Reviewing GOT Metrics as KPIs for the German Women's International Field Hockey team, and as a tool to inform future strategy and training interventions. A Case Study approach

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This dissertation is an original and authentic piece of work produced in fulfilment of my degree regulations. I have fully acknowledged and referenced all secondary sources. I have read and understood the Academic Regulations and I am fully aware of any breach of them.

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Darren Lee Cheesman

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Reviewing GOT Metrics as KPIs for the German Women's International Field Hockey team, and as a tool to inform future strategy and training interventions. A Case Study Approach.

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Abstract

Introduction; This thesis examines the use of GOT Metrics as Key Performance Indicators (KPIs) in the analysis and development of performance and results of the German Women's field hockey team. The research aims to use the GOT Metrics as a tool to explain performance in these games between the Top 4 at the European Cup 2021, identify the key factors that determined performance level, and highlight development areas based on the data and metrics. Method; The study is based on the data gathered through video analysis work done retrospectively of the tournament, but provides a template for the method to be used live in competition in the future if desired. A total of 274 Circle Entries were analysed with an attacking and defensive perspective from 6 games at the European Cup involving Germany and the other teams who are their 'Top 4' peers; the Netherlands, Belgium, and Spain. Results / Discussion; The main findings suggest that the use of GOT Metrics provide valuable insight into pertinent areas that allowed Germany to win the Silver Medal, but also explain the areas needing to be focused on and developed in order to be consistent in their tournament performance and compete more seriously for the Gold Medal and a higher World Ranking. The Netherlands were the team considered to be World Leading in their ability to perform consistently against the GOT/Goal metrics - 18.5 Points/Goal in attack, while opposition teams needed 65.3 Points/Goal to score against the Dutch, compared to Germany's 35.3 in attack and 37.9 in defence. The GOT Metrics also showed the preference of Germany in scoring from the RED Zone; searching for the goal chance that is the most certain if you are able to find it, while the Netherlands were able to score from all areas of the circle and this variability in attacking threat could explain why teams struggled to contain them. Although very powerful and insightful, there is also a belief that the Coaching Staff should use the GOT Metrics and any other KPIs they choose to use as one of their tools to support their decision making and not become reliant on them as the only tool.

Keywords: Key Performance Indicators, Field Hockey, High Performance Sport, Women's Sport, Goal Scoring, Profiling, Benchmarking, Case Study, Germany

1.0 Introduction

The German Women's International field hockey team won a Bronze Medal at the 2016 Rio Olympic Games, which was their first Olympic medal since their 2004 Athens Olympic Gold Medal. Since then, their final ranking in major tournaments has ranged from 2nd (Silver Medals in Antwerp 2019 European Championships and Amsterdam 2021 European Championships) all the way down to 6th (their result in Tokyo 2020 Olympic Games, played in 2021 due to COVID-19 delays). Although there were changes in personnel due to selection, retirement, and new players joining the squad, there are interesting questions to be answered: Why are the Germans so inconsistent at major tournaments, and are there any factors that help underpin their performance and success of the team?

In order to investigate the core factors, a logical first step was analyse the existing Key Performance Indicators (KPIs) used when defining performance in hockey and similar sports, and then to define a set of KPIs to use as a tool when analysing a set of competition matches from Germany and their rivals, and look at Germany's performance against those metrics to decide whether they are indeed relevant to the prediction of good performance, and most importantly games won and improvement of tournament ranking. Having looked at previous KPIs used within hockey, it was clear to see that these were used in isolation of each other, and this research hopes to understand the benefit of utilising the interaction between multiple KPIs in order to give a more accurate understanding of any performance, result or trend.

This research, which analysed the matches played at the 2021 European Cup, was deliberately focused on the team's ability to effectively manage the moments of the game in the Attacking and Defensive Circle using GOT Metrics (Goals, Opportunities, and Threats Metrics: GOT/Goal, GOT/CE, Total GOT, all for Attack and Defence), which awards each Attacking and Defensive Circle Entry (CE) a certain number of points in the performance analytical process based on the shot location, pressure on the ball from defensive player(s), and ultimately the quality of the goal scoring chance.

The aims of this research are then to use GOT Metrics as the KPIs:

- examine Germany's performance at the 2021 European Championships
- identify the correlation between Germany's GOT Metrics at the tournaments and their results
- suggest ways this could inform future strategy and training interventions for Germany.

2.0 Review of Literature

Although used widely in hockey, KPIs are often looked at in isolation, are basic in nature (looking at things like total circle entries, total shots on target, number of penalty corners won etc.), and sometimes poorly defined by practitioners. Parmenter (2010) looked at KPIs specifically in the business world; how to develop, implement and use them in a more productive and efficient way. There is lots to take from this text book, especially the "7 Characteristics of KPIs", which gives a very clear process to follow in defining any KPI, and the "12 Step Model", which was the best practical guide to KPI implementation found during the search through literature on the topic.

Considering most sports are dynamic, Rowlinson (2020) says analytics in sport "increase certainty and decrease risk by providing informed analysis". While this is a modern and now well established view, there is also an opposing concern in the industry that there is often an over reliance on data, whether those be in the form of technical / tactical KPIs or physical metrics both within the training phase and during a match. Data collected is often preferred and relied upon due to it's ease of collection, objectivity, and ability to manipulate in order to form trends and future interventions, however there is a need for more reliability in the data (Muller, 2021) and without the context found within the subjectivity of the game (Phatak et al. 2022), it is hard to truly grasp the full reality of a picture drawn as a result.

When looking at how KPIs are currently used in sport (especially those most similar to hockey) then it is essential to understand what is currently used and how that might inform the usage and effectiveness of GOT Metrics within hockey. There were three key areas that stood out, and were relevant to the shaping and development of this research. These will be summarized below.

2.1 Individual Player Analysis

Most of the literature around KPIs within sport at least mentioned, but were mainly focused on the analysis of individuals within a team and used that analysis to develop those individuals. These metrics are used to support the understanding of an individual player's impact on a game (Santos et al., 2019; Bravo et al., 2021; Heaton & Mitra, 2022; Rahimian et al., 2021), their efficiency (Bravo et al., 2021; Takvorian, 2021), inform coaching interventions specific to the individual (Bravo et al., 2021; Takvorian, 2021), and (although there is still a common belief that within youth sport, Talent ID and the recruitment done as a result is largely guess work due to it's complexity) the recruitment of players in terms of tracking their performance trends (Takvorian 2021) as well as the expected return on any investment made in the signing of any player based on their metrics (Bravo et al., 2021; Taylor, 2020; Phatak et al., 2022; de Hoog, 2015; Takvorian, 2021). It is clear that there is a wealth of data and research to support the deep understanding of an individual's quality and performance, especially for the player who is on or at the ball, and this could have been used to provide an additional level of insight to the metrics studied in this research. However, due to the low number of games analysed in this research and the low frequency of goal scoring actions from individuals within these games, it was determined that not enough data for each player would be

available and therefore hard to form impactful trends. The body of research mentioned in this section could very well support future research into the impact of GOT Metrics if there are more games available to draw data from.

2.2 Team, Goal, and Goal Chance Analysis

Since the GOT Metrics are exclusively measuring moments in the game that involve or could involve goal scoring chances, there was a need to understand how these moments are currently analysed both within hockey and other similar sports. Every goal chance / shot is unique (Umami et al., 2021) but having a model to capture the key attributes of these chances and the outcome allows KPIs (xG in football and GOT in hockey among others) to provide a framework for players and coaches to use when considering which chances give them a higher likelihood of converting into goals. As hockey, like football is a low scoring game, it is important to look at goal opportunities and the factors that are associated with them when analysing trends as you will be able to find more data to form patterns (Wright et al., 2011) and include moments that could potentially lead to goals, as opposed to the almost randomness of actual goals scored (Rowlinson 2020). In other research, these associated factors have included phase of play leading to the goal chance (Lignell et al., 2020), shot location (Wright et al., 2011; Van Haaren, 2021; Michailidis et al., 2013; Eggels, 2016), position of the feed (Bravo et al., 2021; Wright et al., 2011; Rahimian et al., 2021), type and location of repossession preceding the phase of play resulting in a goal chance (Sunderland et al., 2006; Wright et al., 2011), position and pressure of defending player(s) in relation to the goal chance (Eggels, 2016; Lignell et al., 2020; Lucey et al., 2014; Rahimian et al., 2021), and others. These are all helpful and seem to increase the ability to predict the likelihood of the goal chance converting into a successful goal. The traditional KPIs in hockey are mainly focused on the frequency of CEs, Goal shots etc. and do not take into consideration the aforementioned characteristics of the chance, so the inclusion of these into the forming of the GOT Metrics are expected to increase the models ability to accurately analyse performance and inform future interventions.

