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REVIEW ARTICLE

Architecting the athletic life-cycle: A multilevel coordination framework for talent development and sustainable excellence

Hosam Hussein Abdel-Hakim . *Faculty of Sport Sciences. Mansoura University. Mansoura, Egypt.*

ABSTRACT

Institutional investment in athlete development across Arab League states has grown substantially, yet Olympic medal share remains disproportionate to population (approximately 1.4% of medals awarded against approximately 5.9% of world population across the past five Summer Olympic Games; Strategy& Middle East, 2025). This article proposes the Sports Performance and Champion Excellence (SPCE) framework — a multilevel coordination architecture in which the unit of analysis is not the isolated athlete but the Athletic Life-Cycle System: repeated athlete measurements nested within developmental environments and institutional-governance structures across task-defined life-cycle phases. SPCE organizes seven structures (biological, functional, neuro-cognitive, motor-skill, environmental-educational, psychological-values, institutional-governance) and introduces the Health Gate — a time-varying availability-and-recovery state that moderates the translation of capacity into developmental progression. The framework is grounded in a judgment-based scholarly corpus of 66 sources and contextualized through documentary analysis of publicly available institutional and Olympic data; neither component is presented as a systematic review. A mathematical layer is presented strictly as a set of candidate operationalizations (additive, multiplicative, threshold, configurational) to be compared in preregistered longitudinal validation. Eight reformulated propositions specify level, direction, temporal lag, outcome, design, and competing explanations. Ethics, safeguarding, and data governance are integrated as pathway infrastructure. SPCE is offered as a provisional coordination architecture that organizes established models (DMSP, LTAD, FTEM, HEA, DMGT, SPLISS) rather than replacing them, and as a diagnostic research programme for pathway design.

Keywords: talent development; coordination framework; athlete life-cycle; health and availability; sport governance; Arab sport systems.

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Corresponding author. *Faculty of Sport Sciences. Mansoura University. Mansoura, Egypt.*
E-mail: Dr_hosam.hussein@mans.edu.eg
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INTRODUCTION

Motivation and scope

Across the past five Summer Olympic Games (2008–2024), Arab League states secured approximately 1.4% of medals awarded while representing approximately 5.9% of world population (Strategy& Middle East, 2025). We treat this contrast as a descriptive starting point, not an explanatory benchmark: medal share is sensitive to delegation size, sport portfolio, hosting effects, national income, and geopolitical conditions, and both denominator and counting rules require explicit definition, as defined below. The question addressed here is therefore more precise than "why do some systems underperform?": what coordination conditions must a sport system satisfy to convert broad participation and institutional investment into sustainable athlete development — and can existing frameworks answer this question?

Institutional investment is documented across the region: Saudi Arabia has established the Mahd Sports Academy under its Vision 2030 agenda to identify and develop young talent across key Olympic disciplines; Qatar's Aspire Academy combines academics with elite sports training and has produced Olympic medalists, operating alongside a nationwide School Olympic Program engaging tens of thousands of students annually across 25 Olympic sports; Egypt has launched a National Talent and Olympic Champion Project supported by a recently upgraded Olympic Training Center; and Morocco and Jordan have invested in national sports centers and coach-certification systems respectively (Strategy& Middle East, 2025). These are throughput-oriented initiatives — necessary for monitoring, insufficient as evidence of pathway effectiveness. Their growth alongside persisting medal-share disparities motivates a coordination-level rather than input-level analysis.

The unit-of-analysis shift

Talent research has oscillated between individual-focused accounts (biology, psychology, skill) and environment-focused accounts (club, coach, policy). SPCE's primary contribution is not a new inventory of dimensions — most are established — but a shift of the unit of analysis to the Athletic Life-Cycle System: repeated athlete measurements nested within coach/team, club/academy, federation/sport, and country levels. Three specific contributions follow: (1) reframing the central question from which factors matter (inventory) to how levels coordinate (architecture); (2) treating health and availability — operationalized as the Health Gate — as a pathway-governing moderating condition rather than a peripheral consideration; (3) embedding institutional governance, including data governance and safeguarding, as explicit pathway infrastructure.

Purpose, genre, and structure

This is a conceptual/perspective article with two supporting components: a judgment-based scholarly corpus, summarized in Supplementary S1, and a documentary analysis of publicly available institutional and Olympic data. Neither component constitutes a systematic review, and no synthesis claim beyond theoretical organization is advanced. The article proceeds through conceptual background and positioning, methodological approach, the SPCE architecture, comparison with established frameworks, life-cycle phases, diagnostic application to selected Arab systems, propositions and research designs, ethics and governance, practical implementation, discussion, and conclusion.

CONCEPTUAL BACKGROUND AND POSITIONING

Established frameworks in brief

The Developmental Model of Sport Participation (Côté et al., 2007) describes sampling–specializing–investment trajectories within microsystems. Long-Term Athlete Development (Balyi et al., 2013; Ford et al.,

2011) structures age-appropriate training and competition. FTEM (Gulbin et al., 2013a) audits athlete pathways from foundation to mastery. The Holistic Ecological Approach (Henriksen et al., 2010a, 2017) explains successful talent development environments. The Differentiated Model of Giftedness and Talent (Gagné, 2004) generalizes across domains. SPLISS (De Bosscher et al., 2015) models national policy pillars driving international success. Career-transition models (Stambulova & Ryba, 2013; Wylleman & Lavallee, 2004; Wylleman & Reints, 2010) describe lifespan transitions, and Dehghansai et al. (2017) extend developmental analysis to athletes with disabilities.

