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The Fernando Loio Combat Performance Framework (FLCPF): An Ecological-Integrative Conceptual Model for Combat Performance and Coaching Practice

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Abstract

Combat sports involve highly dynamic technical-tactical, perceptual-cognitive, biomechanical, and physiological demands. Traditional training approaches have frequently emphasized isolated technical instruction and physical conditioning. However, contemporary evidence suggests that successful performance emerges from the interaction of technical-tactical, perceptual-cognitive, biomechanical, physiological, and contextual processes operating under continuously changing competitive constraints.

This article presents an integrative conceptual synthesis grounded in longitudinal observational evidence obtained from elite Ultimate Full Contact competition. The framework was developed from a series of investigations conducted at the World Ultimate Full Contact Championships between 2008 and 2017. Across the original research programme, 170 elite fights involving 340 international fighters from 38 countries were analysed. Findings concerning offensive efficiency, counteroffensive efficiency, defensive efficiency, ground fighting control, fight outcomes, contextualized training, and physiological functionality were integrated with principles derived from ecological dynamics, representative learning design, adaptive transfer, and combat performance research.

The synthesized evidence suggests that elite fighters are distinguished not only by technical proficiency, but primarily by their capacity for adaptive transfer, technical-tactical versatility, anticipation, timing regulation, contextual adaptability, representative interaction, and physiological functionality under competitive pressure. Successful fighters demonstrated superior efficiency in offensive and counteroffensive transitions, distance regulation, defensive adaptability, positional dominance, and opportunity exploitation. Anticipated and simultaneous counterattacks emerged as highly efficient temporal responses, while adaptability between striking and grappling phases represented a major determinant of competitive success.

The study proposes the Fernando Loio Combat Performance Framework (FLCPF), an original ecological-integrative model suggesting that combat expertise emerges through the interaction of technical-tactical versatility, anticipation, contextual adaptability, adaptive transfer, combat affordances, representative interaction, and physiological integration. The framework further recognizes that adaptive expertise depends on the complementary interaction between analytical training, which consolidates biomechanical efficiency, technical precision, coordination, speed,

and power production, and representative learning environments, which facilitate decision-making, adaptability, and competitive transfer.
Practical implications for coaches and athletes are presented through integrated training models and applied performance frameworks (Tables 8–10). Although developed from Ultimate Full Contact competition, the proposed principles may be generalized across boxing, kickboxing, Muay Thai, pankration, MMA, grappling, and other combat sports.

Keywords: Combat sports; Performance analysis; Adaptive transfer; Ecological dynamics; Representative learning design; Technical-tactical performance; Physiological integration; Contextual adaptability; Coaching practice.

1. Introduction

Combat sports are characterized by continuous interaction between opponents under conditions of uncertainty, variability, instability, and temporal pressure. Successful performance depends not only on technical execution, but also on the ability to perceive opportunities, regulate distances, anticipate actions, adapt behavior, and make effective decisions under constantly changing environmental constraints (Araújo et al., 2006; Davids et al., 2013; Loio, 2021; Vilar et al., 2012).

Traditional isolated technical repetition, often failing to reproduce the uncertainty, opponent interaction, temporal pressure, and contextual variability that characterize competitive environments. Therefore, the purpose of this study was to propose an integrated ecological-cognitive framework for representative combat training models in combat sports have historically emphasized repetitive technical execution under relatively predictable conditions. Although analytical repetition remains important for biomechanical stabilization, motor refinement, and technical precision, isolated practice may be insufficient to develop adaptability, anticipation, contextual regulation, and competitive transfer. This limitation becomes particularly relevant in striking and hybrid combat sports, such as boxing, kickboxing, sambo combat, Muay Thai, pankration, MMA, grappling, and full contact systems, where athletes continuously transition between offensive and defensive actions, striking and grappling phases, long-, short-, and close-distance exchanges, tactical instability, and contextual uncertainty.

Ultimate Full Contact represents a hybrid full contact combat sport characterized by the integration of striking, takedowns, grappling, submission actions, and ground striking. This competitive context requires fighters to dynamically regulate technical-tactical behavior in accordance with combat distance, opponent pressure, tactical opportunities, positional instability, and physiological demands. In this sense, Ultimate Full Contact provides a particularly relevant model for studying adaptive expertise and representative training design in combat sports.

Previous observational evidence from Ultimate Full Contact demonstrated that offensive efficiency emerges from the interaction between combat distance, fighting style, technical-tactical skills, and contextual affordances (Loio et al., 2020a). Winners showed superior adaptability across all combat distances and styles, suggesting that expert performance depends on the ability to perceive, interpret, and exploit changing affordances in real time. These findings support the ecological dynamics interpretation of expertise, where performance emerges from perception-action coupling rather than from rigid motor reproduction (Araújo et al., 2006; Davids et al., 2013; Renshaw et al., 2019).

Further observational findings demonstrated that elite fighters capable of integrating striking, grappling, defensive regulation, counteroffensive timing, and dominant ground control revealed superior competitive effectiveness. Successful athletes consistently demonstrated greater capacity to regulate combat distances, exploit opportunities, anticipate opponent intentions, adapt dynamically to contextual variability, and transfer tactical solutions between changing combat situations (Loio et al., 2020a, 2020b, 2020c; Loio et al., 2022).

Combat sports performance also cannot be dissociated from physiological integration. Technical-tactical actions are conditioned by intermittent high-intensity demands, requiring the integration of strength, power, speed, aerobic recovery, anaerobic capacity, neuromuscular coordination, and fatigue regulation (Amtmann, 2004; Franchini & Takito, 2014; Loio et al., 2022a; Slimani et al., 2017). Consequently, successful combat behavior emerges from the interaction between technical-tactical efficiency, perceptual-cognitive adaptability, ecological affordance perception, and physiological functionality.

Despite growing interest in representative learning design, ecological dynamics, nonlinear pedagogy, and constraints-led approaches, combat sports literature still lacks integrative frameworks connecting technical-tactical adaptability, physiological conditioning, observational performance analysis, adaptive transfer, and representative training methodologies. Furthermore, limited attention has been given to how versatility, anticipation, contextual adaptability, representative interaction, and physiological integration emerge across different combat systems.

The present article should be interpreted as an integrative conceptual analysis grounded in a series of longitudinal observational investigations conducted in elite Ultimate Full Contact competition. Rather than examining a single performance variable in isolation, the study synthesizes offensive, counteroffensive, defensive, positional, physiological, and training-related evidence into a unified explanatory framework. The objective is not only to summarize existing findings, but also to develop an original conceptual model capable of explaining combat performance and informing evidence-based coaching practice.

