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Finding Trends in Goaltending Data

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Abstract: Goaltending is one of the toughest positions in hockey as it has to do with many factors which include positioning, reaction time, and speed. The best goaltenders in the world have mastered each one of these skills. Goalies have three main analytics they look at when comparing goalies' statistical data. These are goals against average (GAA), save percentage, and goals saved above expected (GSAx). While these stats are great for looking at overall performance, finding trends in Goalie A's game will help foster improvements by looking into seven different categories. The categories include shot placement, direct shot, pass or rebound, line rush or in zone goal, left or right-handed shot, direct shot, tip or screen, stick tape color, and, finally, whether it was from within the house or not. These seven categories will pick up on trends in Goalie A's game from the past two seasons. After looking at trends from Goalie A, the results were compared to other goalies played against in order to see if each goalie is statistically the same or different.

Key words: Analytics, Statistical Data, Save Percentage, Goals Against Average, Goals Saved Above Expected

1. Introduction

Hockey originated in Montreal, Canada in 1875 between two universities and then in 1917, after the National Hockey Association (NHA) disbanded the National Hockey League (NHL) was formed (Fischler et al., 2023). Ever since the creation of the NHL, managers, coaches, players, and fans have all been trying to figure out the best statistics to rate or grade players on. Originally, the only measurements people would look at would be goals and assists. There are two types of assists in hockey, a primary and secondary assist. Another statistic teams look at for their players are expected goals and plus/minus. Now there are more advanced measurements for player performance such as the Corsi Score, Fenwick Score, Goals Above Replacement (GAR), and Weighted Shots. Owners and coaches are always trying to improve their teams by bringing in better players and having more advanced statistical data that will help them find the type of player they are looking for to fill a role in their team.

When to comes to goaltending analytics, most of the public rate their goalies by save percentage and goals against average. These statistics can be rather misleading sometimes because a goalie could be on a very good team where he does not see a lot of shots or his team does not give up many quality chances, driving his GAA down. One way to try to analyze goalies more eqitably is by looking at their goals saved above expectation which is the number of goals they should have given up that night based on the quality of shots (O'Connor & Goldman, 2022).

This paper analyzes different metrics coaches and organizations are evaluating their players with. This analysis will then be used to compare Goalie A to other goalies within the Division I National Collegiate Athletics Association hockey program, who will be referred to as Goalie B. Data is pulled from Instat for Goalie A and B from the 2021-2022 and 2022-2023 seasons. The results will report whether trends in Goalie A's game are independent or comparable to those of Goalie B.

2. Literature Review

Coaches, fans, and players are all looking to figure out who the best players are on the team based on new statistical data methods. Before everyone would look at goals, assists or plus/minus to figure out who the best players are. While this my work on some cases, it does not factor in ice time or if a player is more a defensive player on the penalty kill or a player

only plays on the powerplay. Looking into statistics like the Corsi score, Fenwick score, or Goals Saved Above Expected are even better ways to measure a player or goalie's performance.

2.1 Corsi Score

The Corsi Score was named after Jim Corsi who was Buffalo Sabers goalie coach. "Corsi is the total shots at the net for and against at even strength. It's often expressed as either a differential, like plus/minus, or a percentage" (Wilson, 2014). The Corsi score can be determined by the differential between total number of shot attempts five on five and the total number of shot attempts by the opponent. Shot attempts are any time a team tries to take a shot even if it gets blocked or misses the net. A higher Corsi score is better, as shown in the 2013-2014 NHL season when the Los Angeles Kings won the Stanley cup. They had a positive 931 Corsi Score that season while the lowest team in the division has a negative 1064 Corsi score (Masisak, 2021). This supports that the Corsi score is something teams should be looking into when trying to have a winning season. The correlation between a team's Corsi score and goaltending metrics is demonstrated as follows: a team with a negative Corsi score will have a higher Goals Against average.

