0%
Matched via NHL shot event data ("detected shot attempts")	80,473	77.4%
Matched via puck touch data ("inferred shot attempts")	12,887	12.4%
Total matched shot attempts (with PPT data)	**93,360**	**89.8%**
Unmatched shot attempts (no PPT timestamp available)	10,588	10.2%

3.4 Shot Duration Considerations

We now turn to the question of whether or not a window of time should be used when determining traffic and if so, how to determine an appropriate window. Capturing traffic only at the exact moment of the shot release may miss skaters who obstruct the shot attempt later in its trajectory or skaters seen by the shooter or goaltender just prior to the shot attempt. Consider Figure 3 which presents three screenshots from the broadcast of a shot attempt during the Utah Hockey Club versus Chicago Blackhawks game on October 8, 2024. In the top picture, Utah player #22 (Jack McBain) is positioned in front of the goaltender. As Utah player

#11 (Dylan Guenther) prepares to shoot, McBain likely obstructs the goaltender's view of the puck and Guenther's shooting lane. By the time the shot attempt is released in the middle picture, McBain has moved out of the shooting lane. There appears to be little traffic, aside from the two players near the left post. In the bottom picture, Chicago player #8 Ryan Donato, whose body was not in the shooting lane at the time of the shot release, blocks the shot attempt. Although Donato's stick may appear to be in the shooting lane in the middle picture, we are unable to capture it as each player's location is tracked using a single LED embedded in the sweater, as detailed in the next section. This example, along with many others like it, highlights the need to consider measuring traffic over a window of time rather than just at the moment of release.

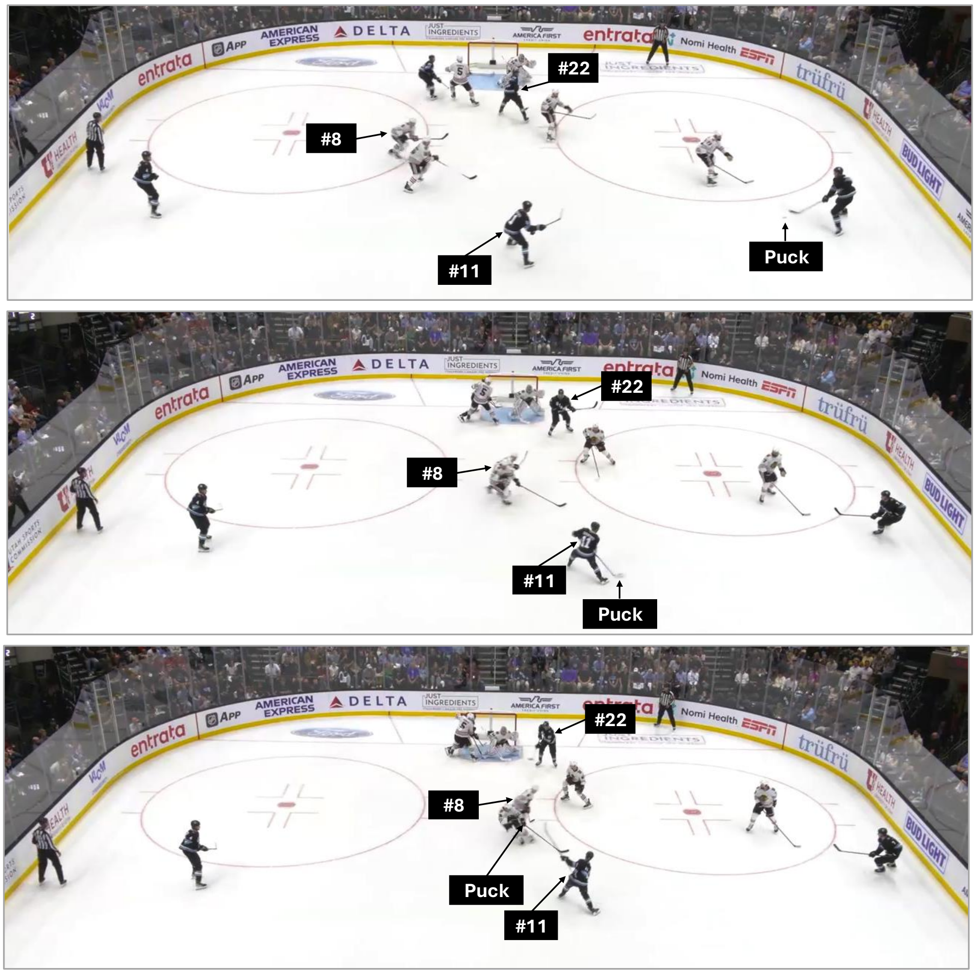

Fig. 3 Sequence of screenshots showing traffic before, during, and after a shot attempt. The top and middle frames are 29 broadcast frames apart (≈ 0.48 s) and the middle and bottom are 14 frames apart (≈ 0.23 s). Utah vs. Chicago, October 8, 2024.

Given these observations, we define two time windows around each shot attempt: a *pre-release window* which captures the shot wind-up and decision-making phase and a *post-release window* approximating the shot attempt duration. Our video review of sample shot attempts suggests that 0.5 seconds reasonably approximates the time required to release a puck, as well as for the duration of a shot attempt. However, even a short post-release window (e.g., 0.1 seconds) often included post-shot events such as rebounds which are unrelated to the initial attempt. For this reason, for the analysis in this paper, we use only a 0.5-second pre-release window and omit the post-release window. This approach also best reflects the information available to the shooter at the time of the shot attempt which is ideal for shooter analysis and shot prediction models.

Selecting a suitable approach for a shot duration window is challenging as different choices carry tradeoffs that may impact the results. We explore the impact of these considerations in Section 7. Although we find that different choices may yield slight variations in specific results, the overall trends remain consistent.

4 Defining and Calculating Traffic

Once we have determined the time window in which to measure traffic for each shot attempt, the next challenge is identifying whether skaters are in or near the shooting lane during the shot window using their location data. Each player wears a single light-emitting infrared diode (LED) positioned in their sweater between the top of their back and right shoulder, as illustrated in Figure 4. Because this is the only tracked point on the player, we are unable to determine the position of their limbs or stick. To account for this, we introduce a buffer around the shooting lane to define the broader *traffic lane*, which represents skaters that may be obstructing the shot attempt even if their LED is not directly within the shooting lane.

Fig. 4 LED embedded in a player's jersey.

