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A Delphi Study on the Key Skills of Tennis Champions
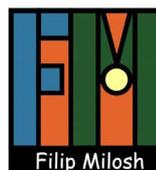
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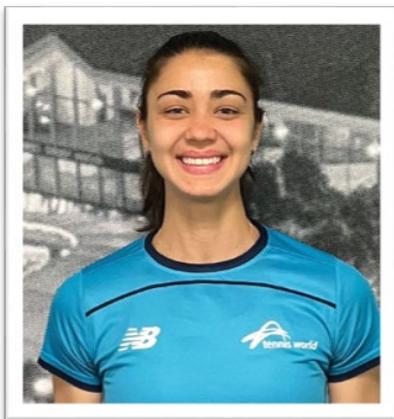
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COACHING & SPORT SCIENCE REVIEW

A delphi study on the key skills of tennis champions

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ABSTRACT

Research was conducted during an internship program at Tennis Australia headquarters from November 2024 to February 2025, supporting Tennis Australia's goal of developing top-level tennis players. The work analyses the skills and techniques of three of tennis's greatest players, Roger Federer, Rafael Nadal and Novak Djokovic, using the Delphi method. Selected for their exceptional achievements and dominance in the sport, the study uses a structured Delphi survey to assess their skills and identifies the key factors that have contributed to their success. The findings can help enhance tennis coaching programs by integrating key skills essential for developing elite players and future champions. Eventually, producing more top players can strengthen fan engagement and attract greater sponsorship opportunities.

INTRODUCTION

Tennis Australia's National Strategy drives the growth and success of tennis across the country. Central to this is the Tennis Australia Vision, which promotes participation, develops elite players and strengthens tennis communities. A key initiative supporting this vision is the Tennis 2020: Facility Development and Management Framework, designed to enhance facility planning, infrastructure and management nationwide. This unified approach aims to produce more active players, world-class champions, passionate fans and stronger communities, reinforcing tennis as a leading sport in Australia (Tennis Australia, 2024).

To support the objective of developing more tennis champions, a summer 2024–2025 internship at Tennis Australia applied the Delphi method to analyse the skills and techniques of Roger Federer, Rafael Nadal and Novak Djokovic. These players were selected for their exceptional records and sustained dominance, having set benchmarks that define success at the sport's highest level. The Delphi method was chosen for its ability to structure expert input, enabling a thorough evaluation of each player's strengths and techniques. By engaging a panel of tennis experts, the study aimed to identify key factors contributing to the players' remarkable careers.

The findings aim to inform a more targeted and effective approach to player training, helping players reach their full potential and compete at the highest level internationally.

RESEARCH METHODS

In the 1970s, Dobrov (1971) identified over 130 distinct methods for scientific decision-making, grouped into three main categories.

1. Trend Interpolation Methods - Predict future conditions using historical trends,

2. Simulation Methods - Model system behaviour under variable conditions, and

3. Convergent Concordance Methods (Intuitive Methods) - Rely on consensus among respondents to forecast outcomes.

The first two methods have limitations in specific scenarios, leading to the development of intuitive methods. These methods combine data, strategic goals and forecasting, emphasising intuition and interdisciplinary approaches in decision-making. Key intuitive methods include (Milosovski et al., 2009):

- Forecasting by Individual Experts, which depends on a single expert's knowledge, but can be limited by the complexity of events;

- Group Forecasting (Brainstorming), which fosters collective expertise and consensus-building, but may be influenced by dominant personalities; and

- Group Forecasting (Individual Opinions), where expert inputs are individually gathered, analysed and synthesised to reach an agreement.

In recent decades, several intuitive methods have been developed, with the Delphi technique being one of the most successful (Quade, 1972). Originally used for forecasting, it is now also applied to group estimation for creating forecasts or setting priorities (Harold & Murray, 1975). The Delphi technique is widely used in fields such as economics, engineering and medicine for technological forecasting and prioritisation (Chorafas, 2002 & Mason et al., 2022).

The Delphi technique has been widely discussed and applied in over 2,600 scholarly papers since its introduction (Flostrand et al., 2020), demonstrating its growing popularity and effectiveness in collecting expert insights. A time series of publications reveals increasing academic acceptance and expansion across various research domains over the past two decades, with a predicted rise in use in the future.

In April 2021, the term 'Delphi method' had 28,200 search hits in Google Scholar from 2016 to 2021, reflecting its importance (Beiderbeck et al., 2021). With rapid technological and social changes creating more uncertainty, collective expert opinions are expected to become even more valuable in addressing complex global challenges.

The following section explains the Delphi technique's definition, procedure and distinctive features, showing its relevance as a strategic decision-making tool.

The Delphi Method: Origins and Applications

The Delphi method, named after the Greek Oracle of Delphi, is a valuable technique for setting priorities to improve and develop complex systems (Kennedy, 2004 & Sandelowski, 2000).

The Delphi technique originated at the RAND Corporation, with its early foundations found in the 1949 article "Prediction for Social and Technological Events" by Kaplan, Skogstad and Girshick, which introduced statistical analysis of individual opinions (Milosovski et al., 2009).

Dalkey and Helmer played a key role in refining and popularising the method. In 1963, they published "An Experimental Application of Delphi Method to the Use of Experts", which helped expand its use. The technique spread from the U.S. to Europe and Asia, becoming widely recognised in various scientific fields. In 1969, Japan's Science and Technology Agency used the Delphi technique to forecast technological advancements by the year 2000, surveying 4,000 individuals (Ferguson, 2000).

