

# 6D-Intelligence: LLM-Based Multi-Agent System Using Six Thinking Hats

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## Abstract

This study investigates the application of multi-agent systems based on Large Language Models (LLMs) in assisting user thinking and decision-making. Drawing inspiration from the Six Thinking Hats theory, we designed multiple agents, each assuming a distinct thinking role, to guide users from various perspectives. A shared vectorized knowledge base supports comprehensive problem analysis. Experimental results demonstrate that our system significantly enhances user satisfaction in task efficiency, cognitive expansion, and creativity, and increases trust in the system’s outputs. However, while the blue summary agent effectively mitigates information overload, some users tend to over-rely on its summaries, overlooking other agents’ viewpoints. Additionally, despite the black critical agent’s strong performance in risk identification, users often do not trust its perspectives after discussions, potentially weakening risk assessment capabilities. This research provides empirical support for designing more insightful and trustworthy multi-agent systems and outlines directions for future optimization. The project is open-source<sup>1</sup>.

## 1. Introduction

In recent years, with the rapid development of Large Language Model (LLM) technologies, multi-agent collaboration has shown great potential in solving complex tasks [BMR+20]. For example, OpenAI’s ChatGPT achieves remarkable task performance through agent collaboration and interaction [Ope23]. However, existing research primarily focuses on improving task efficiency and accuracy, paying less attention to whether multi-agent systems can enhance users’ comprehensive thinking abilities [COI+18]. Specifically, current studies overlook how multi-agent systems can help users broaden and deepen their thinking through the collaboration and interaction of different agents [Woo09]. Moreover, although multi-agent systems can provide multidimensional perspectives, existing work has not thoroughly explored user biases during interactions, such as preferences or trust toward certain agents [Lee18], and the cognitive load issues brought by complex information [Swe88]. It remains to be studied whether information overload affects the quality of user decisions and whether users may over-rely on summaries from specific agents [EM04].

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<sup>1</sup>Project address: <https://github.com/dengxw66/six-hats>

To fill this research gap, this study aims to explore the specific impact of multi-agent systems on users' thinking abilities and the potential biases and preferences users exhibit during interactions [LLYC21].

Therefore, the objectives of this study are to deeply investigate how multi-agent systems enhance users' comprehensive thinking abilities through interaction processes and to identify potential user biases in system usage [COI+18]. We propose the following research questions: (1) Can multi-agent systems enhance users' comprehensive thinking abilities through the collaboration and perspectives of different agents, thereby helping users solve complex tasks more efficiently and comprehensively? This question aims to evaluate the impact of agent systems on improving users' thinking breadth and task satisfaction [Woo09]; (2) During interaction with multi-agent systems, do users exhibit particular preferences or trust toward certain agents [Lee18]? Specifically, does information overload lead users to over-rely on summaries or specific thinking angles from certain agents [EM04]? Through these research questions, we hope to reveal the potential of multi-agent systems in enhancing users' thinking abilities and understanding user interaction biases, providing theoretical support for designing more cognitively stimulating and interactive multi-agent systems, particularly in optimizing user trust and reducing the impact of information overload [Swe88].

Inspired by the renowned parallel thinking model in strategic thinking—the Six Thinking Hats theory [De 85a], we designed six agents with different roles, each thinking from a different perspective. Proposed by Edward de Bono, the Six Thinking Hats theory aims to enhance decision-making by guiding individuals or teams to adopt different thinking perspectives sequentially [De 85a]. Each "hat" represents a specific mode of thinking: the White Hat focuses on facts and data, providing objective information; the Red Hat expresses emotions and intuition, helping understand the emotional aspects of a problem; the Black Hat is responsible for critical thinking, focusing on identifying potential risks or negative consequences; the Yellow Hat advocates optimistic thinking, focusing on opportunities and potential benefits; the Green Hat stimulates creativity, promoting innovation and solutions; and the Blue Hat manages the overall thinking process, ensuring effective application of all thinking modes. Although this parallel thinking approach has been widely validated to enhance the breadth of thinking, it is often not well-utilized due to human cognitive limitations and proficiency levels [BO10]. Therefore, we employ a multi-agent system to address this issue, where each agent focuses solely on a specific thinking angle, achieving parallel thinking [DLC99]. Agents share a vectorized knowledge base based on a Retrieval-Augmented Generation (RAG) model, enhancing the system's knowledge richness and coherence [LPP+20]. Additionally, the Blue Summary Agent plays a key role in information integration and simplification, alleviating information overload caused by multi-angle discussions [EM04]. Through this architecture, agents provide users with multidimensional perspectives, helping them comprehensively examine problems from different angles [Woo09].

Our contributions are threefold:

- We developed a multi-agent system based on the Six Thinking Hats theory, proposing an effective process to support users in expanding their thinking from multiple angles, significantly enhancing user satisfaction in task completion and cognitive depth.

- We investigated the impact of information overload on user decisions and proposed recommendations to reduce cognitive load by sharing a vectorized knowledge base, optimizing information presentation, and refining agent summarization mechanisms, ensuring users maintain balanced cognitive expansion in an information-rich environment.
- We conducted a detailed analysis of user interactions with the multi-agent system, discovering that users exhibit clear preferences among different agent viewpoints, especially showing higher trust in the management (Blue Hat) and innovation (Green Hat) agents. While the critical (Black Hat) agent effectively presented risk assessments, it was not ultimately trusted by most users.

Overall, this study provides important theoretical support and design insights for constructing more intelligent, trustworthy, and cognitively expansive interactive systems through the exploration of multi-agent systems.

## 2. Related Work

### 2.1. Agent Systems Based on LLMs

In recent years, agent systems based on Large Language Models (LLMs) have made significant strides in perception, planning, and task execution, demonstrating the capability to complete complex tasks through natural language processing and reasoning [BMR+20, Ope23]. Systems like AutoGPT [Ric23] and BabyAGI [Nak23] showcase the potential of LLMs in autonomous task execution and multi-step reasoning. Multi-agent systems (MAS) leverage collaboration among multiple agents to tackle complex problems that are challenging for a single agent, particularly excelling in task division, coordination, and strategic interactions [Woo09, SV00].

However, existing research primarily focuses on improving task efficiency and accuracy, emphasizing agent collaboration to enhance automation capabilities [DLC99, WZY+23], while paying less attention to how agent interactions can expand users’ comprehensive thinking abilities [COI+18]. Although some studies have explored the application of LLMs in multi-agent environments [PSZ+23, LGS+23], these works mainly concentrate on interactions and collaboration among agents rather than on user-agent interactions.

Consequently, there is a lack of a systematic multi-agent interaction framework designed to enhance users’ thinking depth and breadth across multiple dimensions. While multi-agent systems perform well in task execution, their potential to assist users in thinking, analyzing, and solving complex problems remains underexplored [SST+23b]. To address this gap, we introduce the Six Thinking Hats theory [De 85a] and design a multi-agent system that assists users in analyzing problems from different cognitive perspectives, thereby compensating for the limitations of existing systems in expanding users’ thinking abilities.