Figure 5 illustrates a power-play goal by Ottawa player #18 (Tim Stützle) at 5:52 of the 1st period in Ottawa's game against Florida on October 10, 2024. The left image shows the game broadcast at the time of the shot, while the right image shows a frame from an animation we produced. The shooting lane is highlighted in blue, and the traffic lane is defined as the combined area of the blue triangle and adjacent green rectangles. Skaters detected within the traffic lane are shown in red. The goaltender is not shown as we ignore them in traffic calculations.

Fig. 5 Traffic lane analysis for a goal scored during the Florida Panthers vs. Ottawa Senators game on October 10, 2024. The yellow skater is the shooter, red skaters are in the traffic lane, and all blue skaters are outside of the traffic lane.

After examining a sample of shot attempts, we found that placing rectangles two feet outside the shooting lane reasonably matched our visual assessments of traffic. Typically, if a skater's LED is within two feet of the shooting lane, they are likely obstructing the shot attempt with their body. Conversely, if a skater's LED is not within this range, they are unlikely to significantly impact the shot attempt, though exceptions do occur. Similar to the shot duration window, we recognize the potential variability in results based on the chosen buffer size (green rectangle). To address the variability, we perform a sensitivity analysis in Section 7 where we repeat our computations with different buffer sizes. That section illustrates that while the magnitude of impact depends on the assumptions made, the trends remain the same.

5 Dividing the Offensive Zone into Regions

As shown in our initial analysis (Section 1), traffic levels are strongly correlated with shot location. To accurately evaluate the impact of traffic on shot outcomes independently from shot distance and angle, we group similar shot attempts together. To do this, we start by dividing the offensive zone into ten regions based on shot distance and angle. We chose ten regions because we wanted a large enough number of regions to have a limited range of distance and angle within each region while keeping the number of regions small enough so that they could be represented graphically in a meaningful way. We analyzed the impact of the number of regions and found that while the quantitative results may change, the qualitative results still stand.

To define the regions, we implemented an algorithm that minimizes within-region variation in shot distance and angle. The goal is for shot attempts within each region to have similar distances and angles but vary in traffic. Shot attempts taken from below the goal line or outside the offensive zone are excluded from this analysis. Distance and angle variation within each region are defined below. 90 degrees is used as the denominator for angle as it represents the maximum possible shot angle deviation, while the maximum distance within each region normalizes variation relative to the range within each region.

$$\text{Distance Variation} = \frac{\max(\text{avg distance}) - \min(\text{avg distance})}{\max(\text{avg distance})} \quad (1)$$

$$\text{Angle Variation} = \frac{\max(\text{avg angle}) - \min(\text{avg angle})}{90} \quad (2)$$

To minimize variation in shooting location within each region, the algorithm evaluates all combinations formed using four distance regions and either two or three angle regions per distance region for a total of 10 regions. Specifically, the two closest distance regions are divided into two angle segments, while the two farthest are divided into three, resulting in a total of 4,088,304 combinations. For each combination, we compute the variation in distance and angle within each region using the formulas above. We then sum the distance and angle variation for each region and evaluate each combination based on the highest such sum among its regions. The ideal set of regions is the one that minimizes this maximum within-region variation. This approach ensures that no single region has disproportionately high spatial variance which could otherwise confound the effects of traffic with those of shot location.

Resulting Regions: Unless otherwise specified, all numeric ranges in the rest of the paper are expressed with exclusive lower bounds and inclusive upper bounds (e.g., 9–23 refers to (9-23]). We omit brackets and parentheses for readability. The resulting regions shown in Figure 1 separate the shot attempts into four distance ranges: 0-9, 9-23, 23-45, and 45-90 feet. The two smaller-distance ranges are further divided into two angle ranges: center (0-37° of the meridian line) or wide (37-90°). The two larger-distance ranges are divided into three angle ranges: center (0-29° of meridian), off-center (29-45°), and wide (45-90°). Across all regions, the maximum distance variation of any region was 12% of the maximum distance in each region, and the maximum angle variation was 6% of 90°. We note that this approach assumes that the traffic lane is symmetric for the left and right sides of the net. Factors such as goaltender and player handedness may introduce asymmetries in how traffic forms. While we do not explicitly account for these possibilities, they represent an area for future exploration.

6 Results: Traffic Versus Shot Attempt Outcomes

In Figure 6, the x-axis represents each of the ten distance-angle regions, ordered by distance (smallest to largest) and then by angle (center to wide). Within each region, shot attempts are grouped by traffic. We refer to each of these bars as a traffic-region group. The y-axis shows the percentage of all shot attempts that result in one of four outcomes: goals (Goal%), shots on goal that are saved by the goaltender (Saved%), blocked shot attempts (Blocked%), and missed shot attempts (Missed%). Unlike the traditional save percentage (SV%) metric, which is used to track goaltenders' saves as a percentage of the shots on goal they face, Saved% here denotes saves among all shot attempts. Goal% (blue) and Saved% (green) together form the shots on goal (SOG) percentage. The rightmost group, labeled "All SA", aggregates all shot attempts (SA) across regions for comparison. To ensure meaningful statistical comparisons, we exclude any traffic-region group that has less than 100 shots on goal.

To assess whether the patterns observed in our results are statistically significant, we apply two types of tests. When analyzing ordered traffic levels (e.g., 0, 1, 2, 3 players) against a

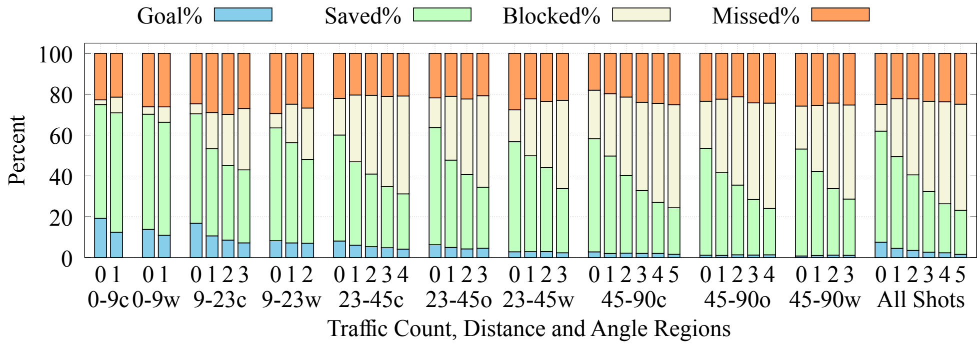

Fig. 6 Shot outcome distributions across traffic levels and location regions.

binary outcome such as Goal vs. No Goal, we apply the Cochran-Armitage trend test [5] [3]. This test evaluates linear trends across the ordered groups. For comparisons between two traffic groups (e.g., attacking versus defending), we use the chi-squared test [16], which compares two independent proportions. Throughout our analysis, we report only results that are statistically significant ($p < 0.05$) or moderately significant ($p < 0.1$). In tables, statistically significant results are marked with an asterisk (*) and moderately significant results with a dagger (†). Given the number of statistical tests performed, false discoveries are a concern [18]. However, the consistency of results across regions and outcomes lends support to the broader patterns we observe.