Myers & Daly (2022) is an exception to this, and was able to take the xG methodology from football and implementing it in hockey; analysing its accuracy when applied to the NCAA Women's College level. While possible to transfer, it is clear that football has access to far more video angles, points of data, and number of analysts per game, meaning they are able to apply formulas like xG with far more effectiveness and efficiency. In hockey however, the time spent by analysts determining the exact angle of each shot in order to collect data for the model, could be spent in other ways that yield far greater return for the team in this typically under-resourced sport.

All aforementioned research was done with an offensive focus, and it is believed to be pertinent to pay just as much attention to detail on the defensive aspect of the team's performance. Understanding the type, quality, and frequency of goal scoring chances conceded alongside the chances created will allow a much deeper analysis of the strengths and weaknesses of current play, and make amendments to future strategies and focuses.

2.3 Benchmarking and Scouting

Whether used by supporters, media, players, coaching staff, Board of Directors, or sponsorship partners, the ability to use some basic metrics to compare teams across a season outside of simply their league position / tournament ranking and match result, provides a helicopter view comprehension of the performance of one team against another over a period of time, or against the league average standard (Lucey et al. 2014). Since this research is focused on Germany within a tournament, the concept of Benchmarking the team's performance against KPIs became a crucial area of focus.

This use of KPIs within sport has supported greatly the idea of how to develop GOT Metrics and the impact of their implementation is Scouting Reports. Among the KPIs currently used in this area, the most relevant were the use of opposition trends in goals scored and goals conceded against the match timeline (Michailidis et al. 2013), opposition attacking chance creation with a view of adapting your own defensive structure or plan (Takvorian, 2021), and creating a profile on your opposition based on trends on repeated behaviours within matches (Lago-Peñas et al., 2011). Germany will of course have their own style, tactics, and preferences when entering a match, however with the insights gained from a detailed Scout Report, they will be able to refine the details within the plan to become more effective within the game, know how to utilise their own strengths, and be prepared for the particularity of the threats the opposition will likely offer in each game.

2.4 Usage and implications of usage of KPIs

While there are clear benefits to the implantation of KPIs, the use of them in sport is not without its challenges. Among the major concerns are the potential for bias in the selection and interpretation of KPIs, which can lead to unfair evaluations of athletes and teams (Croft et al., 2017), the over reliance of KPIs due to the objectiveness of the data gathered and the lowered value placed on the contextual, subjective detail that is also found within the game (McGarry, 2009). It is therefore essential that any KPIs that are used within a team are able to relate to the context of the game, allow for decision making within a model rather than suggesting that one action is "correct" while another is "wrong", are used in combination with other KPIs - not in isolation, and are used primarily as a tool to prompt deeper conversations, analysis, and interventions. As Lago (2007) mentions, if the KPIs are working, there should be a correlation between them and success, although it is also important to note that scoring high on KPIs alone does not guarantee a team to win any one game (Lago, 2007; Wright et al., 2011).

It is hoped that this research on GOT Metrics, with the support from the learnings of the aforementioned previous literature, will provide the German Coaching Staff an ability to better analyse the performance of their own team and their opposition, form profiles of each team to aid an informed decision on future tactical plans, and improve their chances of success at future tournaments. This would then add significant value to the existing body of research within the area of KPIs in Sport, and more specifically Hockey, where there is currently limited research literature to aid such decisions.

3.0 Method

3.1 Match Data

While other studies within hockey have focussed on goals scored and the details surrounding them, such as type and location of repossession (Sunderland et al., 2006), location of the final shot leading to the goal (Crutchley, 2013), feed type (Crutchley, 2013), phase of play leading to the goal (Sunderland et al., 2006), and technique of shot used for the goal shot (Sunderland et al., 2006; Michailidis et al., 2013), this research focusses on Germany's ability to create goal scoring chances, the quality of those chances, the efficiency of those chances, and preventing goal scoring chances in their defensive circle. This is then examined to find metrics that may help explain the pertinent focus areas for Germany moving forwards in their hope to improve their consistency and ability to challenge for medals on the world stage.

The data was collected from 6 International matches played at the 2021 Women's European Cup by Germany and the other 3 teams finishing in the top 4 places of the competition (Netherlands, Belgium and Spain). Only the games played against each other were analysed to ensure the data collected was based on "best vs best" and would not be skewed by performances against lower ranked nations (O'Donoghue, 2009). Germany were in the same group as Belgium, so their match against each other was in the group stages, as was the game between Netherlands and Spain. The next game analysed for all teams was the Semi Final matches between the four teams, and finishing with the Final (between Germany and Netherlands) and the Bronze Medal match (between Belgium and Spain).

| Team | Final Ranking |
|------|---------------|
| NED | Gold |
| GER | Silver |
| BEL | Bronze |
| ESP | 4th |

Table 1. Final ranking of the top 4 teams from Women's European Cup

From these games, the Circle Entries for each team were coded and collected, and used for both the attacking and defensive metrics. There were a total of 274 Circle Entries (CEs) across the 6 games, which were analysed for each team based on whether they were attacking or defensive CEs.

3.2 Collection of Data

Following the analysis of the Match footage on Hudl SportsCode, the data was exported to a Microsoft Excel spreadsheet where it could be manipulated and formed into trends for Germany in attack and defence, which also then provides a profile for the opposing team.

When doing the initial analysis, the main two challenges were clearly defining what constitutes an "event" and the same for a "non-event" (James et al., 2007), and being able to consistently determine where exactly in the circle the scoring opportunity was located so to be sure which points to allocate each Circle Entry according to the GOT Metrics Coding Model. There also needed to be consistency in determining whether there was pressure on the shot or not as this also influenced the points given to each Circle Entry. In order to ensure there was a level of consistency in the classification of each event, a discussion was held involving the coach who was responsible for the coding of each game, some current Senior international Head Coaches, and some Senior Club Head Coaches (Consultation Group) around how to determine each action and how to decide between contentious situations.

Location

The location of the ball was decided the determining factor, not the location of the body of the attacking player. A diagram for the division of the circle was created to aid the decision for each Circle Entry, and this diagram was used as the coding buttons on the coding window in Hudl SportsCode (Figure 1) to ensure the Coach was able to compare the match footage and the definition agreed upon. Rathke (2017) was able to determine that in football, "distance does matter when calculating xG. However, a combination of the distance and the angle of the shot from goal may be better suited to calculating xG", which gives added strength to the rationale behind the points allocated for each of the zones within the GOT Points Matrix. The closer the ball is to the goal at the moment of the shot, the higher the points awarded, and the more central the is, the higher the points awarded are.

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| | | | | | | | | |
| Points to Code | No touch | Control | RED | A | В | C | PC | PS |
| With Pressure | 0.5 | 1 | 5 | 4 | 3 | 2 | 5 | - |
| | 0,0 | | | | | | | |
| Without Pressure | 0,5 | 1 | 6 | 5 | 4 | 3 | - | 6 |
| | | | | | | | | |

Figure 1. Coding window used during the Data Collection

Pressure from Defending Player(s)

The secondary focus on point allocation was the pressure from defending player(s). Lucey et al. (2014), Rahimian et al. (2021), and Eggels (2016) all referred to the importance of the location of defending player(s) when calculating the xG in football, and during the discussion with the hockey coaches, it was determined that it is equally important when calculating GOT Points in hockey, as a shot without pressure in hockey will lead to a higher chance of scoring.

Rebounds

Where there are multiple efforts on goal / chances, each chance within the same CE would be awarded their respective points, meaning there could be multiple scores for each CE, which are totalled to give an overall score.

Shot on goal leading to a PC

When the PC is awarded due to a foul from a defender before the ball has reached the goal, the points for only a PC are awarded. If the PC is awarded after the ball has hit the target due to the ball being made dangerous by the GK's save, the ball hitting a defender's foot or body from the rebound, or similar, the points for both the shot and the PC are awarded.

Rebounds from within a PC

The allocated 5 points assumes that there is a chance to have an opposed shot from the top of the circle during the set play. If the team chooses to run a variation and does not get the shot on goal, it is still counted as 5 GOT Points. If there is a rebound or multiple rebounds, each additional chance will be awarded the relevant points for a chance of that type and included in the original CE data.

PC re-awards

On the event of a PC being awarded during an existing PC, these will be counted in the original CE, but each re-award will create an additional 5 GOT Points for that CE in the data.

