A Pareto Principle Analysis of the NHL: Why Ice Hockey is the Ultimate Team Game

Joshua M. Lupinek, University of Alaska Fairbanks
Esul Pomi Chafin, University of Alaska Fairbanks
Jim Arkell, University of Alaska Fairbanks

Abstract

The 80/20 rule has been explored in-depth as it relates to professional sport organizations earning 80% of their revenue from their top 20% of consumers (Mullin, Hardy, & Sutton, 2014). Previous research has shown that the Pareto Principle applies to the playing surface through scoring and team performance metrics in professional basketball and baseball. This project aims to produce research correlating the sport of ice hockey to the 80/20 rule through NHL player scoring, team success, and payroll. The validity of the 80/20 rule was examined with respect to player performance in professional ice hockey and secondary analysis of 2012-2016 NHL season statistics show that the 80/20 rule does not apply to the NHL. The results of this study further enhance the discussion that ice hockey is in fact "the ultimate team sport."

Introduction

This study aims to demonstrate how professional sport managers can apply the 80/20 rule, Pareto principle (Pareto, 1896), to industry success in the National Hockey League (NHL). Pareto (1896) applied the 80/20 rule to Italy's money and population and Koch (2011) states the "minority of causes, inputs or effort usually lead to a majority of the results, outputs, or rewards" (p. 4). The 80/20 rule was first introduced within business literature by Trueswell (1969) who found that most often times 80% of library use would be observed from 20% of the library's collection. Chen, Chong, and Tong (1993) found that the 80/20 rule can be applied to "managerial and strategic implications in many disciplines" (p. 1) and Singson and Hangsing (2014) found similar consumer behavior results with the 80/20 rule and the variation of results based on changing variables. Through the use of electronic database downloads and journal citations, Nisonger (2008) found that there are limitations to the distribution levels of the 80/20 rule. With professional basketball and baseball passing the Pareto principle examination (Berri & Schmidt, 2010; Perry, 2008; Tzellepis, 2015; Zimmerman, 2010), this study examines the applicability of the 80/20 rule in a professional ice hockey environment through NHL player scoring, team success (season points and goals), and payroll (player salaries).

The significance of this study is practical in nature through the examination of NHL team salary cap hits and the correlation to top scoring performances of teams and individual players in five NHL regular seasons (2011/12 - 2015/16). Levesque (2016) states that the 80/20 rule can be applied to the managerial implications within the NHL, emphasizing "the majority of successes as a hockey player come from a small minority of things [done] well" (p. 1). The application of the 80/20 rule has the potential to guide NHL managers to locate the "20% [of players] that leads to 80% [of team's] success" (Levesque, 2016, p. 1). This exploratory analysis seeks to expand upon Levesque's (2016) call and empirically apply the 80/20 rule to the professional ice hockey industry.

NHL team salary caps have emerged as a league problem for organizational management as individual salaries commanded by the league's top players continue to rise (Traikos, 2017). The level of "top-heavy" professional sport teams is increasing with respect to star player salaries. This has eroded the effectiveness of traditional player management with respect to maintaining a balanced set of team salaries in sports such as basketball and baseball (Gaines, 2017). Emerging metrics, for instance the growing prominence of sport analytics with *against replacement* calculations, have advanced the ways professional sport general managers structure their player rosters. It is critical to continue to examine sport through foundational business theory, such as the Pareto Principle, and this study aims to examine the validity of the 80/20 rule in professional ice hockey to discover if ice hockey is in fact "the ultimate team sport" (Chen, 2017).

Chen (2017) states that ice hockey is the ultimate team game because of the individualism culture in hockey, where players do not want to stand out or be different from the team. Both basketball and baseball are team sports and both have found correlation to the 80/20 rule. Even individual sports (such as professional golf) apply to the Pareto Principle, with the top 29% of golfers on the Professional Golfers Association (PGA) Tour collecting 80% of the winnings in 2015 (PGA Tour, 2017). With professional, individual, and team professional sports showing an 80/20 rule connection, other professional sports (such as ice hockey) warrant Pareto Principle analysis. This original investigation aims to make a unique contribution to the literature and produce practical results for dissemination to the global network of professional ice hockey general managers. As such, this study aims to answer the following three research questions through a longitudinal analysis of secondary data from five NHL regular seasons (2011/12 - 2015/16):

- *RQ1*: Does 80% of NHL league scoring (goals for) come from the top 20% of the league's goal scorers?
- *RQ2*: Does 80% of NHL team offense (goals and assists) come from the top 20% of the team's highest paid players?
- *RQ3*: Is there a correlation with NHL team success (team points) and the total offense (goals and assists) produced by the top 20% of the team's highest paid players?

History suggests that, despite new innovations in managerial metrics and analysis, managers have missed opportunities to connect foundational business literature to modern salary cap and roster management (Kuppinger, 2016). The Pareto Principle is one such traditional business theory and, as to date, no research has examined the connection of the 80/20 rule to professional ice hockey. Thus, understanding to what level the 80/20 rule applies to the NHL could allow general managers to better craft their team's salary distribution and manage their rosters within the modern salary cap era.