These frameworks are complemented by thematic literatures that ground each SPCE component: maturation and relative-age effects (Cobley et al., 2009; Cumming et al., 2017; Deaner et al., 2013; Helsen et al., 2005; Malina et al., 2004; Philippaerts et al., 2006; Towlson et al., 2018; Wattie et al., 2015); practice histories and long-term skill development (Barth et al., 2022; Côté & Fraser-Thomas, 2007; Gulbin et al., 2013b; Güllich et al., 2022; Güllich, 2017; Macnamara & Maitra, 2019); ecological dynamics of skill acquisition (Davids et al., 2012); critical and methodological analyses of talent identification (Abbott & Collins, 2004; Bailey & Collins, 2013; Baker et al., 2017, 2018; Bergkamp et al., 2019; Johnston et al., 2018; Rongen et al., 2018; Sarmiento et al., 2018; Till & Baker, 2020; Williams et al., 2020); developmental environments and their contexts (Hancock et al., 2017; Henriksen et al., 2010b; Larsen et al., 2013; Reeves et al., 2018; Rossing et al., 2018); psychological resources, burnout, and career transitions (Connaughton et al., 2008; Fraser-Thomas et al., 2008; García-Calvo et al., 2010; Gucciardi et al., 2009; Gustafsson et al., 2011; Park et al., 2013); and training load, availability, and injury (Bourdon et al., 2017; Bowen et al., 2017; Gabbett, 2016; Impellizzeri et al., 2020; Soligard et al., 2016). The full mapping of these literatures onto the structures and propositions is provided in Supplementary S1.

What a coordination architecture adds

SPCE does not claim these components are new. It claims an organizing architecture that: (a) connects levels of analysis that existing frameworks address separately — athlete-level development (DMSP, LTAD, FTEM), environment (HEA), and policy (SPLISS); (b) formalizes availability and recovery as a governing moderating condition; and (c) embeds governance — including data governance and safeguarding — as infrastructure rather than backdrop. What SPCE does not claim: validated causal status. It is offered as a provisional architecture and diagnostic research programme.

The scholarly corpus: overview

The corpus was assembled iteratively through database searching (Scopus, Web of Science, PubMed, SPORTDiscus, 1993–2024), reference-list harvesting, and relevance screening against the framework's components, retaining scholarly sources in English (composition and analytic role: Supplementary S1). This corpus grounds the framework; it is not presented as a systematic review.

METHODOLOGICAL APPROACH

Genre declaration

This is a conceptual/perspective article. Its literature base is a judgment-based corpus of 66 scholarly sources, assembled iteratively through database searching, reference-list harvesting, and relevance screening against the framework's components. No systematic-review protocol, formal screening record, or dual review was employed, and none is claimed.

Corpus construction and two evidence tiers

Sources were retained if scholarly (peer-reviewed journal article, academic book, or book chapter), written in English, and directly relevant to at least one framework component or to the critique of snapshot-based

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selection. Tier 1 comprises the 66 scholarly sources used to ground the seven structures and eight propositions. Tier 2 comprises documentary and policy sources (e.g., Strategy& Middle East, 2025), used exclusively for regional contextualization and never for framework construction.

Documentary analysis

Tier-2 material was extracted for: institution, year, documented initiatives and inputs, documented outcomes, and stated objectives. The component is interpretive and illustrative; it cannot support causal claims.

Derivation of the seven structures

Structures were derived through a theoretical synthesis of the corpus: (i) construct mentions were extracted; (ii) grouped by functional role and level of analysis; (iii) consolidated where clusters satisfied four criteria — representation across multiple sources, distinctness at a defined level, plausible non-redundancy, and theoretical coherence; (iv) residual decisions are stated as authorial theoretical judgment. A concept matrix mapping all sources onto the structures and propositions is provided (Supplementary S1). The seven structures are therefore a theoretically organized synthesis, auditable but not an emergent empirical finding.

Limitations of the approach

Because no screening log was maintained, corpus selection cannot be shown to be exhaustive or free of authorial bias; the literature base is presented as illustrative grounding for a conceptual argument rather than as systematic evidence. The corpus is English-language. Regional evidence derives from a small number of documentary sources and is treated accordingly.

THE SPCE ARCHITECTURE

Overview

SPCE distinguishes three analytic levels — individual, developmental-environmental, and institutional — plus a governing condition (the Health Gate). Its core claim is coordination: sustainable excellence emerges from the joint, level-appropriate functioning of these components, not from the superiority of any single structure.

The seven structures

Table 1 defines each structure with its level of analysis, exemplar indicators, and evidence anchors. Structures 1–4 and 6 are individual-level; structure 5 operates at coach/team and club levels; structure 7 operates at federation and country levels. The digital/data component is a cross-cutting implementation mechanism within structure 7, not an eighth structure.

The Health Gate: definition and role

The Health Gate is defined as a time-varying availability-and-recovery state that moderates the translation of individual capacity into developmental progression. It is a formative composite of distinct indicators with different scales and causal roles — injury burden, sleep quality, recovery markers where feasible, and training availability — and is explicitly not a reflective latent construct and not a binary gate. The framework distinguishes health status, injury burden, recovery, availability, and load management rather than collapsing them. Two major consensus documents ground this construct: the International Olympic Committee consensus statement on load in sport and risk of injury (an 18-expert panel synthesizing 104 studies; Soligard et al., 2016) and the international consensus on athlete training-load monitoring (an 11-expert group; Bourdon et al., 2017). The acute:chronic workload ratio is presented with its methodological controversy — including the failure of rolling averages to account for the decaying nature of fitness and fatigue effects (Bourdon et al., 2017) and the conclusion that its causal relation to injury remains unestablished and its statistical properties

problematic (Impellizzeri et al., 2020) — and is not treated as an uncontroversial health-deficit measure. Formally, the gate operates as a continuous moderator of developmental slopes; a screening-threshold reading (minimum availability) is acknowledged as a special case to be tested rather than assumed. Institutional monitoring routines ("governance checkpoints") are practices around the construct, not the construct itself.