PCs awarded for serious fouls outside the circle but within the attacking 23m area

Since there was no actual CE in these events leading to the PC, there was a discussion in the Consultation Group around how to capture these instances. It was agreed that these moments would still be awarded 5 GOT Points for the goal scoring chance associated with the PC set piece, and a CE would be added to the total to assist in the accuracy of the Metrics, as the award of a PC, regardless of whether it was won inside or outside the attacking circle, leads to an opportunity to have a free shot at goal from within the Circle during the set piece.

No contact with ball in Circle

Where a ball is played into or through the circle, but there is no player close to the ball, it was decided that these moments would not be recorded in the data as there was no scoring possibility. The lack of a touch or control of the ball was not due to a technical error, but because the ball was played towards an area where there was no possibility to reach an attacking player. If there was a player who the pass was directed to and there was an interception by the defender or goalkeeper, or the pass did not connect, or the attacking player was not able to touch the ball due to a technical error, this would be recorded in the data, but as a "No Touch", scoring the lowest of the GOT Points; 0,5. The only exception to this is when the player is in a goalscoring position and they try to score with their first touch and miss the ball. This is counted as a goalscoring chance and will be given the same score as if they had made contact with the ball. This is to ensure major goal scoring chances are recorded in the data and not missed due to a technical error from the player trying to score with 1 touch. This is only true when the chance was without pressure from a defending player. If the chance was with pressure, it was considered good defending and the chance was awarded lower points (0,5).

3.3 Analysis and Recommendations

Following the collection of the data from the matches, the results are to be presented in a clear, coherent way in order to analyse, reflect on, and base recommendations on for future interventions pertaining to training detail and tactical plan adaptation / creation.

3.4 Data Reliability

O'Donoghue (2007) outlines 7 recommendations to ensure the method of analysing the performance video to gather data for use against KPIs is a robust, consistent, and reliable one, and this process has been followed as outlined in the steps and measures taken below, resulting in a "Gold Standard". This is an essential process, especially considering the potential impact of human error in the collection and analysis of the data involved in the research (O'Donoghue, 2009).

The GOT Metrics, the events that associated to them, and the point allocation criteria were all defined precisely (found in the Collection of Data), leading to a consistent understanding among the Consultation Group.

The match footage was provided in September 2021, after the tournament had been completed. All 6 of the matches were filmed from the "Tower View", looking at the pitch from high, down the length of the pitch. These games were all filmed using a High Definition camera by the same person; the German Women's Performance Analyst. All footage was analysed using Hudl SportsCode software on the same Apple MacBook, and the resulting data further analysed in Microsoft Excel.

To ensure consistency and reliability, the same coach was tasked with both the coding of each game through Hudl SportsCode and the analysis of data through Microsoft Excel. The coach is a qualified FIH Level 4 Coach and a Post Graduate Diploma in Elite Coaching Practice graduate, as well as being experienced as a Head Coach in the English, Belgian, Dutch, and German top leagues and Junior International level for England and Belgium. In each of these roles, the Coach has experience of utilising the Hudl SportsCode software for the purpose of generating the exact data required for this project.

To formulate a structured and consistent analysis, a discussion involving the aforementioned Coach, current Senior International coaches, and top current club coaches (Consultation Group) was used to define the GOT Metrics, how the Circle area should be divided, and how each point should be awarded based on the perceived ease of scoring goals from each location. There was also a debate about how to award points in a number of potentially contentious situations. An example of a contentious situation is when there is a PC awarded for a serious foul outside of the circle, meaning there was no CE in order to achieve the goal chance. The conclusion of the discussion was that the PC itself is a goal chance, and therefore the act of getting the serious foul allows the attacking team a CE as part of the PC, so will be included in the CE data and metrics. This situation happened just one time in the 6 games, and therefore this protocol was followed.

Once the methodology was confirmed, a coding window was then designed and used for each game to 1) code the games to collect the CEs, and 2) label the CEs with the relevant data. Having this Coding Template as the sole way of collecting the data meant only the codes and labels that were pre-determined could be used, leaving no space for alternate information. The matches were not coded live, which allowed the ability to use freeze-frame and the rewind function, along with a chance to zoom in to make sure the most accurate labels were applied to each instance (James et al., 2007).

After completing the first three matches, the Coach was then required to go back to code and label one of the matches again to see if there were any discrepancies in the coding, allowing an intrareliability test protocol to be executed (James et al., 2007). The frequency of codes used were the same, which was the first sign that no events were missed and all was perceived the same across the two moments of coding (James et al., 2007). It was then pertinent to determine the content of these codes to calculate how each one was perceived and where the discrepancies were. There were no discrepancies calculated (coding outputs can be seen in Appendix A, calculating the Pearson Correlation Coefficient, and all contentious issues were perceived in the same way as the previously coded match, as according to the outcome of the discussions within the Consultation Group. This gave a Pearson Correlation Coefficient of 1. This shows that there was a good amount of clarity in the original definitions and procedures that were to be followed (James et al., 2007).

4.0 Results

Having collected all the data from the games analysed, the data was gathered in tables to allow deeper analysis of the KPI metrics that were achieved during individual games and across the three games each of the teams played. The first step was to gather all the Circle Entries for each team in Attack and Defence, and organise them by the outcome achieved in order to give a clear picture of the frequency for each team for each particular outcome (Table 2 & Table 3). Placing them together in the same table allows an easy comparison between the teams as well as the Average Score across the four teams, which is detailed in the bottom row of both tables.

Important to note that "W" represents the shots from each area of the circle that were made with pressure from defending player(s), and "WO" represents those that are without.

| ATT | No Sho | t | с | | В | | А | | RED | | Set Pie | ce |
|-----|--------|------|------|------|------|-----|-----|----|-----|------|---------|------|
| | 0.5 | 1 | w | wo | w | wo | w | wo | w | wo | PC | PS |
| NED | 19 | 29 | 0 | 1 | 5 | 4 | 4 | 4 | 5 | 3 | 14 | 0 |
| GER | 15 | 21 | 1 | 0 | 6 | 1 | 0 | 0 | 4 | 4 | 16 | 0 |
| BEL | 11 | 25 | 1 | 0 | 7 | 1 | 4 | 0 | 7 | 2 | 5 | 1 |
| ESP | 23 | 23 | 1 | 0 | 3 | 0 | 2 | 0 | 4 | 2 | 15 | 0 |
| Av. | 17 | 24.5 | 0.75 | 0.25 | 5.25 | 1.5 | 2.5 | 1 | 5 | 2.75 | 12.5 | 0.25 |

Table 2. Total frequency of each outcome for each team in Attacking Circle Entries

| DEF | No Sho | t | с | | В | | Α | | RED | | Set Pie | ce |
|-----|--------|------|------|------|------|-----|-----|----|-----|------|---------|------|
| | 0.5 | 1 | w | wo | w | wo | w | wo | w | wo | PC | PS |
| NED | 19 | 16 | 3 | 0 | 3 | 0 | 1 | 0 | 5 | 0 | 11 | 1 |
| GER | 21 | 25 | 0 | 0 | 6 | 2 | 1 | 2 | 3 | 1 | 11 | 0 |
| BEL | 16 | 27 | 0 | 0 | 5 | 2 | 0 | 2 | 2 | 4 | 14 | 0 |
| ESP | 12 | 30 | 0 | 1 | 7 | 2 | 8 | 0 | 10 | 6 | 14 | 0 |
| Av. | 17 | 24.5 | 0.75 | 0.25 | 5.25 | 1.5 | 2.5 | 1 | 5 | 2.75 | 12.5 | 0.25 |

 Table 3. Total frequency of each outcome for each team in Defensive Circle Entries

As each CE is given a score dependent on the outcome, it was then possible to create tables showing Goals Scored in each game, Total number of CEs, and Total number of GOT Points for the game, which then allowed two further columns to be added; GOT/CE (the average number of GOT Points per Circle Entry) and GOT/Goal (the average number of GOT Points that were needed to score each goal).

Having coded the six games for this research, this table (2) shows the frequency of the outcomes in each of the CEs of each of the four teams. It is possible to see from the table the trends for each country on where their goal scoring chances are mostly coming from, and how that compares to the other teams.