The present article should be interpreted as an integrative conceptual analysis grounded in a series of longitudinal observational investigations conducted in elite Ultimate Full Contact competition. Rather than examining isolated performance variables independently, the study synthesizes offensive, counteroffensive, defensive, positional, physiological, and training-related evidence into a unified explanatory framework. The objective is not only to summarize previous empirical findings, but also to establish theoretical connections capable of advancing the understanding of combat performance and informing evidence-based coaching practice across combat sports.

Furthermore, although representative and contextualized training approaches have received increasing scientific support in recent years, the role of analytical technical practice remains fundamental for the consolidation of biomechanical efficiency and motor skill development. Systematic technical repetition contributes to the refinement of movement coordination, technical precision, speed, power production, and movement economy, providing the biomechanical foundation upon which adaptive and context-dependent performance can emerge (Loio et al., 2022b). Consequently, combat training should not be interpreted as a choice between analytical and representative methods, but rather as a complementary process integrating both approaches according to training objectives and athlete development needs.

Accordingly, the present study aims to synthesize previous observational findings from Ultimate Full Contact and integrate them with contemporary principles of ecological dynamics, representative learning design, motor learning, combat sports science, and physiological performance research. Based on this synthesis, an original conceptual framework is proposed to explain how adaptive expertise emerges through the interaction between technical-tactical

efficiency, perceptual-cognitive regulation, contextual adaptability, physiological functionality, and representative training environments.
The study further introduces the Fernando Loio Combat Performance Framework (FLCPF), a conceptual model designed to integrate these dimensions into a coherent explanation of combat expertise while providing practical implications for coaches, athletes, and researchers across striking, grappling, and hybrid combat sports.

2. Methodological Approach

The present study is an integrative conceptual analysis grounded in a series of observational investigations previously conducted in elite Ultimate Full Contact competition. The article synthesizes empirical findings obtained from longitudinal performance analyses and combines them with theoretical principles derived from ecological dynamics, representative learning design, motor learning, combat sports science, and physiological performance research. The primary objective was to develop an original conceptual framework capable of explaining combat performance and informing evidence-based coaching practice.

2.1. Research Design

This article represents an integrative conceptual synthesis derived from a doctoral research project conducted at the University of Beira Interior (Loio, 2021) and from subsequent observational studies examining performance determinants in Ultimate Full Contact competition. The original research programme involved systematic observational analyses of elite-level fights performed during the World Ultimate Full Contact Championships between 2008 and 2017.
The present investigation does not seek to provide a new isolated statistical analysis. Rather, it integrates and interprets empirical findings previously obtained across multiple observational studies addressing offensive efficiency, counteroffensive efficiency, defensive efficiency, ground fighting control, fight outcomes, contextualized training, and physiological demands.
Through this integrative approach, the study combines empirical evidence with contemporary theoretical perspectives from ecological dynamics, representative learning design, perception–action coupling, adaptive expertise, motor learning, and physiological performance science. The purpose of this synthesis was to identify common performance principles and develop an original explanatory model capable of describing the mechanisms underlying successful combat performance.
The resulting conceptual framework, designated the Fernando Loio Combat Performance Framework (FLCPF), represents the principal theoretical contribution of the present study and serves as a basis for practical recommendations regarding combat sports training and coaching practice.

2.2. Sample and Observational Basis

The observational evidence underlying the framework was obtained from 170 elite fights involving 340 international fighters from 38 countries who participated in the World Ultimate Full Contact Championships between 2008 and 2017. The analyzed fighters represented elite competitive standards within hybrid full contact combat systems (i.e., involving boxing skills, kicks, knees, takedowns and submission grappling) and were observed across multiple combat outcomes, technical-tactical exchanges, and fighting contexts.

The analyzed fights included outcomes by submission, decision, technical knockout, knockout, and doctor stoppage. These outcomes were used to identify relationships between technical-tactical behavior, contextual adaptability, positional control, and competitive success (Loio et al. 2020d).

2.3. Observational Procedures

Systematic observational methodology was employed in the original investigations to classify technical-tactical actions according to offensive dynamics, counteroffensive dynamics, defensive dynamics, ground control dynamics, combat distances, tactical transitions, and fight outcomes.

The variables considered across the research program included striking actions, kicking actions, takedowns, submission attempts, counterattacks, evasive actions, defensive responses, positional control, ground-and-pound actions, timing regulation, and adaptive tactical responses. Particular attention was given to transitions between striking and grappling, temporal counteroffensive responses, defensive-offensive regulation, and adaptability across long, short, and close combat distances.

Repeated observation, technical coding, and calibration procedures were used to improve consistency in the classification of combat actions. The original studies applied descriptive statistics, Mann–Whitney U tests, Spearman correlations, and the Kalina combat dynamics method to examine efficiency indices and differences between winners and losers.

2.4. Conceptual Synthesis Procedure

For the present article, a conceptual synthesis approach was adopted to integrate the findings from the author's previous observational investigations with ecological dynamics, nonlinear pedagogy, representative learning design, and physiological performance literature.

Recurring performance patterns were categorized according to six major conceptual dimensions:

1. offensive adaptability;
2. counteroffensive timing;
3. defensive efficiency;
4. ground fighting control;
5. physiological integration;
6. adaptive transfer.

These dimensions were then reorganized into the Fernando Loio Combat Performance Framework, a conceptual model designed to explain how elite combat performance emerges through the interaction between ecological constraints, perceptual-cognitive regulation, technical-tactical behavior, physiological functionality, and representative training design.

2.5. Methodological Positioning

The present study should be understood as a conceptual framework article supported by longitudinal observational evidence. Its contribution is not limited to reporting isolated performance indicators, but rather to integrating previous findings into a coherent model that may guide future research, coaching methodology, and performance development in combat sports.

This methodological positioning is particularly relevant because combat performance is multidimensional and nonlinear. Isolated analyses of techniques, physiological variables, or tactical actions may provide useful partial information, but they are insufficient to explain how fighters adaptively regulate behavior under competitive instability. Therefore, an integrative ecological-cognitive synthesis was considered appropriate for the aims of this study.

3. Results: Observational Foundations of Combat Performance

The observational evidence accumulated throughout the Ultimate Full Contact research programme consistently demonstrated that competitive success cannot be explained through isolated technical actions. Instead, performance emerged from the interaction between offensive efficiency, counteroffensive efficiency, defensive adaptability, ground fighting control, physiological functionality, and contextual regulation.

Across the different investigations, winners consistently demonstrated greater technical-tactical versatility, adaptability to changing combat situations, superior timing regulation, anticipation capacity, and more efficient management of combat transitions. These characteristics were evident regardless of whether the fight was developed predominantly through striking exchanges, grappling interactions, defensive regulation, or ground control situations.

The findings revealed that successful fighters continuously adjusted their behaviour according to contextual opportunities and constraints, supporting the ecological dynamics perspective that performance emerges through perception-action coupling and adaptive interaction with the environment rather than through rigid technical execution (Araújo et al., 2006; Davids et al., 2013).