Table 1. The seven SPCE structures: level, definition, exemplar indicators, evidence anchors.

Structure	Level	Working definition	Exemplar indicators/measures	Evidence anchors
Biological	Individual	Growth, maturation, anthropometric and health-status foundations	Maturity offset, APHV, anthropometrics	Malina et al., 2015; Cumming et al., 2017
Functional	Individual	Strength, power, speed, endurance capacities	Age-relevant test batteries	Lloyd & Oliver, 2012
Neuro-cognitive	Individual	Attention, anticipation, decision-making	Sport-specific cognitive tasks	Davids et al., 2013
Motor-skill	Individual	Skill competence, coordination, learnability (rate of change)	TGMD-3; LSPT; learning slopes	Ericsson et al., 1993; Côté et al., 2007
Environmental-educational	Coach/team; club	Coaching quality, developmental environments, school–club linkage	TDEQ-5; coach-education records	Martindale et al., 2007; Larsen et al., 2013
Psychological-values	Individual	Resilience, mental toughness, autonomous motivation, values	MTQ-48; BRS; BPNES	Jones et al., 2002; Deci & Ryan, 2000
Institutional-governance	Federation; country	Policy coherence, pathway organization, funding governance, safeguarding, data governance	SPLISS-type audits	De Bosscher et al., 2015
Health Gate (governing condition)	Individual, time-varying	Availability-and-recovery state moderating capacity→progression translation	Injury burden; sleep; recovery markers; availability days	Gabbett, 2016; Soligard et al., 2016; Bourdon et al., 2017; Impellizzeri et al., 2020

Multilevel specification

Empirical instantiations should respect nesting: Level 1 repeated athlete measurements (structures 1–4, 6; Health Gate); Level 2 coach/team; Level 3 club/academy (structure 5); Level 4 federation/sport; Level 5 country (structure 7). Governance operates as a contextual moderator of developmental trajectories (cross-level interactions), not as an input commensurable with strength or skill. Single-equation presentations are provisional and mask this nesting.

Candidate formalizations (provisional)

The framework's theoretical claim is joint adequacy: excellence requires non-substitutability at the margin across structures, realized only under sufficient availability. Rather than asserting one functional form, SPCE specifies a candidate set for preregistered comparison:

- F1 (additive benchmark): $SE = \Sigma\ w_k S_k$ — implies perfect substitution; included as the null benchmark.
- F2 (multiplicative, Cobb-Douglas type): $SE = \Pi_k\ S_k^{\alpha_k} \cdot h(A)$, with elasticities α_k free (no sum-to-one constraint is assumed), and $h(\cdot)$ an increasing function of the availability state whose form (smooth increase versus threshold response) is an explicit assumption. Limitations are acknowledged: this form permits substantial substitution except at zero, and its α parameters are elasticities, not importance weights.
- F3 (threshold/Leontief-type): $SE = [\min_k\ adequacy_k] \times capacity$ — represents a strict minimum-adequacy claim.

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- F4 (configurational): Qualitative Comparative Analysis / Necessary Condition Analysis to identify necessary or sufficient configurations (e.g., minimum availability as a necessary condition).

Governance is excluded from F1–F4 because it operates as a contextual moderator. No candidate is privileged; the earlier presentation that multiplied a governance term into the product and constrained elasticities to sum to one has been withdrawn as double-counting and unjustified constraint. A staged validation programme is specified below.

Architecting: designed-but-adaptive pathways

"Architecting" denotes designing, monitoring, and revising developmental conditions at specified review points — not controlling outcomes. The framework accommodates athlete agency, informal sport, unplanned transitions, injury, migration, late development, and multiple routes to expertise: pathways are designed-but-adaptive, and the architecture provides review points, not scripts.

COMPARISON WITH ESTABLISHED FRAMEWORKS

Table 2. Systematic comparison of SPCE with established frameworks.

Framework	Unit of analysis	Primary question	Health/availability	Governance layer	Empirical support	Acknowledged limitation
DMSP (Côté et al., 2007)	Athlete within microsystems	Participation trajectories fostering expertise & sustained engagement	Not formalized	Absent	Substantial	Macro/policy out of scope
LTAD (Balyi et al., 2013)	Athlete across sport stages	Age-appropriate training/competition	Physical literacy emphasis; availability not formalized	Implementation guidance	Widely adopted; mixed	Prescriptive; limited interaction mechanism
FTEM (Gulbin et al., 2013a)	Pathway within a sport	Where athletes sit (foundation→mastery)	Not formalized	Audit utility	Australian cases	Descriptive; transitions not mechanized
HEA (Henriksen et al., 2010a)	Talent development environment	What makes environments successful	Not central	Implicit in environment	Strong qualitative	Individual factors less foregrounded
DMGT (Gagné, 2004)	Gifted→talented person	How gifts transform into talents	Partial (catalysts)	Environmental catalysts	Cross-domain	Domain-general; sport mechanisms thin
SPLISS (De Bosscher et al., 2015)	National policy system	Which policy pillars drive success	Partial (athlete support)	Central	15-nation comparative	Athlete-level processes not modeled
SPCE (this article)	Athletic Life-Cycle System (nested levels)	How levels coordinate into sustainable excellence	Health Gate as moderator	Explicit, incl. data governance & safeguarding	Conceptual — unvalidated	Requires empirical validation; added value over combinations of the above must be demonstrated

Table 2 compares SPCE with the major frameworks using neutral criteria. SPCE is positioned as a coordination layer connecting them; its own unvalidated status is acknowledged in-table.