The below two tables (Table 4 and 5) show the defensive equivalent to Table 2 and 3, showing how many goals each team conceded in the games analysed, how many times opposition were in their Circle, and the GOT Metrics related to those Circle Entries allowed.

| ATT | Goals | Total CE | GOT Total | GOT/CE | GOT/Goal |
|-----|-------|----------|-----------|--------|----------|
| NED | 12 | 84 | 221.5 | 2.6 | 18.5 |
| GER | 5 | 60 | 176.5 | 2.9 | 35.3 |
| BEL | 5 | 62 | 151.5 | 2.4 | 30.3 |
| ESP | 3 | 68 | 160.5 | 2.4 | 53.5 |
| Av. | 6.25 | 68.5 | 177.5 | 2.6 | 34.4 |

Table 4. GOT Metrics summary for all teams in Attacking Circle Entries

| DEF | Goals | Total CE | GOT Total | GOT/CE | GOT/Goal |
|-----|-------|----------|-----------|--------|----------|
| NED | 2 | 53 | 130.5 | 2.5 | 65.3 |
| GER | 4 | 67 | 151.5 | 2.3 | 37.9 |
| BEL | 5 | 67 | 172 | 2.6 | 34.4 |
| ESP | 14 | 87 | 256 | 2.9 | 18.3 |
| Av. | 6.25 | 68.5 | 177.5 | 2.6 | 39.0 |

Table 5. GOT Metrics summary for all teams in Defensive Circle Entries

In order to get an even better insight into each of the teams, their strengths, their weaknesses, and how Germany may benchmark against them or prepare for a match against them in the future, it was essential to present the data collected in country specific profiles.

| | ianhai | ry L | | | | | | | | | | | | | | | | |
|--------|--------|---------|---------|--------|-----------|-----------|-----------|-----------|----------|----------|----------|------|-----|---------|----------|-----------|-------------|---------|
| | No S | Shot | υ | | - 60 | ~ | 4 | _ | RE | Q | Set F | iece | GOT | Metrics | | | | |
| | 0.5 | - | 3 | Ŵ | 3 | Ŵ | 3 | Ŵ | 3 | Ŵ | PC | PS | | Goals | Total CE | GOT Total | GOT/CE | GOT/Goa |
| GER | 4 | 7 | 0 | 0 | 2 | - | 0 | 0 | 0 | - | 5 | 0 | GER | - | 19 | 50 | 2.6 | 50.0 |
| BEL | е | 12 | 0 | 0 | m | ٦ | 0 | 0 | - | 0 | 0 | 0 | BEL | - | 19 | 31.5 | 1.7 | 31.5 |
| GER | 5 | 8 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | ю | e | 0 | GER | 4 | 22 | 59.5 | 2.7 | 14.9 |
| ESP | 11 | 6 | 0 | 0 | m | 0 | - | 0 | - | - | 7 | 0 | ESP | - | 27 | 70.5 | 2.6 | 70.5 |
| GER | 6 | 6 | - | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 8 | 0 | GER | 0 | 19 | 67 | 3.5 | • |
| NED | 7 | 7 | 0 | 0 | 0 | - | 0 | 2 | - | 0 | 4 | 0 | NED | 2 | 21 | 49.5 | 2.4 | 24.75 |
| GER | 15 | 21 | - | 0 | 9 | - | 0 | 0 | 4 | 4 | 16 | 0 | GER | 5 | 09 | 176.5 | 2.9 | 35.3 |
| ОРР | 21 | 25 | 0 | 0 | 6 | 2 | - | 2 | ю | - | 11 | 0 | ЧО | 4 | 67 | 151.5 | 2.3 | 37.9 |
| GOAL | TYPE | _ ≤ | ISTANCE | E # G(| OT LAB | ELS | | | | | | | | | | | GOT POIN | TS |
| GERM | ANY | | | | | | | | | | | | | | | | | |
| vs BEL | | | | 18 W | 'ithout P | ressure, | Location | RED | | | | | | | | | 6 Points | |
| vs ESP | | | | 2 Lo | scation F | RED, Wit | thout Pre | sssure | | | | | | | | | 6 Points | |
| vs ESP | | | | 18 Pe | nalty Co | orner, W | ith Pres | sure, Per | alty Cor | ner, Wit | h Pressu | Ire | | | | | 5 Points, 5 | Points |
| vs ESP | | | | 21 W | ith Pres | sure, Loc | cation RI | Ģ | | | | | | | | | 5 Points | |
| vs ESP | | | | 22 Lo | cation F | RED, Wit | thout Pre | essure | | | | | | | | | 6 Points | |
| OPPO | SITION | | | | | | | | | | | | | | | | | |
| vs BEL | | | | 17 Lo | cation E | 3, Witho | ut Press | ure, Loci | ation RE | D, With | Pressure | a | | | | | 4 Points, 5 | Points |
| vs ESP | | | | 7 Pe | analty Co | orner, W | ith Pres | aure | | | | | | | | | 5 Points | |
| vs NED | | | | 9 Pe | analty Co | orner, W | ith Pres | aure | | | | | | | | | 5 Points | |
| vs NED | | | | 21 Lo | cation E | 3. Witho | ut Press | ar | | | | | | | | | 4 Points | |

4.1 Germany GOT Metrics Profile

| | No Shot | | υ | | | Ĺ | | REI | | Set P | ece | GOT | Metrics | | | | |
|-------|---------|-------|-------|-----------|------------|------------|-------|-----|---|-------|-----|-----|---------|----------|-----------|----------|----------|
| | 0.5 | > | Ŵ | 3 | Ŵ | 3 | Ŵ | 3 | Ŵ | 2 | PS | | Goals | Total CE | GOT Total | GOT/CE | GOT/Goal |
| NED | 5 | 4 | - | 2 | 2 | 4 | 0 | m | - | ~ | 0 | NED | 7 | 38 | 105.5 | 2.8 | 15.1 |
| ESP | 7 | 1 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | ESP | 1 | 18 | 34.5 | 1.9 | 34.5 |
| NED | 7 | 3 | 0 | m | - | 0 | 2 | - | 2 | m | 0 | NED | 3 | 25 | 66.5 | 2.7 | 22.2 |
| BEL | 9 | 1 | 0 | - | 0 | 0 | 0 | - | 0 | - | - | BEL | ۲ | 16 | 29 | 1.8 | 29.0 |
| NED | 2 | 2 | 0 | 0 | - | 0 | 2 | - | 0 | 4 | 0 | NED | 2 | 21 | 49.5 | 2.4 | 24.75 |
| GER | 9 | 2 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 80 | 0 | GER | 0 | 19 | 67 | 3.5 | • |
| NED | 19 2 | 6 | - | 5 | 4 | 4 | 4 | 5 | e | 14 | 0 | NED | 5 | 09 | 176.5 | 2.9 | 35.3 |
| ОРР | 19 1 | 6 3 | 0 | m | 0 | - | 0 | 2 | 0 | 5 | - | OPP | 4 | 67 | 151.5 | 2.3 | 37.9 |
| 1 | | | | | | | | | | 1 |] | | | | | | |
| I TAO | TYPE | INSTA | NCE # | GOTLA | BELS | | | | | | | | | | | GOT POIN | ATS |
| ETHE | RLANDS | | | | | | | | | | | | | | | | |
| s ESP | | | 4 | Without | Pressure, | Locatio | L C | | | | | | | | | 3 Points | |
| s ESP | | | 5 | Location | RED, Wi | th Press | ar | | | | | | | | | 5 Points | |
| s ESP | | | 12 | Penalty (| Comer, W | /ith Pres | sure | | | | | | | | | 5 Points | |
| s ESP | | | 18 | Penalty (| Corner, W | /ith Pres | sure | | | | | | | | | 5 Points | |
| s ESP | | | 20 | With Pre | ssure, Lo | cation A | | | | | | | | | | 4 Points | |
| s ESP | | | 21 | Without | Pressure, | Locatio | n RED | | | | | | | | | 6 Points | |
| s ESP | | | 33 | With Pre | ssure, Loi | cation A | | | | | | | | | | 4 Points | |
| s BEL | | | 2 | Location | RED, Wi | th Press | er | | | | | | | | | 5 Points | |
| s BEL | | | 6 | Without | Pressure, | Locatio | n RED | | | | | | | | | 6 Points | |
| s BEL | | | 20 | Penalty (| Comer, W | /ith Pres | sure | | | | | | | | | 5 Points | |
| s GER | | | 6 | Penalty (| Comer, W | /ith Pres: | sure | | | | | | | | | 5 Points | |
| s GER | | | 21 | Location | B, Witho | out Press | ure | | | | | | | | | 4 Points | |
| PPOS | ITION | | | | | | | | | | | | | | | | |
| s ESP | | | 17 | Location | RED, Wi | th Press | erre | | | | | | | | | 5 Points | |
| s BEL | | | 10 | Penalty : | Stroke | | | | | | | | | | | 6 Points | |