Initially, the Delphi technique was used to forecast international events and scientific-technological advancements (Harold & Murray, 1975). Today, the Delphi technique is used not only for forecasting but also for systematically gathering expert opinions to predict developments in technology and other areas (Soobiah et al., 2019 & Strafford et al., 2022).

The Delphi method involves organising expert opinions and requires an interdisciplinary approach to address complex systems. It is also known as the "group estimation method," as it restructures group communication to formulate predictions or priorities (Tooth et al., 2024). The method is crucial for making strategic decisions on technological innovations and developments, as it allows unrestricted expert input, helping to resolve divergent opinions and reach consensus (Gijon-Nogueron et al., 2022 & Mason et al., 2022).

The Delphi method allows experts to share and reconsider their opinions based on group feedback. The process continues through several rounds until consensus or stability is achieved, with all participants contributing to gaining knowledge.

The results of the Delphi technique reflect expert opinions based on current conditions and should be periodically reviewed and updated.

Delphi Method Procedure

The main steps of the Delphi technique are summarised below (Milosovski et al., 2009).

- Designing the Questionnaire: The research team/ working group creates an initial questionnaire with numerical scale-based questions, offering flexibility in choosing the scale size for ranking factors.
- Collecting Responses: Experts complete the questionnaire, and the research team summarises their responses.
- Revising the Questionnaire: Based on the responses, a revised questionnaire is developed and sent back to the experts for further input.
- Iterative Rounds: Experts reassess their responses based on group feedback. This iterative process continues as needed to refine the results.
- Finalising the Results: After typically three rounds, the process concludes with a final report summarising the objectives, methodology and findings of the Delphi exercise.

The Delphi method is defined by three key features (Quade, 1972):

- Anonymity: Experts' responses are independent and anonymous, with no communication between participants. Opinions are presented statistically to ensure anonymity until the process ends.
- Iterative process and feedback: The procedure is repeated multiple times, with feedback refining opinions toward mutual consensus.
- Collective expert opinion: The result represents a collective consensus, with individual opinions not revealed during the process.

The Delphi technique involves teamwork and an interdisciplinary approach. It facilitates expert communication and opinion refinement through multiple rounds of feedback, all managed by the research team. The results are valuable for system improvements, strategic planning and forecasting.

The Delphi Method: Mathematical Models - Criteria of Objectivity

The primary goal of the Delphi technique is to reach a high level of agreement among experts. This is done through multiple rounds of feedback, which help to align and refine the experts' opinions.

To ensure objectivity, the Delphi method typically involves two key phases for analysing expert opinions (Milosovski et al., 2009):

1. Assessing expert competency;

2. Calculating coefficient of concordance (Ck) of expert opinions.

These phases help to ensure that the results of the Delphi process are both reliable and reflective of expert consensus.

Refer to Milosovski et al. (2009) for a detailed discussion of the advantages and limitations of the Delphi method, as well as the mathematical model used to assess expert competency and calculate the coefficient of concordance (Ck) of expert opinions.

DELPHI METHOD APPLICATION

Development of the Delphi Questionnaire

A questionnaire was developed to assess the tennis skills of Roger Federer, Rafael Nadal and Novak Djokovic. A range of books, reports and papers were consulted for input, with the primary source being the book Coaching Tennis: Technical and Tactical Skills (Figure 1), endorsed by the United States Tennis Association (USTA) (Anderson, 2003). This book offers a summary of coaching techniques and provides valuable guidance on evaluating technical and tactical tennis skills, forming the basis for the questionnaire.

Figure 1. *Primary Source Used for Delphi Questionnaire Development*

The questionnaire has two parts. The first part evaluates the technical, tactical and physical aspects of each player's game through six factor groups, each paired with a question to assess their tennis abilities. These factors provide a detailed breakdown of the skills essential for success in professional tennis, allowing experts to assess each player's strengths and potential weaknesses. The second part includes two open-ended questions on players' integrity and unique qualities, examining their personas and playing styles to define their elite status and global impact.

The credibility of the findings from the Delphi survey is supported by the expertise and professional standing of the participating panel. The respondents were nominated through Tennis Australia's Head Office and comprised ten high-profile coaches and tennis professionals recognised for their contributions to the sport at both national and international levels. The panel included individuals holding senior roles within Tennis Australia's coaching and talent development systems, such as Directors of Coaching, National Program Managers, State Development Coaches and former high-performance coaches with ATP/WTA experience. Collectively, the group brought decades of elite coaching experience and formal coaching accreditations.

Delphi Method Methodology

In the first round, experts provided responses, which were summarised and used to create a revised questionnaire for the second round. The process concluded after two rounds, as the results were sufficiently clear, making a third round unnecessary.

Following the survey, data analysis commenced. Due to strong agreement on many factors, statistical analysis of expert competency was deemed unnecessary. Moreover, the coefficient of concordance was calculated only for the evaluation of Group 1 factors (stroke techniques), as the other groups exhibited similar rankings and consensus, rendering further analysis redundant.

RESULTS

Group 1 Factors: Strokes Evaluation

For the first group of factors, experts evaluated a player's strokes at the peak of their career. The factors were ranked on a scale from 1 to 5:

- Pro Level (1): High professional skill.

- Superior (2): Above-average professional skill.

- Outstanding (3): Exceptional performance.

- One of the Best (4): Among the top players.

- Best Ever (5): The highest level of skill in tennis history.

Table 1 presents the experts' rankings of the players' strokes.