Traffic versus the percentage of shot attempts that miss the net (Missed%): To our surprise, the percentage of shot attempts that miss the net (Missed%) remains fairly constant across regions and traffic levels, showing that players' frequency of missing the net is not strongly affected by location or traffic. The overall Missed% is 22.4%, varying by only 1.5% across traffic levels and 2.5% across locations (values are the coefficients of variation). The only traffic-region groups where Missed% deviates noticeably are zero-traffic shot attempts in the 9-23w and 23-45w regions. We believe that this may be due to these being common one-timer locations where players take quick shot attempts from sharp angles, slightly increasing the possibility of missing the net.

Traffic versus the percentage of shot attempts that are blocked (Blocked%): The percentage of shot attempts that are blocked (Blocked%) increases with traffic, particularly for mid-to-long range shot attempts ($p < 0.05$ for all traffic-region groups). Notably, 29% of all shot attempts in our dataset are blocked and 91% of those blocked shot attempts are by players on the defending team. 29% is a remarkably high proportion, especially given the modern trend toward fewer total shot attempts as teams prioritize puck possession and higher-quality scoring chances [7]. This finding has important implications for shot prediction or expected goal (xG) models, which are now widely used in ice hockey analytics [22] [19] [24] [20] [9]. Most public xG models either exclude blocked shot attempts entirely or include them in limited ways because the NHL does not release shot location data for blocked attempts. As a result, *nearly one-third of all shot attempts are often ignored in these models*, which may limit their completeness and accuracy. In future work it would be interesting to study whether including blocked shot attempts in xG models would increase their accuracy.

Interestingly, a notable number of shot attempts with zero recorded traffic are blocked. This might seem counterintuitive but can be explained by the limitations of traffic detection. Many shot attempts are blocked by sticks rather than bodies, or by players stepping into the traffic lane during the shot attempt's flight. Capturing all such instances as traffic would require larger buffer and window sizes which could result in including players who do not meaningfully affect the shot attempt. We investigate the impact of different choices for buffer size and time window duration in Section 7.

Traffic versus the percentage of shot attempts that result in a shot on goal (SOG%) and goal (Goal%): As shown in Figure 6, the percentage of shot attempts that are on goal (SOG%) declines as traffic increases ($p < 0.05$ for all traffic-region groups), indicating that traffic reliably reduces the likelihood of a shot attempt reaching the goaltender. Notably, the percentage of shot attempts that result in a goal (Goal%) is highest for shot attempts from the 0-9c and 9-23c regions when there is no traffic. For NHL front office staff, coaches and players, this highlights the value of prioritizing shot attempts in these traffic-region groups. In general, while Goal% also tends to decrease as traffic increases, this trend is only statistically significant in regions 0-9c, 0-9w, and 9-23c. Because traffic makes it hard to get a shot on goal, very few goals are scored in high-traffic situations, making it difficult to assess how traffic affects scoring itself. To better understand this, we focus next on Goal% of SOG, which captures whether traffic helps or hurts once a shot attempt reaches the goalie, more directly reflecting the possible effects of tips, deflections, and screens. Note that Goal% of SOG corresponds to what the NHL has historically referred to as "shooting percentage", though we use the term Goal% of SOG as it more clearly describes the metric.

Traffic versus the percentage of shots on goal that result in a goal (Goal% of SOG): To better understand the quality of shot attempts that are on goal, we examine the proportion of shots on goal that result in a goal (Goal% of SOG). Figure 7 presents these results with 95% confidence intervals. In Table 2, we summarize the direction of the trend in Goal% of SOG as traffic increases for each region. To provide context for interpreting these values, Figure 8 shows the total number of shot attempts in each traffic-region group, which helps explain the width of the confidence intervals.

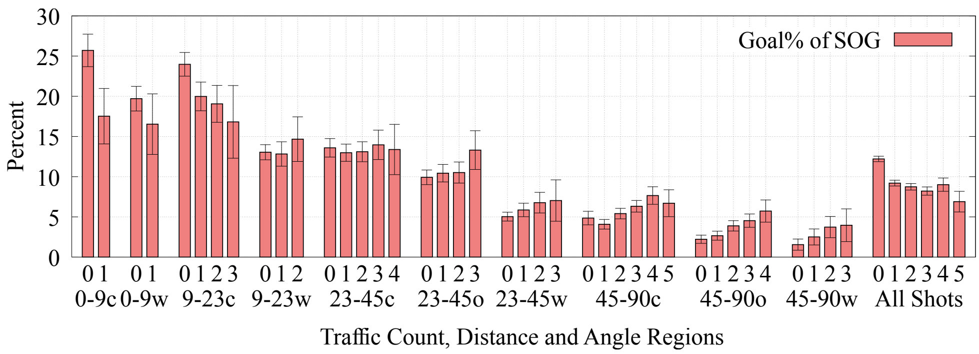

Fig. 7 Goal% of SOG across traffic levels and location regions with 95% confidence intervals.

Table 2 Trend and p-value of Goal% of SOG across traffic levels for each region. Only regions with significant ($p < 0.05$) or moderately significant ($p < 0.1$) trends are shown. * indicates statistical significance, † indicates moderate significance. ↑ indicates an increasing trend and ↓ indicates a decreasing trend.