LIFE-CYCLE PHASES

The framework is embodied in six phases defined by developmental tasks and transitions, with entry/exit criteria (readiness, training history, technical demands, psychosocial development, health status, educational context). Chronological bands are illustrative for late-specialization Olympic sports only: (1) Early Discovery (≈6–9); (2) Neuro-motor Foundation (≈9–12); (3) Competitive Building (≈12–18); (4) Sustainable Peak (≈18–30); (5) Mature Performance and Transition Management (≈30+): managing load, role, and transition rather than presuming decline; (6) Post-competition. Phases vary across sports — early-specialization disciplines, endurance events, para-sport (Dehghansai et al., 2017), and non-linear or interrupted pathways (Wylleman & Reints, 2010) follow different calendars and sequences. The Health Gate runs through all phases (Figure 1).

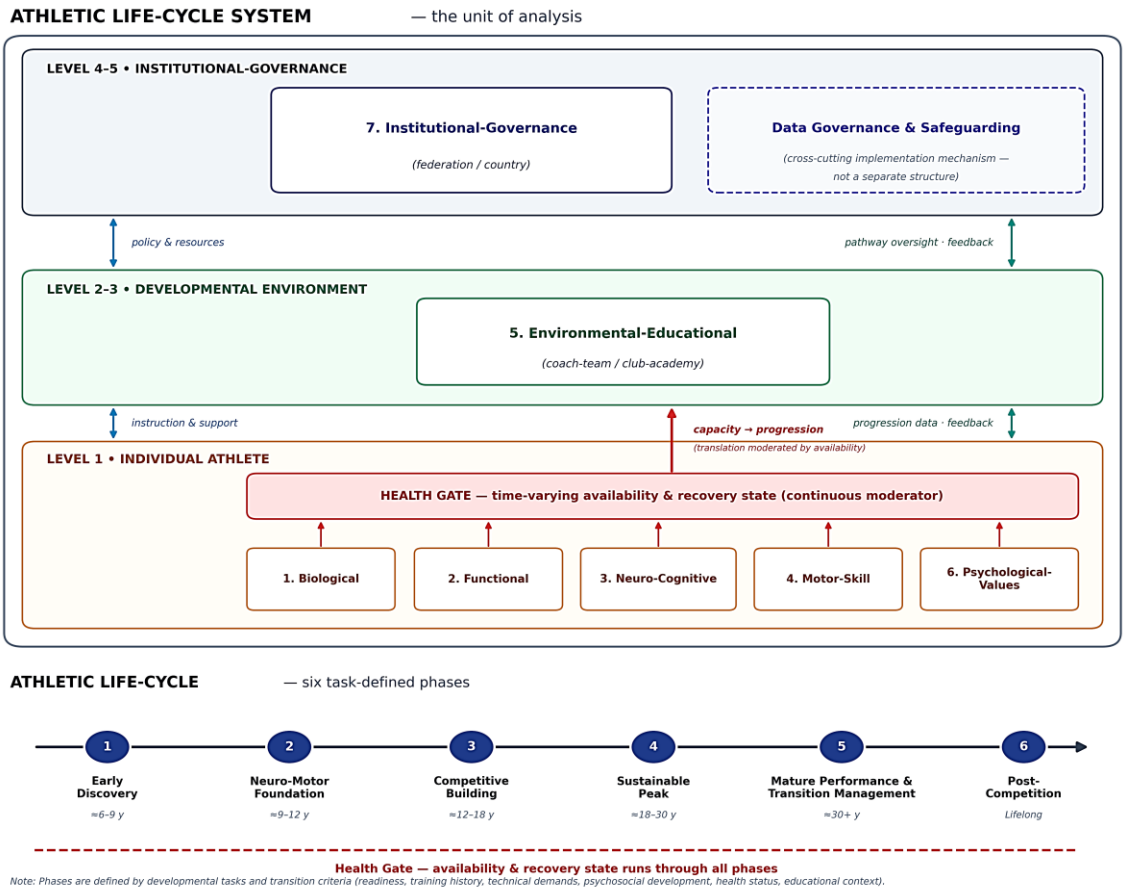

Figure 1. Architectural structure of the SPCE framework. The framework is organized across three analytical levels — institutional-governance (federation/country), developmental environment (coach-team/club), and the individual athlete — with the seven structures distributed by level. The Health Gate — a time-varying availability-and-recovery state — operates as a continuous moderator of the translation of individual capacity into developmental progression. Data governance and safeguarding are depicted as cross-cutting implementation mechanisms within the institutional layer, not as a separate structure. Bidirectional feedback loops connect the levels. The six task-defined life-cycle phases run along the temporal axis at the bottom.

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DIAGNOSTIC APPLICATION TO SELECTED ARAB SYSTEMS

Definitions, denominators, and counting rules

The regional analysis covers the 22 member states of the Arab League (listed in full in Supplementary S2) across the past five Summer Olympic Games (2008–2024, through Paris 2024). According to the source report, these states constitute approximately 5.9% of world population (based on United Nations ESCWA estimates) while their athletes won approximately 1.4% of medals awarded across those Games — roughly 71 of approximately 5,000 medals (Strategy& Middle East, 2025). Three qualifications apply. First, the report does not explicitly specify whether team-event medals are counted once per event or per athlete; its aggregate and per-Games figures are therefore reproduced as published, with this limitation noted. Second, where independently verifiable, figures were checked against the official Olympic medal table: at Paris 2024, seven member states won 17 medals in total (Bahrain 4; Algeria 3; Egypt 3; Tunisia 3; Morocco 2; Jordan 1; Qatar 1), and the remaining 15 — including Saudi Arabia, despite its documented institutional investment — won none. This independently verified total matches the source report's own 2024 figure, with per-nation calculations reproduced in Supplementary S2. Third, population share is approximate and reflects the source's ESCWA-based estimate. Medal share is a coarse benchmark — sensitive to delegation size, sport portfolio, hosting, income, and geopolitics — and is not treated as a performance measure; a balanced outcome dashboard is specified in Table 4.