Table 1
Expert group opinions on stroke techniques

#	Strokes	Roger Federer				Rafael Nadal				Novak Djokovic			
		Mean	Max	Min	σ	Mean	Max	Min	σ	Mean	Max	Min	σ
1	First serve	4.1	5	4	0.32	2.7	3	2	0.48	3.1	4	2	0.88
2	Second serve	4.1	5	4	0.32	3.4	4	3	0.52	3.5	4	3	0.53
3	Serve return	3.5	4	3	0.53	3.8	4	3	0.42	5	5	5	0
4	Forehand	4.2	5	4	0.42	4.8	5	4	0.42	3.8	4	3	0.42
5	Backhand	3.7	4	3	0.48	4	4	4	0	5	5	5	0
6	Backspin (slice)	4.7	5	4	0.48	3.4	4	3	0.52	3	4	2	0.67
7	Approach shot	4.2	5	4	0.42	3.5	5	3	0.85	3.5	4	3	0.53
8	Passing shot	3.6	4	3	0.52	4.5	5	4	0.53	4.6	5	4	0.52
9	Drive volley	3.8	4	3	0.42	3.7	4	3	0.48	3.7	4	3	0.48
10	Volley	4.1	5	3	0.74	3.5	4	3	0.53	3	4	2	0.82
11	Half volley	4.2	5	3	0.79	3.4	4	3	0.52	3	4	2	0.67
12	Overhead/smash	4.4	5	4	0.52	3.9	5	3	0.88	3.2	4	2	0.92
13	Drop shot	3.7	4	3	0.48	3.8	4	3	0.42	3.9	5	3	0.88
14	Lob	3.4	4	3	0.52	3.8	4	3	0.42	4.1	5	3	0.88
15	Groundstroke from deep in the court	3.3	4	3	0.48	5	5	5	0	4.5	5	4	0.53

Table 2 presents the coefficient of concordance (Ck) for each player's stroke technique, calculated per Milosovski et al. (2009) with a 95% confidence interval for reliability.

Table 2
Testing non-randomness of the coefficient of concordance (Ck)

Roger Federer			Rafael Nadal			Novak Djokovic		
C_k	χ^2	$\chi^2_{critical}$	C_k	χ^2	$\chi^2_{critical}$	C_k	χ^2	$\chi^2_{critical}$
0.452	63.32	23.69	0.632	88.48	23.69	0.678	94.89	23.69

For each player, the condition $|\chi^2| > \chi^2_{critical}$ confirms the rejection of the null hypothesis, indicating that the coefficient of concordance (C_k) is not random and reflects strong expert consensus.

Figure 2 further illustrates the distribution of average ranks assigned by experts for each of the 15 strokes of Federer, Nadal and Djokovic. The vertical axis shows the rank (from 1 to 5) assigned to a tennis stroke by experts, while the horizontal axis shows how many times each rank was selected. The results indicate that their stroke skills consistently fall within the top three categories: Outstanding (3), One of the Best (4) and Best Ever (5). This suggests that none of the three players exhibit average strokes or technical weaknesses, highlighting their exceptional proficiency across all aspects of stroke play.
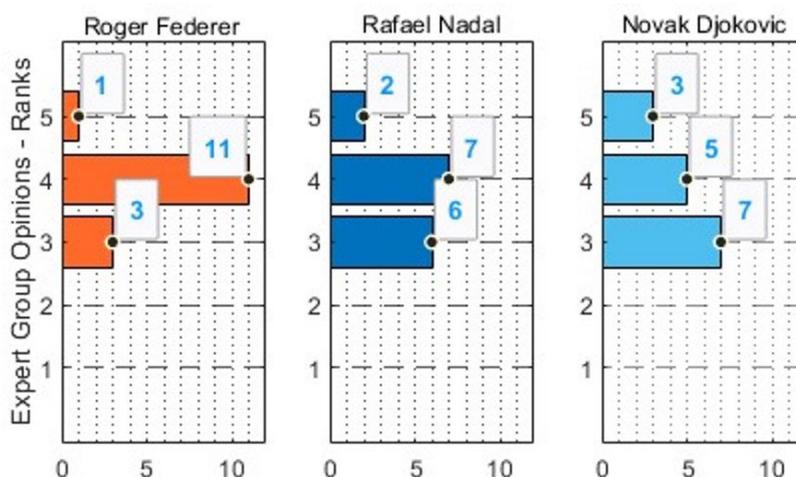

Figure 2. *Average Rank Distribution for Tennis Strokes. (1 - Pro level, 2 – Superior, 3 – Outstanding, 4 – One of the Best, 5 – Best Ever)*

In addition, Figure 3 displays the mean values for each stroke per player in a three-dimensional chart, with the rankings of Federer, Nadal, and Djokovic on the axes, showing that all strokes rank highly, confirming their exceptional technical performance.
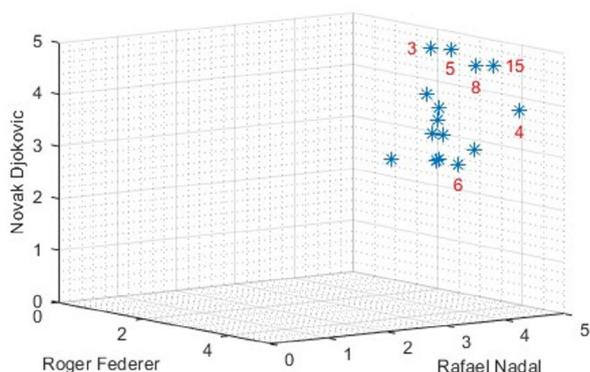

Figure 3. *Expert Opinions on Tennis Strokes of Federer, Nadal and Djokovic. (1 - Pro level, 2 – Superior, 3 – Outstanding, 4 – One of the Best, 5 – Best Ever).*