The following paper begins with an introduction to the Pareto Principle through the business literature and how the 80/20 rule connects to the $1.3 trillion dollar global sport industry (Plunket Research, 2016). Grounded Theory (Glaser & Strauss, 1967; Strauss & Corbin, 1998) is introduced as the theoretical framework that has played a foundational role in secondary data analysis literature, allowing for the data to speak for its self in a number of business areas including professional sport (Andrews & Higgins; Andrews & Lalor, 2012). The study's design with a secondary analysis on NHL records and results are provided, followed by a discussion of the theoretical and practical managerial applications.

Literature Review

The Pareto Principle

The 80/20 rule, also known as Pareto's Rule (Pareto, 1896), was introduced by Vilfredo Pareto. Pareto was an Italian economist and sociologist who noticed a predictable distribution trend when he analyzed income and wealth distribution during the nineteenth century. During his discovery, he broadly noted that 20 percent of the Italian population owned 80 percent of the nation's wealth. Pareto analyzed this concept in various European countries and noticed consistent results of predictable unbalanced ratios regardless of country or time period (Koch, 2011). After Pareto, George K. Zipf (1949) was the "predecessor" of the 80/20 rule. Similar to Pareto, Zipf noticed a consistent unbalance of distribution. In 1949, Zipf examined and introduced the Principle of Least Effort where resources tend to minimize work with an approximate ratio of 20-30 percent resources and 70-80 percent productivity of the resource (Koch, 2011). After Zipf, Joseph Moses Juran was the twentieth century pioneer who applied the 80/20 rule with other statistical methods (Juran, 1975). Juran (1975) applied the rule with different methods to root out quality faults and improve the reliability of industrial and consumer goods.

Today, the 80/20 rule is most commonly used in organizational and business management (Anitha & Kumar, 2008; Krasteva, Sharma, & Wagman, 2015; Weinstein & Barden, 2017). The core of the 80/20 rule states that 80 percent of the output or contribution is produced by 20 percent of the input or cause. The 80/20 rule is applicable in many situations but is most notably known in time management, productivity, and marketing situations. When evaluating customer profitability, Duboff (1992) states marketers are often reminded of the 80/20 rule in that 80% of profits are produced by the top 20% of profitable customers. In the same way, marketers apply this rule to costs with 80% of the costs produced by top 20% of unprofitable customers.

Although the 80/20 rule suggests the ratio 80/20, the rule does not demand the 80/20 ratio to be applied in every situation. Many times the optimal situation for most business application usually demands a 90/10 ratio (Chapman, 2017). While the Pareto Principle is most often cited in the literature as a 80/20 ratio, there are plenty of 70/30 or 90/10 examples as well (Chapman, 2015). No matter which ratio is chosen for analysis, the value most often found lies in diversification. The differences of ratios in certain situations can provide contrast in comparison to the 80/20 rule and can assist with analyzing disproportionate distributions.

Sport Applications of the 80/20 Rule

In the sports industry, the 80/20 rule applies mainly to sport fans and related marketing sales (Chen, Lin, & Chang, 2013). With respect to the Big Four professional sports, most 80/20 rule applications are run to show that 80% of professional team ticket and merchandise revenue comes from the top 20% of consumers (Arnett, & Laverie, 2000; Mahony, Madrigal, & Howard, 2000; Tapp, 2004). Although the 80/20 rule can be applicable to many situations in professional sport consumer behavior, there is not much professional sport research on the application of 80/20 rule to team success and player's salaries. This paucity of research makes this examination critical given the exponential growth of player salaries within the global sports market, estimated to produce $90.9 billion (USD) in revenue (Statista, 2017) from a $1.3 trillion (USD) global sports industry (Plunkett, 2016).

Playing Strategy

The 80/20 rule has been applied to the playing strategy of several team sports, in particular the offensive and defensive roles of basketball. The 80/20 rule applies to the offensive strategy of basketball by understanding judgment and exhibiting patience when receiving screens and picks, finishing routes in set plays, development of "savvy" for the game, and preparation of proper passes. According to Kantor (2004), basketball is a game that thrives on ultimate team configuration. Offensive players must display patience along with extreme understanding and the application of 80/20 in these qualities is critical to be successful. In addition to offense, the 80/20 rule applies to the defensive strategy of basketball. The defensive strategy requires understanding player positioning, impeding cutters across one's face, performing assignments relative to team's philosophy, and understanding team assistance regardless of Man-to-Man or Zone (Kantor, 2004). Throughout the game, a single player will only have the ball in his/her hands or will be directly positioned to guard the ball approximately 20 percent of the game. Therefore, each player must understand how to optimize each play in order to achieve optimal 80 percent "off-ball" game time opportunities and accomplish team objectives.

Individual Professional Sport

The 80/20 rule can also be applied to individual sports, such as professional golf, especially with factors like income inequality. In general, the financial incentives offered in the PGA tournaments influences players' performance and strategy. For example, in the 1987 European Men's Professional Golf Association (PGA) Tour, the level and structure of prizes in tournaments influenced the players' performance, specifically varying positively with both the total money prizes awarded in a tournament and the marginal return of effort in the final round of play (Ehrenberg & Bognanno, 1990). According to Shmanske (2008), the payment structure of the PGA tournaments is disproportionately rewarding players through one-time and exceptional performances rather than consistent steady play. During the 2015 PGA season, 111 out of 385 top ranked players earned 80% of the total money list (PGA Tour, 2017). Therefore, 28.8% of total golf players held 80% of total prize money, further proving the income disproportion present in individual sports such as professional golf.