The following sections summarize the principal findings obtained from the observational studies that formed the empirical basis of the present framework.

3.1 Offensive Efficiency and Distance Adaptation

Previous investigations demonstrated that winners consistently displayed significantly greater offensive efficiency than losers across all combat distances and tactical styles (Loio et al., 2020a). Offensive efficiency was not merely associated with attacking more frequently, but with attacking more effectively according to the contextual opportunities presented during combat. Winners demonstrated superior capacity to regulate combat distance, select appropriate technical actions, and exploit tactical opportunities.

Particularly relevant was the observation that specific combat styles were strongly associated with specific combat distances. Long- and short-distance fighting was predominantly related to stand-up striking actions, while close-distance interactions were strongly associated with grappling and ground fighting strategies. The principal relationships between combat distances and technical-tactical actions are presented in **Table 1**.

This relationship suggests that elite fighters do not select techniques randomly; instead, they continuously adapt their technical-tactical behaviour according to environmental constraints and affordances.

Table 1. Relationship Between Combat Distances and Predominant Technical-Tactical Actions

Combat Distance	Predominant Tactical Style	Main Technical-Tactical Actions
Long Distance	Stand-Up Striking	Jab, cross, overhand, front kick, roundhouse kick, spinning kick, axe kick
Short Distance	Stand-Up Striking	Hooks, uppercuts, shovel punches, knee strikes, low kick
Close Distance	Ground Striking	Clinch, takedowns, ground-and-pound
Close Distance	Submission Grappling	Chokes, joint locks, positional control

Note. Adapted from observational findings reported by Loio et al. (2020a).

As shown in **Table 1**, offensive efficiency appears to depend on the functional adjustment between combat distance and the technical-tactical repertoire available to the fighter. Long- and short-distance interactions favour stand-up striking actions, whereas close-distance interactions favour grappling and ground fighting behaviours.

The findings further demonstrated that ground fighting represented the area where the greatest differences between winners and losers emerged. Nevertheless, successful ground performance was strongly supported by efficient stand-up performance, highlighting the importance of technical-tactical integration rather than specialization in a single combat phase.

3.2 Counteroffensive Efficiency and Anticipation

Counteroffensive efficiency emerged as one of the most distinctive characteristics of successful fighters (Loio et al., 2020b).

The analysis demonstrated that anticipated counterattacks represented the most efficient temporal response category, followed by simultaneous counterattacks and posterior counterattacks. The temporal organization of counteroffensive responses identified in Ultimate Full Contact is summarized in **Table 2**.

These findings suggest that elite fighters possess advanced perceptual-cognitive abilities that allow them to recognize opponent intentions before attack completion, facilitating earlier and more efficient responses.

Table 2. Temporal Structure of Counteroffensive Responses

Counteroffensive Category	Tactical Description	Relative Efficiency
Anticipated Counterattack	Counterattack initiated before opponent attack completion	Very High
Simultaneous Counterattack	Counterattack executed during opponent attack	High
Posterior Counterattack	Counterattack performed after defensive action	Moderate

Note. Adapted from Loio et al. (2020b).

As illustrated in **Table 2**, the effectiveness of counteroffensive actions decreases as the temporal delay between opponent attack initiation and fighter response increases. Anticipated counterattacks therefore represent the highest level of perceptual anticipation and tactical regulation.

The superiority of anticipated and simultaneous counterattacks reinforces the importance of anticipation, opportunity recognition, and temporal regulation in combat performance.

These findings support previous literature demonstrating that expert performers possess enhanced perception-action coupling and anticipation abilities (Shih & Lin, 2016; Milazzo et al., 2016).

3.3 Defensive Efficiency and Adaptive Protection

Defensive efficiency represented another major differentiating factor between winners and losers (Loio, 2021; Loio et al., 2020c).

Successful fighters demonstrated superior efficiency in evasion-based actions, including dodging, slipping, and displacement strategies, while less successful fighters relied more heavily on blocking actions. Importantly, evasion did not merely reduce impact absorption. It

simultaneously created favourable opportunities for counteroffensive actions and tactical repositioning.
The principal defensive behaviours associated with successful combat performance are presented in **Table 3**.

Table 3. Most Efficient Defensive Behaviours Observed in Elite Fighters

Defensive Action	Tactical Function	Competitive Value
Dodging	Avoid impact	Creates counterattack opportunity
Slipping	Avoid impact	Preserves offensive positioning
Displacement	Distance regulation	Facilitates tactical adaptation
Sprawling	Takedown prevention	Prevents ground transition
Escaping	Positional recovery	Restores tactical balance
Blocking	Impact reduction	Primarily protective

Note. Based on observational findings reported by Loio et al. (2020c).

As shown in **Table 3**, the most efficient defensive behaviours were characterized by their dual functionality: protecting the fighter while simultaneously preserving or creating offensive opportunities. Evasion-based actions (e.g., dodging, slipping, and displacement) not only reduced impact exposure but also facilitated tactical adaptation and counteroffensive responses. In contrast, blocking actions appeared to serve a predominantly protective function.
The greatest differences between winners and losers emerged through evasion and sprawling efficiency. These findings suggest that successful defensive behaviour should not be interpreted as a passive process. Rather, it represents an adaptive mechanism that integrates protection, anticipation, distance regulation, and tactical transition.

3.4 Ground Fighting Control and Positional Dominance

Ground fighting control represented one of the strongest predictors of success (Loio, 2021; Loio et al., 2020c).
Winners consistently obtained dominant positions more frequently than losers, particularly through mount control, side control, and back control. Conversely, losers were more frequently observed in defensive positions, including closed guard, half guard, immobilization situations, and sweep attempts.
The principal ground fighting positions associated with competitive success are summarized in **Table 4**.

Table 4. Ground Fighting Positions Associated with Competitive Success

Ground Position	Tactical Characterization	Performance Value
Mount Control	Dominant superior position	Very High
Side Control	Stable positional dominance	Very High
Back Control	Maximum submission potential	Very High
North-South Control	Transitional dominance	Moderate
Closed Guard	Defensive position	Moderate
Half Guard	Defensive-transitional position	Low
Sweeps	Recovery action	Situational

Note. Adapted from Loio et al. (2020c).

As illustrated in **Table 4**, positions associated with superior control over the opponent were consistently linked to higher competitive success. Mount control, side control, and back control provided greater positional stability, increased striking opportunities, and enhanced submission potential. Conversely, positions such as closed guard and half guard were primarily associated with defensive or recovery-oriented behaviours.

The superiority of dominant positions suggests that successful ground fighting depends less on isolated submission attempts and more on the ability to progressively establish positional control before attacking. This finding reinforces the principle that positional dominance constitutes a prerequisite for effective offensive behaviour during ground fighting.