0-9c	9-23c	45-90c	45-90o	45-90w
(↓) 0.01*	(↓) 0.04*	(↑) 0.01*	(↑) 0.01*	(↑) 0.05†

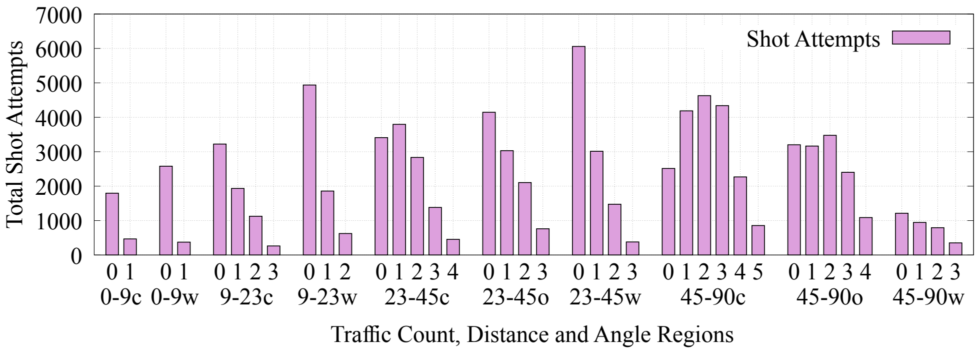

Fig. 8 Total shot attempts across traffic levels and location regions.

We focus on regions with significant or moderately significant trends. In the 0-9c and 9-23c regions, Goal% of SOG decreases as traffic increases, suggesting a decline in shot quality. This means that even when shot attempts from these regions reach the goaltender, they are less likely to result in goals if there is traffic. Teams may benefit from avoiding taking heavily contested shot attempts in these regions, instead seeking ways to create or move into space to shoot with minimal traffic at a similar location. In contrast, for long-range shot attempts (45+ feet), Goal% of SOG increases with traffic. This indicates that while traffic reduces the chance of the shot attempt reaching the goaltender, it improves scoring success when it does, possibly due to tips, deflections or screens. This highlights a strategic tradeoff: for long-range shot attempts, traffic reduces total shot attempt success but increases the probability of scoring for the shot attempts that do reach the goaltender. As a result, teams may benefit from deliberately placing traffic in front of the net for long-range attempts, accepting fewer total shots on goal in exchange for more dangerous ones.

6.1 Attacking Versus Defending Traffic

We next analyze how the balance of attacking versus defending players affects shot outcomes. A heavy defensive presence could lead to more blocked shot attempts and fewer goals, while a strong offensive presence might create tips, deflections, screens, and more goals. However, the opposite could also be true as defensive players may screen their own goalie and offensive players might inadvertantly block shot attempts. One possible approach would be to analyze each unique combination of attacking and defending players in traffic. However, this quickly results in a large number of categories (e.g., 2 attackers and 1 defender, 3 defenders and 0 attackers, etc.), many of which are rare and thus yield unreliable comparisons. Instead, in Figure 9, we categorize shot attempts in each region into three groups: (1) more attacking than defending traffic (A), (2) more defending than attacking traffic (D), and (3) equal attacking and defending traffic (E). This figure and subsection aim to highlight differences between attacking and defending traffic rather than the overall magnitude of traffic. Consequently, shot attempts with one attacking player are treated the same as those with two or three attacking players, and shot attempts with zero traffic are excluded from this analysis.

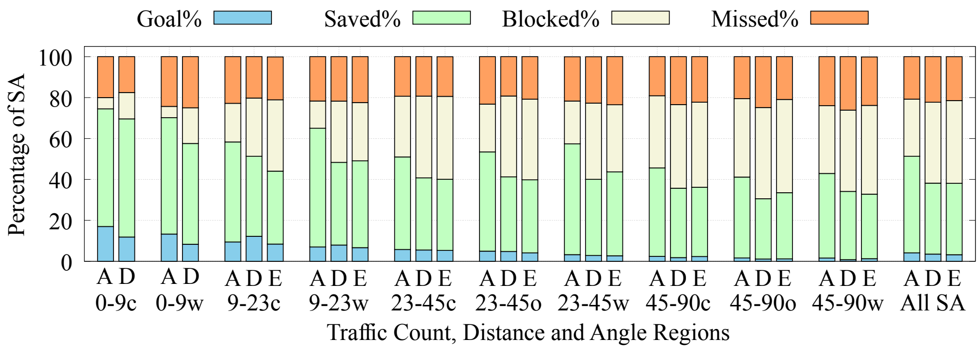

Fig. 9 Shot outcome distributions for attacking versus defending traffic.

For each region, when defending traffic exceeds attacking traffic (D), SOG% is lower and Blocked% is higher compared to when the reverse is true (A) ($p < 0.05$ for all traffic-region groups). This is expected as defenders are typically positioned to block shot attempts whereas attackers aim to tip, deflect, or screen shot attempts. However, the effect on goal scoring is less straightforward. Similar to the previous section, to investigate this, we focus on the proportion of shots on goal that result in goals (Goal% of SOG). This allows us to evaluate whether offensive or defensive traffic is more beneficial (or harmful) to scoring in each region. Results are shown in Table 3.

In all mid-range regions (9–45 ft), shot attempts with more defending traffic (D) have a higher Goal% of SOG (shooting percentage) than those with more attacking traffic (A) ($p < 0.1$ for all four traffic-region groups). This may be because defenders unintentionally screen their goalie or redirect the puck in unpredictable ways. For coaches, this highlights the risk in collapsing defenders to attempt to block mid range shot attempts as defensive traffic may sometimes impair the goalitender more than it helps. The optimal defensive approach may vary by shot location: limiting mid-range screens while emphasizing blocks on both short-range and long-range attempts.

Table 3 Effect of traffic balance on Goal% of SOG for each region. Each cell reports the p-value from a chi-squared test comparing shot attempts with more defending traffic (D) to those with more attacking traffic (A), testing whether D has a significantly higher Goal% of SOG. Only regions with statistically ($p < 0.05$) or moderately significant ($p < 0.1$) differences are shown. * denotes statistical significance, † denotes moderate significance.

9-23c	**9-23w**	**23-45c**	**23-45o**	**23-45w**
0.00*	0.01*	0.06†	0.07†	0.09†

7 Sensitivity

To examine the impact that our choice of buffer size and pre-release and post-release windows have on the results in this paper, we repeat the analysis using alternate buffer sizes and shot attempt duration windows. For buffer size, we compared our 2-foot default to both a 0-foot and 4-foot buffer. For the shot attempt duration window, we evaluate three alternative approaches: specifically using only the shot release timestamp, a window of 0.5 seconds before and after the shot release, and a window of 0.5 seconds extending only after the release. In each case, we recalculate traffic and compare shot outcomes across the same distance-angle regions used in the main analysis. Figure 10 shows the resulting distributions for the 9-23c region across parameter settings. We focus on this region because it is the source of the most goals (18% of all goals), making trends across configurations easier to observe. These alternative configurations sometimes show slightly steeper declines in shot success, but the overall trends remained consistent, helping to demonstrate the robustness of our findings with respect to the choice of buffer size and shot window.

