

Problem 5: Rules Shape Behaviour

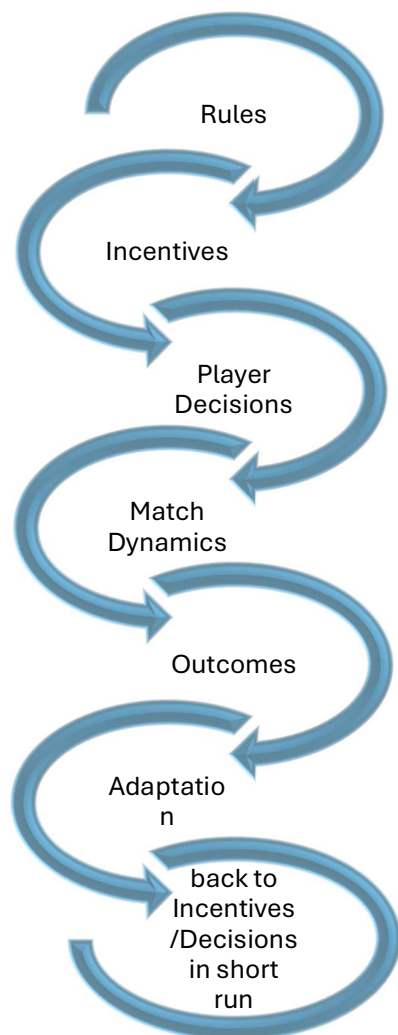
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Executive Summary

I model Kabaddi rules as an incentive system that maps actions to rewards under uncertainty. By framing raids and defensive choices as decisions with expected values dependent on score, time, and player count, we can explain risk-taking as rational behaviour rather than intuition. Using this framework, I show how a small rule change—reducing the all-out bonus—can significantly alter optimal strategies, match volatility, and scoring dynamics. This model can be empirically tested using historical raid-level data and simulation.

Framing the Model: Rules as Incentive Design



Kabaddi rules can be modelled as an **incentive system** that converts actions into rewards and penalties under uncertainty. The rules do not just regulate play; they actively shape how much risk players take and which strategies become optimal.

We can think of it as two levels:

Within a match or season

The cycle mostly runs like this:

Rules → Incentives → Player Decisions → Match Dynamics → Outcomes → Adaptation → back to Incentives/Decisions.

Here, rules are fixed; players and coaches keep updating how they play.

Across seasons / league level

Sometimes, if patterns are too defensive, low-scoring, or unfair, the league reacts:

Outcomes (long-term) → League Evaluation → Rule Changes.

Then the whole chain restarts with new rules.

Each rule changes the *expected value* of possible actions (raid aggressively, play safe

defence, attempt a do-or-die raid, etc.). Players and teams continuously optimize behaviour based on these incentives.

Thus, Kabaddi can be viewed as a feedback system where rules determine incentives, and incentives determine behaviour.

Kabaddi can be modelled as a dynamic, non-cooperative game between raiding and defending teams, where each side chooses actions to maximize expected value under uncertainty.

- Raiders choose how aggressively to raid.
- Defenders choose whether to contain, tackle, or retreat.
- Outcomes depend on probabilistic success and failure.

Formally, each action **a** in state **s** has an expected value

$$EV(a, s) = \sum_i P(outcome_i | a, s) \times Value(outcome_i | a, s)$$

Rules influence behaviour by changing:

- the **probability** of outcomes,
- the **value** of outcomes,
- and the **constraints** on available actions.

State Variables and Action Space

State Variables

At any point in a match, the “state” includes:

- Score difference
- Time remaining
- Number of players on each side
- Raid type (normal / do-or-die raid imposed by the rules)
- Team strengths (raiding vs defending efficiency)

These variables define what actions are feasible and optimal.

Action Space

For the raiding team:

- Conservative raid (low risk, low reward)

- Aggressive raid (higher touch attempts, higher tackle risk)
- Time-consuming raid (clock management)

For the defending team:

- Safe containment
- High-risk tackle attempt
- Strategic retreat (avoid all-out)

Core Incentive Variables

To keep the model parsimonious, the behaviour of teams can be explained using five core variables:

Expected Raid Payoff

How many points a raid is worth on average.

This captures scoring rules, bonus points, and any performance bonuses for high-value raids (for example, raids that earn three or more points).

Capture Probability

How likely the raider is to get caught.

This depends on defender strength, numbers on the mat, and positioning.

Defender Count on Mat

The current defensive strength.

This defines the game state and strongly shifts raiding strategy.

Forced Raid Constraint (Do-or-Die)

Situations where rules force a raid even if it is risky.

This removes the option of playing safe.

All-Out Reset Effect

The sudden reward or penalty when an entire team is eliminated.

This introduces non-linear, momentum-based strategy.

Together, these variables explain incentives, risk-taking, and strategic adjustment.

Payoff Function

Each action is evaluated using an expected value framework:

$$EV(action) = \sum_i P(outcome_i) \times Value(outcome_i)$$

Where values includes:

- **Immediate payoff:** points scored or conceded
- **Future value impact:** momentum, all-out potential, player availability
- **Risk cost:** probability of failure \times penalty

Outcome

In Kabaddi, outcomes for a raid might include: raider scores 1 point and returns, raider scores 2+ points, raider is tackled and concedes 1 point, or an all-out is triggered.