This interpretation is consistent with previous research demonstrating that positional dominance substantially increases submission and ground striking opportunities (Del Vecchio et al., 2011; Miarka et al., 2016).

Collectively, the findings presented in **Tables 1–4** suggest that successful combat performance emerges from the integration of offensive, counteroffensive, defensive, and positional control processes rather than from the isolated execution of technical skills.

3.5 Physiological Functionality and Technical-Tactical Expression

Although technical-tactical efficiency represented the primary determinant of performance, all observed behaviours were conditioned by physiological functionality.

The ability to maintain offensive efficiency, defensive adaptability, anticipation, and ground control under fatigue conditions appeared to differentiate successful fighters from their opponents. This observation supports the notion that physiological preparedness functions as a critical enabling factor for technical-tactical performance rather than as an isolated physical attribute (Loio, 2021).

Observational evidence suggested that physiological fatigue may compromise:

- perception-action coupling;
- reaction speed;
- decision-making quality;
- distance regulation;
- timing precision;
- technical execution;
- positional stability.

The principal physiological constraints that may influence combat behaviour and tactical effectiveness are presented in **Table 5**.

Table 5. Physiological Constraints Influencing Combat Behaviour

Physiological Constraint	Potential Tactical Consequence
Neuromuscular fatigue	Reduced technical precision
Glycolytic fatigue	Lower attack frequency
Reduced reaction speed	Delayed defensive responses
Decreased coordination	Inefficient movement regulation
Reduced force production	Lower striking and grappling effectiveness
Cognitive fatigue	Poor decision-making

Note. Synthesized from Franchini et al. (2011), Amtmann (2004), Del Vecchio et al. (2015), and observational evidence from Ultimate Full Contact studies.

As shown in **Table 5**, physiological fatigue may negatively affect multiple performance dimensions simultaneously. Neuromuscular fatigue can reduce technical precision, glycolytic fatigue may decrease offensive activity, and cognitive fatigue can impair perception, anticipation, and decision-making processes. Consequently, performance deterioration during combat should not be interpreted solely as a physical phenomenon, but rather as a reduction in the functional capacity to express technical-tactical expertise under competitive constraints.

This interpretation is consistent with previous investigations demonstrating that technical effectiveness, tactical decision-making, and physiological regulation are deeply interconnected during combat sports performance (Amtmann, 2004; Franchini & Takito, 2014; Del Vecchio et al., 2015).

Collectively, the findings presented in **Tables 1–5** indicate that combat expertise emerges through the integration of technical-tactical adaptability, perceptual-cognitive regulation, positional control, and physiological functionality. Therefore, successful performance should be understood as a multidimensional adaptive process rather than as the product of isolated technical skills or physical capacities.

The following section introduces the conceptual integration of these findings through the proposed Fernando Loio Combat Performance Framework.

4. The Fernando Loio Combat Performance Framework

The observational findings synthesized in the present study suggest that combat performance emerges through a continuous interaction between environmental constraints, perceptual-cognitive processes, technical-tactical actions, physiological functionality, and adaptive responses.

Traditional approaches frequently interpret performance through isolated technical skills or physical capacities. However, the results obtained from Ultimate Full Contact indicate that successful fighters are distinguished primarily by their ability to adapt their behaviour to contextual variability while maintaining technical effectiveness, tactical functionality, and physiological stability.

The evidence summarized in **Tables 1–5** collectively supports the development of an integrative performance model capable of explaining the interaction between offensive efficiency, counteroffensive efficiency, defensive adaptability, positional dominance, perceptual-cognitive regulation, and physiological functionality.

Consequently, a conceptual model was developed to integrate the principal performance determinants identified across the observational investigations.

The proposed framework is grounded on five fundamental assumptions:

1. Combat performance is adaptive rather than purely technical.
2. Successful behaviour emerges from perception-action coupling.
3. Contextual variability drives skill adaptation.
4. Physiological functionality constrains technical-tactical expression.
5. Representative training environments facilitate adaptive transfer to competition.

This conceptual integration resulted in the development of the **Fernando Loio Combat Performance Framework (FLCPF)**.

The FLCPF proposes that combat expertise emerges through the continuous interaction of technical-tactical, perceptual-cognitive, physiological, and environmental processes rather than through the isolated development of individual skills. The model assumes that performance is adaptive and context dependent, arising from the athlete's ability to perceive relevant affordances, regulate behaviour according to situational constraints, anticipate emerging opportunities, and maintain functional effectiveness under physiological and tactical pressure. Consequently, expertise is conceptualized as a dynamic process of adaptation rather than the simple accumulation of technical proficiency.
The dimensions and functional relationships that constitute the framework are presented in **Table 6.**

Table 6. The Fernando Loio Combat Performance Framework

Core Dimension	Functional Description	Performance Outcome
Technical-Tactical Versatility	Ability to perform multiple efficient actions	Greater adaptability
Anticipation	Recognition of opponent intentions before action completion	Faster responses
Contextual Adaptability	Adjustment to changing constraints and opportunities	Tactical efficiency
Representative Interaction	Continuous adaptation to opponent behaviour	Competitive transfer
Combat Affordances	Recognition of actionable opportunities	Decision-making quality
Adaptive Transfer	Transfer of solutions between combat situations	Performance stability
Physiological Integration	Maintenance of functionality under fatigue	Sustained efficiency

Note. *Conceptual framework proposed by Loio (2026) based on ecological dynamics, representative learning design, adaptive transfer theory, and observational evidence from elite combat sports.*

As illustrated in **Table 6**, successful combat performance emerges from the interaction between seven complementary dimensions rather than from isolated technical abilities. Technical-tactical versatility provides behavioural flexibility, anticipation facilitates proactive responses, contextual adaptability allows continuous adjustment to environmental constraints, representative interaction strengthens competitive transfer, combat affordances guide decision-making, adaptive transfer promotes behavioural stability across situations, and physiological integration sustains functionality under fatigue conditions.
For example, a fighter may possess excellent punching technique. However, if he or she cannot perceive opportunities, adapt to changing distances, anticipate attacks, maintain efficiency under fatigue, or transfer solutions to novel situations, performance effectiveness becomes substantially limited.
Thus, expertise emerges from adaptive functionality rather than technical perfection alone, reinforcing the need for training methodologies that simultaneously develop technical, tactical, cognitive, perceptual, and physiological dimensions of performance.
Importantly, the dimensions included in the FLCPF should not be interpreted as independent components. Instead, they operate as an interconnected adaptive system. Technical-tactical versatility facilitates contextual adaptability; anticipation enhances affordance perception; representative interaction promotes adaptive transfer; and physiological integration sustains the functionality of all dimensions under competitive stress. The simultaneous interaction of these processes ultimately determines performance effectiveness during combat.