Team Sports

When applying the 80/20 rule to team sports, researchers have looked at team sports in a number of ways. In 2008, Economics professor Mark Perry did a simple Pareto analysis to National Basketball Association (NBA) scoring. When analyzing NBA stats from 2007, Perry (2008) found that 80% of the league's scoring was accounted for by only 20% of the players. In their 2010 book "Stumbling on Wins", David Berri and Martin Schmidt applied the Pareto Principle to the NBA. They measured wins produced through regression analysis and calculated the wins produced by each player. Berri and Schmidt (2010) found that 20% of NBA players (3 of the 16 players) produced 80% of all of the team's wins.

Prompted by the findings of Berri and Schmidt (2010), Jeff Zimmerman conducted a similar 80/20 analysis to Major League Baseball (MLB). Zimmerman (2010) looked at baseball by using a Wins Against Replacement (WAR) database and he found that 15% of all players produced 85% of the total wins, concluding that the Pareto Principle applied to the statistics during the MLB 2009 season (Zimmerman, 2010). Conversely, in a 2015 MLB blog entitled "A quick look at baseball stats and the Pareto Principle," Angelo Tzelepis (2015) found that when looking at a

single season of MLB stats, the 80/20 rule did not apply. After reviewing Tzelepis' (2015) findings, the research team performed a brief review and found that in almost every statistical area, 20% of MLB players contributed consistently between 40% and 50% of Runs, RBI, HR, Hits, and Wins. However, the Save category fell into the 80/20 range. While these studies looked at team performance when applying the 80/20 rule, no research to date has taken into account team salary when evaluating individual or team performance.

Team Salary and Performance

The relationship between difference in income and performance has a big impact in the overall psychological morale in professional sport settings and overall performance success in professional sport teams. In a social science study, Frey, Schaffner, Schmidt, and Torgler (2013) examined two different disciplines of sports (basketball and soccer) to see if there was behavioral evidence between performance in professional team sport and difference in income when compared between peers. Sporting activities were used to represent controlled environments and 26 seasons of basketball and 8 seasons of soccer were collected. Frey et al. (2013) found that income disadvantage was positively correlated with a decrease in individual performance. This was especially noticed if the individual found out there was a large disparity between their income and their peer's income.

When looking at employee performance and satisfaction, Seibert, Silver and Randolph (2004) found that closer wage gaps suggested higher performance levels in individual and overall organizational performance. Interestingly, findings suggested more compressed pay gaps were positively related to multiple measures of individual and organizational performance, along with satisfaction and overall increased empowerment (Seibert et al., 2004). Since individuals tend to constantly compare themselves when involved in an organization or during a sporting activity, this can greatly impact the individual's choices. Therefore, both aspects of an individual's situation, such as pay, and relative position in the setting are important.

Overall, the pay structure within an organization has important behavioral consequences in work organizations (Harder, 1992). Individuals in fact do care about their relative economic position and can face signs of demotivation and lack of performance in team sports because of the income difference. Results recommend decision makers to consider income position when creating pay-for-performance measures within firms and teams (Frey et al., 2013).

In addition to morale, income differences have effects on team cohesion and performances and can decrease the winning chances of a team. In an *International Review of Economics & Finance* study (Tao, Chuang, & Lin, 2016), the MLB relationship between compensation through team payroll and team performance was studied between the years of 1985-2013. This study focused on salary dispersion along with team performance and was created to find out if compensation affected overall team performance. Tao et al. (2016) found that greater wage disparity negatively correlated to team performance and team cohesion. From the negatively correlated results, the study suggested MLB's current salary structure was not a strong enough incentive for team performance and should be reconsidered by management (Tao et al., 2016).

In a *Journal of Issues in Intercollegiate Athletics* article, a relationship between college coaches, performance, and total compensation was tested from new contracts and contract extensions during the 2007-2012 period (Fogarty, Soebbing, & Agyemang, 2015). Fogarty et al. (2015) found higher actual performance, compared to expected performance in both the previous year and over the past five years, led to an increase in total compensation. In *Economic Letters*, with

data describing baseball teams from 1985 to 1998, Depken (2000) examined if there was a relationship between productivity and wage disparity in the MLB. It was found that MLB teams with greater wage disparity reduced overall team performance (Depken, 2000).

From aforementioned team salary and performance studies, professional sports managers can use this information to make more informed roster decisions when analyzing player salaries with playing performance. This information carries practical significance toward overall player satisfaction and the winning success of professional sport teams. As mentioned above, NHL team salary caps have emerged as a league problem for organizational management as individual salaries commanded by the league's top players continue to rise (Traikos, 2017). Testing the validity of the 80/20 rule in the NHL will help understand if there are income and performance disparities on playing rosters. Filling this literature gap has the opportunity to make a practical impact as professional ice hockey general managers can utilize the findings to make better decisions with respect to optimizing team performance.