4.2 Netherlands GOT Metrics Profile

KNHB

| | No S | hot | 0 | | | ~ | 4 | _ | RE | Ģ | Set F | iece | GOT | Metrics | | | | |
|--------|-------|-----|--------|----------|-----------|-----------|-----------|-----------|----------|---------|----------|------|-----|---------|----------|-----------|-------------|----------|
| | 0.5 | - | 3 | Ŵ | 3 | Ŵ | 3 | Ŵ | 3 | Ŵ | PC | PS | | Goals | Total CE | GOT Total | GOT/CE | GOT/Goal |
| BEL | m | 12 | 0 | 0 | е | - | 0 | 0 | - | 0 | 0 | 0 | BEL | 1 | 19 | 31.5 | 1.7 | 31.5 |
| GER | 4 | 7 | 0 | 0 | 2 | ٦ | 0 | 0 | 0 | ٦ | 5 | 0 | GER | 1 | 19 | 50 | 2.6 | 50.0 |
| BEL | 9 | 5 | - | 0 | - | 0 | 0 | 0 | - | 0 | - | - | BEL | 1 | 16 | 29 | 1.8 | 29.0 |
| NED | 7 | 8 | 0 | 0 | e | - | 0 | 2 | - | 2 | e | 0 | NED | 3 | 25 | 66.5 | 2.7 | 22.2 |
| BEL | 2 | 80 | 0 | 0 | ę | 0 | 4 | 0 | 5 | 2 | 4 | 0 | BEL | 3 | 27 | 16 | 3.4 | 30.3 |
| ESP | 5 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | 6 | 0 | ESP | 1 | 23 | 55.5 | 2.4 | 55.5 |
| BEL | 11 | 25 | - | 0 | 7 | ٦ | 4 | 0 | 7 | 2 | 5 | - | BEL | 5 | 62 | 151.5 | 2.4 | 30.3 |
| ОРР | 16 | 27 | 0 | 0 | S | 2 | 0 | 2 | 2 | 4 | 14 | 0 | OPP | 5 | 67 | 172 | 2.6 | 34.4 |
| GOAL T | YPE | ≤ | ISTANC | Б # Э | OT LAB | ELS | | | | | | | | | | | GOT POIN | ITS |
| BELGIU | Σ | | | \vdash | | | | | | | | | | | | | | |
| vs GER | | | | 17 Lc | ocation F | 3, Witho | ut Press | ure, Loca | ation RE | D, With | Pressure | | | | | | 4 Points, 5 | Points |
| vs NED | | | | 10 Pé | enalty St | troke | | | | | | | | | | | 6 Points | |
| vs ESP | | | | 11 Lc | ocation F | RED, Wit | h Pressu | ıre | | | | | | | | | 5 Points | |
| vs ESP | | | | 16 Lc | ocation F | RED, Wit | h Pressu | ıre | | | | | | | | | 5 Points | |
| vs ESP | | | | 18 W | (ith Pres | sure, Loc | ation A | | | | | | | | | | 4 Points | |
| OPPOS | ITION | | | | | | | | | | | | | | | | | |
| vs GER | | | | 18 W | /ithout P | ressure, | Locatio | ר RED | | | | | | | | | 6 Points | |
| vs NED | | | | 2 Lc | ocation | RED, Wit | h Pressu | Ire | | | | | | | | | 5 Points | |
| vs NED | | | | 6 W | /ithout P | ressure, | Location | ר RED | | | | | | | | | 6 Points | |
| vs NED | | | | 20 Pŧ | enalty C | orner, W | ith Press | aure | | | | | | | | | 5 Points | |
| vs ESP | | | | 13 W | fithout P | ressure, | Location | RED | | | | | | | | | 6 Points | |

4.3 Belgium GOT Metrics Profile

| Ě | equency | | | | | | | | | | | | | | | | |
|----------|---------|-------|-------|----------|------------|------------|-----------|-----------|-----------|-----------|-----|-----|---------|----------|-----------|-------------|--------|
| | No Sho | | υ | | | Ĺ | ٩ | RE | 6 | Set Pi | ece | GOT | Metrics | | | | |
| + | 0.5 | 2 | Ŵ | 3 | Ŵ | 3 | Ŵ | 3 | Ŵ | ñ | PS | | Goals | Total CE | GOT Total | GOT/CE | GOT/Go |
| • | 7 | 5 | 0 | 0 | 0 | - | 0 | 2 | 0 | 2 | 0 | ESP | ٢ | 18 | 34.5 | 1.9 | 34.5 |
| | 5 | 4 0 | - | 2 | 2 | 4 | 0 | e | - | 7 | 0 | NED | 7 | 38 | 105.5 | 2.8 | 15.1 |
| ۵. | 1 | 9 | 0 | e | 0 | - | 0 | - | - | 7 | 0 | ESP | ٢ | 27 | 70.5 | 2.6 | 70.5 |
| ≃ | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | m | m | 0 | GER | 4 | 22 | 59.5 | 2.7 | 14.9 |
| ۵. | 5 | 2 0 | 0 | 0 | • | 0 | 0 | - | - | 9 | 0 | ESP | ٢ | 23 | 55.5 | 2.4 | 55.5 |
| - | 2 | 0 | 0 | m | 0 | 4 | 0 | 5 | 2 | 4 | 0 | BEL | æ | 27 | 91 | 3.4 | 30.3 |
| ٩ | 23 2 | 3 | 0 | m | 0 | 2 | 0 | 4 | 2 | 15 | 0 | ESP | e | 68 | 160.5 | 2.4 | 53.5 |
| <u>e</u> | 12 | 0 | - | ~ | 2 | 80 | 0 | 10 | Ŷ | 14 | 0 | OPP | 14 | 87 | 256 | 2.9 | 18.3 |
| | | | | | | | | | | | | | | | | | |
| ٦Ч | YPE | INSTA | NCE # | GOTLA | BELS | | | | | | | | | | | GOT POIN | ITS |
| | | | | | | | | | | | | | | | | | |
| B | | | 17 | Location | RED, W | lith Press | ure | | | | | | | | | 5 Points | |
| Ш | | | 7 | Penalty | Corner, V | With Pres | sure | | | | | | | | | 5 Points | |
| щ | | | 13 | Without | Pressure | e, Locatio | n RED | | | | | | | | | 6 Points | |
| SOSI | ITION | | | | | | | | | | | | | | | | |
| B | | | 4 | Without | Pressure | e, Locatio | u C | | | | | | | | | 3 Points | |
| Ð | | | ŝ | Location | RED, W | fith Press | ure | | | | | | | | | 5 Points | |
| | | | 12 | Penalty | Corner, V | With Pres | sure | | | | | | | | | 5 Points | |
| Ð | | | 18 | Penalty | Corner, V | Vith Pres | sure | | | | | | | | | 5 Points | |
| B | | | 20 | With Pre | essure, Lo | ocation A | | | | | | | | | | 4 Points | |
| B | | | 21 | Without | Pressure | e, Locatio | n RED | | | | | | | | | 6 Points | |
| Ð | | | 33 | With Pre | essure, Lo | ocation A | | | | | | | | | | 4 Points | |
| jER | | | 2 | Location | RED, W | fithout Pr | essure. | | | | | | | | | 6 Points | |
| 3ER | | | 18 | Penalty | Corner, V | With Pres | sure, Per | nalty Cor | ner, With | h Pressur | e. | | | | | 5 Points, 5 | Points |
| iER | | | 21 | With Pre | essure, Lo | ocation R | Ð | | | | | | | | | 5 Points | |
| iER | | | 22 | Location | RED, W | ithout Pr | essure. | | | | | | | | | 6 Points | |
| щ | | | 11 | Location | RED, W | ith Press | nre | | | | | | | | | 5 Points | |
| 긆 | | | 16 | Location | RED, W | ith Press | nre | | | | | | | | | 5 Points | |
| ᆸ | | | , | | | | | | | | | | | | | | |

4.4 Spain GOT Metrics Profile

4.5 Team GOT Metrics Profile Summary

Each GOT Metrics Profile contains the same categories of data so that it is possible to compare, benchmark, and analyse each team.

GOT Frequency

This is a frequency table outlining where each of the chances came from in the Circle based on the mapping from the coding window. Each location on the map is also broken down into two, showing whether the shot was taken with or without pressure from a defending player. Attack and Defence for each of the games were analysed, with an overall performance against all opposition at the bottom of the table. This section gives a picture of volume of chances rather than any indication of efficiency.