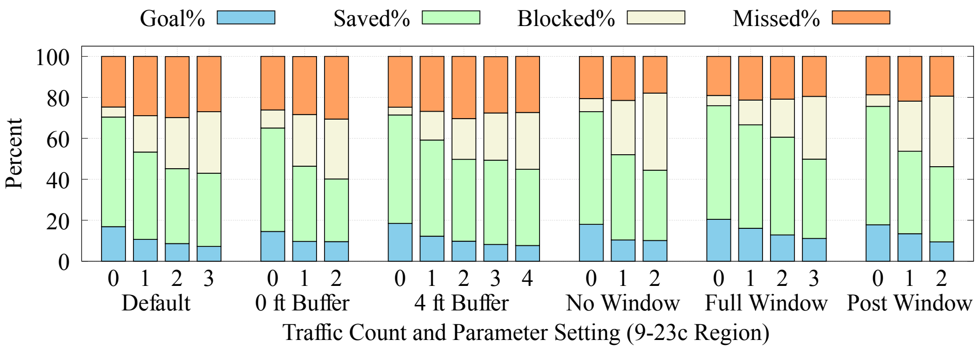

Fig. 10 Shot outcome distributions across traffic levels and parameter settings (9-23c region).

8 Regular Season Versus Playoffs

Most published hockey analytics research focuses on the regular season rather than the playoffs, likely because it provides a much larger and more stable dataset, making statistical comparisons easier and models more reliable. The NHL playoffs, however, are often described as a different environment: the thinking is that checking tightens and teams put a greater emphasis on defensive structure [6]. Additionally, one study reports that for seasons from 2014-15 and 2023-24 eight of the ten seasons had a decrease in scoring in the postseason relative to the regular season [21].[1] For these reasons, it is important to examine whether the relationships we observe from the regular season for traffic, shot location, and outcomes persist in the postseason. In this section, we apply the same methodology used for regular season games to the 2024-25 playoffs to compare games from the regular season with the playoffs.

Because our methodology includes overtime periods, it is worth noting that the regular season overtime period in the NHL uses three skaters per team, is sudden death and lasts a

[1] Note that the results were not tested for statistical significance.

maximum of five minutes. Additionally, a shootout takes place if the tie is not broken during the 5-minute overtime period. In contrast, although playoff overtimes are also sudden death, they consist of five skaters per team, overtime periods are 20 minutes long and periods are added until the tie is broken (there are no shootouts).

8.1 Methodology

We apply the same shot-matching process used in the regular season analysis described in Section 3 (results for the regular season are shown in Table 1) to 85 of the 86 games in the 2025 playoffs (game 3 between TBL and FLA is excluded due to insufficient data). Of the 10,815 official shot attempts in these games, 9,201 were successfully matched to PPT data (85.1%). All playoff analyses below use these 9,201 matched shot attempts. Note that when we refer to the "regular season" below, we mean the 870 games used in our study, not the entire 2024-25 regular season.

In contrast with our approach used for the regular season data, we do not reapply the regular-season requirement of at least 100 shot attempts per traffic-region group when computing the playoff statistics. However, for consistency, we restrict the playoff analysis to the same set of traffic-region groups that met this criterion in the regular season. As a result, some playoff shot attempts are excluded because they fall into groups that do not appear in the regular season results (for example, shots from 0-9 ft with two or more skaters in traffic). This approach preserves as much playoff data as possible while ensuring that the playoff results are directly comparable to the regular season. The minimum number of shot attempts during the playoffs in any included region is 37 (9-23c), with two regions having 48 attempts (23-45c and 0-9w), and all remaining regions containing more than 50 attempts. We use the same distance-angle regions and the same traffic parameters as in the regular-season analysis: a two-foot buffer around the shooting lane and a traffic window that includes skaters present at the moment of the shot and up to 0.5 seconds prior.

8.2 Overall Shot Volume, Scoring, and Traffic Levels

Before examining the impact of traffic on shot outcomes, we first examine whether the underlying shooting environment changes between the regular season and the playoffs. In particular, we compare the average number of shot attempts and goals, along with the average number of skaters in traffic around each shot attempt. Table 4 shows that when all play is included, average shot volume per game is slightly higher in playoff games, while the average number of goals per game is not statistically different between the two contexts. When restricting attention to regulation play only, however, average shot volume per game is very similar between the regular season and the playoffs, with overlapping confidence intervals. This suggests that the higher overall shot volume observed in playoff games is likely attributable to differences in overtime rules rather than systematic changes in shot generation during regulation play. We also note that although previous work found that there were typically fewer goals in the playoffs [21], that work did not test if the difference is statistically signifcant. Despite changes in play during the playoffs reported by Vollman [6], and what some people might perceive as an increase in traffic during the playoffs, we find that, for the games examined in the 2024-25 season, the average amount of traffic during each shot attempt does not change between the regular season and the playoffs.

Table 4 Summary of shot attempts, goals, and traffic metrics for regular season and playoffs.

	Regular Season		Playoffs	
Metric (average)	**Value**	**95% CI**	**Value**	**95% CI**
Shot attempts per game (all periods)	120.02	[119.11, 120.94]	127.24	[122.99, 131.48]
Shot attempts per game (regulation)	117.97	[117.14, 118.81]	120.23	[117.70, 122.76]
Goals per game (all periods)	6.09	[5.94, 6.24]	6.21	[5.73, 6.69]
Traffic per shot attempt (all periods)	1.30	[1.29, 1.30]	1.27	[1.25, 1.30]

8.3 Traffic and Shot Outcomes

We next examine the distribution of shot attempts across traffic-region groups. Figure 11 shows the number of shots originating from each distance-angle region for the regular season (top) and playoffs (bottom). Overall, the playoff distribution appears remarkably similar to the regular season suggesting that both where shots are taken from and the traffic conditions under which they occur do not noticeably change The maximum difference between the regular season and playoffs, in terms of percentage of shots, is 0.82% which occurs for the 45-90c region with a traffic count of 2, while the average difference across all distance-angle regions is 0.24%).

