Where not to lose the puck

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Abstract. In a fast-paced free-flow game as Ice Hockey the decision making of the players is crucial for the success of the team. A game in the Swedish Hockey League (SHL) has on average 244 possession changes where both teams play at full strength. Previous studies have shown that the most effective way to create scoring chances is by exiting and entering zones with the puck under control. On the contrary, this paper studies the question of risk and reward of different plays. Based on an extensive data-driven investigation of three full SHL seasons, the conclusion is that the best way not to concede goals is also by doing the transition plays with control. Specifically, a failed dump-out is 57% more likely to end up in the opponents scoring a goal than a failed outlet pass.

Keywords: Ice Hockey, Dumps, Controlled Entry, Controlled Exit

1 Introduction

Within sports there is a lot of conventional wisdom that has become truths, whether based on facts or not. Data analysis is now, sport by sport, tearing down these truths and creating new knowledge which is indeed well-grounded in facts and data. Using a data-driven approach, this paper will investigate risk and reward of different plays, and, consequently, what players should strive for and avoid.

Compared to other major sports like baseball, basketball, American football and soccer, ice hockey should be considered a sport where the results to a large degree are random. Weissbock [1] tried to quantify the randomness in sports, showing that in the NHL, the underdog wins more often than in any of the other major sports in the US. In fact, the favorite wins only 57% of the games in the NHL. In both the NFL (64%) and the NBA

(64%) the favorite wins significantly more often. MLB (56%), finally, is very similar to the NHL.

Good teams of course try to increase that number and reduce the randomness. To minimize luck, teams need to calculate risk and reward for the actions in the game. Compared to baseball and American football, ice hockey is a "free flow 360 degree" game where a play (or an episode) in theory can last for a full period of 20 minutes. Players both attack and defend within the same play, in sharp contrast to baseball and American football where one team attacks (tries to score) and one defends. These fundamental characteristics of ice hockey create a lot of situations that cannot be planned for in advance. Players need to be quick thinkers and problem solvers in order to adopt to new and unique situations in this dynamic and high-speed game. To minimize randomness and achieve success the teams, however, set up some ground rules on how the coach wants the players to act in the different situations that occur frequently and in slight variations during the free-flowing plays.

2 Background

An Ice Hockey rink is divided into three zones. Defensive Zone (DZ), Neutral Zone (NZ) and Offensive Zone(OZ). To create scoring chances, teams need to transport the puck in some way from the DZ to the OZ. In fact, no goals the last three seasons in the SHL were scored from the the NZ or the DZ, when the teams both play at full strength and the goalkeeper has not been pulled. The combination of the rules offside and icing makes it almost impossible to go directly from the DZ to the OZ, so the NZ needs to be used for this transition. Here, the conventional wisdom says that players must be very careful not to lose the puck in the NZ, i.e., losing the puck in this zone increase the other team's scoring chance significantly.

Table 1. Terminology Entries and Exits

TYPE	SUB-TYPE	DESCRIPTION
Controlled	Carry	A Player transports the puck over the blue line
Controlled	Pass	A player passes the puck to another player over the blue line
Dump	Dump	A player shoots the puck to next zone without a direct receiver
Dump	Chip	A player shoots the puck in the air into next zone without intended receiver
Exit		Puck moves from Defensive Zone to Neutral Zone
Entry		Puck moves from Neutral Zone to Attacking Zone

Losing the puck - The term describes the next possession after the puck changes team. If Team A shoots and Team B collects the puck, it is a possession change. All situations where Team B touches the puck when Team A has it, count as a possession change and is therefore included in the term “Losing the puck”.

On a risk/reward scale the *Dump-in-play* is generally considered to be low risk/low reward while *Controlled entries/exits* are associated with higher risk, but also higher reward.

This paper will focus on data from the SHL. Team wise the playing styles differ quite a lot when it comes to zone exit and zone entry strategies. For instance, Skellefteå AIK carries out the puck almost twice as often as they dump it out from the DZ, meanwhile Malmö Redhawks dumps it more often than they carry it.

Total average zone exit numbers for the SHL are:

- Dump Out 23%
- Carry Outs 25%
- Passing 51%

In Figure 1 the dump-out rates and dump-in rates are shown to highlight the different playing styles in SHL for the season 20/21. Malmö Redhawks was the team that used the “dump-out” as an exit strategy out of the DZ the most and “dump in” into the OZ most as well. On the opposite side, Skellefteå AIK makes the most controlled plays, both when exiting the DZ and entering the OZ. The differences in numbers are huge between the teams. Malmö Redhawks performed 41% more uncontrolled exit and entries during the season than Skellefteå AIK (3119 vs. 2208).