Figure 4 summarises the top average ranks assigned by experts for each of the 15 evaluated strokes. The analysis reveals that for every stroke, at least one player, Federer, Nadal or Djokovic, is rated in the highest range (One of the Best to Best Ever, ranks 4-5).
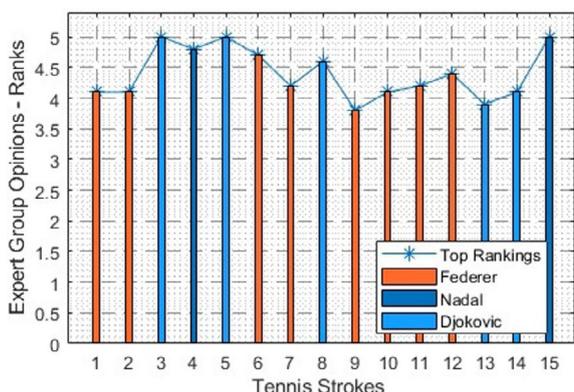

Figure 4. *Expert Ratings of Top Strokes.*

As detailed above in Table 1 and Figure 3, expert evaluations identified several strokes as exceptionally strong, particularly:

- Djokovic's passing shot (stroke No. 8) – Average rank: 4.6
- Federer's backspin/slice (stroke No. 6) – Average rank: 4.7
- Nadal's forehand (stroke No. 4) – Average rank: 4.8

Additionally, perfect scores of 5 (Best Ever) were awarded to:

- Nadal's groundstroke from deep in the court (stroke No. 15)
- Djokovic's serve return (stroke No. 3)
- Djokovic's backhand (stroke No. 5).

Group 1 Factors: Strokes Evaluation – Cluster Analysis

Additionally, a cluster analysis of expert stroke evaluations was conducted for each player using the 3-means algorithm as a partition-based method (King, 2015), based on Table 1 results.

Table 3 presents the clustering outcomes, categorising stroke techniques into three groups, with the Top-Ranked Cluster containing the highest-ranked and most effective strokes.

Table 3
Clustering Results of Stroke Techniques for Each Player.

	Lower-Ranked Cluster	Mid-Ranked Cluster	Top-Ranked Cluster
Roger Federer	15. Groundstroke from deep in the court (3.3) 14. Lob (3.4) 3. Serve return (3.5)	8. Passing shot (3.6) 5. Backhand (3.7) 9. Drive volley (3.8) 13. Drop shot (3.7)	1. First serve (4.1) 2. Second serve (4.1) 10. Volley (4.1) 4. Forehand 4.2) 7. Approach shot (4.2) 11. Half volley (4.2) 12. Overhead (smash) (4.4) 6. Backspin (slice) (4.7)
Rafael Nadal	1. First serve (2.7) 2. Second serve (3.4) 6. Backspin (slice) (3.4) 11. Half volley (3.4) 7. Approach shot (3.5) 10. Volley (3.5)	9. Drive volley (3.7) 3. Serve return (3.8) 13. Drop shot (3.8) 14. Lob (3.8) 12. Overhead (smash) (3.9) 5. Backhand (4)	8. Passing shot (4.5) 4. Forehand (4.8) 15. Groundstroke from deep in the court (5)
Novak Djokovic	6. Backspin (slice) (3) 10. Volley (3) 11. Half volley (3) 1. First serve (3.1) 12. Overhead (smash) (3.2)	2. Second serve (3.5) 7. Approach shot (3.5) 9. Drive volley (3.7) 4. Forehand (3.8) 13. Drop shot (3.9) 14. Lob (4.1)	15. Groundstroke from deep in the court (4.5) 8. Passing shot (4.6) 3. Serve return (5) 5. Backhand (5)

Federer's top-ranked cluster included the first serve, second serve, volley, forehand, approach shot, half volley, overhead (smash) and backspin (slice). This collection of strokes emphasised Federer's focus on offensive techniques, reflecting his aggressive playing style and ability to dominate at the net and in fast rallies.

Nadal's top-ranked cluster included passing shots, forehand and deep groundstrokes, which showed his strategy of controlling rallies and countering opponents effectively. The emphasis on passing shots and deep groundstrokes highlighted his defensive skills and ability to outlast opponents in extended rallies, while his forehand was a powerful weapon that strengthens both his attack and defence.

Djokovic's top-ranked cluster included the serve return, passing shot, backhand and deep groundstroke. These strokes reflected Djokovic's strategy of maintaining control and consistency in rallies, while also showing his ability to counter opponents effectively. His proficiency in serve returns and passing shots, combined with his strong backhand and deep groundstrokes, emphasised his consistent and reliable game in different situations.

Group II Factors: Technical/Tactical Skills Evaluation

For the second group of factors, experts evaluated a player's technical/tactical skills, at the peak of their career. The factors were ranked on a reduced scale from Pro Level (1) to Outstanding (3), using the same definitions as for the first group.

As shown in Table 4, Federer, Nadal and Djokovic all received a perfect score of 3 for 'Outstanding,' reflecting their mastery of shot selection, footwork and recovery, key elements of their long-term dominance in the sport.

Table 4
Expert Group Mean Opinions on Technical/Tactical Skills Evaluation.

#	Technical / Tactical skills	Federer		Nadal		Djokovic	
		Mean	σ	Mean	σ	Mean	σ
16	Shot selection	3	0	3	0	3	0
17	Footwork	3	0	3	0	3	0
18	Recovery	3	0	3	0	3	0

Group III Factors: Tactical Skills Evaluation

For the third group of factors, experts evaluated a player's tactical skills across eleven shots at the peak of their career. The factors were ranked on a scale from Pro Level (1) to Outstanding (3), using the same definitions as for the first group.