## 2.2. Human-Computer Interaction with Multi-Agent Systems

In the field of human-computer interaction (HCI), research has predominantly focused on interactions between users and single agents, particularly in dialogue systems and task-oriented applications where agents engage with users through natural language to accomplish specific tasks [BP05, YGTW13]. With the advancement of LLMs, however, researchers have begun to explore the potential of multi-agent systems in enhancing user experience and cognitive capabilities [LGS+23, SMR23].

Existing work largely emphasizes user satisfaction with system task performance, often neglecting users' trust, preferences, and potential cognitive biases toward multiple agents during interactions [Lee18, HRSL20]. Specifically, when multiple agents participate simultaneously, research on users' trust and preferences regarding different agent roles is still limited [XWC15]. Additionally, the impact of information overload and cognitive load on decision quality is an issue warranting attention [Swe88, EM04].

To address these issues, we propose a Six Thinking Hats-based agent system. Our system aids users in analyzing problems from six distinct perspectives, tracking user preferences and responses during interactions with agents of different roles [De 85a]. This research is the first to systematically examine the effect of multi-agent collaborative interactions on stimulating user thinking, as well as users' trust and preferences toward different agent roles [BO10]. Furthermore, we investigate the impact of information overload on decision quality and propose solutions to optimize user experience through information simplification mechanisms [Swe88]. Through these explorations, our study fills a gap in current multi-agent systems by enhancing users' thinking abilities and analyzing user preferences and trust, providing a theoretical foundation for the design of future human-computer interaction systems.

## 3. Method

This section introduces the multi-agent system we designed, starting with a description of the basic functions of each agent, followed by an explanation of their role-playing mechanism, and finally, detailing the interaction process between the agents.

### 3.1. Role-Playing

Each agent in the system is designed based on the "Six Thinking Hats" theory [De 85a], with each hat representing a different mode of thinking. We define an agent set  $\mathcal{A} = \{A_W, A_G, A_B, A_Y, A_R, A_M\}$ , where each element  $A_i$  represents a corresponding Thinking Hat agent,  $i \in \{W, G, B, Y, R, M\}$ , as described below:

- **White Hat (Objective):**  $A_W$  is responsible for stating objective facts and data, directly answering questions, explaining specific conditions, and boundaries to ensure accuracy and neutrality of information.
- **Green Hat (Creative):**  $A_G$  is responsible for creative thinking, proposing novel ideas or unconventional solutions, engaging in divergent thinking, and exploring more possibilities.

- **Black Hat (Critical):**  $A_B$  is responsible for critical thinking, reviewing logical flaws or risks, raising objections, and helping the user identify potential problems or contradictions.
- **Yellow Hat (Positive):**  $A_Y$  is responsible for positive thinking, expressing constructive and optimistic viewpoints, searching for positive ways to solve problems, and optimizing existing solutions.
- **Red Hat (Emotional):**  $A_R$  views the issue from emotional and intuitive perspectives, expressing feelings and instincts, and providing emotional feedback and judgments.
- **Blue Hat (Management):**  $A_M$  manages the entire thinking process, assigns speaking turns to other agents based on user input, and summarizes the responses of all agents at the end of each discussion round, making an overall judgment.

The task input to the system is defined as  $Q_t$ , representing the user's question or follow-up query at time  $t$ , with the task assignment strategy of the Blue Hat being  $A_{M,t}$ . The response from each agent at time  $t$  is represented by  $R_{i,t}$ , where  $i \in \{W, G, B, Y, R\}$ . Finally, the summary by the Blue Hat  $A_M$  at time  $t$  is  $S_t$ .

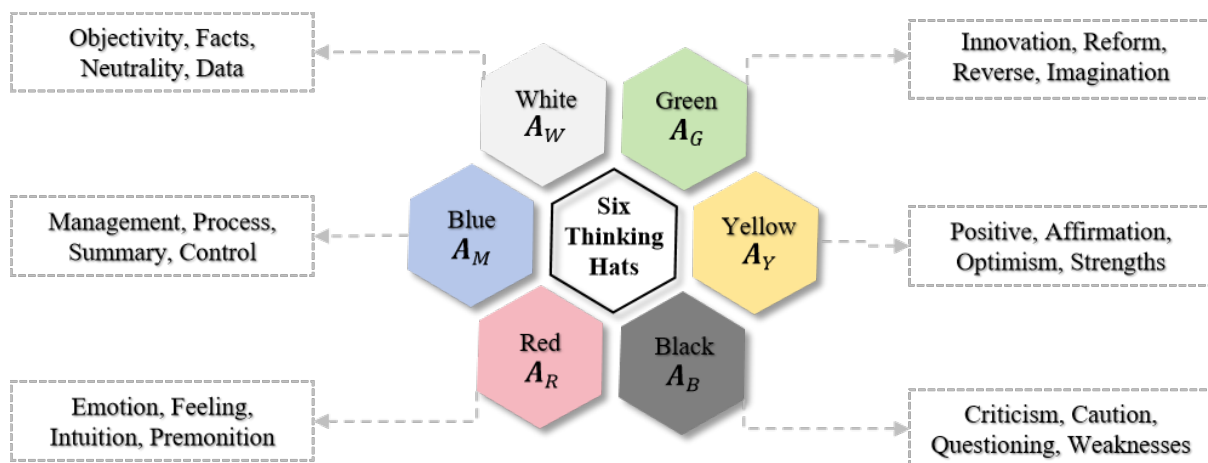


Figure 3.1: Role Definition and Characteristics of the Six Thinking Hats

## 3.2. Basic Functions

Each agent in the system is equipped with specific basic functions to ensure efficient task completion and multi-perspective thinking. The specific functions are as follows:

- **Perception and Action:** Agents can perceive external inputs, understand user queries, and respond appropriately in complex scenarios.
- **Knowledge Base Learning and Retrieval:** Agents connect to specialized knowledge bases and historical conversation records through a RAG (Retrieval-Augmented Generation) model, learning new knowledge and retrieving relevant information to ensure that responses refer to appropriate data and context [LPP+20].

- **Decision Planning and Reasoning:** Agents possess planning and reasoning capabilities, deriving reasonable solutions or multi-step task execution paths based on the user’s queries.
- **Collaboration and Contradictory Dialogue:** Agents can collaborate or present differing viewpoints, deepening and broadening the discussion through cooperation or critical thinking.
- **Memory and Recap:** Agents can remember previous interactions, organize and review key information, and provide related summaries or feedback when necessary.
- **Tool Creation and Usage:** Agents can create or call external tools based on task requirements, improving task execution efficiency [SST+23a].