GOT Metrics

An Attacking and Defensive summary of the key headlines for the team in mention. Goals Scored, Goals Conceded, Circle Entries in Attack and Defence, as well as the GOT Metrics (GOT Total, GOT/CE, and GOT/Goal) are all found in this table for each game played and an overall summary. This is the section to check when benchmarking or comparing efficiency.

Goal Type

All goals scored and conceded by the team is recorded here with the detail from the labelling used in the coding process. It is possible to see who the opposition was, which instance number it was (how many times the team was in the circle up to the point of that goal), GOT Labels (the goal chance labels associated with that CE), and how many GOT Points that CE and Goal tallied.

5.0 Discussion

Whereas previous research on KPIs in hockey had been focused very much on the basic attacking game data involving CEs, shots on target, goals scored etc. (Crutchley, 2013), or penalty corners in terms of their role and the variations used (Laird & Sutherland, 2003; Vinson et al., 2013), this research had the aim of investigating the potential use of GOT Metrics as a set of interacting KPIs that provide deeper insight into the attacking and defensive circle moments, and can help explain the performance of Germany within the European Cup as well as provide insight into the development needs in the preparation for future competition and support tactical plan design.

The ability to analyse the games and teams through the GOT Metrics was shown to provide a tool and model to get a deeper understanding of the key and determining factors of Germany's performance and results within the games analysed. It was able to highlight the link between frequency of CEs, the location of the final scoring opportunity, and the amount of pressure that was applied by a defending player when the final shot was taken, which were previously deemed important in the research of xG in football (Lucey et al., 2014; Rahimian et al., 2021; Eggels, 2016) and xG in hockey (Myers & Daly, 2022), but until now had not been translated in a model that can be accurately deployed within hockey consistently considering the lowered level of resources (Lord et al., 2022) found compared to football.

These were then used to successfully analyse the performance of the German team in the Best v Best games (O'Donoghue, 2009) involving themselves, the Netherlands, Belgium, and Spain, highlight trends that indicate potential areas of focus for future training and strategy interventions, and create a profile for each of the opposition teams in attack and defence to show which strategies were most effective for each team, which were the least effective, and how many chances a team would need to create in order to score on average.

5.1 Examining the performance of Germany at the Euros using GOT Metrics

Germany had the lowest number of CEs across their three games of the four teams analysed (60 compared to the average of 68.5), but were able to have the highest GOT/CE and PC wins of all the teams, showing their preference for quality penetrations over pure frequency (Lucey et al., 2014; Rathke, 2017; Labedz Jr. & Schumaker, 2018). This fits with the German methodical approach that is often seen in their style of play, but considering the higher quality of chance created per CE, they still require an above average number of GOT Points per Goal showing there is potentially a technical issue in the execution of the eventual goal shot.

Germany were also the only team not to have a single goal shot from the top of the circle (Zone A). with half of their goal shots coming from wide angles (Zone B or C) and the other half from within the RED Zone, close to goal. Shots from the RED Zone are considered to be extremely dangerous and increase your likelihood of scoring, and while this seems to have been a good strategy for Germany considering all their open play goals came from this zone, teams will want to defend this area as priority and a lack of alternate strategy / ability could potentially lead to lost opportunity and unsuccessful attacks. Wide angles when taking goal shots has the opposite effect, lowering the likelihood of scoring, and Germany's tendency to shoot from when unable to enter the RED Zone could be a factor in the lower than expected goals scored by the Euro Finalists. Another really import insight is that Germany were only able to create 5 shots across the three games that had no pressure from a defending player. While this is a better frequency than Belgium (3) and Spain (2), it is significantly lower than the Netherlands (12), which is another indicator that the strategy for future games could be improved to further improve their chances of success, and a more effective "Plan B" should be shared for when they are unable to access their preferred RED Zone scoring chances. Netherlands were able to score from Zones A, B, C, Red and with Penalty Corners, which gives them a varied threat within the circle and makes it a real challenge for the opposition to strategise on the safest place to lead the attack when making a defensive game plan. This could also explain the ability for the Dutch to lower their GOT/Goal score to an incredible 18.5 compared to Germany's 35.3.

Having managed to earn 16 Penalty Corners (the most among the four teams) in their three games (5 vs BEL, 3 vs ESP and 8 vs NED), Germany scored only once, showing a really poor return on their earned opportunities. Although this research has not focused heavily on Penalty Corners as a KPI, this data would heavily suggest the German Coaching Staff should spend greater effort in the future on their PC routines and execution in order to improve their ability to score goals and convert their attacking threat into more wins and tournament success. The Dutch in comparison were able to score 4 goals from their 15 PCs, which, although is not at the expected level for International hockey (1 goal in 3 attempts), it is only marginally short and will no doubt be a contributing factor in the confidence of the Netherlands in their attacking game.

In the Final vs the Netherlands, Germany were able to accumulate far more GOT Points than the Dutch and had a much higher GOT/CE ratio, mainly due to their ability to win PCs. However, the Dutch were able to create 3 moments in the game where they had a shot on goal without pressure from a defender, scoring from one of these, and were also able to score 1 from 4 PCs compared to 0 from 8 achieved by the Germans. These metrics firstly reiterate the sentiments in the research of Lagos (2007) and Wright et al. (2011) that scoring highly in KPIs are no guarantee of match success, but also secondly, they indicate that the Germans performed well in the game and created enough chances to win the game and the Gold Medal. The Coaching Staff of Germany could use this data and insight to support the building of confidence in their team for future matches, letting the players see the potential reward waiting for them if they are able to develop their execution in key moments during the penalty corner and develop a more reliable Plan B for creating more unopposed shots and shots from Zone A.

Defensively, the data shows that Germany were able to limit their opposition to the lowest GOT/CE of all four teams (2.3 compared to average of 2.6) suggesting they have a good strategy within the defensive circle. Ward (2015) detailed the ability to lower the quality of goal scoring chances from the opposition as a key aim to support winning the game. 68% (46 in total) of all CEs against Germany resulted in no actual shot on goal, with either the defending team making a successful repossession or the opposition attackers failing to make contact with the ball inside the circle. This high percentage is marginally above the Netherlands (66%) and Belgium (64%) and is another indication of their tactical plan. More than this, Germany were able to limit teams to the least amount of goal chances in the most dangerous area of the circle (Zone A), giving away only 4 chances here (3 of which included pressure from a defender) across the 3 games. This allowed the Germans to concede only 1 goal from this area of the circle, which was the result of a second phase goal chance. Belgium, in contrast to this, conceded 4 of their 5 goals from the RED Zone and Spain conceded 7 of their 14 goals from this zone.

From the 4 goals Germany conceded, 2 were PCs and 2 were from a shot without pressure from the shoulder of the circle (Zone B); 1 of which was scored directly from that zone by the Netherlands in the Final and the other led to a second phase chance in the RED Zone, which Belgium were able to convert.

Germany performed well against the above metrics defensively, however the Netherlands were able to set an extremely high standard for one of the most important metrics; GOT/Goal. Germany

were able to lower the quality of an opponents average CE or goal chance with their GOT/CE metric, but the Netherlands were able to make their opponents work considerably harder in order to score each of their goals. Teams on average needed 65.3 GOT Points for each goal against the Netherlands, which is incredible, especially considering that Belgium only managed to accumulate 29 GOT Points in their game against the Dutch and Spain only managed 34.5 GOT Points in their game against the Dutch. A deeper look into the video associated to these events could be used to understand some of the technical and tactical elements that allowed the Dutch to perform so well in this metric compared to the other teams, and could support the German Coaching Staff to amend their own strategy.

While there are statistics in previous research that look at defensive actions, most of these focus on the tackles, blocked shots, interceptions and saves (Labedz Jr. & Schumacker 2018) rather than where you are limiting teams and players from shooting from and the quality of those shots once made. Caley (2015) is an exception to this and is able to use xG in football to show teams in the English Premier League and the contrast between their attacking and defensive statistics. This research, similar to that, has shown the importance of analysing attacking KPIs alongside their defensive mirror to get a more realistic understanding of a team's performance in relation to their result, rather than looking at attacking or defending in isolation.