Table 5 presents the experts' evaluations of players' tactical skills.

The results show that all three players demonstrate strong tactical skills, with Nadal and Djokovic consistently earning the highest ratings (a perfect score of 3) in most categories. Federer also scores highly, but has slightly lower ratings in certain areas, such as defending against aggressive baseline players (2.6) and keeping the ball in play (2.3).

Notable differences include:

- Aggressive serve-and-volley: Federer (2.7) scores higher than Nadal (1.6) and Djokovic (1.4), suggesting a greater emphasis on this tactic in his playstyle.

- Keeping the ball in play: Nadal and Djokovic (3.0) outperform Federer (2.3), reflecting their strong defensive capabilities.

- Defensive play: Nadal and Djokovic score higher in defending against aggressive baseline players and serve-and-volley tactics.

Overall, Nadal and Djokovic appear to have a more consistent tactical approach across different play styles, while Federer shows a distinct preference for attacking tactics.

Group IV Factors: Spin Application Evaluation

For the fourth group of factors, experts assessed the level of spin a player applied to their shots at the peak of their career. The factors were ranked on a scale from Pro Level (1) to Outstanding (3), using the same definitions as for the first group.

Table 6 presents the expert group's opinions on the spin levels applied to players' shots. The table shows that Nadal and Djokovic are highly proficient in topspin, both scoring 3.0, while Federer demonstrates more versatility with backspin and sidespin, also scoring 3.0.

Group V Factors: Shot Control Evaluation

For the fifth group of factors, experts assessed the level of control a player applied to their shots at the peak of their career. The factors were ranked on a scale from Pro Level (1) to Outstanding (3), using the same definitions as for the first group.

Table 7 presents the expert group's evaluations of the control applied by players to their shots across four key areas.

All three players received high ratings in shot angles (2.9), with Nadal leading in shot height (3.0). Nadal ranked higher in shot speed, while Djokovic performed best in shot depth with a perfect score. Overall, Nadal leads in height, Djokovic in depth and Federer remains consistent.

Group VI Factors: Physical Skills Evaluation

For the sixth group of factors, experts assessed the level of physical skills a player demonstrated at the peak of their career. The factors were ranked on a scale from 1 to 3:

- Competent (1): Demonstrates reliable physical skill.

- Advanced (2): Displays high-level physical skill.

- Exceptional (3): Exhibits elite physical skill.

Table 8 provides the expert group's evaluations of players' physical skills across five key areas.

Table 8 highlights the players' strong physical attributes, with Nadal and Djokovic leading in strength, power and flexibility. Nadal achieved near-perfect scores, while Djokovic received three perfect ratings. Federer remained consistent across all aspects.

Open ended questions

The questionnaire included two open-ended questions asking experts why tennis fans might admire some players more than others.

Experts expressed admiration for Federer, Nadal and Djokovic for their grace, talent and ability to make tennis look effortless. They praised their humility, fairness and sportsmanship, alongside their fierce competitiveness, work ethic and determination. Despite their differences in personality, experts emphasised that the players remained gracious in defeat and developed into thoughtful, classy figures. Off the court, they contributed significantly through exhibition matches and charity work, using their platforms to support various causes and promote the sport.

Experts noted that their passion for tennis, ability to handle pressure and strong self-belief set them apart. Their willingness to give everything on the court, combined with exceptional shot-making, defence and effort on every point, defined their success and legacy.

On the other hand, experts note that some behaviours of the three players, such as repetitive on-court habits and slow pace of play, can be seen as unappealing to the public. Additionally, political stances, match volatility and outbursts toward their players' boxes have drawn mixed reactions. While these behaviours reflect their competitive spirit, they can sometimes overshadow their exceptional skill and contributions to the sport.

Experts Final Comments

Final comments and expert discussions emphasised the challenges of assessing tennis skills, often due to their subjective nature. Experts noted that while the exceptional abilities of Federer, Nadal and Djokovic offer valuable insights, coaching other players based on their superior skills remains a complex task.

Table 5
Expert Group Mean Opinions on Tactical Skills Evaluation.

#	Tactical Skills	Federer		Nadal		Djokovic	
		Mean	σ	Mean	σ	Mean	σ
19	Hitting every shot with purpose	2.8	0.42	3	0	3	0
20	Playing to his strength	3	0	3	0	3	0
21	Aggressive baseline play	2.7	0.52	2.9	0.32	2.8	0.42
22	Aggressive serve-and-volley	2.7	0.48	1.6	0.52	1.4	0.52
23	Hitting to the open court	3	0	3	0	3	0
24	Attacking weak serves	2.7	0.48	2.7	0.48	3	0
25	Keeping the ball in play	2.3	0.48	3	0	3	0
26	Deal with the strengths, weaknesses and idiosyncrasies of opponents	2.8	0.42	3	0	3	0
27	Defending against aggressive baseline players	2.6	0.48	3	0	3	0
28	Defending against the serve-and-volley	2.6	0.48	2.9	0.32	3	0
29	Understands physical playing conditions and reacts appropriately	3	0	3	0	3	0

Table 6
Expert Group Mean Opinions on Spin Applied to Players' Shots.

#	Spin Applied	Federer		Nadal		Djokovic	
		Mean	σ	Mean	σ	Mean	σ
30	Topspin	2.6	0.52	3	0	3	0
31	Backspin	3	0	2.5	0.53	2.5	0.53
32	Sidespin	3	0	2.6	0.52	2.3	0.82

Table 7
Expert Group Mean Opinions on Control Applied to Players' Shots.