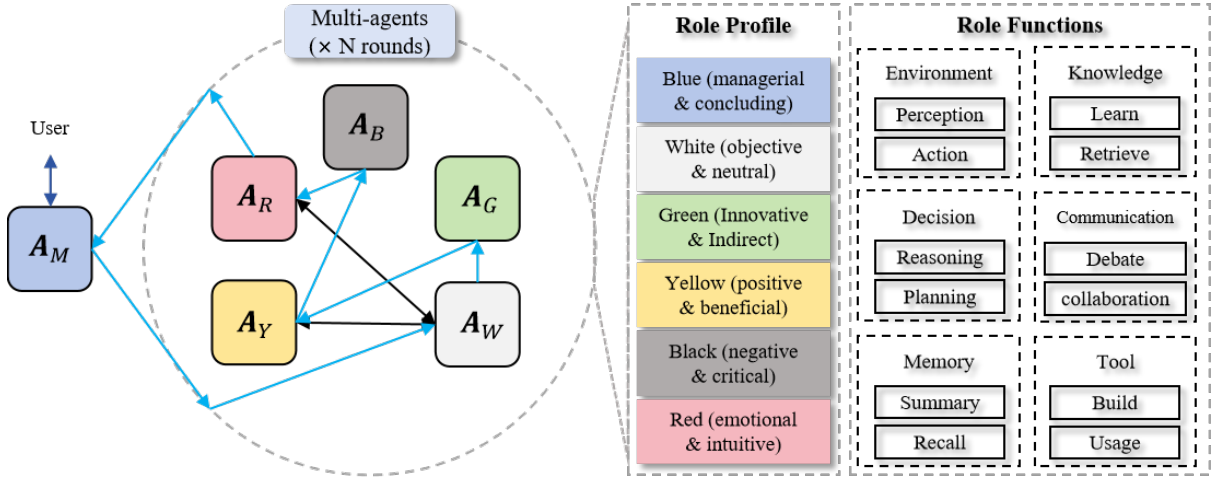


Figure 3.2: Interaction process of the Six Hats. The Blue Hat manages the sequence of the other hats.

### 3.3. Interaction Process

The interaction process of the agents is coordinated and planned by the Blue Hat  $A_M$ . Each user interaction with the agents is a multi-round dynamic discussion, with the specific steps as follows:

1. **User Question or Follow-up:** At time  $t$ , the user inputs a question  $Q_t$ , which could be a factual query, strategy planning, or emotional feedback. The content of the question determines the subsequent task allocation and thinking direction of the agents.
2. **Blue Hat Analysis and Strategy Formulation:** Upon receiving the user’s question  $Q_t$ , the Blue Hat  $A_{M,t}$  retrieves relevant information from the historical dialogue records  $\mathcal{H}_t$  and the RAG knowledge base  $\mathcal{K}$ , generating a task allocation strategy, determining the set of speaking agents  $\mathcal{A}_t$  and the speaking order  $O_t$ .

$$(\mathcal{A}_t, O_t) = A_{M,t}(Q_t, \mathcal{H}_t, \mathcal{K})$$

Here, the Blue Hat  $A_{M,t}$  represents the strategy behavior at time  $t$ , and based on the input  $Q_t$ , historical dialogue records  $\mathcal{H}_t$ , and the system's RAG knowledge base  $\mathcal{K}$ , it determines the participating agent set  $\mathcal{A}_t$  and their speaking order  $O_t$ .

3. **Agents Speak in Turn:** Following the speaking order  $O_t$  determined by the Blue Hat  $A_{M,t}$ , each agent  $A_i$  responds to the question  $Q_t$ , generating a response  $R_{i,t}$ .

$$R_{i,t} = A_i(Q_t), \quad i \in O_t$$

Each agent  $A_i$  generates its response based on its role function and thinking mode. The speaking order is as follows: the White Hat  $A_W$  provides objective facts  $R_{W,t}$ , the Green Hat  $A_G$  offers creative ideas  $R_{G,t}$ , the Black Hat  $A_B$  conducts critical analysis  $R_{B,t}$ , the Yellow Hat  $A_Y$  offers positive thinking  $R_{Y,t}$ , and the Red Hat  $A_R$  provides emotional feedback  $R_{R,t}$ .

4. **Blue Hat Summarization and Feedback:** After all agents have spoken, the Blue Hat  $A_{M,t}$  summarizes the discussion, generating the output  $S_t$ .

$$S_t = A_{M,t}(\{R_{i,t}\}_{i \in O_t})$$

The Blue Hat is responsible for summarizing the views of all agents and providing a comprehensive analysis or further suggestions.

5. **RAG Knowledge Base Update:** The summarized result  $S_t$  is stored in the RAG knowledge base  $\mathcal{K}$ , to be used in future retrieval. The update process is as follows:

$$\mathcal{K}_{t+1} = \mathcal{K}_t \cup \{S_t\}$$

This process ensures that the results of previous discussions accumulate in the knowledge base, enhancing the quality of future agent responses and the depth of discussions.

6. **User Feedback and Iterative Interaction:** After receiving the summary  $S_t$ , the user can ask a new question  $Q_{t+1}$ . The Blue Hat  $A_{M,t+1}$  will replan the next round of agent speaking order  $O_{t+1}$ . This process continues iteratively until the question is fully answered or the user chooses to end the interaction.

The mathematical representation of the entire interaction process is:

$$(Q_t, A_{M,t}, \{R_{i,t}\}_{i \in O_t}, S_t) \rightarrow Q_{t+1}, A_{M,t+1}$$

Through this iterative design, users can gain insights from multiple perspectives, while the Blue Hat  $A_{M,t}$  is responsible for summarizing and providing structured outputs to ensure comprehensive and organized responses.



Table 3.1: Performance Comparison on GSM8K and FOLIO-wiki datasets.

Method Category	Method	GSM8K (%)	FOLIO-wiki (%)
Single-agent	Zero-shot CoT	69.30	70.50
	Few-shot CoT	83.20	76.10
Multi-agents	Debate	76.80	70.60
	Ours (random)	72.10	69.40
	Ours	78.50	74.00

## 4. Results and Evaluation

### 4.1. Metric

This section analyzes and discusses the performance of our proposed multi-agent system on the GSM8K and FOLIO-wiki datasets.

#### 4.1.1. Datasets

GSM8K and FOLIO-wiki are two commonly used benchmark datasets for reasoning tasks, each used to evaluate different types of reasoning abilities.

- **GSM8K:** This dataset focuses on academic reasoning tasks, primarily testing the model’s performance in mathematical and logical reasoning problems. The problems in GSM8K require the model to have strong reasoning capabilities, capable of handling complex multi-step calculations and logical deductions.
- **FOLIO-wiki:** This dataset is used to evaluate the model’s common-sense reasoning abilities, with data mainly sourced from Wikipedia, involving numerous questions based on everyday life and general knowledge. FOLIO-wiki tasks focus more on the model’s understanding and reasoning abilities related to common sense, assessing whether the model can make reasonable inferences in real-life scenarios.

#### 4.1.2. Methods and Results Analysis

Table 3.1 presents the performance of different methods on the GSM8K and FOLIO-wiki datasets, with the evaluation metric being accuracy (%). We categorized the methods into single-agent and multi-agent approaches and analyzed their performance differences. In Table 3.1, Zero-shot CoT is used as the baseline method, achieving 69.30% and 70.50% on GSM8K and FOLIO-wiki respectively, reflecting its reasoning ability without relying on context information. In contrast, Few-shot CoT introduces a few prompt examples, significantly improving reasoning performance, especially in academic reasoning tasks (GSM8K), reaching 83.20%. In the multi-agent methods, the Debate mechanism introduces two agents debating with each other, achieving 76.80% on GSM8K. Although lower than Few-shot CoT, its performance still surpasses Zero-shot CoT; however, on FOLIO-wiki, its performance is close to the baseline, possibly because debating does not provide a significant advantage in common-sense reasoning. The Ours (random) method, which does not use the blue summarizing agent and randomly assigns roles, performs relatively lower on both datasets (72.10% on GSM8K and 69.40% on FOLIO-wiki), possibly due to



the lack of an effective information integration mechanism. In contrast, Ours (with blue summarizing agent) achieves 78.50% on GSM8K and 73.00% on FOLIO-wiki, indicating that the blue agent plays a key role in integrating information and alleviating information overload, flexibly assigning different numbers and types of agent hats based on the task, which helps improve the system’s reasoning performance.