5.2 Potential use of GOT Metrics in informing future training and strategy interventions

This research has shown the success of this model in the ability to understand and analyse a performance, but there are also clear ways in which it can help inform and direct future training as well as tactical and strategic plans. Before addressing the specific uses of GOT Metrics and their role in these future interventions, it is important that the ground work is done in establishing an environment where GOT Metrics as KPIs are deemed to be important in the team, and will therefore be able to have maximal benefit. Parmenter (2010) outlines a 12 step model to support this process, including best practice in creating a Taskforce within the team to be responsible for the KPIs, the marketing of the importance of the KPIs, the need for the reporting of the performance against the KPIs to be digestible and impactful, and the pertinence of continually reevaluating the KPIs with the view of refreshing them to the potentially new requirements of the team. The Coaching Staff of Germany would need to make the decision about who to involve in this process, but the Taskforce would likely contain the Performance Analyst, at least one of the Coaching Staff, and a selection of the Leadership Group from within the playing staff, giving a collective and joined-up feel to the usage of GOT Metrics, and likely increase the importance of them perceived within the team.

Once the groundwork has been done within the team, it is important to make sure the GOT Metrics and the language used within them are used consistently in and with the team, and that the grid mapping used for the data collection mirrors that used with and by the players and staff (Van Haaren, 2021). This will keep the GOT Metrics front of mind and place them as a tool used by default when in the attacking and defensive circles both within training and competitive games. This can be further strengthened by ensuring that all training sessions that involve circle attack and defence are based on scenarios that are derived from trends drawn from the data, and coaching feedback should be given to the players based on their decision making within the model (Phatak et al., 2022; Yi et al., 2021; Kubayi & Toriola, 2020); determining which options will bring the team the best chance of scoring in each situation, and which defensive strategies and behaviours will limit the opposition's chances of scoring against them.

This leads nicely onto the application into future tactical and strategic plans made by the German Coaching Staff based on the use of GOT Metrics and the insight it can bring.

The research has also shown a very good ability to gather the trends of each team and present them in a simple and digestible manner allowing the coaching staff to quickly understand the assumed preferences and weakness of any team in attack and defence within the scoring circle. While this research is only based on limited data, a more comprehensive dataset would strengthen the profiles created using this model and indicate adjustments needed in order to improve the chances of success in matches against each opponent.

As an example, in future matches against Belgium, the German Coaching Staff will be able to draw the conclusion that Belgium are a team that prefer to create goal scoring chances from the shoulders of the circle (Zone B), even if there is pressure from a defending player, or from within the RED Zone, which is the 7m area in front of the goal. Their targeting of shots from these areas comes at the cost of a significantly lower frequency of PC wins compared to the other teams (5 PCs across their 3 games, compared to the average of 12.5). This could suggest an ability for future German strategy to increase the pressure applied on shots, knowing that Belgian players are unlikely to use this additional pressure to search for a PC win, likely resulting in a lowered likelihood of scoring for Belgium.

In terms of attack, Rathke (2017) and Labedz Jr. & Schumaker (2018) have written articulating the importance of not just volume of shots within a game, but the need to take on good choices in shot selection, leading to higher efficiency. It would be predicted that, with a new understanding of GOT Metrics and how they relate to any attack, players are able to make better decisions in attack, and coaches are able to advise on better strategies to achieve efficient attacks.

In order to do this, Germany should decide how they want to set attacking and defending objectives using the GOT Metrics based on their style of play overall and against a certain opposition. Scout Reports would then be an important tool in facilitating this (Lago-Peñas, et al., 2011). While Scout Reports are generally very useful, for the Final between Germany and the Netherlands, the Dutch team used a defensive press that they had yet to use in the tournament or elsewhere in competitive matches. Germany would not then have been able to prepare for this scenario, and needed to make the adjustments and solutions live within the match as this press would not have shown up in any scout report. With the current GOT Metrics model, the tactics of Germany and their opposition and the details surrounding the phases of if play leading to the CE are not taken into consideration, and would therefore not be available in a Scout Report based solely on GOT Metrics. This is a prime example of the danger of being over-reliant on data, especially a limited source of data when forming conclusions about past or expected performances. It also highlights the need to have a

more holistic approach to viewing the game, which involves the subjective side of the game that considers the context and reality of the game (Muller, 2021; Phatak et al. 2022).

Used correctly, the data and insight provided in the GOT Metrics Scout Report would be able to stimulate a deeper analysis of an opponent, trigger conversations about potential trends, and indicate potential weaknesses and preferences of the opposition, both known and unknown by the opposition. With the data being collected from SportsCode, there is an option to create directly within the software an output window to display the data from each game, and also the functionality of creating databases, which could be where the opposition Scout Reports could be found. This gives the bonus of attaching video to the data, closing the gap between the data and the context as mentioned in previous research (Muller, 2021; Phatak et al. 2022; McGarry, 2009) and allows the players to bring the data to life.

5.3 Limitations of research and recommendations for future study

Overall, the use of GOT Metrics as KPIs in hockey performance can be a valuable tool for coaches and athletes, but it is important to recognise the limitations and ensure that context and process are also considered rather than focussing alone on outcome (McGarry, 2009). By considering both the strengths and weaknesses of GOT Metrics, coaches and athletes can use these metrics effectively and optimise their performance. Further research could identify the GOT Metrics vs another one or two set of KPIs to have a more holistic and encompassing understanding of any one performance or set of performances and should definitely involve a much greater data set to allow a deeper insight into the trends of Germany and their opposition.

In order to further strengthen the usage of GOT Metrics, it could be a good idea to track these metrics throughout each game in relation to the timeline so it becomes possible to determine whether there are moments in games where a team is most likely to score (Michailidis et al. 2013), create chances, concede goals, concede chances, as well as whether a team is able to score from random moments or instead, they need sustained pressure on the opposition's defensive circle in order to break them down to score. To make the data and therefore the insights more robust and reliable, it would also be a good idea to track these metrics for each nation over a longer period of time. This would give a much more accurate indication of the trends for each team, rather than a potentially one-off performance, which could be the case in this research.

It would also be beneficial to add a layer of analysis to focus on individual player profiles (Rowlinson, 2020; Bravo et al., 2021) to help understand the specifics within the KPIs, which could help identify technical and tactical solutions as well as within a scouting tool to highlight strengths and weaknesses of an upcoming opposition.

Adding the labelling of phase of play (how the possession was initiated, from where, score in that moment, cards leading to sin-bin for one / both teams, time on the clock...) would strengthen the data significantly, providing yet more context to every action and goal chance. Similar work in this

area has already been done by Sunderland et al. (2006), Wright et al. (2011), and others, but could be made more effective if paired with the GOT Metrics analysis.

Lastly, Penalty Corners have shown in this research as well as other research by Decroos & Davis (2020) and Mosquera et al. (2007) that they play such an important role in field hockey. It would be interesting for there to be additional labelling and analysis surrounding teams' ability to and focus on winning penalty corners as a strategy when in the attacking circle based on their perceived strength as well as understand if there are equivalent metrics to GOT Metrics that could help further understand which PC routines reap the best rewards. This would allow the German Coaching Staff to have a more informed understanding of their attacking PCs, while also knowing the key areas of focus to help improve their PC Defence, making it even harder for their opposition to score against them.

6.0 Conclusion

The findings from this research on GOT Metrics lends itself very well to the development of the work done by Myers & Daly (2022), giving a simpler and more hockey friendly way of achieving the desired results, while also adding a layer missing in that work; looking at the defensive metrics and their equal importance in determining the bigger picture of team performance and likelihood of winning. Working on the premise set by Rathke (2017) and Ladbedz Jr. & Schumaker (2018) that shot selection and quality of shots is a superior strategy to just a high volume of shots, the GOT Metrics model was successful in helping to understand to bring the data from the game into a digestible and insightful tool to aid future training and tactical decisions.

There was a clear indication that Germany's metrics supported their eventual tournament ranking above Belgium and Spain to finish 2nd, but also that the Netherlands were the dominant team at the tournament due to their GOT/Goal scores in both attack and defence, as well as their ability to score from all areas of the circle, while Germany relied on goals from the RED Zone.

As mentioned previously, it would be an ideal scenario that research would be conducted to further deepen the parameters around each goal scoring chance and the phases leading to those chances, as well as layering on top labels for individual players in both the attacking and defensive circles to strengthen the model and increase it's ability to support the Coaching Staff of Germany and any other hockey team that wanted to understand and develop their own performance and results.