Comparative archetypes

Rather than treating the region as homogeneous, Table 3 presents three illustrative archetypes; member states differ substantially in population, income, education, gender participation, and sport organization.

Table 3. Comparative diagnostic archetypes (illustrative; country-level verification in Supplementary S2).

Archetype	Illustrative cases	System features	SPCE diagnostic emphasis	Priority actions
High-investment, small-population	Qatar; Bahrain	Imported expertise; concentrated academies; high per-capita returns (e.g., Bahrain's documented Paris 2024 per-capita yield)	Organic-pipeline sustainability; post-career transition; safeguarding across dual pathways	Organic pathway investment; education/dual-career support; governance institutionalization
Large-population, centralized tradition	Egypt; Morocco	Broad base; urban concentration; resource constraints; established traditions in some sports	School–club linkage; regional access; coach-quality distribution	School–club bridges; regional hubs; federated governance reform
Resource-rich, rapid-scaling	Saudi Arabia; UAE	Massive recent inputs; high screening throughput; conversion lag (no Paris 2024 medal despite documented investment)	Junior-to-senior conversion; availability; wellbeing; institutional continuity	Convert throughput into progression metrics; longitudinal monitoring; governance coherence

Input–output asymmetry and its interpretation

The coexistence of growing documented inputs with persisting medal-share disparities is documented. The interpretation favored here — that pathways emphasize tangible inputs over complete pathway coordination — is a conjecture consistent with this asymmetry; it requires organizational case-study research and is not asserted as established fact.

A balanced outcome dashboard

Sustainable excellence is defined multidimensionally (Table 4), aligning the outcome construct with the framework's life-cycle ambition and reducing dependence on distal, infrequent medal counts.

Table 4. Sustainable-excellence outcome dashboard.

Domain	Exemplar indicators	Data source	Review interval
Competitive performance	Finals and medals at junior/senior world and Olympic events	Public results databases	Annual
Retention/conversion	Junior→senior conversion; dropout rates	Federation registries	Annual
Availability	Available days; training exposure	Medical/monitoring systems	Monthly
Wellbeing	Validated athlete-wellbeing instruments	Monitoring program	Quarterly
Education/dual career	Completion; attendance	Institutional records	Annual
Safeguarding	Policy compliance; case-handling timeliness	Federation audit	Annual
Post-career transition	Support uptake; education/employment outcomes	Alumni tracking	Biennial

PROPOSITIONS AND RESEARCH DESIGNS

Table 5 reformulates the eight propositions with level, direction, lag, outcome, design, and competing explanations. P8 is a cross-cutting governance-implementation proposition, not a proposition about a digital structure.

Table 5. Reformulated propositions mapped to research designs.

P#	Proposition (condensed)	Level	Direction	Lag	Primary outcome	Design	Competing explanation
P1	Higher cross-level coordination → higher sustainable-excellence outcomes	System (L3–L5)	+	8–12 y	Dashboard composite (retention, availability)	Multilevel longitudinal cohort	Investment volume alone
P2	Selection on current performance favors early maturers/relatively older athletes; advantage attenuates at senior level	L1 within selection systems	Early +, senior attenuation	6–10 y	Selection; senior conversion	Bio-banding cohorts + historical analyses	Training-quality differences
P3	Low availability/recovery states reduce progression rates	L1, time-varying	–	Season-to-season	Progression rate; availability	Intensive longitudinal monitoring (multilevel)	Load/coaching quality
P4	Readiness→progression association is stronger in higher-quality environments	L1×L2/L3	Cross-level +	Annual waves	Progression	Multilevel SEM (TDEQ)	Self-selection into better environments
P5	Learning rates predict senior outcomes beyond baseline performance	L1	+ beyond baseline	≥4 y	Senior international selection/performance	Standardized learning tasks; growth models	Task specificity
P6	Psychological-values resources attenuate early-pressure→burnout/dropout	L1	Buffering	Adolescence	Burnout; dropout	Prospective cohorts; moderated mediation	Workload differences
P7	Coordination quality predicts outcomes net of investment; investment's marginal returns are lower where coordination is low	L4–L5	+ (conditional)	Panel	Dashboard	Comparative panel; quasi-experimental	Wealth/hosting effects
P8	Codified data-governance standards (consent, minimization, explainability, contestability) → higher trust and monitoring retention	L4–L5 institutional	+	Before/after	Monitoring retention; trust indicators	Quasi-experimental federation comparisons	Parallel investment increases

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Validation proceeds in stages: instrument development and content validation; expert review; feasibility testing; then preregistered multilevel longitudinal studies comparing F1–F4 (the features described above), with NCA testing whether any structure or availability state is a necessary condition.

ETHICS, SAFEGUARDING, AND DATA GOVERNANCE

Longitudinal developmental profiles involve sensitive health, psychological, educational, and biometric data, often from minors. The following are pathway infrastructure within structure 7, not future additions: informed consent and age-appropriate assent; purpose limitation; data minimization; access control and retention limits; athlete access and data portability; algorithmic explainability; human oversight of algorithm-supported decisions; and the athlete's right to challenge such decisions. Safeguarding alignment follows IOC standards; surveillance and algorithmic-bias risks are explicit design considerations (Morgulev & Azar, 2026). Dual-career protection and post-career welfare are included in the outcome dashboard (Table 4).

PRACTICAL IMPLEMENTATION

Anchoring to existing instruments

SPCE organizes existing tools rather than requiring new administration: SPLISS-type policy audits (structure 7), TDEQ-based environment assessment (structure 5), IOC-aligned load and monitoring consensus (Bourdon et al., 2017; Soligard et al., 2016; the Health Gate), dual-career and safeguarding standards, and federation governance codes.