## 4.2. Experimental Questionnaire

### 4.2.1. Questionnaire Design and Objectives

To evaluate the impact of the multi-agent system on users’ task performance, cognitive expansion, information load, and trust, we designed a comprehensive questionnaire aiming to explore the following research questions:

- Does the multi-agent system enhance users’ satisfaction with task outcomes and efficiency [COI+18, KHCC10]?
- Does the system assist users in thinking from multiple perspectives, enhancing critical and creative thinking [De 85b, LL11]?
- Do users develop trust or preferences for specific agents [Lee18, HB15], particularly the management (Blue Hat) agent?
- Does information overload occur during complex discussions, affecting decision quality [Swe88, EM04]?

The questionnaire assessed users’ satisfaction, trust levels, agent preferences, and reactions to different viewpoints during the task-solving process. These insights aim to inform system optimization and enhance user experience.

### 4.2.2. Findings from the Questionnaire

The survey results highlighted significant advantages of the multi-agent system, alongside areas for improvement:

- **Enhanced Trust:** Users exhibited higher trust in the multi-agent system compared to single-agent systems, although trust levels remained below those for human experts [HB15]. While the system provided multidimensional perspectives, further enhancements are needed to strengthen user trust in its outputs.
- **Task Satisfaction and Cognitive Expansion:** Users expressed satisfaction with the system’s task performance and efficiency, noting its effectiveness in facilitating multi-perspective thinking and significantly boosting creativity [LL11]. The collaborative nature of the system was validated in expanding cognitive depth and breadth [COI+18].
- **Information Overload and the Blue Hat Agent’s Role:** Information overload was a common issue during complex discussions, particularly when numerous viewpoints were presented [EM04]. The Blue Hat Agent effectively mitigated this by

simplifying and integrating information, aiding decision-making [De 85b]. However, this also led to a tendency for users to overly rely on the Blue Hat’s summaries, potentially neglecting other agents’ insights.

- **Agent Preferences:** The management (Blue Hat) and innovation (Green Hat) agents were highly favored by users [Lee18], attributed to their assistance in task completion and provision of creative perspectives [LL11]. Conversely, despite the Black Hat Agent’s effectiveness in risk identification, users displayed lower trust and preference for its viewpoints, indicating a possible underestimation of risk assessments [HB15].

These findings suggest that while the multi-agent system enhances task satisfaction and cognitive expansion, attention must be given to managing information load and balancing agent influence to ensure equitable consideration of diverse perspectives.

## 5. Application

We demonstrate the operation of the multi-agent system through a task involving SWOT analysis and a marketing promotion plan for smart wearable devices.

### 5.1. Theme Evolution During the Discussion

In Task 2, the team conducted a SWOT analysis and developed a marketing promotion plan for smart wearable devices. We utilized Latent Dirichlet Allocation (LDA) to analyze the thematic changes in each agent’s contributions during the discussion. From Table 5.1, we observed the following patterns:

- **White Hat Agent:** Initiated the discussion with an objective overview, listing the product’s strengths and weaknesses. Keywords included *innovative design*, *limited budget*, and *brand awareness*, providing a factual foundation for the dialogue.
- **Green Hat Agent:** Proposed numerous innovative strategies, particularly regarding market opportunities and marketing methods. Keywords such as *social media*, *KOL (Key Opinion Leader) collaboration*, and *customized advertising* introduced creative thinking into the discussion.
- **Black Hat Agent:** Analyzed potential market threats and challenges from a critical perspective. Keywords like *technical barriers*, *low brand loyalty*, and *budget constraints* helped identify potential risks.
- **Yellow Hat Agent:** Offered optimistic marketing suggestions from a positive viewpoint. Keywords included *word-of-mouth marketing*, *social media promotion*, and *low-cost strategy*, emphasizing feasible actions under budget limitations.
- **Red Hat Agent:** Expressed concern for the psychological needs of young consumers on an emotional level. Keywords such as *fashion*, *personalization*, and *environmental awareness* highlighted emotional considerations in product design and marketing.

- **Blue Hat Agent:** Integrated the contributions of all agents, guiding the discussion systematically. Keywords like *management*, *summary*, and *strategy* reflected its role in maintaining focus on the SWOT analysis and promotional strategies.

Overall, the discussion progressed from outlining the product’s basic strengths and weaknesses to exploring market opportunities and potential threats, culminating in specific marketing promotion strategies. Each agent’s input at different stages facilitated a deeper and more concrete exploration of the topics.

Table 5.1: Thematic Changes During Discussion

Round	Agent (Thinking Hat)	Keywords Summary	Unique Keywords
1	Blue (Management)	thinking, emotion, analysis, yellow, black	thinking, emotion, analysis, yellow, black
	Green (Creative)	function, product, marketing, user, add	function, product, marketing, user, add
	White (Objective)	function, product, innovation, idea, user	innovation, idea
	Red (Emotional)	product, thinking, innovation, idea, discussion	discussion
	Yellow (Positive)	innovation, product, market, analysis, discussion	market
2	Black (Critical)	innovation, market, strategy, product, design	strategy, design
	Blue (Management)	thinking, innovation, emotion, objective, black	thinking, innovation, emotion, objective, black
	Green (Creative)	innovation, wristband, design, function, user	wristband
	Red (Emotional)	social, demand, product, innovation, emotion	social, demand
	Yellow (Positive)	market, product, expectation, strength, demand	expectation, strength
3	Black (Critical)	product, innovation, process, cost, design	process, cost
	White (Objective)	product, innovation, process, focus, cost	focus
	Blue (Management)	thinking, emotion, innovation, market, green	green
	Green (Creative)	product, innovation, eco-friendly, idea, collaboration	eco-friendly, collaboration
	Red (Emotional)	market, demand, product, innovation, expectation	none
4	Yellow (Positive)	market, product, demand, expectation, opportunity	opportunity
	Black (Critical)	product, innovation, market, demand, eco-friendly	none
	White (Objective)	idea, propose, product, marketing, strategy	propose
	Blue (Management)	thinking, innovation, propose, market, product	none
	Green (Creative)	product, eco-friendly, user, packaging, attract	packaging, attract
	White (Objective)	idea, marketing, product, innovation, propose	marketing
	Black (Critical)	product, innovation, thinking, market, discussion	discussion
	Red (Emotional)	market, innovation, demand, product, idea	none
	Yellow (Positive)	market, product, opportunity, expectation, strength	none

## 5.2. Emotional Dynamics During the Discussion

Analyzing the emotional tendencies of each agent’s contributions yielded the following insights:

- **Red Hat Agent:** Displayed a high level of emotional engagement, especially concerning user needs. Keywords like *emotional needs*, *fashion*, and *environmental consciousness* indicated a strong focus on the psychological requirements of the target audience. Figure 5.1 shows an upward trend in the Red Hat Agent’s emotional intensity throughout the discussion.
- **Yellow Hat Agent:** Maintained a consistently positive and optimistic emotional stance, concentrating on overcoming product limitations through innovative strategies and marketing efforts.
- **Black Hat Agent:** Exhibited a cautious emotional tendency, primarily highlighting potential risks. Negative sentiments were associated with concerns over budget and technological constraints. Figure 5.1 illustrates that the Black Hat Agent’s emotional scores remained low and negative, reflecting ongoing attention to potential challenges.