5. Adaptive Transfer in Combat Sports

One of the most important findings emerging from the observational studies was the recurring capacity of elite fighters to successfully transfer tactical solutions between different combat situations.

This phenomenon is referred to in the present study as **adaptive transfer**.

Adaptive transfer can be defined as:

The capacity to apply previously acquired technical-tactical solutions to novel, changing, or unstable competitive situations while maintaining functionality and effectiveness.

Traditional approaches often assume that motor learning occurs through repetition of identical situations. However, competitive combat rarely presents identical situations.

Instead, elite fighters continuously encounter:

- different opponents;
- different distances;
- different tempos;
- different tactical pressures;
- different physiological states;
- different opportunities.

The ability to adapt previously acquired solutions to these changing circumstances appears to be one of the defining characteristics of expertise.

Examples of adaptive transfer observed across combat situations are presented in **Table 7**.

Table 7. Adaptive Transfer Across Combat Contexts

Original Situation	Adaptive Response	New Context
Long-distance striking	Distance closure and takedown	Grappling transition
Defensive evasion	Simultaneous counterattack	Offensive transition
Failed takedown	Positional adaptation	Ground control
Lost dominant position	Tactical recovery	Defensive stabilization
Ground attack failure	Positional maintenance	Renewed offensive opportunity

Note. *Conceptual representation of adaptive transfer proposed by Loio (2026).*

As illustrated in **Table 7**, successful fighters demonstrated the capacity to maintain effectiveness despite substantial contextual variation. Rather than reproducing fixed technical patterns, they continuously adjusted their actions according to emerging constraints and opportunities.

For example, a fighter who initially attacks from long distance may rapidly transition into a takedown sequence when distance collapses. Similarly, a failed offensive action may be transformed into a positional advantage through immediate tactical adaptation.

These observations suggest that combat expertise should not be viewed as the accumulation of isolated techniques, but rather as the development of a flexible behavioural system capable of generating effective solutions under varying constraints.

This interpretation is consistent with ecological dynamics theory, where learning emerges through adaptation to environmental constraints rather than through rigid motor reproduction (Araújo et al., 2006; Davids et al., 2013; Renshaw et al., 2019).

Importantly, adaptive transfer appears to function as a connecting mechanism between technical versatility, anticipation, contextual adaptability, and physiological regulation, thereby constituting one of the central dimensions of the proposed Fernando Loio Combat Performance Framework.

6. Representative Training Design

The observational findings consistently demonstrated that competitive success depends on the ability to solve problems under uncertainty.
Therefore, training environments should reproduce the essential informational, tactical, technical, physiological, and emotional characteristics of competition.
This principle is referred to as representative learning design.
Representative training does not simply involve sparring. Instead, it requires the systematic manipulation of constraints to stimulate adaptive behaviour and facilitate transfer to competitive performance.
Such constraints may include:

- combat distance;
- timing pressure;
- restricted technical repertoires;
- positional disadvantages;
- fatigue states;
- tactical objectives;
- opponent unpredictability.

By progressively manipulating these variables, coaches may create environments that stimulate perception-action coupling and adaptive expertise development.
The relationship between ecological constraints, adaptive responses, and competitive outcomes is summarized in **Table 8**.

Table 8. Ecological Constraint – Adaptive Response Model

Ecological Constraint	Adaptive Response	Combat Outcome
Distance variability	Tactical adaptation	Offensive efficiency
Opponent pressure	Anticipation	Counteroffensive success
Transitional instability	Adaptive transfer	Tactical continuity
Fatigue accumulation	Physiological regulation	Sustained performance
Positional disadvantage	Tactical recovery	Defensive efficiency
Tactical uncertainty	Exploration of affordances	Decision-making quality

Note. *Conceptual model illustrating the relationship between environmental constraints, adaptive responses, and combat outcomes.*

As shown in **Table 8**, performance adaptation emerges through the interaction between environmental demands and athlete responses. Distance variability stimulates tactical adaptation, opponent pressure promotes anticipation, transitional instability facilitates adaptive transfer, and fatigue accumulation requires physiological regulation.
Consequently, performance should be interpreted as the outcome of continuous athlete-environment interactions rather than as the expression of isolated technical abilities.

This perspective is aligned with ecological dynamics theory, which proposes that expertise emerges through the continuous adaptation of behaviour to changing constraints (Araújo et al., 2006; Davids et al., 2013; Vilar et al., 2012).
The model suggests that training should progressively increase ecological complexity rather than merely increase technical volume.
In practical terms, this means that coaches should design exercises where athletes are required to continuously perceive, interpret, decide, and adapt.

6.1 Analytical Training as a Foundation for Adaptive Expertise

Although the present framework emphasizes representative learning design and contextualized training, analytical training remains an essential component of combat sport development. Technical actions cannot be effectively adapted to competitive variability unless they have first been consolidated through systematic repetition and biomechanically efficient execution.
Repeated analytical practice contributes to the stabilization of motor patterns and promotes neuromuscular adaptations associated with coordination, movement economy, speed, precision, timing, and force production. From this perspective, analytical training provides the structural foundation upon which adaptive behaviour can subsequently emerge in representative environments. The progressive refinement of technical gestures through repetition facilitates more efficient perception–action coupling during competition and increases the athlete's capacity to execute complex technical-tactical solutions under pressure.
This interpretation is consistent with previous work demonstrating that repeated technical practice remains fundamental for the development and transferability of combat sport skills across different competitive contexts (Loio et al., 2022b).
Consequently, the present framework does not advocate the replacement of analytical training by representative training. Instead, it proposes a complementary relationship in which analytical methods contribute to technical stabilization and biomechanical optimization, while representative methods facilitate contextual adaptability, decision-making, and adaptive transfer.
A proposed progression model for representative training design is presented in **Table 9.**

Table 9. Representative Training and Adaptive Expertise Progression Model

Level	Main Objective	Training Approach	Representative Constraint
Level 1	Technical stabilization	Analytical training	Repetition under low variability
Level 2	Biomechanical refinement	Analytical + guided interaction	Controlled technical opposition
Level 3	Tactical integration	Mixed training	Controlled opposition
Level 4	Adaptive regulation	Representative training	Variable constraints
Level 5	Contextual adaptability	Representative training	Unpredictable scenarios
Level 6	Competitive transfer and adaptive expertise	Representative training	Complex ecological environments

Note. *Progression model integrating analytical and representative learning approaches for the development of adaptive expertise in combat sports.*

As illustrated in **Table 9**, athlete development progresses from technical stabilization towards adaptive expertise through the gradual increase of contextual variability and ecological complexity. While early stages emphasize skill acquisition under controlled conditions, advanced stages focus on behavioural adaptation within unpredictable and representative competitive environments.

