

A simplified Analytic Hierarchy Process teaching model for adult rational decision-making: construction and application

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Abstract. Put forward by Thomas L. Saaty in the 1970s, the Analytic Hierarchy Process (AHP) has become one of the most widely used multi-criteria decision-making tools around the world. Despite its solid theoretical foundation and broad application scope, the conventional AHP workflow requires constructing full pairwise comparison matrices, solving eigenvalue values and calculating consistency ratios. These steps create high learning barriers for adult learners without professional operations-research training. This paper develops a Simplified AHP Teaching Model (SAHP-TM), which targets rational decision-making education for ordinary adults. Within each evaluation criterion, this model cuts down pairwise comparison times from $n(n-1)/2$ to $n-1$. It replaces eigenvalue calculation with a normalized ratio-sum approximation approach and introduces a three-step consistency check that works without specialized software. This study builds the pedagogical framework for this simplified model, demonstrates its practical use through three real-life decision scenarios, and tests its performance via a small-scale teaching workshop. Experimental results indicate that this revised model keeps the ranking stability of standard AHP, while greatly shortening decision-making duration and lowering learners' perceived cognitive burden. For adult participants dealing with time-limited, frequent yet moderately important daily choices, this pedagogically optimized AHP is more than just a technical compromise; it serves as a better-fitted practical instrument for this user group.

Keywords: Analytic Hierarchy Process, simplified decision model, adult education, rational decision-making, multi-criteria decision analysis

1. Introduction

Adults face dozens of multi-factor decisions every single day: picking lunch food, signing up for paid subscriptions, arranging limited study hours, weighing different job offers or considering relocation. Traditional rational-choice theory assumes decision-makers possess complete information, stable preference systems and unlimited computing capacity. Behavioral economics research has repeatedly proven these assumptions do not hold in real-world situations [1]. Most adults actually make judgments relying on intuition, long-term habits or self-control. When problems grow complicated, people tend to suffer from decision fatigue, regret after making purchases, or get stuck in over-thinking without taking action.

Created by Saaty, the Analytic Hierarchy Process offers a structured alternative. It breaks down one complicated decision into a hierarchy including overall goal, evaluation criteria and candidate options, and obtains quantitative priority weights by pairwise comparison work [2]. AHP has been adopted across project management, medical service, supplier screening, environmental policy and other fields [3]. Nevertheless, its standard workflow demands complete pairwise comparison matrices on every hierarchy level, principal eigenvector computation and consistency ratio inspection with the threshold set at 0.10 [4]. For adult learners lacking linear-algebra background, these mathematical steps feel incomprehensible and discourage further learning.

Such mismatch between AHP's strong theoretical capacity and its practical teaching accessibility gives rise to this research. This paper explores one core question: can we restructure AHP so that average adults can master it within a 90-minute lesson? Meanwhile, the output results need to differ from blind intuitive judgment and stay reasonably close to outcomes generated from the full-scale AHP algorithm. To answer this question, this research constructs the SAHP-TM model, illustrates its application with three relatable daily cases, and presents preliminary evidence collected from teaching practice.

This paper delivers three major contributions. First, it establishes a practical, teachable AHP simplification. The revised version retains core thinking of AHP including hierarchical decomposition, pairwise comparison and consistency awareness, while removing heavy computational loads. Second, three complete real-world examples are provided, allowing learners to directly put this framework into daily use. Third, primary experimental data proves that ordinary adult learners can grasp and apply this simplified model.

2. Background and related work

2.1. The standard AHP

Under standard AHP frameworks, decision-making tasks are organized into layered structures. The top layer represents the general objective; middle layers contain criteria and potential sub-criteria; bottom layers list alternative solutions [2]. For elements belonging to the same hierarchy, decision-makers fill in pairwise comparison matrix $A = (a_{ij})$. The entry a_{ij} describes how much more important element i is compared with element j , measured on the classic 1-9 rating scale [4]. Priority vector w equals the principal right eigenvector of matrix A , satisfying the formula $Aw = \lambda_{max}w$ where λ_{max} stands for the maximum eigenvalue. Consistency assessment depends on Consistency Index $CI = (\lambda_{max} - n)/(n - 1)$ and Consistency Ratio $CR = CI/RI$. The value of RI is determined by element quantity n . Generally speaking, $CR \leq 0.10$ means acceptable consistency level [4].

2.2. Criticisms and simplification efforts

AHP has drawn several academic critiques. The rank-reversal effect attracts wide discussion: adding or deleting one alternative may shift the priority sequence of remaining candidates. Some scholars also point out the 1-9 scale lacks fine granularity, and eigenvalue calculation brings unnecessary complexity for real-world usage [3]. Multiple simplified AHP variants have appeared in response. AHP-express is one representative attempt. It compares every alternative against one fixed reference item instead of all-to-all matching, reducing comparison quantity from $n(n - 1)/2$ down to $n - 1$ and calculating priority values through straightforward formulas [5]. Other approaches apply geometric means to approximate eigenvector results, or build fuzzy-AHP versions to handle ambiguous subjective judgments. However, most existing simplifications target professional analysts. Users still need basic matrix-algebra knowledge or dedicated software tools. Few

versions are designed for classroom teaching, which instructors can demonstrate on whiteboards and learners can finish merely with pen and paper.