- **Green Hat Agent:** Demonstrated a neutral to positive emotional state, contributing creative ideas during discussions on innovative marketing strategies, with relatively stable emotions.

The analysis indicates that the diverse emotional perspectives provided by different agents enriched the discussion, aiding in a multifaceted evaluation of the product’s market positioning and promotional strategies.

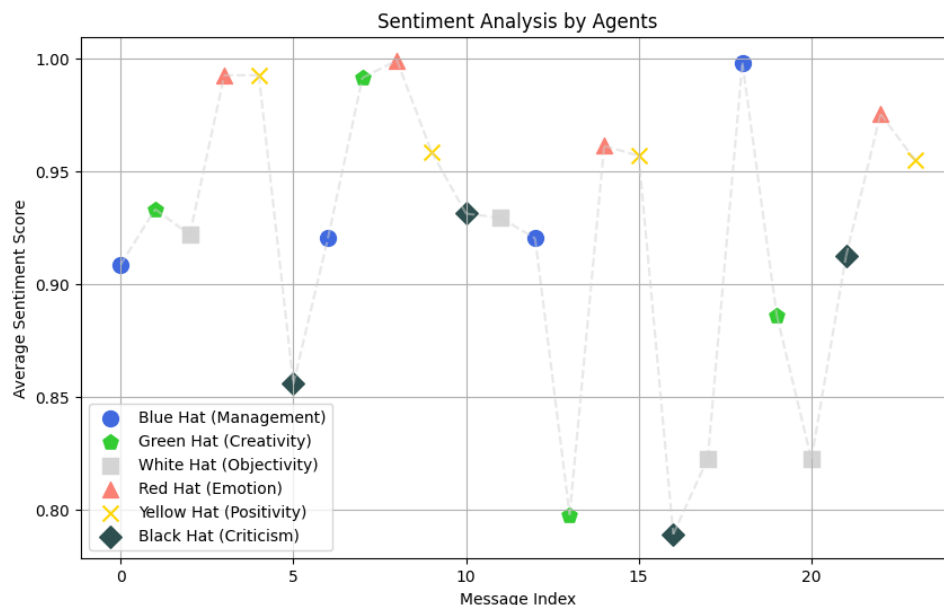


Figure 5.1: Emotional Trend Chart During the Discussion

### 5.3. Agent Contribution and Participation

We aggregated each agent’s contributions and applied LDA [BNJ03] to extract thematic keywords, thereby assessing their respective roles. By analyzing unique terms associated with each agent and referencing Figure 5.2, we found:

- **Blue Hat Agent:** Played a crucial role in managing and synthesizing the discussion. Keywords such as *strategy*, *management*, and *summary* indicate its effectiveness in coordinating the dialogue and ensuring comprehensive consideration of all viewpoints.
- **Green Hat Agent:** Contributed innovative ideas, particularly in market promotion and product design. Keywords like *customized advertising*, *KOL collaboration*, and *innovative design* highlight its creative input.
- **Black Hat Agent:** Focused on identifying potential threats and weaknesses. Keywords such as *technical barriers*, *market competition*, and *risk* reflect its critical assessment of challenges.

- **Yellow Hat Agent:** Provided practical solutions under budget constraints, injecting positive energy into the discussion. Keywords like *word-of-mouth marketing* and *low-cost social media promotion* showcase its focus on feasible strategies.
- **White Hat Agent:** Supplied objective information about the product and market at the outset, with keywords such as *innovative design*, *budget limitations*, and *market growth* establishing the discussion’s foundation.
- **Red Hat Agent:** Offered user-centered suggestions by emphasizing emotional needs and market trends. Keywords like *sense of fashion*, *personalized needs*, and *social interaction* underscore its understanding of the target demographic.

Figure 5.2 demonstrates that each agent’s unique keyword topics were concentrated and non-overlapping, indicating focused semantic contributions of role fulfillment.

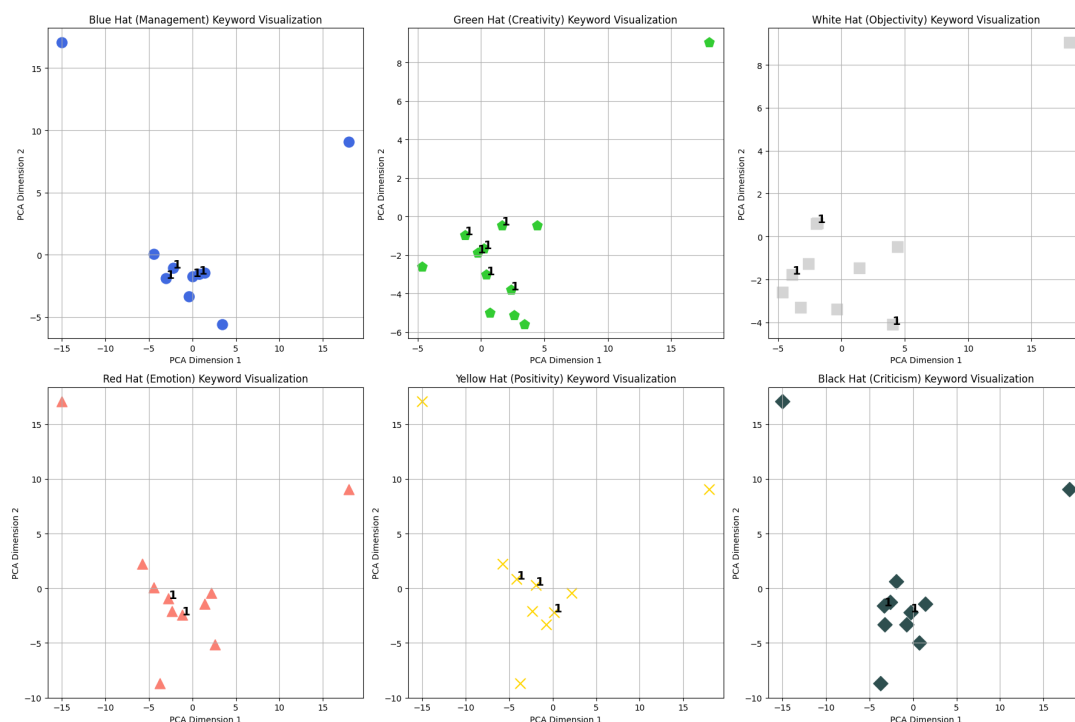


Figure 5.2: Contribution and Participation of Each Agent. Each number 1 next to the keywords refers to the unique words that appear only in that agent’s discussion, representing the contribution of that agent to the overall theme.