This progression allows coaches to move beyond purely technical instruction and create environments where adaptive expertise can emerge naturally through interaction with realistic constraints.

Ultimately, the framework proposes that the primary objective of training is not the reproduction of idealized techniques, but the development of athletes capable of maintaining effectiveness across changing, uncertain, and physiologically demanding competitive environments.

Collectively, **Tables 6–9** operationalize the Fernando Loio Combat Performance Framework by translating theoretical principles into practical training implications, thereby offering coaches a structured pathway for developing adaptive combat expertise.

7. Physiological Integration as a Performance Constraint

Combat sports performance cannot be fully understood through technical-tactical analysis alone. Although offensive efficiency, counteroffensive timing, defensive adaptability, and positional dominance represent major determinants of success, their expression is continuously conditioned by physiological functionality.

The observational findings synthesized throughout this article suggest that technical-tactical superiority remains effective only when supported by adequate physiological capacity. In practical terms, successful fighters must sustain perception-action coupling, decision-making quality, movement precision, anticipation, and tactical adaptability under conditions of progressive fatigue accumulation.

Previous investigations have demonstrated that combat sports are characterized by highly intermittent physiological demands involving repeated high-intensity actions interspersed with periods of active recovery and tactical reorganization (Amtmann, 2004; Del Vecchio et al., 2015; Franchini & Takito, 2014). Consequently, successful performance depends upon the interaction between anaerobic power, aerobic recovery capacity, neuromuscular efficiency, movement economy, and cognitive resilience.

From an ecological dynamics perspective, fatigue should not be interpreted merely as a physiological phenomenon but rather as a performance constraint capable of influencing perception, action selection, timing regulation, movement execution, and tactical functionality. As physiological resources progressively decline, fighters may experience reductions in reaction speed, technical precision, anticipation capacity, positional stability, and decision-making quality. This interpretation provides a potential explanation for why technically proficient athletes are sometimes unable to reproduce their optimal tactical behaviour under competitive pressure. The limiting factor is frequently not the absence of technical knowledge, but rather the inability to maintain functional performance when physiological constraints become increasingly demanding. The principal physiological capacities contributing to technical-tactical functionality during combat are summarized in **Table 10.**

Table 10. Physiological Integration Model

Physiological Component	Functional Combat Contribution
Explosive Strength	Striking power and takedown execution
Reactive Strength	Counterattacking and movement transitions

Isometric Strength	Grappling control and submission application
Anaerobic Power	High-intensity attack sequences
Anaerobic Capacity	Sustained combat exchanges
Aerobic Capacity	Recovery between actions
Neuromuscular Coordination	Technical precision
Cognitive Resilience	Decision-making under fatigue

Note. *Physiological capacities contribute to maintaining technical-tactical functionality throughout combat. Adapted from Amtmann (2004), Franchini and Takito (2014), Del Vecchio et al. (2015), and integrated with observational findings from Ultimate Full Contact investigations.*

As illustrated in **Table 10**, physiological functionality supports the continuous expression of technical, tactical, perceptual, and cognitive performance during combat. Explosive and reactive strength contribute to offensive and counteroffensive actions, isometric strength facilitates grappling control, anaerobic qualities sustain high-intensity exchanges, aerobic capacity supports recovery processes, while neuromuscular coordination and cognitive resilience help preserve decision-making quality under fatigue.

Accordingly, physiological conditioning should not be developed independently from technical-tactical training. Rather, conditioning strategies should be integrated into representative learning environments where physiological stress, perceptual demands, decision-making processes, and tactical actions coexist in a manner consistent with competitive reality.

Therefore, physiological functionality should be viewed not merely as a conditioning factor, but as a dynamic constraint that continuously influences perception, action selection, movement execution, anticipation, adaptability, and ultimately combat performance itself.

Collectively, the evidence presented in **Tables 1-10** supports a multidimensional interpretation of combat expertise in which technical-tactical efficiency, perceptual-cognitive regulation, adaptive transfer, representative learning, and physiological integration operate as interconnected components of performance.

8. Original Contributions of the Study

The present investigation provides several original contributions to combat sports science.

First, it integrates offensive efficiency, counteroffensive efficiency, defensive efficiency, ground fighting control, perceptual-cognitive regulation, and physiological functionality within a unified conceptual framework. Although these dimensions have traditionally been studied independently, the present work proposes an integrative interpretation of combat expertise.

Second, the study introduces **adaptive transfer** as a fundamental determinant of combat performance. This concept describes the capacity of fighters to transfer previously acquired solutions to novel, unstable, and dynamically changing competitive situations while maintaining effectiveness.

Third, the study extends ecological dynamics theory into combat sports by demonstrating how performance emerges through the interaction between environmental constraints, combat affordances, technical-tactical behaviour, and adaptive responses.

Fourth, physiological functionality is conceptualized as a performance constraint rather than merely a conditioning variable, highlighting its influence on perception, decision-making, movement regulation, and technical-tactical execution.

Finally, the study proposes the **Fernando Loio Combat Performance Framework (FLCPF)**, a novel integrative model grounded on observational evidence from Ultimate Full Contact, ecological dynamics principles, representative learning design, adaptive transfer, and physiological integration.

The conceptual progression developed through Tables 6–10 operationalizes this framework and provides coaches, athletes, and researchers with a structured model for understanding and developing adaptive combat expertise.

9. Discussion

The purpose of this study was to synthesize observational evidence obtained from elite Ultimate Full Contact competition and to propose an integrative framework capable of explaining combat performance through technical-tactical, perceptual-cognitive, ecological, and physiological perspectives.

Overall, the findings suggest that combat expertise cannot be adequately explained through isolated technical skills or physical capacities. Rather, successful performance emerges from the continuous interaction between the athlete, the opponent, and the competitive environment. This interpretation is consistent with ecological dynamics theory, which proposes that skilled behaviour emerges through adaptive interactions with environmental constraints rather than through the reproduction of idealized movement patterns (Araújo et al., 2006; Davids et al., 2013).

One of the most consistent findings across the observational studies was the superior offensive efficiency displayed by winners. However, offensive effectiveness was not simply associated with attack frequency. Instead, successful fighters demonstrated a greater ability to regulate combat distances, identify tactical opportunities, and select appropriate technical actions according to contextual demands (**Table 1**). These findings reinforce previous research indicating that expert fighters continuously adapt their technical behaviour according to environmental information and changing affordances (Hristovski et al., 2006; Vilar et al., 2012).

Importantly, these findings should not be interpreted as diminishing the value of analytical training. While representative learning environments appear essential for developing adaptive expertise, systematic technical repetition remains fundamental for consolidating biomechanically efficient movement patterns and enhancing coordination, precision, speed, and power production. Therefore, high-performance combat training should integrate both analytical and representative methodologies in a complementary manner (Loio et al., 2022b).