#	Shot Control	Federer		Nadal		Djokovic	
		Mean	σ	Mean	σ	Mean	σ
33	Shot angle	2.9	0.32	2.9	0.32	2.9	0.32
34	Shot height	2.6	0.52	3	0	2.8	0.42
35	Shot speed	2.7	0.48	2.8	0.42	2.7	0.48
36	Shot depth	2.7	0.48	2.8	0.42	3	0

Table 8
Expert Group Mean Opinions on Physical Skills Evaluation.

#	Physical Skills	Federer		Nadal		Djokovic	
		Mean	σ	Mean	σ	Mean	σ
37	Strength	2.6	0.52	3	0	2.8	0.42
38	Speed	3	0	3	0	3	0
39	Agility	3	0	3	0	3	0
40	Power	2.8	0.42	3	0	2.9	0.32
41	Flexibility	2.7	0.48	2.9	0.32	3	0

Additionally, the Delphi exercise identified the need for a Comprehensive Tennis Skills Training Manual. This Manual would serve as the primary reference for teaching the technical, tactical, physical and non-physical skills essential for developing top-level tennis players.

The Manual shall include "functional" requirements detailing player actions and performance requirements setting measurable outcomes to ensure systematic skill development and assessment. It shall categorise tennis skills with detailed clauses for each, classified as Essential, Important, Desirable or Advice and assign standard verification methods such as Test, Demonstration, Analysis or Inspection.

In summary, the Manual shall provide the technical guidelines and verification methods needed to develop advanced tennis skills, enhancing coaching and shaping future champions.

The need for a Comprehensive Tennis Skills Training Manual aligns with a Functional Performance Specification, commonly used in Systems Engineering. Systems Engineering plays a critical role in the successful execution of complex projects such as building an aircraft, robotics, computer chip design or city-wide infrastructure. It provides a structured process that covers the entire project lifecycle, from the initial concept and design to development, implementation and maintenance.

CONCLUSIONS

The Delphi exercise identified key skills and tactics for integrating into coaching programs to develop top-level tennis players. While the study focused on male players, many of its findings are also applicable to female tennis, particularly in areas such as physical and non-physical skills, as these are fundamental and universally required in high-level competition. However, future research is necessary to examine the extent to which the specific technical and tactical insights identified in this study are relevant to the women's game, considering potential differences in playing style, match dynamics and physical demands.

Conclusions: The Tennis Skills of Federer, Nadal and Djokovic

The tennis skills of Federer, Nadal and Djokovic were consistently ranked among the best, with perfect scores achieved in multiple areas.

- Strokes Evaluation: Federer, Nadal and Djokovic were ranked highly in all strokes, reflecting exceptional technical performance. For each of the 15 main strokes, at least one player was rated as "One of the Best" or "Best Ever". Perfect scores of 5 ("Best Ever") were awarded to Nadal's deep groundstroke, Djokovic's serve return and Djokovic's backhand.

- Technical/Tactical Skills: Each player received a perfect score of 3 ("Outstanding"), reflecting their mastery of shot selection, footwork and recovery.

- Tactical Skills: Tactical skills were evaluated across eleven components, with all players ranked highly. Nadal and Djokovic displayed a balanced approach, while Federer's style was more aggressive.

- Spin Application: All three players were highly ranked in topspin, backspin and sidespin, with Nadal and Djokovic particularly dominant in topspin, while Federer was recognised for his versatility.

- Shot Control: Each player was highly ranked for shot control, with Nadal dominant in height, Djokovic in depth and Federer maintaining consistency across categories.

- Physical Skills: Physical skills were assessed across five aspects. Nadal and Djokovic were highly ranked in strength, power and flexibility, while Federer maintained a strong overall performance.

Conclusions: The Legacy and Perception of Tennis Legend

Experts have recognised Federer, Nadal and Djokovic for their elegance, talent and sportsmanship. Their competitive spirit has set new standards, making them iconic figures. While their game styles and personalities inspire admiration, occasional on-court behaviour has drawn mixed reactions. Despite this, their legacy is defined by exceptional skills, discipline and a lasting impact on the sport.

Conclusions: Experts' Final Comments

Experts stressed the challenge of assessing tennis skills due to their subjective nature. While Federer, Nadal and Djokovic's abilities offer valuable insights, applying them to coaching others remains difficult. They emphasised the need for a Comprehensive Tennis Skills Training Manual to provide a structured reference for teaching technical, tactical, physical and non-physical skills. The Manual would include functional and performance requirements with standardised verification methods, ensuring systematic skill development and assessment, aligned with Systems Engineering principles for developing future champions.

Conclusions: Enhancing Tennis Coaching for Champions

Enhancing tennis coaching to develop more champions should focus on eliminating weaknesses in technical and tactical tennis skills. Prospective major champions must show strong performance across all evaluated techniques, ensuring their stroke skills consistently rank within the top three categories: Outstanding, One of the Best and Best Ever.

Mastery in shot selection, footwork, recovery and spin control suggests that coaching should prioritise these skills, aiming for near-perfect execution.

Physical and non-physical skills are equally important. Comprehensive conditioning and on-court creativity are essential, while character skills such as sportsmanship, resilience and composure under pressure should be integrated into coaching. By focusing on these areas, coaches can develop well-rounded, championship-calibre players.

As a key outcome, the Delphi exercise emphasised the need for a Comprehensive Tennis Skills Training Manual. This manual would serve as a structured guide, not only for coaching but also for assessing the technical, tactical, physical and non-physical skills necessary for developing elite players and future champions.