Method

In the initial stage of this research, a grounded theory approach was used to allow researchers to clarify meanings within the secondary NHL data context. Past secondary data analysis research has utilized a grounded theory method (Andrews et al., 2012), as it allows the researcher to examine data in a different context from which originally collected (Glaser & Strauss, 1967; Strauss & Corbin, 1998). In addition, previous research with secondary data in sport has also used grounded theory as a method to explore what drives outcomes (Hand, 1998; Kahn, 1993; Landry, Edgar, Harris, & Grant, 2015). There are no identified methodological or ethical challenges for this study as all data was collected from public record.

Data collection consisted of collecting public record statistical and financial data from the 2011/12 – 2015/16 NHL seasons to create a database for investigation with 894 players in 2011/12, 839 players in 2012/13, 886 players in 2013/14, 882 players in 2014/15, and 898 players in 2015/16 (n=4,399). For each NHL regular season between 2011/12 - 2015/16, secondary data was collected for three variables from all thirty NHL teams. These variables include, 1) all rostered NHL player salaries from 2011/12 - 2015/16, 2) complete NHL regular season scoring records from 2011/12 - 2015/16, and 3) complete NHL team regular season game records from 2011/12 - 2015/16. NHL salaries data was collected from Spotrac.com, "the largest online sports team and player contract resource on the Internet" (Sportrac.com, 2017). NHL game records, scoring, and team performance data was collected from NHL.com, the official site of the National Hockey League.

To begin, complete statistical and financial data was collected for each team and year during the five-season examination period of this study. The dataset was created and stored via Excel spreadsheets with unique tabs containing each respective team and season. This data collection method allowed for side-by-side comparison of player statistics along with their team salary cap hit each season. Descriptive statistics were then used to determine the 80/20 percentages for the three research questions. This 80/20 percentage was determined by calculating 20% of each team's payroll for that season and finding the highest paid players that composed the top 20% of the team's payroll. Next, the points scored by those top paid 20% of players for each team were analyzed against their team's complete season scoring records to determine the team's 80/20 percentage number for that respective season. Further data analysis consisted of utilizing basic descriptive statistics to determine the statistical and practical relationships between variables.

Results

Within the five NHL regular seasons examined (2011/12 - 2015/16), the 80/20 rule was not valid in the NHL with respect to individual and team performance or linked player salaries. In terms of the research framework of investigating the performance variables contained within 20% of a team's payroll, the league's highest 80/20 rule team was the Anaheim Ducks, who achieved an 80/20 rule average of 26% of team scoring, peaking especially during the 2011/12 and 2012/13 regular seasons (see Table 1). The Florida Panthers produced the lowest 80/20 rule average over five seasons as the players accounting the top 20% of the payroll accounted for 14% of the team's offensive production.