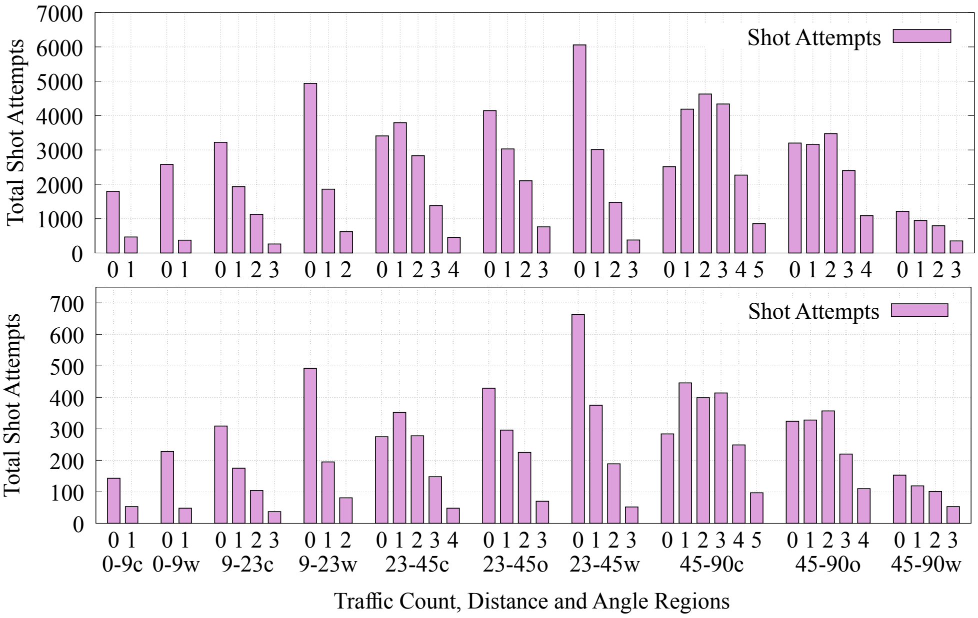

Fig. 11 Shot attempt locations for regular season (top) and playoffs (bottom).

Although shot attempts are taken from similar locations and under similar traffic conditions in the regular season and the playoffs, the locations from which goals are scored differ more noticeably in some distance-angle regions. Figure 12 shows the share of goals scored across traffic-region groups, with the y-axis representing the percentage of total goals and the x-axis indexing traffic count within each distance-angle region.

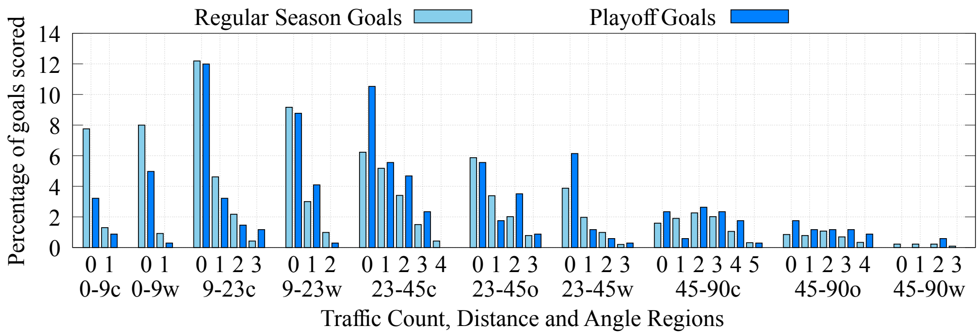

Fig. 12 Comparing the percentage of goals scored in each traffic-region group in the regular season and playoffs.

We now highlight some of the differences that can be seen between the regular season and playoff games. In the 0-9 ft regions, playoff goals make up a smaller share of overall scoring than in the regular season, despite comparable shot volumes in these areas. Conversely, in the 23-45 ft center region, playoff goals account for a larger fraction of total scoring than during the regular season (except with a traffic count of 4 during the playoffs). In the 23-45 ft wide region more goals are scored during the playoffs with a traffic count of zero than during the regular season while this is not the case with more traffic. Despite these differences, it is important to note that, as in the regular season, most goals still originate from close range and/or with no skaters in traffic, so longer-distance shot attempts and their associated traffic play a comparatively small role in overall scoring.

To more closely examine the differences between the percentage of goals scored in the 0-9 ft regions between regular season games and playoffs (as seen in Figure 12), Figure 13 shows the distribution of outcomes for attempted shots (goals, saves, blocks, and misses) in these regions. Table 5 shows these outcome percentages, combined across traffic levels, for the regular season and the playoffs, along with p-values from chi-square tests. Relative to the regular season, playoff shot attempts from 0–9 ft are less likely to result in a goal which is driven by moderately higher rates of blocked shot attempts in both regions and a statistically significant increase in missed shot attempts in the center region only, while save rates show no meaningful change.

Because Figure 12 shows some differences in the share of goals scored between the regular season and the playoffs for the 23–45 ft center and wide regions, we now examine these regions in more detail. Figure 14 shows the percentage of shot attempts that result in each outcome. Unlike the 0–9 ft regions, the difference in Goal% are not uniform across all traffic levels. Instead, they arise almost entirely from shot attempts taken with no skaters in traffic. We therefore restrict our analysis here to zero-traffic shots. Table 6 shows the resulting outcome percentages for the regular season and playoffs, along with p-values from chi-square tests. For zero-traffic shots in the 23–45c and 23–45w regions, there is a notable decrease in Saved% in the playoffs. For 23–45c, this reduction is large enough that Goal% increases significantly. In the 23–45w region, the decrease in Saved% is largely offset by a substantial increase in Missed%, resulting in only a small and statistically insignificant change in Goal%.

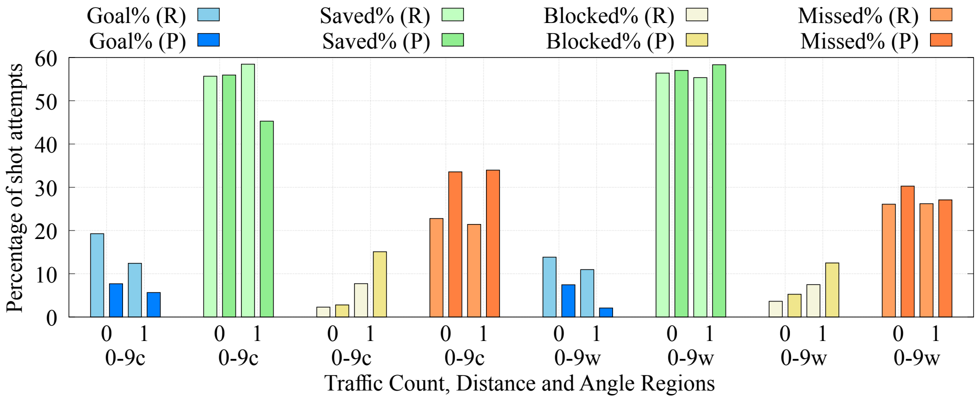

Fig. 13 Comparing shot outcome distributions in the regular season (R) and playoffs (P) for the 0-9c and 0-9w regions.