## 6. Conclusion

This study explores the application of large language model (LLM)-based multi-agent systems in assisting users with thinking and decision-making. Drawing on the Six Thinking Hats theory [De 85a], we designed multiple agents to represent different thinking roles, guiding users from multiple dimensions of thought and utilizing a shared vectorized knowledge base to support multi-perspective problem analysis [LPP+20]. Our empirical

findings provide support for designing more insightful and trustworthy multi-agent systems, showcasing the potential of LLM-based agents to enhance human decision-making processes. This work contributes to the development of interactive systems that not only efficiently complete tasks but also enrich the user’s cognitive experience through multi-agent collaboration.

The experimental results showed that this system significantly improved user satisfaction in terms of task completion efficiency, cognitive expansion, and creativity [LL11], while also enhancing trust in the system’s outputs [HB15]. The collaborative interaction of the multi-agent system promoted greater depth and breadth of user thinking, demonstrating the system’s effectiveness in enhancing users’ cognitive abilities [COI+18].

Despite the system’s benefits, the study found that users tended to trust the conclusions of the management (Blue Hat) agent more, potentially overlooking the perspectives of other agents—particularly the critical (Black Hat) agent whose insights are vital for risk assessment [HB15]. This preference could lead to an imbalance in absorbing diverse viewpoints during decision-making. Additionally, although the Blue Hat agent effectively alleviated information overload, users still experienced some degree of cognitive load during complex discussions [EM04]. These findings suggest that while multi-agent systems enhance users’ cognitive capabilities and task satisfaction, further optimization is needed to balance the influence of different agents and manage information load. Future work should focus on improving the integration and presentation of diverse viewpoints to prevent over-reliance on specific agents, ensuring that critical perspectives are adequately considered.

## References

- [BMR+20] T. B. Brown, B. Mann, N. Ryder, M. Subbiah, J. Kaplan, P. Dhariwal, A. Neelakantan, P. Shyam, G. Sastry, A. Askell, et al. Language models are few-shot learners. *Advances in neural information processing systems*, 33: 1877–1901, 2020.
- [BNJ03] D. M. Blei, A. Y. Ng, and M. I. Jordan. Latent dirichlet allocation. *Journal of Machine Learning Research*, 3: 993–1022, 2003.
- [BO10] B. A. Benjamin and C. A. O’Reilly. Becoming a leader: early career challenges faced by mba graduates. *Academy of Management Learning Education*, 9(4): 596–616, 2010.
- [BP05] T. Bickmore and R. W. Picard. Establishing and maintaining long-term human-computer relationships. *ACM Transactions on Computer-Human Interaction*, 12(2): 293–327, 2005.
- [COI+18] J. W. Crandall, M. Oudah, F. Ishowo-Oloko, S. Abdallah, J.-F. Bonnefon, M. Cebrian, A. Shariff, M. A. Goodrich, and I. Rahwan. Cooperating with machines. *Nature Communications*, 9(1): 233, 2018.
- [De 85a] E. De Bono. *Six Thinking Hats*. Penguin, 1985.
- [De 85b] E. De Bono. *Six Thinking Hats*. Penguin, 1985.
- [DLC99] E. H. Durfee, V. R. Lesser, and D. D. Corkill. Trends in cooperative distributed problem solving. *IEEE Transactions on Knowledge and Data Engineering*, 11(6): 705–716, 1999.
- [EM04] M. J. Eppler and J. Mengis. The concept of information overload: a review of literature from organization science, accounting, marketing, mis, and related disciplines. *The Information Society*, 20(5): 325–344, 2004.
- [HB15] K. A. Hoff and M. Bashir. Trust in automation: integrating empirical evidence on factors that influence trust. *Human Factors*, 57(3): 407–434, 2015.
- [HRSL20] L. Hofeditz, F. Roeser, M. S"ollner, and J. M. Leimeister. Perceived trustworthiness of intelligent virtual agents. *Computers in Human Behavior*, 104: 106166, 2020.
- [KHCC10] F.-Y. Kuo, G.-J. Hwang, S. Y. Chen, and J. S. Chen. Developing an intelligent agent-based system for personalized educational games. *Educational Technology Society*, 13(3): 107–123, 2010.
- [Lee18] M. K. Lee. Understanding perception of algorithmic decisions: fairness, trust, and emotion in response to algorithmic management. *Big Data Society*, 5(1): 2053951718756684, 2018.
- [LGS+23] Y. Li, J. Guo, S. Shen, M. Zhang, Z. Wang, and X. Qiu. Camel: communicative agents for “mind” exploration of large scale language model society. *arXiv preprint arXiv:2303.17760*, 2023.
- [LL11] R. B. Lewis and P. J. Lovatt. Facilitating creativity in online groups. *Computers in Human Behavior*, 27(2): 718–728, 2011.



- [LLYC21] Y. Li, Z. Liu, L. Yu, and Z. Chen. Multi-agent reinforcement learning in sequential social dilemmas. *arXiv preprint arXiv:2106.13408*, 2021.
- [LPP+20] P. Lewis, E. Perez, A. Piktus, F. Petroni, V. Karpukhin, N. Goyal, H. Kuttler, M. Lewis, W.-t. Yih, T. Rocktaschel, et al. Retrieval-augmented generation for knowledge-intensive nlp tasks. *Advances in Neural Information Processing Systems*, 33: 9459–9474, 2020.
- [Nak23] Y. Nakajima. *BabyAGI*. <https://github.com/yoheinakajima/babyagi>. 2023.
- [Ope23] OpenAI. Gpt-4 technical report. *OpenAI*, 2023.
- [PSZ+23] J. S. Park, J. C. Shi, B. D. Ziebart, E. Choi, D. Sadigh, M. Zhang, and P. Liang. Generative agents: interactive simulacra of human behavior. *arXiv preprint arXiv:2304.03442*, 2023.
- [Ric23] T. B. Richards. *AutoGPT*. <https://github.com/Torantulino/Auto-GPT>. 2023.
- [SMR23] M. Shanahan, K. McDonell, and L. Reynolds. Role play with large language models. *Nature*, 623(7987): 493–498, 2023.
- [SST+23a] T. Schick, P. Schmid, T. Thiel, D. Dohan, N. Shazeer, S. Bengio, and K. Schutt. Toolformer: language models can teach themselves to use tools. *arXiv preprint arXiv:2302.04761*, 2023.
- [SST+23b] Y. Shen, K. Song, X. Tan, D. He, W. Lu, and Y. Zhuang. Hugginggpt: solving ai tasks with chatgpt and its friends in huggingface. *arXiv preprint arXiv:2303.17580*, 2023.
- [SV00] P. Stone and M. Veloso. Multiagent systems: a survey from a machine learning perspective. *Autonomous Robots*, 8(3): 345–383, 2000.
- [Swe88] J. Sweller. Cognitive load during problem solving: effects on learning. *Cognitive Science*, 12(2): 257–285, 1988.
- [Woo09] M. Wooldridge. *An Introduction to MultiAgent Systems*. John Wiley Sons, 2009.
- [WZY+23] X. Wang, Y. Zhang, Y. Yu, Y. Wen, and H. Jin. A survey of multi-agent reinforcement learning: challenges and applications. *IEEE Transactions on Neural Networks and Learning Systems*, 2023.
- [XWC15] B. Xu, N. Wang, and N.-S. Chen. Feeling blue? go online: an empirical study of social support among patients. *Information Systems Research*, 26(3): 526–545, 2015.
- [YGTW13] S. Young, M. Gaić, B. Thomson, and J. D. Williams. Pomdp-based statistical spoken dialog systems: a review. *Proceedings of the IEEE*, 101(5): 1160–1179, 2013.