Table 1: *80/20 Rule 2011/12 – 2015/16 NHL Data Set*

Team	80/20 AVG	PTS AVG	GF AVG	80/20 2011	PTS 2011	GF 2011	80/20 2012	PTS 2012	GF 2012	80/20 2013	PTS 2013	GF 2013	80/20 2014	PTS 2014	GF 2014	80/20 2015	PTS 2015	GF 2015
Anaheim Ducks	26%	95	208	32.00%	80	201	31.08%	66	134	23.80%	116	263	20.56%	109	228	21.70%	103	215
Boston Bruins	15%	94	218	16.93%	102	260	15.07%	62	127	14.40%	117	258	13.00%	96	209	15.77%	93	236
Buffalo Sabres	20%	65	166	27.70%	89	211	15.26%	48	118	9.27%	52	150	28.98%	54	153	19.69%	81	199
Calgary Flames	17%	77	199	18.11%	90	199	10.58%	42	128	10.83%	77	202	27.11%	97	237	16.85%	77	229
Carolina Hurricanes	19%	73	185	15.96%	82	212	28.61%	42	127	19.32%	83	205	14.31%	71	183	18.97%	86	196
Chicago Blackhawks	25%	98	221	18.64%	101	241	30.98%	77	149	19.24%	107	261	28.83%	102	220	25.91%	103	234
Colorado Avalanche	19%	82	196	13.33%	88	199	14.19%	39	114	18.32%	112	245	29.60%	90	209	19.28%	82	212
Columbus Blue Jackets	15%	76	196	16.07%	65	198	6.96%	55	115	10.73%	93	226	18.49%	89	227	24.34%	76	213
Dallas Stars	21%	86	164	28.22%	89	204	25.28%	48	128	16.75%	91	231	20.06%	92	257	17.03%	109	265
Detroit Red Wings	18%	89	204	6.20%	102	239	29.13%	56	122	14.68%	93	217	20.83%	100	231	17.84%	93	209
Edmonton Oilers	22%	64	185	14.18%	74	207	9.33%	45	123	26.51%	67	199	30.43%	62	193	27.04%	70	199
Florida Panthers	14%	78	185	21.31%	94	197	22.06%	36	109	13.32%	66	188	9.24%	91	198	5.89%	103	232
Los Angeles Kings	18%	90	192	11.48%	95	188	17.88%	59	131	20.08%	100	198	18.49%	95	218	20.94%	102	223
Minnesota Wild	19%	84	185	21.70%	81	166	23.00%	55	118	17.71%	98	199	16.50%	100	227	18.28%	87	213
Montréal Canadiens	16%	87	198	2.55%	78	207	21.92%	63	146	22.66%	100	209	19.06%	110	214	16.02%	82	216
Nashville Predators	17%	87	201	16.90%	104	232	17.73%	41	109	18.60%	88	214	13.44%	104	226	18.44%	96	224
New Jersey Devils	20%	80	176	27.52%	102	216	23.76%	48	110	18.77%	88	197	20.91%	78	176	10.44%	84	182
New York Islanders	16%	83	204	23.11%	79	196	16.71%	55	135	13.16%	79	216	5.50%	101	245	22.43%	100	227
New York Rangers	17%	95	209	23.51%	109	222	23.03%	56	126	15.68%	96	214	18.39%	113	248	6.86%	101	233
Ottawa Senators	18%	84	209	18.47%	92	243	6.13%	56	112	22.95%	88	229	19.45%	99	232	23.39%	85	230
Philadelphia Flyers	17%	85	210	12.99%	103	260	14.25%	49	132	20.66%	94	233	21.08%	84	212	15.52%	96	211
Phoenix Coyotes	19%	74	183	18.30%	97	210	17.50%	51	121	25.30%	89	210	17.40%	56	165	18.55%	78	208
Pittsburgh Penguins	23%	98	227	19.65%	108	273	20.18%	72	162	26.47%	109	242	25.71%	98	217	22.03%	104	241
San Jose Sharks	22%	90	207	23.11%	96	219	0.229	57	116	22.05%	111	239	19.61%	89	224	20.19%	98	237
St. Louis Blues	15%	99	205	16.06%	109	206	8.14%	60	124	13.41%	111	239	14.05%	109	239	20.88%	107	219
Tampa Bay Lightning	18%	86	219	23.51%	84	232	21.45%	40	147	11.16%	101	232	18.03%	108	259	15.75%	97	224
Toronto Maple Leafs	17%	72	195	26.17%	80	227	11.20%	57	128	19.17%	84	222	16.57%	68	206	12.62%	69	192
Vancouver Canucks	25%	86	194	29.67%	111	241	30.15%	59	115	18.91%	83	191	23.21%	101	236	23.25%	75	186
Washington Capitals	23%	92	212	20.55%	92	218	25.87%	57	130	25.36%	90	225	24.46%	101	237	21.08%	120	248
Winnipeg Jets	19%	79	203	18.80%	84	221	16.13%	51	141	23.69%	84	219	21.72%	99	223	16.67%	78	212

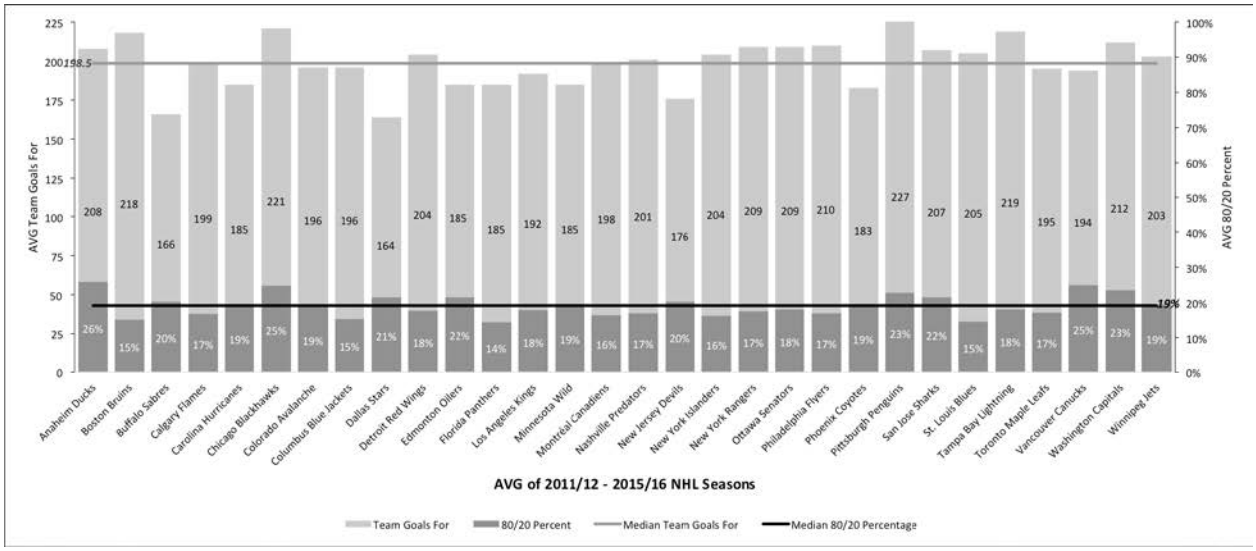
The range of average team points earned toward league standings within five NHL seasons was between 64 and 99. The highest team point averages over the five seasons were the St. Louis Blues at 99 points (15% 80/20 average), the Pittsburgh Penguins at 98 points (23% 80/20 average), and the Chicago Blackhawks at 98 points (25% 80/20 average). The lowest team point averages were the Edmonton Oilers at 64 points (22% 80/20 average) and the Buffalo Sabres at 65 points (20% 80/20 rule average). The general trend shows that a majority of NHL teams between the 2011/12 - 2015/16 seasons achieved an approximate "20/20" ratio (19%), with 20% of the NHL's highest paid players having a hand in approximately 20% of the team goals. The highest 80/20 rule peaks occurred mostly during the 2011/12 and 2012/13 NHL seasons with the Anaheim Ducks at 32.00% in 2011/12 and 31.08% in 2012/13, the Chicago