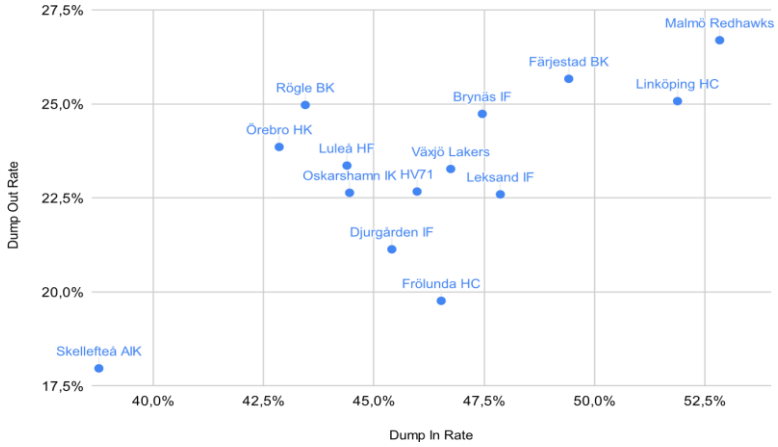

Fig. 1. SHL teams Dump out and dump in rates

3 Related Work

Chatel [2] presents base rates on how the different types of zone exits and entries are connected to expected goals (xG). By bringing the puck out of your own zone with control, the chance of scoring a goal increases dramatically. When entering the offensive zone, it is even more important. Actually, and as seen in Table 1 below, it is the chance of scoring a goal is almost doubled with a successful controlled entry compared to a successful dump-in. Other works concludes similar takes [6, 7] that carry-ins outperforms dump-ins by margin.

Table 2. Chatel's xG Contribution Figures

TYPE	SUB-TYPE	CONTRIBUTION TO XG
Zone Exit	Carry-Out	0.024
Zone Exit	Pass	0.026
Zone Exit	Dump-Out	0.016
Zone Entry	Controlled Entry	0.04
Zone Entry	Dump-In	0.022

Stimson quantified [3] how the different breakout (exit) strategies were leading to shots for and against in the next play. He concluded that controlled exit had the best Net Shot Differential of all breakout types, meaning more shots for than against.

In the NHL, the entry strategy dump-in is getting more popular for the last couple of seasons [4]. Due to lower risk to get a turnover in the neutral zone, teams are more careful with the puck. Mike Kelly has earlier examined this [4] and concluded that dump-ins significant lower the number of odd man rushes against, which is one of the most efficient ways to score goals in ice hockey [8].

A study similar to this paper has been published present to this [5] and concludes that some existing results are in fact questionable when it comes to exiting strategies, the results presented show that neither of the exit strategies are superior to the other. The study, however, only targets successful plays with the motivation that it is reasonable to assume that a player on, in this case, the college level is generally successful in his attempts to play the puck. We argue that this assumption is incorrect, and consequently that the results have limited bearing on real-world ice hockey. In fact, there are a lot of "bad plays" in ice hockey resulting in turnovers to the defending team. As an example, teams in the SHL have on average only 57% successful entries into the offensive zone. The other 43% the defending team gets control of the puck.

4 Data Preparation

4.1 Data Collection

All data was extracted from SportLogiq[1] for the SHL regular season games 2018/19 to 2020/21. The dataset includes 4 160 282 events before filtering. There are 266 different ways to lose the puck possession to the other team in our data. Most of these are unusual, specifically 213 such events have occurred fewer than 500 times the last three seasons in SHL. A game in SHL averages 244 possession changes per game after filtering to both teams playing at full strength. 0,52% of all puck losses ends up in a goal against.

4.2 Data Preparation

The data was, as described above, filtered by removing all events occurring when not both teams play at full strength (5-vs.-5). In addition, all situations where the goalie is the last player to touch the puck in a possession are also excluded since these situations, including e.g., rebounds from shots etc. are very specific. Furthermore, all situations where a team has been in possession of the puck for less than 1.5 seconds are also excluded.