A worked 12-month dashboard and bottleneck protocol

A federation operating SPCE would review Table 4's domains at their stated intervals with named owners (technical director; medical lead; coach-education lead; safeguarding officer; governance board) and pre-agreed decision rules (e.g., availability below threshold for two consecutive months → load-management review; conversion rate below cohort benchmark → pathway audit). Bottleneck protocol: when one structure is identified as limiting — (i) confirm by measurement, (ii) implement a targeted correction (e.g., motor-skill deficit → revised practice design before further selection exposure), (iii) re-assess at the next interval, (iv) escalate to governance review if persistent. Decisions remain reviewable and revisable; no irreversible classification is made on unstable estimates.

DISCUSSION

Contribution

SPCE makes three contributions: the unit-of-analysis shift to the Athletic Life-Cycle System; the Health Gate as a pathway-governing availability construct; and the explicit governance layer including data governance and safeguarding. The seven structures organize known components; the architecture is the claim.

Table 6. Whetten (1989) criteria applied to SPCE.

Element	Status	Basis
What (factors)	Addressed	Seven structures with levels and indicators (Table 1)
How (mechanism)	Partially addressed; weakest	Candidate formalizations; multilevel specification; staged validation programme
Why (logic)	Addressed	Coordination claim; non-substitutability; availability governance
Who/Where/When (boundaries)	Addressed	Task-defined phases; sport-type variation; level-specific propositions (Table 5)

Whetten (1989) self-assessment

Table 6 applies Whetten's criteria to SPCE itself. The "How" remains the weakest element, now partially addressed via candidate formalizations, the multilevel specification, and the staged validation program — improvement pending empirical testing.

Limitations

No empirical testing has occurred; the corpus was constructed by a single author without a preserved screening log and is presented as judgment-based grounding, not systematic evidence; the corpus is English-language; comparative PE-provision and pathway data for Arab states are sparse — the study type required is exemplified by Alayan et al. (2025) from a neighboring national setting, and systematic regional evidence remains an open gap; the archetypes are illustrative; no candidate formalization has been estimated.

Falsifiability conditions

A crucial criterion for any scientific framework is its falsifiability (Popper, 1959). The coordination claim is rejected if preregistered longitudinal evidence shows: (a) structures operating as independent additive inputs with full mutual compensation; (b) no necessary conditions identified (NCA), including no availability threshold; and (c) no cross-level governance or health moderation. The Health Gate is rejected if availability states show no moderation of the capacity→progression relation. Under rejection, SPCE reduces to an organizing taxonomy — an informative outcome, not a failure of the exercise.

CONCLUSION

This article documents a documented asymmetry between Arab League institutional investment and Olympic returns (approximately 1.4% of medals awarded against approximately 5.9% of world population; Strategy& Middle East, 2025) and proposes SPCE as a provisional multilevel coordination architecture and diagnostic research programme — not a validated causal model. Its value depends on demonstrating, through the staged program specified here, that coordination across levels, governed by availability and embedded in sound governance, explains sustainable athlete development beyond what existing frameworks provide separately.

Until then, the framework's practical role is diagnostic and advisory: organizing existing instruments, structuring monitoring, and specifying testable questions.

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CONFLICT OF INTEREST

The author declares no competing financial or non-financial interests related to this work.

DATA AVAILABILITY STATEMENT

All Arab Olympic performance data cited are publicly available from the Strategy& Middle East 2025 report and the IOC Olympic medal database. All cited sources are published peer-reviewed materials.

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AI USE DISCLOSURE

In accordance with current publishing ethics and transparency recommendations, artificial intelligence (AI) tools were used solely to assist with translation and language editing, with the aim of improving clarity and readability. No AI tools were used to generate scientific content, including the study design, data collection, analysis, interpretation, or conclusions. The author retains full responsibility for the manuscript and confirms its originality, integrity, and accuracy.

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SUPPLEMENTARY MATERIALS

Supplementary S1. Evidence Summary of the Scholarly Corpus and Concept Matrix

S1.1 Purpose and construction. This summary was compiled during revision directly from the cited sources to make the framework's grounding auditable. It is an analytic summary of the judgment-based corpus described in the methodological approach, not a record of a prospective extraction procedure.

Table S1.1. Evidence summary (66 scholarly sources, Tier 1).