Blackhawks at 30.98% in 2012/13, the Vancouver Canucks at 30.15% in 2012/13, and the one exception coming from the Edmonton Oilers at 30.43% during the 2014/15 season.

For *RQ1*, data analysis began by determining the number of regular season goals scored by the top 20% of NHL goal scorers for each season (2011/12 = 3,481; 2012/13 = 1,835; 2013/14 = 3,299; 2014/15 = 3,191; 2015/16 = 3,305). The number of goals scored by the top 20% of goal scorers, for each respective season, was then divided by the total NHL goals scored to determine the league 80/20 percentages (2011/12 = 53.19%; 2012/13 = 47.1%; 2013/14 = 48.87%; 2014/15 = 47.49%; 2015/16 = 49.54%), with a five season average of 49.24%. This result shows that from 2011/12 to 2015/16, 49.24% of the NHL league scoring (*goals for*) comes from the top 20% of the league's goal scorers.

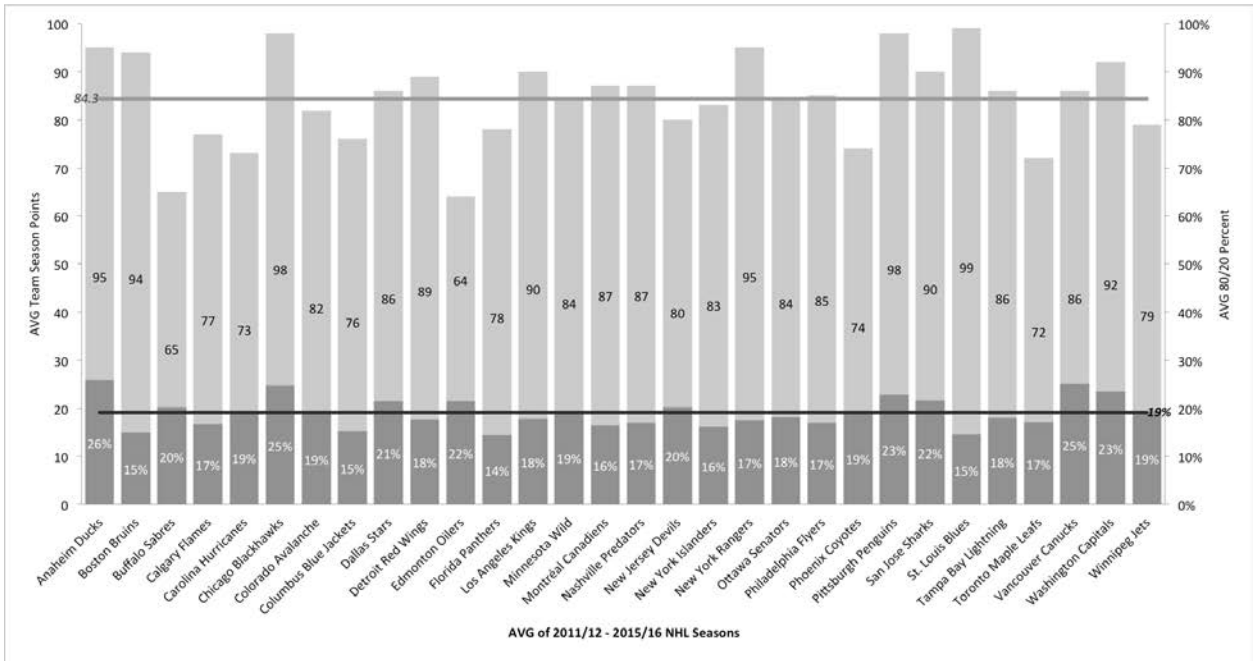
For *RQ2*, each team's 80/20 percentages were calculated using regular season goals and assists (see Figure 1). Goals and assists were used as the scoring metric to encapsulate total team offense (*goals for*) to better include defensemen who potentially made the top 20% of a team's payroll. For example, the Anaheim Ducks averaged 208 *goals for* from the 2011/12 – 2015/16 seasons and the players who made the team's top 20% of payroll had a hand in producing an average of 26% of those 208 goals scored. The range of total team *goals for* within those five NHL seasons (excluding the 2012/13 lockout season) was between 153 and 273. The average lowest team *goals for* over five NHL seasons were the Dallas Stars (164 *goals for* average at 27% 80/20 average) and the Buffalo Sabres (166 *goals for* average at 27% 80/20 average). The average highest team *goals for* from the 2011/12 – 2015/16 seasons were the Pittsburgh Penguins (227 *goals for* average at 24% 80/20 average), the Chicago Blackhawks (221 *goals for* at 26% 80/20 average), and the Tampa Bay Lighting (219 team *goals for* average at 29% 80/20 average).