Table 5 Shot outcome percentages and p-values for the 0–9c and 0–9w regions in the regular season and playoffs. We consider $p < 0.05$ statistically significant and $p < 0.1$ moderately significant.

Region	Outcome	Reg. season (%)	Playoffs (%)	p-value	Significant
0-9c	Goal	17.9	7.1	1.3×10^{-4}	Yes
0-9c	Saved	56.3	53.1	0.39	No
0-9c	Blocked	3.4	6.1	0.05	Moderate
0-9c	Missed	22.5	33.7	3.9×10^{-4}	Yes
0-9w	Goal	13.5	6.5	9.8×10^{-4}	Yes
0-9w	Blocked	4.1	6.5	0.06	Moderate
0-9w	Missed	26.1	29.7	0.19	No

Overall, the results could point to either more dangerous zero-traffic mid-range attempts in the playoffs or a decline in how effectively they are saved.

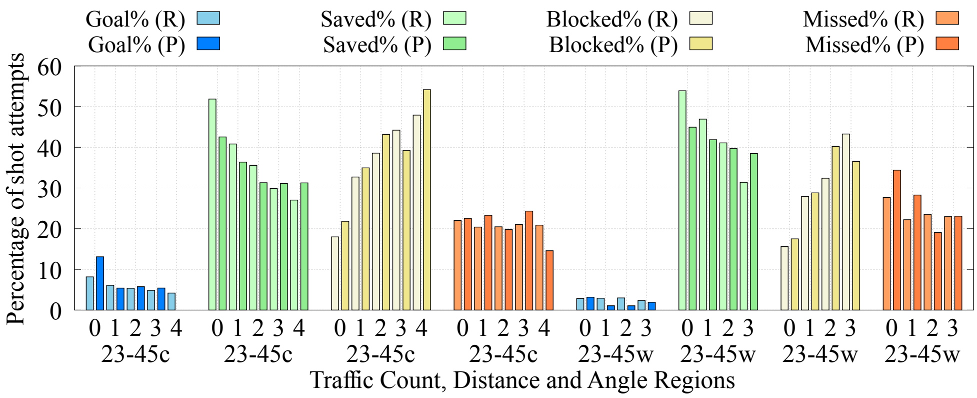

Fig. 14 Comparing shot outcome distributions in the regular season (R) and playoffs (P) for the 23-45c and 23-45w regions.

Table 6 Shot outcome percentages for zero-traffic shots in the 23–45c and 23–45w regions in the regular season and playoffs. We consider $p < 0.05$ statistically significant and $p < 0.1$ moderately significant.

Region	Outcome	Regular season (%)	Playoffs (%)	p-value	Significant
23-45c	Goal	8.20	13.10	4.8×10^{-3}	Yes
23-45c	Saved	51.86	42.55	2.9×10^{-3}	Yes
23-45c	Blocked	17.97	21.82	0.11	No
23-45c	Missed	21.99	22.55	0.83	No
23-45w	Goal	2.86	3.17	0.65	No
23-45w	Saved	53.92	44.96	1.2×10^{-5}	Yes
23-45w	Blocked	15.61	17.49	0.20	No
23-45w	Missed	27.66	34.38	2.6×10^{-4}	Yes

To complete the analysis for all regions, we next consider the remaining distance-angle regions, where the proportion of goals in each region are quite similar between the regular season and playoff games. Figure 15 summarizes shot outcomes across these regions. Consistent with the earlier patterns, differences between the regular season and the playoffs are generally small and are not statistically significant.

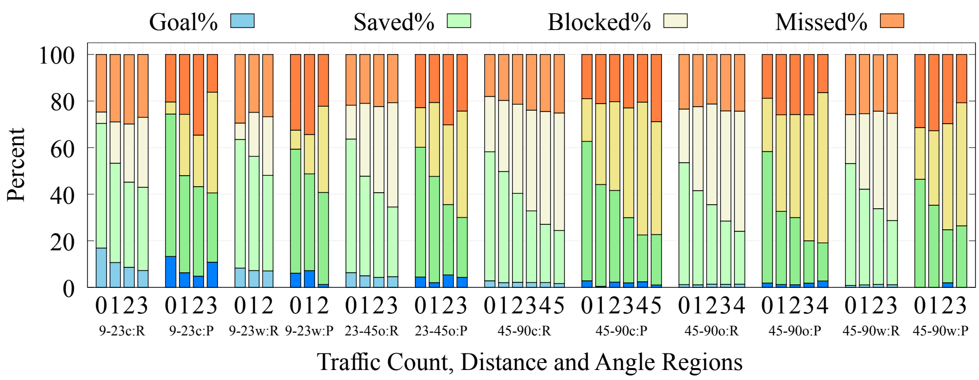

Fig. 15 Comparing shot outcome distributions in the regular season and playoffs (remaining regions).

8.4 The Amount of Attacking Versus Defending Traffic

We next examine whether the composition of traffic around shot attempts changes between the regular season and the playoffs. In particular, we separate total traffic into attacking skaters (teammates of the shooter) and defending skaters (opponents). Table 7 summarizes the results. On average, the total amount of traffic during a shot attempt is similar across the two contexts, 1.30 skaters in the regular season versus 1.27 in the playoffs (with overlapping confidence intervals). This is consistent with the earlier finding that overall traffic levels do not change meaningfully. The breakdown into attacking and defending skaters likewise shows only small, insignificant differences. The average amount of attacking traffic is 0.54 skaters per shot attempt in the regular season and 0.53 in the playoffs, while defending traffic averages 0.76 skaters and 0.75 skaters, respectively. The confidence intervals associated with these values overlap, indicating that there is no evidence of a difference between the regular

Table 7 Comparing the amount and composition of traffic in the regular season and the playoffs.