To demonstrate the practical implications of this finding, Annex A provides a brief outline of the proposed Comprehensive Tennis Skills Training Manual, including its structure, format and potential application in player development and coaching environments.

ANNEXES

A. Coaching Framework: Tennis Coaching Manual
B. A List of Tennis Skills

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RECOMMENDED ITF TENNIS ACADEMY CONTENT (CLICK BELOW)

ANNEX A

COACHING FRAMEWORK: TENNIS COACHING MANUAL

This annex outlines the *Comprehensive Tennis Skills Training Manual* (hereafter referred to as the Tennis Coaching Manual or the Manual). In response to key research findings, the Manual is intended to align with Systems Engineering practices and demonstrate how structured methodologies can support the effective design and delivery of coaching programs.

Systems Engineering

For readers who may have limited familiarity with Systems Engineering (SE), it is important to note that SE is a structured, interdisciplinary approach used to design, manage and optimise complex systems across their entire lifecycle (Fauconbridge & Ryan, 2014).

The process begins by defining system-level requirements through a comprehensive analysis of the entire system, including its environment and interfaces. This holistic view allows for the systematic breakdown of the system into subsystems, assemblies and individual components, ensuring that all functions and interactions are clearly defined.

In addition to physical elements such as hardware and software, SE also considers essential supporting factors, including people, training, facilities and procedures. This integrated approach ensures that all parts of a system work together effectively, guiding development, integration and ongoing support to deliver a complete and capable solution that meets project goals (Fauconbridge & Ryan, 2014).

SE in Tennis Coaching

While traditional coaching relies on experience and intuition (Roberts et al., 2009), applying SE introduces a structured, holistic approach, treating the player as an integrated system with performance requirements aligned to the game's demands.

Key skill areas including technical, tactical, physical and non-physical are managed as subsystems, each with defined requirements to guide targeted development. Breaking them down further clarifies skill interactions and supports measurable outcomes and verification.

Based on Fauconbridge & Ryan (2014) and Holt (2021), Table A1 outlines the SE activities for planning, developing, verifying and managing a player's skills throughout their career. While it provides a comprehensive overview of SE tasks in tennis coaching, detailed exploration is beyond the scope of this paper.

Simplified Application of Systems Engineering for Tennis Coaching

Since some tasks in Table A1 are not discussed and some readers may be unfamiliar with SE, a simplified application of SE to tennis coaching is presented before discussing the Tennis Coaching Manual. Figure A1 illustrates this simplified application, offering a clearer understanding of how SE principles integrate into tennis coaching.

Table A1
Applying Systems Engineering Principles in Tennis Coaching.

	System Engineering Tasks
1.	**Need and Requirements**
1.1.	**Need (Concept)**
1.1.1.	*Tennis National Governing Body Strategy*
1.2.	**Requirements (Definition)**
1.2.1.	*Player Development Requirements*
1.2.2.	*Tennis Performance Criteria and Skill Specifications*
1.2.3.	*Athlete Selection Criteria for Coaching Programs*
2.	**Coaching Program Implementation**
2.1.	**Planning**
2.1.1.	*Tennis Coaching Systems Management Plan*
2.1.2.	*Player Skill Certification Plan*
2.1.3.	*Player Skills Assessment and Evaluation Plan*
2.1.4.	*Player Skill Configuration Management Plan*
2.2.	**Skill Development in Tennis Coaching**
2.2.1.	*Player Skill Baseline*
2.2.2.	*Tennis Coaching System Implementation*
2.3.	**Skill Validation and Evaluation**
2.4.	**Coaching Logistics and Support Resources**
2.4.1.	*Player Equipment Inventory*
2.4.2.	*Tennis Training Environment & Facilities*
2.4.3.	*Player Skill Specifications*
2.4.4.	*Tennis Coaching Standards*
2.4.5.	*Coaching Handbooks and Training Guides*
2.4.6.	*Tennis Performance Visual Resources*
2.4.7.	*Player Readiness and Condition Check*
2.4.8.	*Skill Application Caveats*
2.4.9.	*Integrated Coaching Support Instruction*
2.5.	**Player Skill Matrix**
2.6.	**Verification Cross Reference Matrix**
2.7.	**Tennis Skills Risk Assessment**
2.8.	**Technical Certification of Player Competence**
3.	**On-Tour Performance Phase**
3.1.	*Performance Sustainment and Monitoring*
3.2.	*Performance Deficiency Review*
3.3.	*Skill Change Proposal*
3.4.	*Skill Reliability and Maintenance Review*
3.5.	*Player Retirement*

Figure A1. *Simplified Application of Systems Engineering for Tennis Coaching.*

As shown in Figure A1, the functional skills and performance standards for a tennis player are defined to guide development, assessment and progression. This includes specific technical, tactical, physical and non-physical skills, with measurable benchmarks to evaluate performance in training or match conditions.

The coaching system is implemented based on this plan, ensuring skill acquisition and athlete progression. Player skills are then confirmed through testing and observation, validating coaching effectiveness and guiding progression decisions.

Formal recognition of meeting performance standards involves evidence review, coach assessments and independent evaluations. Ongoing observation ensures the player maintains competence, with periodic evaluations to address skill degradation and keep the player match-ready.

Tennis Coaching Manual

Several tasks/activities in Table A1 are displayed in red text. In the authors' opinion, these tasks are crucial and should be collectively used to develop the Tennis Coaching Manual. Brief definitions of these tasks/activities are provided below.