Similarly, counteroffensive efficiency highlighted the importance of anticipation and temporal regulation. Anticipated and simultaneous counterattacks emerged as the most efficient temporal responses (**Table 2**), suggesting that elite performers possess superior perceptual-cognitive abilities that facilitate earlier recognition of opponent intentions. These observations support previous findings that anticipation represents one of the defining characteristics of expertise in combat sports (Milazzo et al., 2016; Shih & Lin, 2016). Importantly, anticipation appears not only to increase counteroffensive success but also to reduce the temporal demands imposed on decision-making processes during combat.

Defensive behaviour revealed another important dimension of expertise. Winners consistently demonstrated greater efficiency through evasive actions such as dodging, slipping, and displacement strategies (**Table 3**), whereas less successful fighters relied more frequently on blocking actions. These findings suggest that defense should not be interpreted as a passive protective mechanism. Instead, successful defensive behaviour simultaneously reduces vulnerability, preserves tactical initiative, and creates opportunities for immediate offensive or counteroffensive transitions. Thus, offensive and defensive actions appear to function as complementary components of an integrated adaptive system.

Ground fighting control also emerged as a critical determinant of competitive success. Dominant positions such as mount control, side control, and back control consistently differentiated winners from losers (**Table 4**). These positions provided greater opportunities for striking, submission attempts, and tactical regulation while simultaneously restricting opponent actions. Consequently, positional dominance should be interpreted not as an isolated technical achievement but as a platform from which offensive effectiveness and tactical control emerge. This interpretation supports previous investigations highlighting the strategic importance of dominant positions during grappling exchanges (Del Vecchio et al., 2011; Miarka et al., 2016).

A particularly important contribution of the present study concerns the concept of adaptive transfer. Across all observational investigations, successful fighters repeatedly demonstrated the ability to transfer previously acquired technical-tactical solutions to novel and unstable situations (**Table 7**). This finding suggests that expertise is characterized not merely by the possession of technical skills but by the ability to adapt those skills across different opponents, distances, tempos, tactical pressures, and physiological states. Because combat environments rarely reproduce identical situations, adaptive transfer appears to represent a central mechanism underlying expert performance.

The concept of adaptive transfer extends current ecological dynamics interpretations by emphasizing the functional transferability of behavioural solutions across changing contexts. In this sense, learning is not the acquisition of fixed motor patterns but the development of adaptable behavioural repertoires capable of maintaining effectiveness under variable constraints. This perspective may provide an important theoretical contribution to combat sports research by explaining how athletes maintain performance despite environmental instability.

The findings also provide strong support for representative learning design principles. If successful performance depends upon anticipation, contextual adaptability, affordance perception, and adaptive transfer, then training environments must reproduce the informational and tactical characteristics of competition (**Tables 8 and 9**). Consequently, excessive reliance on decontextualized repetition may improve isolated technical execution while limiting the development of adaptive expertise. Instead, coaches should progressively manipulate constraints to create representative situations that stimulate perception, decision-making, adaptation, and tactical functionality.

Another important contribution concerns physiological integration. The findings presented in **Table 10** suggest that physiological functionality operates as a dynamic performance constraint influencing technical-tactical expression. Fatigue appears capable of affecting perception-action coupling, anticipation, movement precision, decision-making quality, and positional control. Therefore, physiological conditioning should not be viewed as an independent component of preparation but as a factor that directly influences the athlete's ability to maintain adaptive functionality during competition.

This interpretation provides a possible explanation for why technically proficient fighters occasionally fail to reproduce optimal tactical behaviours under competitive pressure. The limiting factor is often not the absence of technical knowledge but the inability to maintain effective perception, decision-making, and movement execution under increasing physiological stress. Consequently, training environments should integrate technical, tactical, cognitive, and physiological demands within representative practice designs.

Collectively, the findings presented in **Tables 1–10** culminated in the development of the **Fernando Loio Combat Performance Framework (FLCPF)** (**Table 6**). The framework extends previous ecological dynamics approaches by explicitly integrating technical-tactical versatility, anticipation, contextual adaptability, representative interaction, combat affordances, adaptive transfer, and physiological functionality within a unified explanatory model of combat performance.

The present framework proposes that expertise emerges through adaptive effectiveness rather than through isolated technical proficiency. Accordingly, successful fighters are distinguished by their capacity to perceive opportunities, regulate behaviour, transfer solutions across contexts, maintain functionality under fatigue, and continuously adapt to changing competitive constraints.

From a practical perspective, these findings suggest that coaches should prioritize training environments that simultaneously develop technical proficiency, perceptual-cognitive skills, tactical adaptability, physiological resilience, and adaptive transfer. Such an approach may provide a more ecologically valid pathway for developing combat expertise than traditional models based primarily on technical repetition.

In summary, the present study suggests that combat performance is best understood as a multidimensional adaptive process emerging from the interaction between technical-tactical, perceptual-cognitive, ecological, and physiological systems. This interpretation provides the theoretical foundation for the Fernando Loio Combat Performance Framework and offers a novel perspective for future research and applied practice in combat sports.

10. Practical Applications

The findings synthesized throughout this study provide several practical implications for coaches, athletes, and combat sport practitioners.

First, training should prioritize adaptability rather than merely technical repetition. Although technical stabilization remains important, athletes should progressively be exposed to representative environments characterized by uncertainty, opponent interaction, contextual variability, and physiological demands.

Second, coaches should systematically manipulate constraints to stimulate adaptive behaviour. Examples include variations in combat distance, positional disadvantage, temporal pressure, fatigue conditions, tactical restrictions, and opponent unpredictability.

Third, offensive, counteroffensive, defensive, and positional control skills should be developed simultaneously rather than in isolation. The present findings suggest that competitive performance emerges through their continuous interaction.

Fourth, physiological conditioning should be integrated into representative technical-tactical tasks to preserve functionality under fatigue and maintain adaptive effectiveness.

Finally, coaches should focus on developing adaptive transfer capacities, enabling athletes to successfully apply previously acquired solutions across changing combat situations.

The coaching implications derived from the Fernando Loio Combat Performance Framework are summarized in **Table 11.**

Table 11. Fernando Loio Coaching Model

Coaching Objective	Intervention Strategy
Technical Stabilization	Analytical repetition
Tactical Integration	Constraint manipulation
Adaptive Transfer	Variable practice

Anticipation Development	Temporal uncertainty
Contextual Adaptability	Representative sparring
Physiological Integration	Fatigue-based decision-making
Competitive Transfer	Ecological simulation

Note. *Coaching framework derived from the Fernando Loio Combat Performance Framework*.