Corsi = (Total shots for 5 on 5) – (Total shots against 5 on 5) (1)

2.2 Fenwick Score

Another improved statistical rating is the Fenwick score named after Matt Fenwick (Wilson, 2014). The Fenwick score builds off of the Corsi score but does not include blocked shots for or against. The reason some teams prefer to use the Fenwick score over the Corsi score is because it tends to have a better correlation with scoring chances. Blocking shots is part of defending your goal so offensive players should not get "rewarded" for getting a shot blocked. Blocked shots do play a large role in a hockey game as there are between fifteen and twenty blocked shots per game on average. When comparing the Fenwick versus the Corsi score the Fenwick does predict a team's chances of winning better (Lee, 2022).

$$Fenwick = (Shots\ on\ goal\ FOR + missed\ shots\ FOR) - (Shots\ on\ gaol\ AGAINST + missed\ shots\ AGAINST) \quad (2)$$

2.3 Weighted Shots

Ken Krzywicki took a new approach to hockey statistics by looking at the probability of scoring a goal based on four categories: Shot Location, Shot Type, Rebound, and Situation (Krzywicki, 2005). Before this model, improvements to cameras, and AI technology, teams could only look at the number of shots each team took. Krzywicki took this as a challenge and created a logistic regression model that could predict the probability of a goal based on the four variables (Krzywicki, 2005). He used a points system and an intercept in order to predict the probability of a goal. Please reference Figure 1 with the breakdown of each category and points.

$$P(Goal) = \frac{1}{1+e^{-\sum points}} \quad (3)$$

Looking at Krzywicki's model and the points he has associated with each category, analysts can predict the probability of a shot going in. This can play a significant role in a team deciding where to put players on the powerplay and what type of shots they need to be shooting to increase the chances of scoring. One thing Krzywicki did note is that a straight on shot had a higher probability of going in compared to a shot not from the slot or outside the face-off dots due to the net getting smaller based on the angle of the shooter (Krzywicki, 2005). From a goalie statistic perspective, this model posits that the opponent plays a factor and this impacts both the Goals Against Average and the Goals Saved Above Expected.

Variable	Range	Points
Intercept	Add to all records	-2.2369
Distance	Less than 10 ft	0.6884
	10 - 12 ft	0.6374
	13 - 14 ft	0.5564
	15 - 16 ft	0.5174
	17 - 22 ft	0.3654
	23 - 31 ft	0.0000
	32 - 36 ft	-0.3805
	37 - 38 ft	-0.4758
	39 - 44 ft	-0.8155
	45 - 57 ft	-1.0848
	58 ft or more	-1.3824
Shot Type	Wrap	-0.0742
	Slap	-0.0573
	Wrist	0.0093
	Snap	0.0130
	Backhand	0.0361
	Tip-In	0.1487
Rebound	Yes	1.3362
	No	0.0000
Situation	EV	-0.1244
	SH	0.0399
	PP	0.4007

Figure 1. Model Scorecard (Krzywicki, 2005).

2.4 Goals Saved Above Expected (GSAx)

When looking at goaltending specifically, there are not many statistics that can be evaluated. Goals Saved Above Expected is the best statistic that can get goalies on a level playing field regardless of their team. If a team is giving up very high-quality chances and not many shots, the goalie will more than likely have a lower save percentage. For teams that are very good, their goalies normally have a very low Goals Against Average due to their team having control of the puck most of the game. Goals Saved Above Expected is calculated by the expected goals minus actual goals against. Expected goals is based on the quality of shot the goalie is facing in that game (Elieff, 2022). Zero is the baseline average when looking at GSAx. This is one of the best measurements to look at when it comes to goaltending because it factors in the difficulty of shots given up. Therefore, even if a team is very bad and the goalie gives up five goals in one game but the goalies Expected Goals Against was five and a half, the goalie's GSAx is only .5. Furthermore, on a team that is very good, if a goalie gives up two goals but had an Expected Goals Against of one then the goalies GSAx is negative one, which is worse than the goalie that gave up five.

GSAx = Expected Goals Against – Actual Goals Against (4)

2.5 The Royal Road

The Royal Road is one of the newest statistics that coaches and players are looking at to increase a player's chances of scoring. The Royal Road suggests that if you cut the ice in half horizontally and the puck moves from one half of the ice to the other then it has crossed the Royal Road. Please reference Figure 2 for a visual of the Royal Road. Studies have shown that if the puck passed the Royal Road before shooting it increased the scoring opportunity by over 10 times (Chris Boyle, MSG Networks, 2019). This is due to the goalie having to change his position in the net which can throw off his angle. It is also much harder to stop a puck when the body is moving trying to track it. A green goal is when a goalie has limited time to get set on depth and angle and less than a half a second to track the puck. Across 100 games in the 2014-2015 NHL season, 76% of all goals scored were green goals. Of those green goals, 22% crossed the Royal Road (Chris Boyle, MSG Networks, 2019). This is critical in both goaltending and offensive player performance when it comes to stopping the puck or scoring more goals.