The probabilities $P(\text{outcome}_i)$ are not assumed; they can be estimated from historical raid-level data using models such as logistic regression or multinomial regression.

Rules directly affect:

- Outcome probabilities
- Outcome values

Modelling Risk-Taking

Risk-taking emerges endogenously from the model when the **marginal reward of an action increases faster than its marginal risk**, or when teams face **time and score pressure**.

I model risk appetite as a function of:

- **Score deficit:** Teams behind in score are willing to accept higher failure probabilities for larger potential rewards.
- **Time remaining:** As time decreases, the cost of conservative play rises.
- **Player-specific factors:** Experience, role (primary raider vs support), and fatigue affect individual risk tolerance.

Formally, this implies that the same action can have different expected utilities depending on game state. As a result:

- **Leading teams** tend to choose conservative raids and safe defensive containment to preserve advantage.
- **Trailing teams** optimally attempt super raids and high-risk tackles to increase variance and create comeback opportunities.

Thus, risk-taking in Kabaddi is not irrational or emotional; it is a **strategic response to incentives and constraints imposed by the rules and current state of play**.

How Specific Kabaddi Rules Shape Behaviour

Example 1: All-Out Bonus

- **Rule:** Eliminating all defenders gives 2 extra points
- **Behavioural effect:**
 - Defenders may avoid risky tackles when close to all-out
 - Raiders are incentivized to attempt multi-touch raids
- **Strategic consequence:**
 - Non-linear scoring — one raid can swing a match. In EV terms, the same multi-touch raid has higher expected value when the defending team is close to all-out, because the upside includes both touch points and the additional all-out bonus.
 - Encourages momentum-based play rather than steady accumulation

Example 2: Do-or-Die Raids

- **Rule:** Must score or be out after two empty raids
- **Behavioural effect:**
 - Forces aggression even when risk is high
 - Reduces stalling and time-wasting
- **Strategic consequence:**
 - Increases variance
 - Makes weaker teams more volatile but occasionally dangerous

Example 3: Super Tackle Point

- **Rule:** Extra point when fewer than four defenders tackle successfully
- **Behavioural effect:**
 - Undermanned defenses attempt tackles they would otherwise avoid
- **Strategic consequence:**
 - Prevents runaway leads
 - Keeps matches competitive longer

- The super tackle rule raises the expected value of tackle attempts when only 3 defenders remain, which rationally encourages high-risk tackles instead of passive containment in those states

Small Rule Change Shows Large System Effect

Example Rule Change

Reduce the all-out bonus from 2 points to 1 point

Modelled Effects

1. Raid Incentives Change

- Multi-touch raids become less attractive
- Safer single-point raids increase

2. Defensive Behaviour Changes

- Defenders less afraid of being wiped out
- More aggressive collective tackles

3. Match Dynamics

- Lower variance in scores
- Fewer sudden momentum swings
- Matches become more “chess-like” and less explosive

A one-point change shifts optimal strategies across the match, demonstrating a **non-linear system response**.

Dimension	Current rule: 2-pt all-out bonus	Proposed rule: 1-pt all-out bonus
Raid incentives	High EV for multi-touch raids near all-out; aggressive raiding optimal.	Lower EV for multi-touch; single-point raids become relatively more attractive.
Defensive behaviour	Defenders avoid tackles when near all-out to protect against big swings.	Defenders less afraid of all-out; more collective tackle attempts.

Dimension	Current rule: 2-pt all-out bonus	Proposed rule: 1-pt all-out bonus
Score dynamics	High variance, frequent momentum swings, more comebacks.	Lower variance, more incremental scoring, more “chess-like” matches.

Statistical Extensions

This framework can be empirically calibrated using:

- Logistic regression for raid success probabilities

For example, we can model the probability that a raid results in at least 1 point as **$\text{logit}(P(\text{score} \geq 1)) = \beta_0 + \beta_1 \times \text{defender_count} + \beta_2 \times \text{do_or_die} + \beta_3 \times \text{time_remaining} + \beta_4 \times \text{score_difference}$**

The estimated coefficients then tell us how much each rule-related factor (like do-or-die) shifts raid success odds

- Markov decision processes or agent-based models for team dynamics

In an MDP formulation, each game state (score difference, time, players on mat, raid context) is a node, actions are raid/defence choices, transition probabilities are estimated from data, and the reward function encodes the scoring rules.

- Monte Carlo simulation to test rule changes before implementation
- This structure allows rapid A/B testing of rule changes using historical data before real-world implementation.

Why This Model Is Useful

The model allows leagues to:

- Simulate rule changes in advance
- Predict effects on excitement, balance, and safety
- Design rules that encourage desired styles of play (e.g., faster pace, closer matches)

Summary

I model Kabaddi rules as a **dynamic incentive system** that:

- Assigns values to actions under uncertainty
- Shapes risk-taking and strategic choices
- Produces emergent match dynamics

Even small rule changes can dramatically alter behaviour because they shift expected values at critical decision points.

This makes Kabaddi not just a physical sport, but a carefully engineered strategic system. Modelling the rules in this way also demonstrates how statistical tools (regression, MDPs, simulation) can be used in practice to support rule design and competitive balance decisions.