	Regular Season		Playoffs	
Metric (average)	**Value**	**95% CI**	**Value**	**95% CI**
Traffic per shot attempt	1.30	[1.29, 1.30]	1.27	[1.25, 1.30]
Attacking traffic per shot attempt	0.54	[0.53, 0.54]	0.53	[0.51, 0.54]
Defending traffic per shot attempt	0.76	[0.75, 0.76]	0.75	[0.73, 0.77]

season and the playoffs. Taken together, these results suggest that the playoffs do not feature meaningfully more (or fewer) defending skaters during shot attempts than the regular season, nor do shooters appear to have substantially more support from teammates. Any differences observed in scoring outcomes arise from something other than a difference in this type of traffic. Potentially, this could include differences in shooter or goalie performance, or potentially other unobserved changes in play.

8.5 Summary

Overall, the playoff shooting environment closely resembles the regular season: shot volumes, locations, and traffic levels are broadly stable, and the relationship between traffic and outcomes changes little. The main exception occurs in the 0–9 ft region, where shot attempts in the playoffs are less likely to result in goals because they are more likely to be saved, get blocked, or miss the net. Although some distance–angle regions show noticeable differences between the regular season and the playoffs, some of these account for a relatively small share of total shot attempts. When outcomes are viewed across all regions (Figure 16), the overall patterns look quite similar. Consistent with the regular-season results, most goals are scored with no traffic, increased traffic reduces the chance of scoring, and for distances under 45 ft, shot attempts taken farther from the center of the ice are less likely to result in goals and more likely to be saved, miss the net, or be blocked. These results indicate that distance and traffic effects measured during the regular season generally persist into the playoffs, although models trained only on regular-season data may slightly overestimate goal probabilities for very close-range chances in postseason contexts.

9 Discussion

This paper presents a new method for detecting and analyzing traffic in ice hockey. By leveraging PPT data including puck touch events to determine shot timing and duration, and by decoupling traffic from shot location, we introduce several techniques useful to analysts studying traffic. In analyzing the impact of traffic on shot outcomes, we also offer insights that may be valuable to NHL front office staff, coaches, players, and fans. While our techniques offer a new way to quantify traffic, they do have some limitations. First, the tracking data does not contain explicit shot start and end times for all shot attempts. The data is not official and detecting the point of release is difficult and may not be 100% accurate (despite our improvements). This inaccuracy may impact our findings. As well, to approximate shot duration, we construct a timing window based on empirical estimates. While our sensitivity analysis suggests the findings are robust to reasonable variations, having true shot start and end markers would improve precision. Second, our definition of traffic considers only the

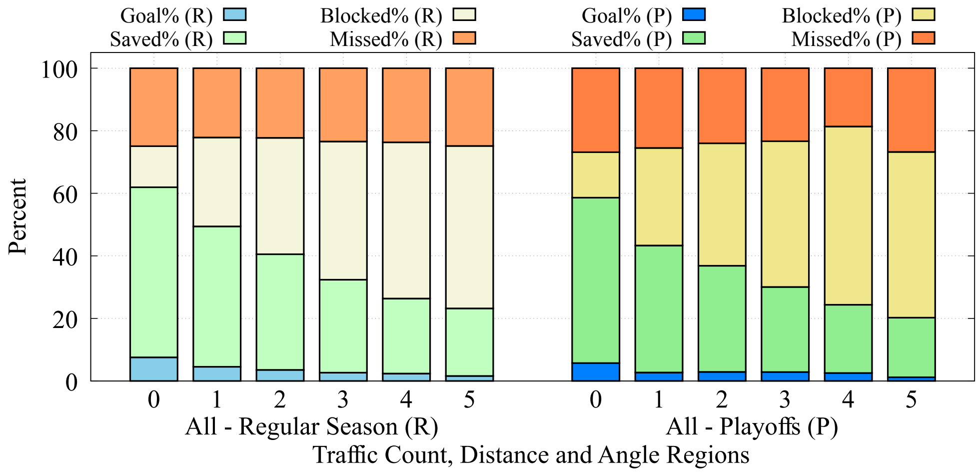

Fig. 16 Shot outcome distributions across traffic levels for all location regions for both the regular-season (R) and playoffs (P).

number of skaters in the traffic lane without considering player orientation, posture, or stick position. This is a necessary simplification due to the use of a single LED per player. Additionally, our analysis does not account for a skater's specific position within the shooting lane as being close to the shooter potentially increases the chance of blocking the shot attempt, but being near the goaltender may enhance the likelihood of obsructing the goaltender's view. To address these simplifications, in subsequent research, we propose two new metrics. The first is net visibility, and is defined as the fraction of the net that can be seen from the perspective of the puck. The seconds is net reachability and is defined as the fraction of the net that could be reached by the puck. These metrics are computed using a combination of PPT data and video analysis (image processing) [8]. This approach captures full player body positioning and uses a rasterization technique to account for players within the shooting lane [8].

Despite these limitations, our work offers a foundation for future research on the impact of traffic in ice hockey. To our knowledge, this is the first study in ice hockey to systematically quantify the impact of traffic using puck and player tracking data. We hope that these contributions not only advance academic understanding but also offer practical techniques for analysts and insights for NHL front office staff, coaches, players, and fans seeking to gain a competitive edge.

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Declarations

Competing Interests

Not applicable.

Funding Information

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Author Contributions

Conceptualization: Tim Brecht originally suggested looking at traffic during shot attempts; Methodology: Miles Pitassi and Tim Brecht came up with the orignal methodology which was improved through discussions with Evan Iaboni Fauzan Lodhi and Ben Resnick; Formal analysis and investigation: Miles Pitassi with help from Tim Brecht and Evan Iaboni; Writing - original draft preparation: Miles Pitassi, Tim Brecht and Evan Iaboni; Writing - review and editing: all authors; Funding acquisition: Tim Brecht; Resources: Tim Brecht, Supervision: Tim Brecht. Section 8 which compares regular season games with playoff games was suggested by Tim Brecht and executed by Miles Pitassi and Tim Brecht with editing help from Ben Resnick.

Data Availability

The puck and player tracking data is proprietary, provided by the NHL and is not publicly available. The NHL API data is available at: https://api-web.nhle.com/v1/.

Research Involving Humans

We have obtained ethical clearance for this research from the University of Waterloo's Delegated Ethical Review Committee (DERC) which is part of the Human Research Ethics Board (HREB) (approval reference number 44678).

Informed Consent

Consent requirements were satisfied and approved as part of the ethics review described above.

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