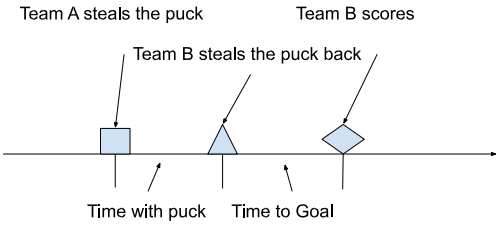

Fig. 2. Visual description of "Time with puck". Team A must have the puck in possession for at least 1.5 seconds for Team Bs goal to be included in the dataset.

The situation where a team has a possession for less than 1.5 second tends to be more of reactions than decision making and therefore creates noisy data, e.g., rebounds from shots of the bodies of the defenders. It may be noted, though, that 13.6% of all goals in SHL are created in the possession after a "less than 1.5 second" possession.

[1] http://www.sportlogiq.com

Goals are created from possession changes in all zones as shown in Table 3. In our dataset 58% of all goals are created from possession changes in the DZ (seen from the team that did not score). SHL is a league where forechecking is an important part of the game and it is seen in the data. In total, 0,75% of all turnovers in the defensive zone is converted into goals against. It seems intuitive that the further away from your own goal, the safer you are. High level data confirms this, losing the puck in the offensive zone has a turnover rate to goal against at 0,38% which is lower than both the DZ, and the NZ (0,44%).

$$\Sigma \textit{ Goal Against} / \Sigma \textit{ Possession Drops} = \textit{Goal\%}$$

Table 3. Conversion rates to goal per zone

ZONE LOSING THE PUCK	NO OF GOALS	MEDIAN TIME TO GOAL	GOAL%
Defensive	837	5.7 Seconds	0.75%
Neutral	179	7.2 Seconds	0.44%
Offensive	427	8.3 Seconds	0.38%

5 Results

5.1 Location of Puck Drop

The results in Figure 3 are grouped in to 4x6 m quadrants. Each quadrant shows the Goal Conversion rate (Goal%) after puck loss. The number representing goals scored against after puck was lost at that quadrant. Focusing on the areas around the bluelines shows that the puck steals converted to goal does not increase in the transition phase between DZ and NZ. 0.4% of all lost pucks round defensive blue line is converted to goals against, which is close to the complete neutral zone (0.44%). On this high-level data, we do not know what the intention with puck was.

The offensive blue line, on the other hand, has an increased Goal% (0.5%) compared to the areas around it indicating that losing the puck on offensive blue line is a dangerous place to lose the puck. One area on the offensive blue line has close to 1% Goal% which is as high as losing the puck in the high slot.

The forechecks popularity is obvious, the highest total Goal% for data in x-axis is found behind the goal, winning back the puck when forechecking the opponent.

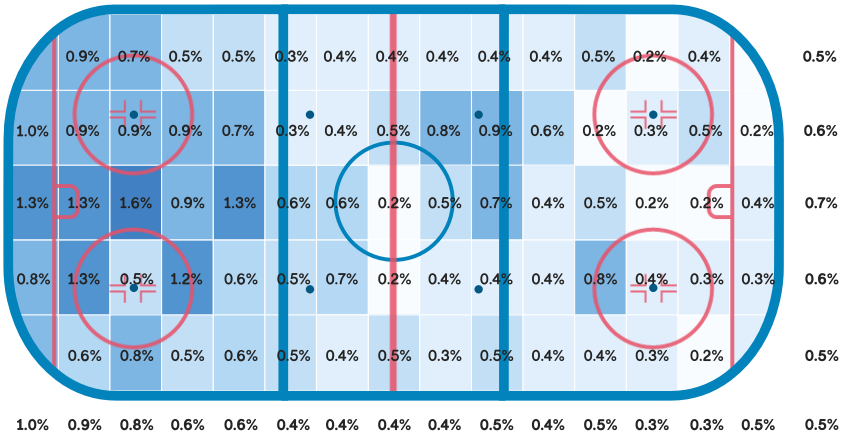

Fig. 3. Goal% per turn over location

5.2 Entries and Exits

Grouping data in the same way as Chatel [Table 1] did for the different types of exits and entries connected to xG-value, the actual outcome for these actions against are presented in Table 4 in Goal%.

Table 4. Goal% per transition type

TYPE	SUB-TYPE	Goal%
Zone Exit	Carry-Out	0.43%
Zone Exit	Pass	0.59%
Zone Exit	Dump-Out	0.65%
Zone Entry	Controlled Entry	0.43%
Zone Entry	Dump-In	0.29%

So, based on these numbers, dump-outs are actually the most dangerous transition play in ice hockey. In particular, it is the failed ones that create these numbers. This key result of the paper is further broken down in Table 5. 1.63% off all failed dump-outs, that are not air bound (Flip Dump Outs) and fails to reach the NZ, turns in to a goal against and that is the highest Goal% for any sub-event of transitions plays.