#	Source	Design	Sample (as documented)	Context	Structure(s)	Role
1	Ericsson et al. (1993)	TH	Theoretical synthesis; musicians & athletes	Cross-domain	MOT	P
2	Côté et al. (2007)	CH	Handbook chapter	Cross-domain	MOT, ENV	P
3	Côté and Fraser-Thomas (2007)	CH	Handbook chapter	Youth sport	MOT, PSY	P
4	Gulbin et al. (2013a)	TH	FTEM model; Australian pathway audit	Australia	GOV, ENV	P
5	Gulbin et al. (2013b)	LN	Elite athletes; performance trajectories	Australia	MOT, BIO	S
6	Balyi et al. (2013)	BK	LTAD model book	Cross-domain	ALL	P
7	Ford et al. (2011)	RV	Evidence review of LTAD	Cross-domain	BIO, FUN	P
8	Henriksen et al. (2010a)	QS	Sailing milieu: Athletes, coaches, parents	Denmark	ENV	P
9	Henriksen et al. (2010b)	QS	Track & field environment case	Denmark	ENV	P
10	Henriksen and Stambulova (2017)	CH	Holistic ecological approach chapter	Cross-domain	ENV	P
11	Larsen et al. (2013)	QS	Soccer environment case	Scandinavia	ENV	S
12	Martindale et al. (2007)	SV	Elite coaches, UK	UK	ENV	P
13	Gagné (2004)	TH	DMGT model paper	Domain-general	ALL	P
14	De Bosscher et al. (2008)	BK	Comparative policy study, 6 nations	International	GOV	P
15	De Bosscher et al. (2015)	BK	SPLISS 2.0, 15 nations	International	GOV	P
16	Davids et al. (2012)	CH	Ecological dynamics chapter	Cross-domain	NCG, MOT	P
17	Davids et al. (2013)	TH	Ecological dynamics & talent	Cross-domain	NCG, MOT	P
18	Lloyd and Oliver (2012)	TH	Youth physical development model	Youth sport	FUN, BIO	P
19	Malina et al. (2015)	RV	Maturation assessment review	Youth sport	BIO	P
20	Malina et al. (2004)	BK	Growth & maturation reference	Cross-domain	BIO	S
21	Cumming et al. (2017)	RV	Bio-banding applications	Youth sport	BIO	S
22	Philippaerts et al. (2006)	LN	Youth soccer players; PHV & performance	Belgium	BIO, FUN	P
23	Towlson et al. (2018)	LN	Youth athletes; maturation timing	Multiple	BIO, FUN	S
24	Cobley et al. (2009)	MR	Meta-analysis of relative age effects	Global	BIO	P
25	Helsen et al. (2005)	CS	Youth soccer; relative age	Europe	BIO, MOT	S
26	Deaner et al. (2013)	CS	NHL draftees; selection bias	N. America	BIO	S
27	Wattie et al. (2015)	TH	Relative age developmental systems model	Cross-domain	BIO	P
28	Jones et al. (2002)	QS	Elite performers; mental toughness	Multi-sport	PSY	P
29	Connaughton et al. (2008)	QS	Elite performers; MT development	Multi-sport	PSY	P
30	Gucciardi et al. (2009)	SV	MT inventory validation; Australian footballers	Australia	PSY	S
31	Deci and Ryan (2000)	TH	Self-determination theory	Cross-domain	PSY	P
32	García-Calvo et al. (2010)	SV	Adolescent athletes; SDT & dropout	Spain	PSY, MOT	S
33	Gustafsson et al. (2011)	TH	Athlete burnout integrated model	Sport	PSY	P
34	Fraser-Thomas et al. (2008)	QS	Adolescent athletes; dropout & engagement	Canada	PSY, ENV	P
35	Davids et al. (2013, TD&E)	TH	Ecological dynamics & skill acquisition	Cross-domain	NCG, MOT	P
36	Abbott and Collins (2004)	TH	Psychology in talent ID critique	Cross-domain	PSY, MOT	P
37	Vaeyens et al. (2008)	RV	Talent ID programmes review	Cross-domain	ALL	P
38	Bailey and Collins (2013)	TH	Standard model critique	Cross-domain	ALL	S
39	Baker et al. (2017)	BK	Edited handbook	Cross-domain	ALL	P
40	Baker et al. (2018)	PK	Talent selection issues perspective	Cross-domain	ALL	S
41	Johnston et al. (2018)	SR	Talent ID systematic review	Cross-domain	ALL	S
42	Bergkamp et al. (2019)	SR	Soccer talent ID methodology	Soccer	MOT, NCG	S
43	Sarmiento et al. (2018)	SR	Male football talent ID review	Soccer	MOT, ENV	S
44	Williams et al. (2020)	RV	Soccer talent development review	Soccer	ALL	S
45	Till and Baker (2020)	PK	Talent ID optimization perspective	Cross-domain	ALL	P
46	Rongen et al. (2018)	RV	Youth systems necessity & health	Youth sport	BIO, GOV	S
47	Güllich (2017)	MP	Medalists vs non-medalists, matched pairs	Germany	MOT, ENV	P
48	Güllich et al. (2022)	SR	What makes a champion	Cross-domain	MOT, ENV	P

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49	Barth et al. (2022)	MR	Junior vs senior predictors	Cross-domain	MOT	S
50	Macnamara and Maitra (2019)	RP	Deliberate practice replication	Cross-domain	MOT	S
51	Dehghansai et al. (2017)	SR	Para-athlete development review	Para-sport	ALL	P
52	Gabbett (2016)	RV	Training-injury paradox	Training load	HG	P
53	Soligard et al. (2016)	CN	IOC consensus; 18-expert panel; 104 studies synthesized	International; Olympic sport	HG	P
54	Bourdon et al. (2017)	CN	Training-load monitoring consensus; 11-expert group	International; multi-sport	HG	P
55	Impellizzeri et al. (2020)	TH	ACWR methodological critique	Training load	HG	P
56	Bowen et al. (2017)	LN	Elite youth footballers; workload & injury	England	HG	S
57	Rossing et al. (2018)	CS	Population size, density, proximity to talent clubs	Denmark	ENV	S
58	Hancock et al. (2017)	CS	Population size & birthplace effects	Multiple	ENV	S
59	Stambulova and Ryba (2013)	BK	Careers across cultures	Cross-cultural	PSY, GOV	S
60	Wylleman and Lavallee (2004)	TH	Developmental transitions model	Cross-domain	PSY	P
61	Wylleman and Reints (2010)	TH	Lifespan career model	Cross-domain	PSY, GOV	P
62	Park et al. (2013)	SR	Career transition out of sport	Cross-domain	PSY	S
63	Reeves et al. (2018)	QS	Stakeholders' understanding of LTAD	UK	GOV, ENV	S
64	Morgulev and Azar (2026)	PK	AI in talent ID; bias & privacy	Cross-domain	GOV	S
65	Alayan et al. (2025)	SV	PE provision, single national setting	Neighboring region	ENV	C
66	Popper (1959)	BK	Falsifiability criterion	Philosophy of science	ALL	C

Legend. Design: *TH = theoretical/model; CH = book chapter; BK = academic book; QS = qualitative study; SV = survey; LN = longitudinal; CS = cross-sectional; MP = matched pairs; RP = replication; SR = systematic review; MR = meta-analysis; RV = narrative/critical review; CN = consensus statement; PK = policy/perspective.* ***Role:*** *P = primary; S = supporting; C = contextual.* ***Structures:*** *BIO, FUN, NCG, MOT, ENV,* PSY, GOV; HG = Health Gate; ALL = framework-wide relevance.

