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SDG Buddy: A Holistic Framework for Individual Sustainability Tracking using Multi-Criteria Impact Assessment and LLM-Driven Gamification

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Abstract- While the United Nations' 2030 Agenda for Sustainable Development calls for universal action, contemporary sustainability applications remain predominantly focused on environmental metrics, specifically carbon footprint tracking. This paper introduces "SDG Buddy," a novel framework designed to track, quantify, and gamify individual actions across the full spectrum of the 17 Sustainable Development Goals (SDGs). By integrating Large Language Models (LLMs) for natural language action processing and Life Cycle Assessment (LCA) principles for impact scoring, the proposed system bridges the gap between vague intentions and measurable global impact. We detail a cloud-native, serverless architecture that ensures scalability and resilience, addressing the technical and financial pitfalls of previous sustainability tracking initiatives.

Keywords: Sustainable Development Goals, Gamification, Life Cycle Assessment, LLM, Cloud Architecture, Individual Sustainability.

I. INTRODUCTION

The 2030 Agenda for Sustainable Development serves as a "shared blueprint for peace and prosperity," yet progress toward the 17 Sustainable Development Goals (SDGs) remains sluggish. While national policies and corporate ESG (Environmental, Social, and Governance) reporting are critical, the UN "ActNow" campaign emphasizes that individual action is a cornerstone of the agenda.

However, existing consumer-facing tools suffer from "carbon-centrism," neglecting social and economic goals such as Quality Education (SDG 4) or Reduced Inequalities (SDG 10). "SDG Buddy" addresses this market gap by providing a holistic tracking engine. The system does not merely reward "green" habits but empowers users to visualize their contributions to an integrated, indivisible framework of global development.

II. RELATED WORK AND MARKET GAP

A. Precedent Analysis

A review of the "Sustainability Action Tracker" from Santa Clara University reveals that project failure in this domain often stems from fragile architecture and a lack of data persistence. Early projects relied on expensive cloud instances that, when funding ceased, led to system collapse. "SDG Buddy" mitigates this by utilizing a serverless-first approach.

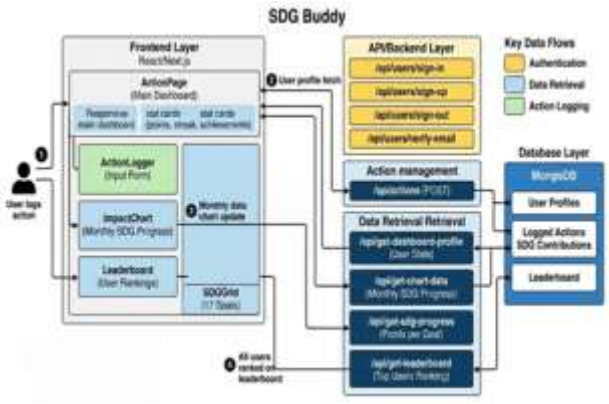
B. Competitive Landscape

Current market leaders such as AWorld, Commons, and JouleBug provide specialized tracking. However, most rely on manual self-reporting with indirect links to official UN targets. "SDG Buddy" differentiates itself by mapping actions directly to the 169 official SDG targets using an LLM-based interpretation engine.

App	Focus	SDG Mapping
AWorld	Education	High-level Goal
Commons	Spending/CO2	Indirect
Klima	Offsetting	Goal 13 only
SDG Buddy	**Holistic SDG**	**Target-level**

III. SYSTEM ARCHITECTURE

The system utilizes a modular, cloud-native architecture to ensure high availability and low operational overhead.



A. Frontend Layer

The user interface is built using React/Next.js, providing a responsive dashboard that visualizes progress via an "SDG Grid." This allows users to see their personal "SDG profile" in real-time.

B. Backend and LLM Integration

As illustrated in the flow logic, the core innovation lies in the "Process Action" module. When a user logs an action in natural language (e.g., "I donated textbooks to a local school"), the system initiates an LLM request to:

1. Identify relevant SDG Targets (e.g., Target 4.1).
2. Assign impact scores based on pre-defined LCA heuristics.
3. Update the user's gamification stats (points, badges, streaks).

IV. THE IMPACT FRAMEWORK

To prevent "greenwashing" and ensure scientific integrity, "SDG Buddy" employs a four-step quantification framework:

- Action-to-Target Mapping: Each action is mapped to one of the 169 targets. For example, composting is mapped to Target 12.5 (Waste Reduction).
- LCA-Informed Scoring: Scores are derived using Life Cycle Assessment principles, accounting for Global Warming Potential (GWP), water depletion, and resource use.
- Tiered Rewards: Actions are classified into Bronze (Daily habits), Silver (Conscious efforts), and Gold (Transformative lifestyle changes).
- Multi-Goal Aggregation: A single action can contribute to multiple goals, reflecting the interconnected nature of the 2030 Agenda.

V. ETHICAL CONSIDERATIONS

Tracking personal habits raises significant privacy concerns. "SDG Buddy" implements a "Privacy-First" approach, utilizing data minimization and local-first storage where possible. Furthermore, to combat economic bias, the action database prioritizes no-cost actions (e.g., civic participation, volunteering) to ensure that "Sustainability Champion" status is achievable regardless of socioeconomic standing.

VI. CONCLUSION AND FUTURE WORK

"SDG Buddy" represents a strategic advancement in individual sustainability tracking. By moving beyond carbon metrics to a holistic SDG framework, the application fosters a more authentic global citizenship. Future iterations will focus on:

1. Automated logging through IoT and API integrations (e.g., smart meters, health apps).
2. Predictive LLM recommendations based on user history (Currently under development).
3. Longitudinal studies to measure actual behavioral spillover.

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