Table 5. Dump-outs breakdown

SUB-TYPE	Goals	Goal%
Dump Out-	36	1.63%
Flip Dump Out-	7	1.16%
Off Glass Dump Out-	57	1.02%
Flip Dump Out+	21	0.52%
Dump Out+	20	0.36%
Off Glass Dump Out+	31	0.36%
All Dump Out Attempts	**172**	**0.65%**

5.3 Risk/Reward

Plotting [figure 4] the result from Chatels's entry data [table 2] and comparing it to the result of this paper, setting xG gain equal to reward and goals against equal to risk, shows that making controlled plays when exiting the zone is better for both scoring more goals but also conceding fewer. Dump-Out has the highest risk of all plays and lowest reward. As the result implies this is due to the failed dump-outs. Entries is more complex with higher risk and higher reward for controlled plays. In the long run Controlled Entries beats Dump-Ins. The lower risk is worth to have in consideration when in lead and clock closing in.

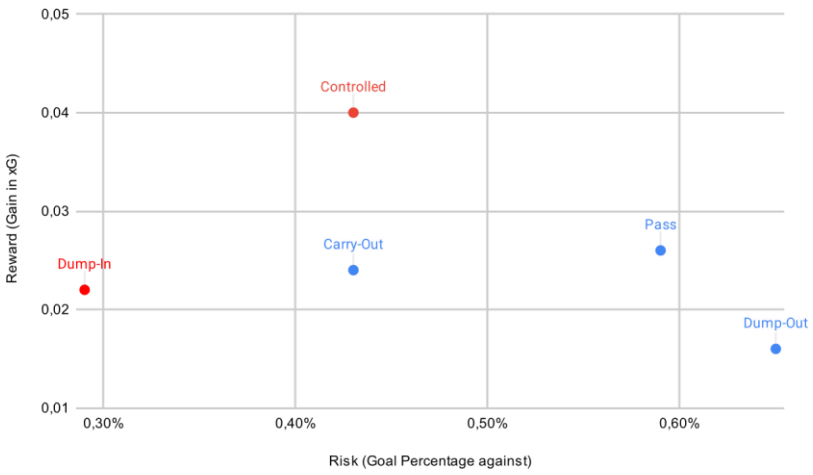

Fig. 4. Risk vs Reward. Red Dots = Entries. Blue Dots = Exits.

6 Conclusion

We have in this paper described risk/reward when moving the puck from the defensive zone to the offensive one. From the analysis, we have identified that moving the puck with control from the defensive zone is superior to dumping it. Controlled zone exits are better both for scoring goals and avoid conceding goals. In fact, a failed dump-out is one of the worst plays when looking into goals against in the next possession. The specific area with the highest conversion rate to goal, except from right in front of the net, is from behind the goal line. Teams in Sweden generally forecheck a lot and get goals from this specific situation.

The analysis also concludes that a dump-in is a safer option when entering the attacking zone, than doing it with control. Still, due to the increased likelihood of scoring, when entering with control, a controlled entry is the best alternative, when not considering the scoreboard or the time left of the game.

7 Discussion and future work

We have discussed risk/reward of different type of plays and areas within the sport of ice hockey in this paper. When discussing controlled vs. uncontrolled exits and entries it's easy to regard it as a decision made by the player executing the play. But, the teammates/opponents positioning, coaching directives and the sequences building up the situation all have major implications on the final decision made by the player executing the play. A coach cannot just instruct the players to do more controlled plays but needs to change the overall structure to make it possible. While this is not considered within the paper, it should be kept in mind.

It should be noted that we are in this paper mixing data from the Swiss League NL (reward) with the Swedish league SHL (risk). While we have no reason to believe that the results would be significantly different if we had either studied the leagues separately, or combined both leagues, this remains to be verified.

To calculate risk, we did not use expected goals against, but instead actual goals against. The reason was the data available. The xG-model for the reward uses sequences within the buildup of the figure. The data we have at hand does not provide us that level of information. Using goals against, we get the actual outcome over three seasons, which should correlate well with an xG-model including sequences.

For future work we would like to use data (risk and reward) from the same league to verify our results from this paper, but also investigate other leagues to find and important differences between leagues.

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