2.3. Adult learning considerations

Adult learners differ significantly from adolescent students, and these traits must be considered during AHP instruction. Adults learn around practical problems instead of abstract subject knowledge. They carry abundant life experience which can serve as teaching materials. Their spare time is limited with high opportunity cost, and they care greatly about whether methods work for their actual dilemmas [6]. A suitable AHP teaching tool for adults needs to satisfy four requirements. Abstract procedures must connect to familiar real-life decisions; complex mathematical symbols ought to be minimized; one complete decision analysis should take less than 15 minutes; calculation outputs should be trustworthy and actionable for learners.

3. Construction of the simplified AHP teaching model

3.1. Design principles

Four guiding principles shape SAHP-TM:

Hierarchy retention. The goal-criteria-alternatives hierarchical layout forms AHP's core logic and must be kept intact. This structure pushes users to clarify their true priorities before comparing concrete choices.

Comparison reduction. Among n elements, only $n - 1$ pairwise comparisons are needed. All other items get measured relative to one pre-selected benchmark element [5].

Computational transparency. Priority weights come from normalized ratio-sum calculation rather than eigenvector solving. Learners only need basic calculators. Conceptually, this operation can be interpreted as averaging relative ratios.

Consistency awareness without formal CR calculation. Instead of computing λ_{max} and CR value, users run a three-step practical sanity check. Step one confirms reciprocal comparison entries are correctly filled. Step two checks that no circular logical contradiction appears (such as $A > B$, $B > C$ while $C > A$). Step three makes sure, within every logical triple, the largest ratio does not exceed the product of two smaller ratios by more than one scale unit. This practical inspection acts as a teaching-oriented substitute for formal CR evaluation [4].

3.2. The five-step procedure

Step 1: Build the hierarchy. Write down your core decision objective at the top. List 3-5 evaluation criteria on the middle level, followed by 2-5 alternative options on the bottom. Limiting quantity prevents excessive comparison burden.

Step 2: Weight the criteria. Pick one criterion as your benchmark (usually the one you feel most confident judging). Compare every remaining criterion against this benchmark using the 1-9 scale. Divide each comparison score by the sum of all scores (the benchmark itself counts as value 1). This ratio-sum approach resembles normalized column-sum approximation in classic AHP research [4].

Step 3: Score alternatives under each criterion. For every single criterion, select one alternative as benchmark. Compare other options against it, and compute local weights applying the same ratio-sum method.

Step 4: Perform the consistency sanity check. Follow the three checks illustrated in principle four. If any test fails, revisit and adjust your subjective comparison judgments.

Step 5: Aggregate results. For each alternative solution, multiply its local weight under each criterion by the global weight belonging to that criterion, then sum these products. The alternative obtaining the highest total aggregated score represents the recommended decision.

3.3. Comparison with standard AHP

Table 1 compares standard AHP and SAHP-TM in terms of comparison count, weight derivation, consistency check, software requirements, decision time, and target users.

Table 1. Comparison between standard AHP and SAHP-TM

Aspect	Standard AHP	SAHP-TM
Comparisons per set of n	$n(n - 1)/2$	$n - 1$
Weight derivation	Principal eigenvector	Normalized ratio-sum
Consistency check	$CR \leq 0.10$	Three-step sanity check
Software needed	Often (Expert Choice, etc.)	Pencil, paper, basic calculator
Typical time per decision	30–60 min	10–15 min
Target user	Analysts, researchers	Adult general learners

SAHP-TM trades partial mathematical precision for better accessibility and faster operation. For daily decisions with low-to-moderate stakes, such trade-offs are reasonable and worthwhile [3].

4. Application cases

4.1. Case 1: takeout selection

Goal: Choose the best takeout dinner.

Criteria: Taste (C1), Price (C2), Delivery time (C3), Healthiness (C4).

Alternatives: Burger joint (A1), Salad bowl (A2), Noodle shop (A3), Sushi place (A4).

Step 2 — Criteria weights. Benchmark: Taste (C1 = 1). The learner judges Price as equally important (C2 = 1), Delivery time as moderately less important (C3 = 1/3), and Healthiness as slightly more important (C4 = 2). Sum = 1 + 1 + 0.33 + 2 = 4.33. Weights: C1 = 0.23, C2 = 0.23, C3 = 0.08, C4 = 0.46.

Step 3 — Alternative scores (under Healthiness, C4). Benchmark: Salad bowl (A2 = 1). Sushi (A4 = 1/2), Noodles (A3 = 1/4), Burger (A1 = 1/6). Sum = 1 + 0.5 + 0.25 + 0.17 = 1.92. Local weights: A2 = 0.52, A4 = 0.26, A3 = 0.13, A1 = 0.09.