## 7. Supplementary Materials

The following section provides complete details of the experiment.

- **Sec 6.1 Overview of the Process:** A summary of each agent's specific function and role.
- **Sec 6.2 Full Process Details:** A direct presentation of each agent's specific dialogue details.

## 7.1. Summary of Each Agent's Role and Function During the Process







Question 1: "Our company is preparing to launch a new smart wearable device targeting young people aged 18 to 35. The budget is limited

1. 🟢 Blue (Management): Organizes and guides the team discussion, first proposing the use of the SWOT analysis method. Emphasizes that the White Hat will list the product's strengths and weaknesses, the Red Hat will express emotions, the Black Hat will present threats and critical opinions, and the Yellow Hat will provide constructive suggestions.
2. ⚪ White (Objective): Strengths: The company has an innovative design capability and a young team's sense of fashion, with products that are novel and focus on practical functions (e.g., health monitoring). Weaknesses: Limited budget and research resources, restricted technical capabilities, low brand awareness, and lack of marketing experience. Opportunities: Rapid growth of the smart wearable market, strong interest from young people in fashion, high demand for customization and social features, and opportunities in social media marketing. Threats: Large brands dominate the market, high technical barriers, and low brand loyalty among young consumers, making them easily attracted to new brands.
3. 🟡 Red (Emotional): Emphasizes that young users are particularly interested in personalization, fashion, and social features. The product needs to appeal to their emotional needs. It is suggested that users' expectations for eco-friendly and innovative design can drive the market, but these high expectations may also lead to significant pressure.
4. ⚫ Black (Critical): Highlights potential risks in product functionality and quality, warning that incomplete features may cause user loss. The highly competitive market and limited budget pose significant challenges for promotion.
5. 🟡 Yellow (Positive): Optimistically believes that effective social media marketing and innovative design can compensate for the limited budget. Through precise targeting of the user group and low-cost social media promotion strategies, there is a chance to break through market barriers. Suggests utilizing word-of-mouth and community marketing to attract loyal users and involve them in product promotion.

## Question 2: "Based on the SWOT analysis

1. 🟢 Blue (Management): Organizes the discussion on the marketing plan, clarifying the target market positioning and budget allocation. Suggests adopting a social media-driven promotion strategy combined with low-cost online marketing methods.
2. ⚪ White (Objective): Prioritized platforms: Recommends selecting social platforms popular among young people, such as Instagram, TikTok, and WeChat. Increasing exposure through short videos and user experiences related to the product. Budget allocation: Prioritize low-budget social media ads and partner with Key Opinion Leaders (KOLs) to post product reviews and recommendations. Maintain a steady advertising budget on trending topics and relevant areas to increase visibility.
3. 🟢 Green (Creative): Proposes collaborating with popular KOLs to post videos showcasing product features and encouraging user interaction. Suggests increasing user engagement through social media challenges and brand collaboration events. Using personalized ads to capture users' attention with tailored content.
4. 🟡 Red (Emotional): Emphasizes focusing on users' feelings during the promotion by sharing lifestyle, social features, and fashion experiences to resonate with young people's emotions. Incorporates eco-friendly, health, and personalization themes in promotional content, encouraging emotional participation and creating a sense of connection.
5. ⚫ Black (Critical): Warns that budget limitations may result in insufficient ad coverage and that social media promotion without precise targeting may not meet expectations. Recommends maintaining flexibility and avoiding over-reliance on a single platform. Also highlights potential technical challenges during promotion, particularly changes in platform algorithms that could affect exposure.
6. 🟡 Yellow (Positive): Optimistically believes that by optimizing ad strategy and employing flexible content marketing, a small budget can still yield good results. By leveraging social trends and hot topics, brand recognition can be gradually increased. Emphasizes using user-generated content and word-of-mouth to increase brand influence through cost-effective methods.

### Question 3: "To ensure the effectiveness of our marketing strategy

1.  Blue (Management): Establishes the goal of data analysis as monitoring the effectiveness of marketing activities and proposes adjusting the strategy based on actual data. Ensures that user feedback is collected in real-time during the campaign to optimize channels and content.
2.  White (Objective): Key metrics: Track ad click-through rates, conversion rates, interaction rates on social platforms (such as comments, shares, likes), user growth rate, and sales data. Regularly analyze ad performance reports to evaluate the effectiveness of ads on different platforms. Strategy adjustment: Based on changes in these metrics, determine whether to reallocate the budget to better-performing platforms or optimize ad content.
3.  Green (Creative): Suggests innovative data analysis tools such as A/B testing and user behavior prediction models. Uses AI to analyze user behavior and feedback data, predicting market trends and user preferences. Recommends tracking the full user journey from ad click to purchase to precisely adjust content and delivery methods.
4.  Red (Emotional): Emphasizes that data analysis should not only focus on numerical metrics but also consider emotional feedback and user satisfaction. Data from social media comments, reactions, and feedback can help understand the emotional response of users. User loyalty and emotional connection to the brand should also be important metrics for evaluating the success of the campaign.
5.  Black (Critical): Highlights potential issues in data analysis, such as incomplete data or sampling bias. Warns that the method of data collection may face technical limitations, leading to distorted or missing data. Suggests that relying solely on social media data may not reflect the overall market situation and advises cross-validation with other data sources.
6.  Yellow (Positive): Emphasizes that by flexibly adjusting ad placements and tracking trending topics, ad performance can be effectively improved. As data becomes more comprehensive, the marketing plan can be continuously optimized for maximum impact. Encourages using user-generated content and word-of-mouth to enhance brand awareness through lightweight user interactions.

Question 4: "Please continue with the analysis. Summarize the previous responses

1. 🟢 Blue (Management): Summarizes the previous analysis, pointing out that the current focus is how to maximize the marketing effect with a limited budget while ensuring accuracy and effectiveness in data tracking. Proposes integrating opinions from all teams to create an effective promotional plan. Suggests the new problem to be solved: How can we combine innovative design with effective marketing to ensure the successful launch of the smart wearable device?

2. Sequence of hats:

👩 Red (Emotional): First, understand the emotional needs of the target users to design more appealing promotional content.

🟡 Yellow (Positive): Adopt an optimistic and constructive attitude in formulating the marketing strategy to ensure its feasibility.

👤 White (Objective): Analyze the current market, resources, and constraints objectively to ensure the feasibility of the plan and the effectiveness of data tracking.

🖤 Black (Critical): Critically examine the risks and potential issues in the plan to avoid unnecessary mistakes.

🌱 Green (Creative): Finally, propose innovative solutions to ensure the uniqueness and appeal of both the product and the marketing plan.