Figure 1: *80/20 Rule 5-Year Average Compared to Team Goals For*



For *RQ3*, the 80/20 percentages calculated from *RQ2* were used to examine the relationship between the Pareto Principle and the NHL team points earned toward the regular season standings (see Figure 2). The range of average team season points within the five NHL seasons was between 64 and 99 points. The highest average season point earners were the St. Louis Blues (99 points average at 15% 80/20 average), Chicago Blackhawks (98 points average at 26% 80/20 average), and the Pittsburgh Penguins (98 points average at 25% 80/20 average). Conversely, the lowest average season point earners were the Edmonton Oilers (64 points average at 22% 80/20 average) and the Buffalo Sabres (65 points average at 20% 80/20 average). Interestingly, the bottom two teams in season point average (Edmonton Oilers and Buffalo Sabres) both were above the median 80/20 percentage threshold.

Figure 2: *80/20 Rule 5-Year Average Compared to Team Points*



Through salary and performance analysis, there is a significant gap between professional ice hockey and the Pareto Principle. The strong dissociation from the 80/20 rule is revealed through NHL salary and performance metrics throughout the five-year span. The results of this study show that the 80/20 rule is not applicable to NHL individual and team performance and does not have a relationship to ice hockey player salaries.

Discussion

The results of the research indicates that the 80/20 rule does not apply to professional ice hockey as it relates to team offense or overall team success. While the 80/20 rule was investigated, through the analysis done in this research, no statistical measures came close to meeting the Pareto Principle. Unlike prior research, which found an 80/20 correlation when applying the Pareto Principle to Major League Baseball and the National Basketball Association (Berri & Schmidt, 2010; Perry, 2008; Tzelepis, 2015; Zimmerman, 2010), the numbers from the

NHL analysis indicate that success is predicated on a greater balance of salaries further identifying hockey as a more complete team game.

When viewing the Pareto Principle (Pareto, 1896) from the premise that 20% of the workers produce 80% of the results, this study investigated the total goals scored by the top 20% of players in the NHL to see if the 80/20 rule applied. The statistics from the past 5 years show that the top 20% of NHL goal scorers consistently accounted for just under 50% of the total number of goals scored in the league during that period. The 5 year scoring average was 49.24%, with the only season above 50% being the 2011-2012 season at 53.19%. Interestingly, even the lockout-shortened year (2012-2013 season) was still statistically consistent at 47.10%. These findings contrast with Perry's previous NBA 80/20 rule analysis (2008). Mark Perry's statistical review of NBA scoring in 2007 found that the top 20% of league-wide scorers accounted for 79.50% of the total points scored in the NBA. Jeff Zimmerman's (2010) analysis of the Pareto Principle as it applied to WAR (Wins Against Replacement) in baseball found that the 80/20 rule held true. However, a separate analysis of the Pareto Principle as it applies to baseball by Angelos Tzelepis (2015), found that when analyzing a single MLB season the 80/20 rule failed. Conversely, when a complete history of MLB is taken into account, the 80/20 split was almost exact (Tzelepis, 2015). The research team followed up on Tzelepis' findings using MLB's 2016 statistics and found that baseball produces a consistent 40% to 50% with respect to all statistics across the board. The only major statistical area where the 80/20 rule applied was in the Saves category where most MLB teams had five pitchers who accounted for saves and one pitcher accounted for 80% of them.

Although the top 20% of NHL goal scorers account for almost 50% of the goals league-wide, the top 20% of salaried players on each team account for far fewer goals. When viewing the Pareto Principle from an investment perspective, the 80/20 difference drops significantly to approximately 20/20. The players accounting for 20% of an NHL team's salaries contributed only 20% of the team's total offense, as compared to approximately 80% in basketball and approximately 45% in baseball.

When taking these findings and applying them to team success, it appears that the higher the percentage of offense provided by 20% of the highest paid players on a team, the better the overall team success was. Of the eight teams (Anaheim, Chicago, Dallas, Edmonton, Pittsburgh, San Jose, Vancouver and Washington) that had more than 20% of their offense provided by their top 20% of salaried players, all but one (Edmonton Oilers) averaged better than the league average in team points (84.3 points) over the 5 year span. Only one of those teams (Chicago Blackhawks, 2013 & 2015) won the Stanley Cup. However, during that time frame, nine other teams averaged over 84.3 points per season (Boston, Detroit, Los Angeles, Montreal, Nashville, New York Rangers, Philadelphia, St. Louis, and Tampa Bay) and all had less than 20% of the offense being provided by their top paid players. In fact, the other Stanley Cup winners (Los Angeles, 2012 & 2014 and Boston, 2011) fell below the 20% line, with Boston at 15% and Los Angeles at 18% of their offense coming from their top 20% of salaried players. Additionally, the most successful team during the past 5 years in average league points (St. Louis Blues at 99 points average) received only 15% of their offense from their top salaried players.