Tennis Performance Criteria and Skill Specifications

It outlines the functional and performance requirements for tennis players, which are essential for achieving desired outcomes.

Functional requirements describe the actions, activities or tasks the player must perform to achieve specified objectives. Performance requirements establish quantitative measures for how well these functional requirements must be met under defined conditions.

The process involves:

- Creating a comprehensive list of tennis skills.

- Assigning a separate requirement clause for each skill.

- Detailing the functional and performance characteristics for each requirement clause, including design characteristics, constraints and interfaces.

- Annotating each requirement clause with a category: Essential, Important, Desirable or Advice.

- Assigning a verification method to each requirement clause: Test, Demonstration, Analysis or Inspection.

This structured approach ensures systematic player development and skill assessment.

To demonstrate specification development and in accordance with Anderson (2003), a list of tennis skills to be specified is provided in Annex B. In addition, Table A2 outlines a structured format for registering clauses, categories and verification methods within the document.

Table A2 includes, for demonstration purposes, three randomly selected clauses referring to the first serve skills. Due to space limitations, the full content of these clauses is shown below: "The player shall consistently deliver first serves at minimum speeds of 190 km/h, 200 km/h and 210 km/h, with corresponding success rates of at least 60%, 65% and 70% and location accuracies of 75%, 80% and 85%, for the Essential, Important and Desirable categories, respectively, all verified under standardised testing conditions."

Developing a Tennis Performance Criteria and Skill Specifications document is a demanding task that requires the involvement of an interdisciplinary team. The final

document would be comprehensive, specifying various skills and methods for their verification across different environments and situations. Similar to complex engineering projects, creating such a document can take considerable time to complete.

Skill Development in Tennis Coaching

It involves developing and implementing the coaching system based on prior planning. This process covers all training components and applies structured activities to support skill acquisition, ensure athlete progression and establish a foundation for future evaluation and improvement. The ultimate goal is to meet the skill requirements specified in the *Tennis Performance Criteria and Skill Specifications*.

Skill Validation and Evaluation

This task involves confirming that the player has acquired and can apply baseline skills through testing and observation. It validates coaching effectiveness by comparing the player's performance to the requirements outlined in the *Tennis Performance Criteria and Skill Specifications*, informing decisions on progression or refinement.

Tennis Coaching Standards

This involves documenting consistent procedures, guidelines and best practices to ensure that coaching methods and outcomes are safe, effective and reliable across all stages of player development.

Coaching Handbooks and Training Guides

These provide practical instructions, training methods and best practices to help coaches and players effectively apply the tennis coaching system and maximise performance outcomes.

Tennis Performance Visual Resources

These provide coaching tools, resources and support systems needed to sustain skill development, based on Integrated Logistic Support principles.

Performance Sustainment and Monitoring

This involves ongoing training and reassessment to ensure the player maintains certified competence. The phase includes technical refreshers, skill drills, conditioning and periodic evaluations to detect and address skill degradation, fatigue or inefficiencies, ensuring the player remains match-ready and aligned with performance standards.

In summary, the Tennis Coaching Manual is designed as a structured, practical resource for coaches, players and development programs. It aims to guide the systematic acquisition, assessment and refinement of technical, tactical, physical and non-physical tennis skills. The skills specified in the *Tennis Performance Criteria and Skill Specifications* will serve as the primary reference throughout the Manual, ensuring that all developmental activities align with the established performance and functional requirements.

Table A2
Tennis Performance Criteria and Skill Specifications Matrix

Requirements, Verification and Comments									
	Category				Verification Method				
Requirement	Essential	Important	Desirable	Advice	Test	Demonstration	Analysis	Inspection	References & Comments
1. Technical Skills									
1.1. Serve									
1.1.1. First Serve									
1.1.1.1. Requirement clause	X				X				Verification standard or method shall be identified for each clause
1.1.1.2. Requirement clause		X			X				
1.1.1.3. …			X		X				

ANNEX B

A LIST OF TENNIS SKILLS (Derived from Anderson, 2003)

Tennis Skills			
Technical Skills	Tactical Skills	Physical Skills	Non-physical Skills
Stances - Square groundstroke - Open groundstroke - Closed groundstroke **Grips** - Eastern forehand - Semi-Western - Western - Continental - Eastern backhand - Two-handed backhand **Strokes and Shots** - Eastern Forehand - Forehand - One-handed backhand - Two-handed backhand - First serve - Second serve - Serve return - Approach shot - Volleys - Swinging midcourt volley - Overhead - Drop shot - Lob - Passing shot **Applying** - Topspin - Backspin - Sidespin **Controlling** - Shot angle - Shot height - Shot speed - Shot depth	**Tactics** - Keeping the ball in play - Hitting to the open court - Playing to the opponent's weakness - Playing to one's strength **Offensive** - Aggressive baseline play - Drop shot - Keeping the ball in play - Serve-and-volley - Swinging midcourt volley - Approach shot - Volley and overhead - Offensive lob - Passing shot - Attacking weak serves **Defensive** - Serve return - Playing defensively using the passing shot - Playing defensively using the lob - Defending against aggressive baseline players - Defending against the serve-and-volley	**Strength** **Speed** **Agility** **Power** **Flexibility**	**Mental Skills** - Emotional control anxiety - Emotional control anger - Maturity - Self-confidence - Motivation to achieve - Ability to concentrate - Experience **Communication Skills** - Sends positive messages - Sends accurate messages - Listens to messages - Understands messages - Receives constructive criticism - Receives praise and recognition - Credibility with teammates - Credibility with coaches **Character Skills** - Trustworthiness - Respect - Responsibility - Fairness - Caring - Citizenship