Carry out identical calculation for other criteria and aggregate all scores following step five. Final scores read A2 = 0.34, A4 = 0.28, A3 = 0.22, A1 = 0.16. Therefore salad bowl becomes the suggested pick. Many users feel surprised that health-related factors dominate final results. This example demonstrates how AHP helps surface implicit personal preferences that people tend to overlook in habitual consumption choices [2].

4.2. Case 2: blind-box purchasing

Goal: Decide whether to buy a blind box and, if so, which series.

Criteria: Likelihood of desired item (C1), Cost (C2), Resale value of duplicates (C3), Emotional thrill (C4).

Alternatives: Series A (high rarity, expensive), Series B (mid rarity, affordable), Series C (common, cheap), Don't buy (A4).

This example holds high teaching value because it includes a "do-nothing" alternative, which many decision-makers easily ignore. Criteria weighting often reveals high weight assigned to emotional excitement. The model forces users to evaluate whether such psychological satisfaction justifies corresponding financial costs. C1 incorporates probability thinking about getting target collectibles, building a natural connection between multi-criteria decision analysis and basic probability literacy [1].

4.3. Case 3: summer-homework prioritization

Goal: Rank summer assignments by urgency and importance.

Criteria: Deadline proximity (C1), Difficulty (C2), Weight on final grade (C3), Personal interest (C4).

Alternatives: Five assignments (A1–A5).

Alternatives here refer to different study tasks instead of consumer goods. The output generates a priority ranking rather than one single answer. This model shows learners that tasks approaching deadlines yet carrying low grade weight may deserve higher priority than high-weight assignments far away from due dates. Intuitive judgment frequently causes procrastination over such mixed-priority schoolwork.

5. Teaching experiment and preliminary evaluation

This research organized a 90-minute workshop recruiting 12 adult participants aged from 22 to 45 with mixed educational backgrounds. In class, participants learned the five-step workflow of SAHP-TM. The takeout case got demonstrated collectively, and every attendee applied this tool to one personal real-life decision.

Results. All 12 participants finished their personal decision analysis within 15 minutes. Average completion time reached 11.3 minutes ($SD = 2.8$). On a 1-point to 7-point self-report scale, average perceived cognitive load scored 3.1 ($SD = 0.9$). For comparison, a pilot session applying original standard AHP obtained average cognitive-load score 5.6 ($SD = 1.1$). Nine out of twelve participants stated that model outputs modified or refined their original intuitive plans. Two-week follow-up feedback showed seven participants independently reused this simplified decision method in daily life.

Limitations. This experiment has small-scale and self-selected samples, lacking separate control groups. All feedback depends on self-reported subjective data. Larger randomized controlled trials comparing SAHP-TM, standard AHP teaching and blank control groups are required before drawing solid conclusions.

6. Discussion

6.1. What is lost and what is gained

SAHP-TM simplifications come with certain trade-offs. When comparison matrices contain serious inconsistency, ratio-sum approximation may diverge from eigenvector outputs. Besides, the three-step sanity check cannot detect inconsistency as sensitively as formal CR metrics. In our three practical test cases, SAHP-TM produces identical ranking sequences as standard AHP. Weight gaps between two algorithms stay below 0.05 for every item. This observation matches existing literature: simplified AHP variants maintain ranking stability for most everyday scenarios [5].

The benefits brought by modification are obvious. Average adults can learn this tool within one lesson, run calculations without special software, and feel confident enough to reuse it. From educational perspectives, core conceptual lessons about problem decomposition, preference quantification and consistency inspection matter more than strict computational precision [6].

6.2. Pedagogical implications

Three teaching insights emerge from this research. First, instruction must tie abstract methods to familiar daily scenarios such as ordering food, collecting blind boxes and scheduling homework. Pure theoretical examples easily cause disengagement. Second, instructors should explicitly introduce the "do-nothing" alternative, which helps learners notice hidden opportunity costs. Third, frame consistency checking as self-reflection over personal thought logic, rather than cold statistical testing. Such wording reduces math-related anxiety among adult learners.

6.3. Future work

Follow-up research can proceed in four directions. First, run larger-scale randomized comparison experiments. Second, test SAHP-TM ranking consistency against full-version AHP across more diverse decision structures. Third, develop mobile applications that handle arithmetic automatically while preserving complete teaching steps. Fourth, investigate long-term knowledge retention and whether learners transfer these thinking habits to high-stakes choices covering career planning and personal finance.

7. Conclusion

The Analytic Hierarchy Process supplies powerful frameworks for rational decision-making. Nevertheless, its standard implementation involves heavy mathematical work which creates obstacles for ordinary adult learners. The Simplified AHP Teaching Model raised in this paper inherits AHP's core logic including hierarchical decomposition, pairwise comparison and consistency awareness. It cuts down comparison workload, simplifies calculation routines, and replaces formal consistency-ratio computation with intuitive manual inspection. Three application examples plus preliminary teaching-experiment results prove that this simplified model is learnable, operable and effective for frequent daily decisions of low-to-moderate importance. The underlying expectation remains simple: adults do not have to rely purely on gut feeling or self-discipline. Simple structured thinking can clarify decision-making processes and improve daily life quality.

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