Although the Pareto Principle failed in this context, this 80/20 rule research framework does produce practically significant results and indicates that hockey is an incredibly well balanced team sport. When 2 or 3 players provide over 20% of a team's total offense, this appears to be a good indicator of overall league success since all but one team was above average. While

having better than average production from the top paid players led to better than average regular season play success, it had little bearing on who won the Stanley Cup Championship.

It is interesting to note that salaries in hockey, like the offensive output, are fairly well balanced. This balance connects to the research of Frey et al. (2013) and Tao et al. (2016) and relates to the performance of players in sports where there is a significant disparity in salary. When looking at NHL team salaries versus NBA team salaries, the disparity between the top paid players and the lower paid players is considerable. In the NHL, the top few players on each roster may make a few million USD more per year, whereas in the NBA and MLB the difference is in the tens of millions USD. For example, if you look at the top 5 paid players on the 2017 NBA Champion Golden State Warriors; Steph Curry earned $34,500,000 USD, which is almost $10,000,000 USD more than Kevin Durant, $17,000,000 USD more than Klay Thompson, $18,000,000 USD more than Draymond Green, and $20,000,000 USD more than Andre Iguodala (Spotrac.com, 2017). Based on these disparities, Frey et al. (2013) and Tao et al. (2016) suggest that resentment will begin to affect performance, making basketball less a team game than a game dictated by the top 20% of earners. Although Kantor found that basketball thrived on team configuration and the 80/20 rule applied to playing strategy from a salary perspective, Perry's findings show that the team relies on only 20% of the team for 80% of the offensive production. However, when looking at current professional hockey salaries, the top players tend to be paid within $2 million USD dollars of each other. For example, the 2017 Champion Pittsburgh Penguins top salaried player was Evgeni Malkin at $9,500,000 USD, which was $800,000 USD more than Sydney Crosby, $2,250,000 USD more than Kris Letang, $2,700,000 USD more than Phil Kessel and $4,000,000 USD more than Justin Schultz. (Spotrac.com, 2017). The Pittsburgh Penguins, like other NHL teams with one or two highly paid 'superstars' were a slight outlier and the majority of teams had even less of a difference between the top 5 salaried players.

Assessing an 80/20 performance based on salary in baseball is incredibly difficult. When looking at salaries of teams for 2017, all but four teams have only one or two players that account for 20% of the salary. Of those two players, one or both is often a pitcher. Baseball relies so much on individual performance that the team aspect of the 80/20 calculation based on salary does not produce statistically consistent numbers. Also, like basketball, the disparity in baseball salaries from the top paid to the second highest player can be greater than $10,000,000 USD (Spotrac.com, 2017). As previously stated in the NHL, the top paid players on each team tend to be within $2,000,000 USD of each other (Spotrac.com 2017). In line with Chen's (2017) findings, this lack of salary disparity in the NHL likely contributes to the culture of hockey being more of a complete team game than other professional sports and is likely why the 80/20 rule fails when applied to team performance in the NHL.

Limitations & Future Research

This study has several limitations. First, there is not a defined way to apply the 80/20 rule to individual or team performance as each sport has unique metrics from which to calculate. Second, a few salary reporting inconsistencies were found when verifying the 2017 Spotrac.com data. Nhlnumbers.com (2017) was used to verify the salary data collected for this study. While there was some minor inconsistencies with players making less than $500,000 and playing under 10 games per season (2-way players with the AHL), the "Adjusted Salary Cap Hit" was consistent throughout and was thus used for the 80/20 percentage calculations. This adjusted salary cap hit integration into the data collection proved useful as it provided a practical managerial perspective to star player trades that fell within the top 20% of payroll, e.g. the

Marian Gaborik trade from New York to Columbus (Klein, 2013) and how that salary cap hit impacted overall team offense.

Third, the unique exploratory nature of this study and contribution to the literature is also a limitation. Because this is the first Pareto Principle investigation into the professional ice hockey industry, the research questions were broadly formed. Now with a baseline of results and practical implications strengthening the ice hockey as the ultimate team game argument (Chen, 2017), future research can examine if the 80/20 rule applies to analytical metrics. While the results of this study show that the Pareto Principle does not apply to traditional metrics, future research should examine if there is an 80/20 rule correlation to emerging analytic measures such as against replacement, zone entries, score effects, back-to-backs, and player deployment (Parnass, 2015).

With respect to the data showing that ice hockey is the ultimate team game in comparison to the other Big 4 professional sports, or Big 5 (Silver, 2014), future research should focus on basketball. Professional basketball should be investigated as the next "team game" and analyzed in more depth due to the smaller roster size and the ability to look at minutes played instead of just offensive metrics. As such, is 80 percent of NBA team minutes played produced from the top 20% of team salaries? This future line of inquiry should also seek to collect longitudinal data from the history of the league(s) with respect to Tzelepis' (2015) findings. While five regular seasons of data collection produced the desired results and data trends, generational scoring differences and "once in a lifetime players," such as Michael Jordan and Kareem Abdul-Jabbar, will be encapsulated in a historical analysis.

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