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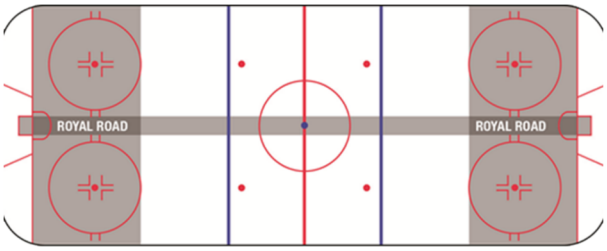

Figure 2: The Royal Road, (Chris Boyle, MSG Networks, 2019).

3. Model Development

Teams from the NHL all the way down to the collegiate level are looking for ways to improve their chances of winning by using statistical data. Statistical data is becoming more readily available to teams as the years continue due to the growing influence that analytics have in sports. The Army hockey team at the United States Military Academy is lucky enough to have each game broken down though an analytics software called Instat, which provides statistical data and video clips to both the players and coaches. This information is sent back to the player via email so each player can watch their own clips after every game, broken down by shift. For goalies it is no different, and they are provided with a shot map as well as a video clip of each shot taken during that game. For the purpose of this research, Instat allowed me to break down every goal that Goalie A gave up within the past two seasons, from 2021-2022 to 2022-2023. The objective of this project was to look at each goal and collect data on it to find trends in Goalie A's game, breaking down each goal into seven different categories which include: shot placement in the net, direct shot, pass or rebound, line rush or in zone goal, left or right-handed shot, direct shot, tip or screen, stick tape color and finally whether the goal came from within the house or not. This model's main purpose is to find trends to improve Goalie A's game and bring more wins into the Army hockey program. The trends of Goalie A will be compared to Goalie B to evaluate whether there is a similar trend or if each goalie is unique.

3.1 Data Collection

Since data analytics is becoming very popular in sports, it was relatively easy to choose categories of analysis to distinguish trends in Goalie A's game. The raw data from Instat was good but not always accurate because the camera did not pick up on every screen or rebound that happened during a play. Therefore, by breaking down the film and creating a data set from each goal over the past two seasons, the data became more accurate. Instat broke every goal down into 10 second clips which provided a visual of what happened leading up to the goal against. The first category is a grid pattern establishing where a puck entered the net. The net is six feet wide by 4 feet tall and this was broken down into a one through nine grid. A one is on the ice, low blocker and a nine is high glove for a regular handed goalie, catching with the left hand. The grid shows where a goalie is scored on the most. The second category is even-strength, penalty kill or shorthanded. The power play is when a team has one or more players than their opponent, giving them the man advantage. Shorthanded, or a penalty kill, is when the opposing team has an extra skater. Even-strength is when teams are five on five. The third category is whether the goal was a direct shot, a pass that was then shot directly into the goal as a quick play, or a goal scored off a rebound. A rebound is when the goalie makes the first save and then the puck is shot directly into the next during the same sequence of play. The fourth category is looking at if the goal was scored on a line rush which is when the play is moving into the offensive zone or if the play was already set up in the zone noted by an in-zone goal. The fifth category is if the goal scorer was a left-handed or right-handed shooter. It is normally a 50-50 split with handedness in hockey. The sixth category is if the puck was shot directly into the net, was tipped, or was the goalie screened. A tip is when the puck gets defected by another player on the ice which changes the direction of the puck. A screen is when there is a player in front of the goalie obstructing his or her vision. The seventh category is stick tape color, being either black or white on the blade of the stick. The eighth category is jersey color for both the home and away team. The ninth and final category is shot location based on if it was in the house or not. The house is considered the most dangerous scoring area on the ice, being centered between the faceoff dots. Please see Figure 3 which shows a photo of the house.

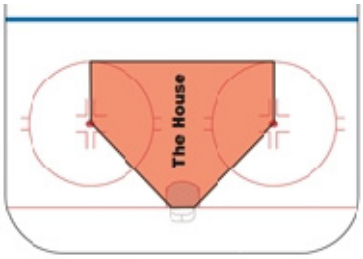

Figure 3: The house (*Hockey Terminology – Weekend Warriors Hockey*, n.d.)