Table S1.2. Concept matrix (condensed). ● = primary grounding; ○ = supporting.

Structure / Proposition	Primary sources (●)	Supporting sources (○)
BIO	Malina et al. 2015; Cobley et al. 2009; Wattie et al. 2015; Philippaerts et al. 2006	Malina et al. 2004; Cumming et al. 2017; Towlson et al. 2018; Helsen et al. 2005; Deaner et al. 2013
FUN	Lloyd & Oliver 2012	Ford et al. 2011; Philippaerts et al. 2006
NCG	Davids et al. 2012, 2013 (×2)	Bergkamp et al. 2019
MOT	Ericsson et al. 1993; Côté et al. 2007; Güllich et al. 2022	Güllich 2017; Barth et al. 2022; Macnamara & Maitra 2019
ENV	Henriksen et al. 2010a, 2010b; Henriksen & Stambulova 2017; Martindale et al. 2007	Larsen et al. 2013; Rossing et al. 2018; Hancock et al. 2017; Reeves et al. 2018
PSY	Deci & Ryan 2000; Jones et al. 2002; Gustafsson et al. 2011; Wylleman & Lavallee 2004	Connaughton et al. 2008; Gucciardi et al. 2009; García-Calvo et al. 2010; Fraser-Thomas et al. 2008; Park et al. 2013
GOV	De Bosscher et al. 2008, 2015; Gulbin et al. 2013a	Rongen et al. 2018; Reeves et al. 2018; Morgulev & Azar 2026; Stambulova & Ryba 2013
HG	Gabbett 2016; Soligard et al. 2016; Bourdon et al. 2017; Impellizzeri et al. 2020	Bowen et al. 2017
P1 (coordination)	Gulbin et al. 2013a; De Bosscher et al. 2015	Vaeyens et al. 2008; Baker et al. 2017
P2 (maturation/RAE)	Cobley et al. 2009; Wattie et al. 2015	Helsen et al. 2005; Deaner et al. 2013; Cumming et al. 2017
P3 (availability)	Gabbett 2016; Soligard et al. 2016; Bourdon et al. 2017; Impellizzeri et al. 2020	Bowen et al. 2017
P4 (environment quality)	Henriksen et al. 2010a; Martindale et al. 2007	Larsen et al. 2013; Reeves et al. 2018
P5 (learning rate)	Güllich et al. 2022; Ericsson et al. 1993	Güllich 2017; Barth et al. 2022; Macnamara & Maitra 2019
P6 (psychological buffering)	Gustafsson et al. 2011; Deci & Ryan 2000	Fraser-Thomas et al. 2008; García-Calvo et al. 2010
P7 (governance net of investment)	De Bosscher et al. 2015	Gulbin et al. 2013a; Rongen et al. 2018
P8 (data governance)	Morgulev & Azar 2026	De Bosscher et al. 2015

Supplementary S2. Regional Data Reproduction and Verification

S2.1 Denominator definition. The 22 member states of the Arab League, as enumerated by the source report (Strategy& Middle East, 2025, endnote 4): Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, and Yemen.

Table S2.1. Official Paris 2024 medal table for Arab League member states (independently verified against the official Olympic medal table).

Nation	Gold	Silver	Bronze	Total
Bahrain	2	1	1	4
Algeria	2	0	1	3
Egypt	1	1	1	3
Tunisia	1	1	1	3
Morocco	1	0	1	2
Jordan	0	1	0	1
Qatar	0	0	1	1
Total (7 states)	7	4	6	17
Remaining 15 member states	—	—	—	0

Note. The Saudi Arabia figure of zero is verified and corresponds to the conversion-lag archetype discussed in the discussion under 'the relevant heading'.

Table S2.2. Arab League medals per Games, as reported by the source (Exhibit 1 of Strategy& Middle East, 2025).

Games	Medals (as reported)
2008 (Beijing)	8
2012 (London)	14
2016 (Rio)	14
2020 (Tokyo)	13
2024 (Paris)	17

Note on internal consistency. The per-Games breakdown above sums to 66 event-level medals, whereas the report's text cites approximately 71 medals across the same window ("roughly 71 medals out of 5,000"). The difference most plausibly reflects team-medal counting conventions, which the report does not specify. The headline gap statistic (≈1.4% of medals; ≈5.9% of world population) is therefore quoted as published, and the Paris 2024 figure (17) — Which was independently verified and matches the official table — Is used wherever a directly checkable figure is required.

S2.3 Population basis and per-capita calculation

Population share follows the source's citation of United Nations ESCWA demographic estimates for the Arab region (≈5.9% of world population). Bahrain's per-capita yield: 4 medals ÷ ≈1.6 million population ≈ 25 medals per 10 million population, consistent with the source's framing of Bahrain's Paris 2024 performance as the region's highest per-capita return.

S2.4 Source data trail

Population: UN ESCWA, "Demographic Trends in the Arab Region 1950–2030" (as cited by Strategy& Middle East, 2025). Medals: ESPN Summer Olympics 2024 Medal Tracker and Olympedia.org (as cited by Strategy& Middle East, 2025); Paris 2024 figures independently re-verified against the official Olympic medal table.

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