7.0 Reference List

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8.0 Appendices

8.1 Appendix A: BEL v ESP Coding Output Comparison - Data Reliability

BEL ESP MOMENTUM POINTS Ungrouped Notes Flags Row Instance number MOMENTUM Timeline 20210613_M19_BEL-ESP CE ESP 1 Contro 1 Point 20210613 M19 BEL-ESF CE ESF 1 Point 2 Contro 20210613_M19_BEL-ESF CE ESF 1 Point 3 Contro 20210613_M19_BEL-ESF CE ESF 4 Contro 1 Point 20210613_M19_BEL-ESP CE ESF 5 No Touch 0,5 Point 20210613 M19 BEL-ESF 6 No Touch CE ESF 0,5 Point 20210613_M19_BEL-ESF CE ESP 7 Control 1 Point 20210613_M19_BEL-ESF CE ESP 8 Penalty Corner, With Pressure 5 Points 20210613_M19_BEL-ESP CE ESP 9 No Touch 0,5 Point 20210613 M19 BEL-ESF CE ESP 10 With Pressure, Penalty Corner 5 Points 20210613_M19_BEL-ESF CE ESP 11 Penalty Corner, With Pressure 5 Points 20210613_M19_BEL-ESP CE ESP 12 Contro 1 Point 20210613_M19_BEL-ESP CE ESP 13 Without Pressure, Location RED 6 Points GOAL 20210613 M19 BEL-ESF CE ESP 14 No Touch 0,5 Point 20210613 M19 BEL-ESF CE ESF 15 No Touch 0,5 Point 20210613 M19 BEL-ESF CE ESP 16 Control 1 Point 20210613_M19_BEL-ESF CE ESP 17 Contro 1 Point 20210613 M19 BEL-ESF CE ESF 18 Contro 1 Point 20210613 M19 BEL-ESF CE ESP 19 Penalty Corner, Penalty Corner, With Pressure, Penalty Corner, With Pressu 5 Points, 5 Points, 5 Points 20210613 M19 BEL-ESF CE ESP 20 Contro 1 Point 20210613 M19 BEL-ESF CE ESP 21 Contro 1 Point 20210613 M19 BEL-ESF CE ESP 22 Control 1 Point 20210613 M19 BEL-ESP CE ESP 23 Location BED. With Pressure 5 Points 20210613 M19 BEL-ESP CE BEL 1 No Touch 0.5 Point 20210613 M19 BEL-ESF CE BEL 2 Penalty Corner, With Pressure, Location RED, With Pressure 5 Points, 5 Points 20210613 M19 BEL-ESF CE BEL 3 Control 1 Point 20210613 M19 BEL-ESF CE BEL 4 Control 1 Point 1 Point 20210613_M19_BEL-ESF CE BEL 5 Control 20210613_M19_BEL-ESF CE BEL 6 Control 1 Point 20210613_M19_BEL-ESF CE BEL 7 Penalty Corner, With Pressure 5 Points 20210613 M19 BEL-ESF CE BEL 8 Location RED, With Pressure 5 Points 20210613 M19 BEL-ESF CE BEL 9 Location B. With Pressure 3 Points 20210613_M19_BEL-ESF CE BEL 10 Location RED, With Pressure 5 Points 20210613_M19_BEL-ESP CE BEL 11 Location RED, With Pressure 5 Points GOAL 20210613_M19_BEL-ESP CE BEL 12 With Pressure, Location B 3 Points 20210613_M19_BEL-ESP CE BEL 13 No Touch 0,5 Point 20210613_M19_BEL-ESF CE BEL 14 Penalty Corner, With Pressure 5 Points 20210613_M19_BEL-ESF CE BEL 15 Control 1 Point 20210613_M19_BEL-ESF CE BEL 16 Location RED, With Pressure 5 Points GOAL 20210613_M19_BEL-ESF CE BEL 17 Control 1 Point 20210613_M19_BEL-ESP CE BEL 18 With Pressure, Location A 4 Points GOAL 20210613_M19_BEL-ESP CE BEL 19 With Pressure, Location A 4 Points 20210613_M19_BEL-ESP CE BEL 20 With Pressure, Location A 4 Points 20210613_M19_BEL-ESP CE BEL 21 With Pressure, Location B 3 Points 20210613 M19 BEL-ESF CE BEL 22 With Pressure, Location A 4 Points 20210613_M19_BEL-ESF CE BEL 23 Without Pressure, Location RED 6 Points 20210613 M19 BEL-ESF CE BEL 24 Penalty Corner, With Pressur 5 Points 20210613_M19_BEL-ESF CE BEL 25 Without Pressure, Location RED 6 Points 20210613 M19 BEL-ESF CE BEL 26 Control 1 Point 20210613_M19_BEL-ESF CE BEL 27 Contro 1 Point Row Instance number MOMENTUM MOMENTUM POINTS Ungrouped Notes Flags Timeline 20210613 M19 BEL-ESP Reliability Test CE ESF 1 Contro 1 Point 20210613 M19 BEL-ESP Reliability Test CE ESP 2 Contro 1 Point 20210613 M19 BEL-ESP Reliability Test CE ESP 3 Control 1 Point 20210613 M19 BEL-ESP Reliability Test CE ESP 4 Control 1 Point 20210613 M19 BEL-ESP Reliability Test CE ESP 5 No Touch 0.5 Point 20210613_M19_BEL-ESP Reliability Test CE ESP 6 No Touch 0,5 Point 20210613_M19_BEL-ESP Reliability Test CE ESP 7 Control 1 Point 20210613_M19_BEL-ESP Reliability Test CE ESP 8 Penalty Corner, With Pressure 5 Points 20210613 M19 BEL-ESP Reliability Test CE ESF 9 No Touch 0,5 Point 20210613_M19_BEL-ESP Reliability Test CE ESP 10 With Pressure, Penalty Corner 5 Points 20210613_M19_BEL-ESP Reliability Test CE ESP 11 Penalty Corner, With Pressure 5 Points 20210613_M19_BEL-ESP Reliability Test CE ESF 12 Contro 1 Point 20210613_M19_BEL-ESP Reliability Test CE ESF 13 Without Pressure, Location RED 6 Points GOAL 20210613_M19_BEL-ESP Reliability Test CE ESP 14 No Touch 0,5 Point 20210613_M19_BEL-ESP Reliability Test CE ESP 15 No Touch 0,5 Point 20210613_M19_BEL-ESP Reliability Test CE ESP 16 Contro 1 Point 20210613_M19_BEL-ESP Reliability Test CE ESF 17 Contro 1 Point 20210613_M19_BEL-ESP Reliability Test CE ESF 18 Contro 1 Point 20210613_M19_BEL-ESP Reliability Test CE ESF 19 Penalty Corner, Penalty Corner, With Pressure, Penalty Corner, With Pr 5 Points, 5 Points, 5 Points 20210613_M19_BEL-ESP Reliability Test CE ESP 20 Contro 1 Point 20210613_M19_BEL-ESP Reliability Test CE ESP 21 Control 1 Point

| 20210613_M19_BEL-ESP Reliability Test | CE ESP | 22 | Control | 1 Point | | |
|---------------------------------------|--------|----|---|--------------------|------|--|
| 20210613_M19_BEL-ESP Reliability Test | CE ESP | 23 | Location RED, With Pressure | 5 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 1 | No Touch | 0,5 Point | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 2 | Penalty Corner, With Pressure, Location RED, With Pressure | 5 Points, 5 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 3 | Control | 1 Point | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 4 | Control | 1 Point | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 5 | Control | 1 Point | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 6 | Control | 1 Point | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 7 | Penalty Corner, With Pressure | 5 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 8 | Location RED, With Pressure | 5 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 9 | Location B, With Pressure | 3 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 10 | Location RED, With Pressure | 5 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 11 | Location RED, With Pressure | 5 Points | GOAL | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 12 | With Pressure, Location B | 3 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 13 | No Touch | 0,5 Point | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 14 | Penalty Corner, With Pressure | 5 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 15 | Control | 1 Point | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 16 | Location RED, With Pressure | 5 Points | GOAL | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 17 | Control | 1 Point | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 18 | With Pressure, Location A | 4 Points | GOAL | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 19 | With Pressure, Location A | 4 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 20 | Location A, With Pressure | 4 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 21 | With Pressure, Location B | 3 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 22 | With Pressure, Location A | 4 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 23 | Location RED, Without Pressure | 6 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 24 | Penalty Corner, With Pressure | 5 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 25 | Location RED, Without Pressure | 6 Points | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 26 | Control | 1 Point | | |
| 20210613_M19_BEL-ESP Reliability Test | CE BEL | 27 | Control | 1 Point | | |
| | | | | | | |
| | | | Pearson Correlation coefficient calculated as: | 1 | | |
| | | | Using: =COUNTIF(B2:H51,INDEX(B54:H103,MATCH(B2,A2:A51,0)))/COUNTA | (B2:H51)*100. | | |
| | | | The Scale is -1 to 1, making 1 a 100% correlation | | | |