3.2 Category selection

Statistical data for goaltending is the least advanced, considering that there are many different factors that go into goaltending, but the attainable data is only saves and goals against. By looking at where a goal is scored in the net, goalies can visualize where they get scored on the most. By knowing this trend, goalies can focus on a save selection that will reduce the number of goals given up. When looking at direct shot versus pass or rebound type goals, goalies can see if they are getting scored on during the movement from point A to point B on a pass or if they need to work on their rebound control. The odds of scoring goes up drastically when the puck is being passed due to the goalie having to re-position his angle for a new shooter while also getting his feet set for the shot. Furthermore, looking at whether a goalie gives up more goals from line rushes or in-zone play can also factor into the training needed to be doing during the off season. While more goals are scored in-zone due to more time being spent there, line rush goals are more frequent and can increase probability of being scored on due to odd-man rushes or breakaways. Line rushes also tend to have more passes on the entry creating more scoring chances. When it comes to the handedness of the shooter, it is almost 50/50 for hockey unlike other sports, meaning a goalie can determine if they struggle against a particular handedness more easily. It is important in goaltending to know whether most goals are direct shots, tips, or rebounds. Having good rebound control is critical as a goalie as it limits the opposing teams' opportunities and helps control the game. Looking into stick color, many players think that black tape hides the puck better. However, it is about 50/50 when looking at tape color choice and the subsequent goals scored. Lastly, knowing how many goals are scored from within the house area is important.

3.3 Other Goalie Statistics

When looking at trends in Goalie A's game, it was important for the results to be compared then to other goalies in the NCAA Division I program as well in order to determine if all goalies are the same or if some are different based on the categories selected above. A random sample of goalies from teams that Army hockey played in the past two seasons was taken, the sample makes up Goalie B, and a comparison of goals was conducted. Taking a random sample of different goalies produced another model identical to the model of Goalie A. Looking at seventy different goals the Army hockey team scored, this data was compared to the data from Goalie A using a Chi-square test to look at independence based in the P-values.

4. Results & Analysis

Goalie A will be analyzed across the seven categories stated earlier: 1) shot placement, 2) direct shot, pass or rebound, 3) line rush or in-zone goal, 4) left or right-handed shot, 5) direct shot, tip or screen, 6) stick tape color, and 7) whether the shot was from within the house or not. Statistical significance was set at a P-value of less than .5 for Chi-square tests.

4.1 Statistics from seasons 2021-22 and 2022-23

The results from this study came from the Excel dataset that was created based of the past two seasons and the nine categories that chosen to pick up on trends in Goalie A's game in hopes to see if the trends fit other goalies as well, modeled by Goalie B. To show the data, pivot tables and bar charts were used which provided the ability to compare each season to

each other. Starting with shot location on the net on the 2022-23 season, of the seventy-three goals that Goalie A gave up, 43.8% either beat them at medium glove or blocker which is just over the pad. During the 2021-22 season, of the 73 goals given up, 30.1% beat Gpalie A at medium glove and blocker while the worst areas were low glove and high glove. What stands out the most is that Goalie A got beat more times on his glove side than blocker side both seasons, with a total of seventy times compared to fifty-three, respectively. Please see Table 1 below.

Table 1. Counts of goal location on net

Season/ Grid on net	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2021-22	6	9	14	11	0	11	9	0	15
2022-23	5	13	7	16	1	16	4	2	7

The second results came from if the goal was scored on a direct shot, pass, or rebound. Of the seventy-three goals scored in the 2022-23 season, twenty-two were direct shots, thirty-three were off a pass and eighteen came from a rebound. Comparing that to the 2021-22 season, thirty-two were direct shots, twenty-seven were off a pass, and fourteen came from a rebound. These results suggest that Goalie A struggled more when the puck was passed before it was shot. This supports the research stating that when the puck moves across the Royal Road, the chances of a team scoring increases. While Goalie A improved performance on direct shots, his rebound control decreased from the 2021-22 season to the 2022-23 season. After running a Chi-squared test, there is no statistical evidence between direct shot, pass or rebound between the two seasons with the P-value being .229.