As shown in **Table 11**, coaching interventions should progressively evolve from technical stabilization toward adaptive expertise development. Rather than focusing exclusively on isolated technique acquisition, coaches should design learning environments that stimulate anticipation, adaptability, transfer, and decision-making under representative constraints.

To operationalize these coaching principles, an integrated technical-tactical training matrix is proposed.

The relationship between the major combat performance dimensions and representative training methods is presented in **Table 12.**

Table 12. Technical-Tactical Training Matrix

Training Focus	**Primary Objective**	**Representative Method**
Offensive Efficiency	Effective attack selection	Distance-based sparring
Counteroffensive Efficiency	Anticipation development	Temporal response drills
Defensive Efficiency	Impact avoidance	Evasion-based tasks
Ground Control	Positional dominance	Constraint grappling
Adaptive Transfer	Tactical flexibility	Variable scenario training
Physiological Integration	Functional endurance	Intermittent representative tasks

Note. *Integrated matrix for representative combat training.*

As illustrated in **Table 12**, each performance dimension may be developed through representative training methods specifically designed to reproduce the informational and tactical demands of competition. This approach facilitates the development of adaptive expertise while maintaining technical functionality.

To assist coaches in applying these principles, a set of practical guidelines is proposed.

The practical recommendations derived from the Fernando Loio Combat Performance Framework are presented in **Table 13.**

Table 13. Practical Guidelines Derived from the Fernando Loio Combat Performance Framework

Dimension	**Training Objective**	**Practical Application**
Offensive Efficiency	Improve attack success	Distance-specific attack drills
Counteroffensive Efficiency	Improve anticipation	Reaction-based sparring
Defensive Efficiency	Reduce impact exposure	Evasion-focused training
Ground Fighting Control	Increase dominance	Positional sparring
Adaptive Transfer	Enhance contextual adaptation	Variable constraint training
Physiological Functionality	Sustain efficiency under fatigue	Integrated interval combat training

Developed by Fernando Loio based on observational investigations conducted in Ultimate Full Contact between 2008 and 2025.

As shown in **Table 13**, effective coaching should prioritize variability, representativeness, adaptability, anticipation, transfer, integration, and affordance perception. Collectively, these

principles provide a practical pathway for developing adaptive combat expertise across different levels of performance.
The conceptual integration of all findings is illustrated in **Figure 1**.

Figure 1. Fernando Loio Combat Performance Framework (FLCPF)

Note. Conceptual model integrating ecological dynamics, perceptual-cognitive regulation, adaptive transfer, physiological functionality, representative learning design, and technical-tactical determinants of combat performance. Developed by Fernando Loio.

PHYSIOLOGICAL FUNCTIONALITY
↓
REPRESENTATIVE INTERACTION
↓
PERCEPTION–ACTION COUPLING
↓
ANTICIPATION
↓
CONTEXTUAL ADAPTABILITY
↓
TECHNICAL–TACTICAL VERSATILITY
↓
ADAPTIVE TRANSFER
↓
COMBAT PERFORMANCE

Combat Performance expressed through:

- Offensive Efficiency
- Counteroffensive Efficiency
- Defensive Efficiency
- Ground Fighting Control

As illustrated in **Figure 1**, combat expertise emerges through the interaction of physiological, perceptual-cognitive, technical-tactical, and ecological dimensions. The model proposes that adaptive transfer functions as the central mechanism connecting these dimensions and enabling athletes to maintain effectiveness under changing competitive constraints.

11. Conclusions

The present study synthesized longitudinal observational evidence obtained from elite Ultimate Full Contact competition and proposed an integrative ecological-cognitive framework for understanding combat sports performance and training design.
The findings demonstrated that successful performance emerges through the dynamic interaction between offensive efficiency, counteroffensive timing, defensive adaptability, ground fighting

control, perceptual-cognitive regulation, physiological functionality, and adaptive transfer. Across the observational studies, successful fighters consistently displayed greater technical-tactical versatility, anticipation, contextual adaptability, representative interaction, and capacity to exploit competitive opportunities than less successful performers.

The evidence summarized throughout Tables 1–13 and Figure 1 suggests that combat expertise cannot be adequately explained through isolated technical proficiency or physical conditioning alone. Rather, expertise appears to emerge from the athlete's capacity to maintain functional effectiveness while continuously adapting to changing environmental constraints, tactical pressures, opponent behaviours, and physiological demands.

The Fernando Loio Combat Performance Framework (FLCPF) integrates ecological dynamics, representative learning design, combat affordances, adaptive transfer, perceptual-cognitive regulation, and physiological integration into a unified explanatory model of combat expertise. The framework identifies technical-tactical versatility, anticipation, contextual adaptability, representative interaction, affordance perception, adaptive transfer, and physiological functionality as key determinants of elite combat performance.

Importantly, the present study extends current ecological and combat sport perspectives by proposing adaptive transfer as a central mechanism underpinning expertise development and by conceptualizing physiological functionality as a dynamic performance constraint that continuously influences perception, decision-making, movement regulation, and tactical behaviour during competition.

From an applied perspective, the framework provides coaches with a systematic model for organizing training environments that simultaneously develop technical proficiency, tactical adaptability, perceptual-cognitive regulation, and competitive functionality. Such environments should progressively expose athletes to contextual variability, uncertainty, opponent interaction, tactical instability, and physiological stress representative of competitive reality.

Furthermore, although representative learning environments constitute the primary mechanism for developing adaptive expertise, analytical training through systematic technical repetition remains indispensable for consolidating biomechanical efficiency and refining coordination, precision, speed, power production, and movement economy (Loio, 2022b). Consequently, the framework advocates a complementary relationship between analytical and representative training methods, recognizing that technical stabilization provides the foundation upon which adaptive performance can emerge.

Ultimately, the findings support a shift from technique-centred models of instruction toward an adaptive performance paradigm in which success depends not merely on what athletes know how to do, but on their ability to perceive, decide, adapt, and act effectively under continuously changing competitive conditions.

Therefore, the Fernando Loio Combat Performance Framework provides both a theoretical foundation and a practical guide for future research, coaching practice, and athlete development across striking, grappling, and hybrid combat sports, contributing to a broader understanding of how combat expertise emerges, develops, and is sustained in high-performance environments.

Biographical Note

Fernando Loio holds a PhD in Sport Sciences and is an integrated researcher at CIEQV – Research Centre for Quality of Life. He is the author of research and reflection papers in the fields of sport coaching, martial arts, and combat sports.

He has more than 50 years of experience in martial arts and combat sports as an athlete, coach, event promoter, and sports official. Throughout his career, he has been associated with several national and international organizations linked to Boxing, Taekwondo, Ultimate Full Contact, Pankration, MMA, Free Fight, Kickboxing, Muay Thai, and Grappling.

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