The most similar results from both seasons came on goals that were scored on a line rush or in-zone. During the 2022-23 season, forty-six goals were scored on in-zone time while twenty-seven were scored during a line rush. Comparing to the season before, forty-eight were in-zone and twenty-five were on the line rush. This data does not show that there are more shots against during in-zone time but the chances of scoring on a line rush are much greater as the play is coming faster and there is often an odd man situation during this time. There are also more passes made during line rush situations thus throwing the goalie off angle.

Stick color has always been a hot topic of discussion when it comes to goal scoring. The two main colors are either black or white tape. Many goal-scoring players believe that black tape hides the puck better than white tape which would make sense since the puck is black, but does it really make that big of a difference to the goalie? The result from both seasons is conclusive that tape color does make a slight difference to Goalie A as shown in the chart below. The total goals scored when the shooter uses white tape was sixty-four compared to eighty-two with black, so of the total goals scored 56.1% came off a stick with black tape. After running a Chi-squared test, there is no statical evidence based on a P-value of .505 that black tape is better than white tape.

Table 2. Tape Color

Season/Color	White	Black
2021-22	34	39
2022-23	30	43

Does handedness of the shooter play a factor in Goalie A's ability to stop the puck? After looking at both seasons' data, the answer is no. While during the 2022-23 season, left-handed shooters did out score right-handed shooters by nine goals. During the 2021-22 season, the data was much closer, with only a difference of three, with the advantage to left-handed shooters compared to right-handed shooters.

When looking at the shot itself, whether it went directly into the net, tipped or screened, is something coaches look at often. How many pucks get tipped or how many players take the goalie's eyes away by screening them? As you can see in the results below, both seasons had very similar results. While the data shows tipping and screening do play a large role in goal scoring, goalies need to be focused on direct shots first. As you can see of the 146 goals, ninety-two were direct shots,

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with nothing obstructing the goalie. What makes this data more interesting is that both seasons had very close to the same numbers, demonstrating consistency with Goalie A.

Table 3. Goal Type

Season/Goal type	Direct shot	Screen	Tip
2021-22	47	10	16
2022-23	45	13	15

Does shot location play a role in goals against? The data from the past two seasons show that of the 146 goals scored against Goalie A, 128 came from within the house area. This is the most dangerous part of the ice for a goalie because they have less time to react and must rely more on position than reaction time. Goalies need to focus a majority of their training on shots from within this area as almost 88% of the goals scored on Goalie A from the past two seasons came from this house area. When comparing the data from two seasons, there is no statistical evidence that one season was better or worse based on a P-value of .301.

4.2 Comparing Other Goalies

After looking at the trends from the last two seasons, it was important to see how Goalie A compares to other goalies. Goalie B comes from the random sample of seventy different goals that the Army hockey team has scored over the past two seasons. After taking the seventy goals that were scored, the best way to compare trends between Goalie A and B was to use a Chi-squared test. This lets you compare multiple proportions to determine if differences are statically significant. Minitab allowed a comparison of all categories based on their P-values. The null hypothesis is that there is no statistical difference between Goalie A and B. If the P-Value is less than .05, we can reject the null hypothesis and say that there is a statistical difference between the goalies.

Table 4. Chi-square values

Category	Grid	Hand	Line rush or In-Zone	Goal Type	Tape Color	Shot Type	With House
P-value	.479	.825	.059	.250	.647	.418	.082

After running the Chi-squared test on each category, Goalie A and Goalie B's statistics were similar, as all the P-values were greater than .05. This proves that there is strong evidence for no statically significant difference between the statistics of Goalie A and B. The only statistic that was close to a P-value less than .5 is how the goal was scored based on a line rush or in-zone goal. When comparing the actual statistics in that category, Goalie A gave up 35.6% of his goals on line rushes compared to other goalies who only gave up 22.9%. This should be further evaluated by Goalie A to make improvements for the future.

5. Conclusion

From the study conducted, the null hypothesis cannot be rejected. After running the data and comparing trends between Goalie A and B, it is evident that most goalies are the same and there is little statistical difference based on categories we looked at that goalies are different. No statistically significant differences between Goalie A and Goalie B support the fact that looking at Goals Against Average and Save Percentage are likely not an accurate predictor of goalie ability. Future improvements to this research that would make a similar study better would be to increase the sample size which would give more accurate results. Adding more variables such as slap shot, or wrist shot and breaking down the power play goals and even strength goals to see if there is any difference could also be added into those data statistics.

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