## 7.2. Detailed Conversation of Each Agent

**Question 1: "Our company is preparing to launch a new smart wearable device targeting young people aged 18 to 35. The budget is limited, so I'd like to know how you would help me conduct a SWOT analysis. What are our strengths and weaknesses, and what market opportunities and potential threats exist?"**

### Blue Hat (Management)

1) Based on the historical records, we conducted a SWOT analysis of the new product. The White Hat thoroughly explained the product's strengths, weaknesses, market opportunities, and potential threats. The Red Hat expressed the team's expectations and emotions, the Black Hat raised critical opinions, and the Yellow Hat provided constructive suggestions.

2) During the analysis, we discovered that the segmentation of the target audience was not specific enough and requires further refinement. Additionally, the depth of analysis for market opportunities and potential threats was insufficient.

3) Based on the problem and the roles of the different thinking hats, I believe the appropriate order of hats should be: Green Hat (Creative), White Hat (Objective), Red Hat (Emotional), Yellow Hat (Positive), Black Hat (Critical). This order allows us to propose innovative ideas, objectively analyze the problem, express emotions and expectations, and conduct critical thinking.

4) In my proposed order, I will start with the Green Hat's creativity to generate novel ideas. Next will be the White Hat's objective analysis to understand the product's situation and limitations. Then the Red Hat will express emotions and expectations. Following that, the Yellow Hat will give constructive suggestions for specific solutions. Finally, the Black Hat will provide critical thinking to identify potential problems and challenges.

5) The final order of hats is: Green Hat (Creative), White Hat (Objective), Red Hat (Emotional), Yellow Hat (Positive), Black Hat (Critical).

### Green Hat (Creative)

Thank you very much for your suggestion, and I will continue to apply this hat order in the following discussions.

First, regarding the new product our company is launching, I believe we can innovate in the following areas:

1. Design: We can focus on the aesthetic preferences of young people to design stylish, novel, and attractive products. We could also consider collaborating with other fashion brands to increase the product's appeal.
2. Functionality: Based on young people's needs, we can develop more fun and practical features. For example, adding social functions so users can share their activity data with friends, or integrating a music feature so users can enjoy music while exercising.
3. Marketing: We can try new marketing approaches, such as leveraging short video platforms to attract more attention from young users.

These are some of my innovative ideas for the new product, and I hope they can be helpful to everyone.



#### White Hat (Objective)

Thank you for your innovative ideas. In the following discussion, I will try to analyze these ideas from an objective perspective so that we can better understand their feasibility and possible challenges.

1. Design Innovation: Designing a stylish, novel, and attractive product can attract young users, but it also increases product development costs and complexity. Additionally, collaborating with other fashion brands may bring more attention and market share, but it could also pose challenges regarding brand image and product quality.
2. Functionality Innovation: Developing fun and practical features based on young people's needs is important. For example, social features can enhance user engagement and improve the product's reputation, while a music feature can enhance the user experience and interest. However, the realization of these features requires technical support and development costs.
3. Marketing Innovation: Using short video platforms for marketing is a great idea, but it requires a certain budget and manpower. Additionally, it's important to pay attention to the competitive environment and user preferences on these platforms to promote the product effectively.

Overall, these innovative ideas have feasibility and market potential, but adjustments and optimizations will be needed during implementation. We also need to focus on the product's quality and performance to ensure its stability and reliability in the market.

#### Red Hat (Emotional)

Thank you for your ideas and suggestions. I will continue to use the Red Hat in the following discussion.

Regarding your innovative ideas, I have some emotional perspectives:

1. Design Innovation: I believe that stylish, novel, and attractive product designs can greatly stimulate young people's interest and desire to purchase. This will help us attract our target audience and improve the product's market competitiveness.
2. Functionality Innovation: I fully agree with your ideas. Fun and practical features can enhance user experience and satisfaction, thereby improving the product's reputation and loyalty. Moreover, adding social and music features can make the product more relevant to young people's lives.
3. Marketing Innovation: Short video platforms are a great choice, as young people generally enjoy using these platforms. By creating fun and creative short videos, we can let more young people know about and pay attention to our product.

Overall, I think your innovative ideas are very practical and feasible, and they can bring more market opportunities and competitive advantages for our product in actual operations.

#### Yellow Hat (Positive)

Thank you all for the discussion. I think we can summarize our discussion results as follows:

1. We conducted a SWOT analysis, clarifying our strengths, weaknesses, market opportunities, and potential threats.
2. We proposed innovative ideas regarding the design, functionality, and marketing of the new product, providing more possibilities for our product.
3. Through discussion, we realized that the implementation of innovative ideas requires attention to product quality and performance to ensure stability and reliability in the market.
4. We determined the appropriate order of hats, including the Green Hat (Creative), White Hat (Objective), Red Hat (Emotional), Yellow Hat (Positive), and Black Hat (Critical), to help us propose novel ideas, objectively analyze issues, express emotions and expectations, and conduct critical thinking effectively.

In summary, I believe our discussion has yielded positive results, providing more market opportunities and competitive advantages for our new product.

#### Black Hat (Critical)

Thank you for your summaries and emphasis. Regarding our new product, I believe we also need to consider the following aspects:

1. Product Cost: Although our design, functionality, and marketing innovations may bring more market opportunities and competitive advantages, we need to ensure that our innovations do not result in a price that is too high, which could affect our sales and market share.
2. Technical Support: Our innovations in design, functionality, and marketing require a certain degree of technical support. We need to ensure that we have sufficient technical capability and resources to support these innovations; otherwise, they may be compromised.
3. Market Acceptance: While our innovations may attract more young users, we also need to consider whether these innovations meet market demand and acceptance. We must ensure that our innovations are aligned with market trends and user preferences.
4. Risk Management: Our innovations and optimizations may introduce risks and challenges. We need to have sufficient risk management and mitigation strategies to address any potential problems and challenges.

In summary, our innovations and optimizations need to be based on our SWOT analysis of strengths, weaknesses, market opportunities, and threats. We also need to consider product cost, technical support, market acceptance, and risk management. While innovating, we must remain sensitive to market and user needs.

**Question 2: "Based on the SWOT analysis we just completed, can you help me develop a detailed marketing plan? Specifically, which social media platforms should we prioritize, how should we allocate the budget, and how can we maximize the product's exposure?"**

#### Blue Hat (Management)

1) Summary: In the previous discussion, we conducted a SWOT analysis of the new product, identifying the product's strengths, weaknesses, market opportunities, and threats. We proposed innovative ideas for product design, functionality development, and marketing strategies, while also considering costs, technical support, market acceptance, and risk management. We used various thinking hats during the discussion, including White Hat, Red Hat, Yellow Hat, Black Hat, and Green Hat.

2) Unclear Issues: We need to further clarify the needs and expectations of the target market so that we can better tailor innovations to this group. Additionally, we need to ensure the product's quality and performance to maintain stability and reliability in the market.

3) Hat Order: Based on the problem and the functions of each thinking hat, I believe the optimal order should be: Green Hat (Creative), Red Hat (Emotional), Yellow Hat (Positive), Black Hat (Critical), and White Hat (Objective). This sequence will help us propose innovative ideas, objectively analyze the problem, express emotions and expectations, and perform critical thinking.

4) Hat Order: Green Hat (Creative), Red Hat (Emotional), Yellow Hat (Positive), Black Hat (Critical), White Hat (Objective).

5) Blue Hat (Management): Based on this hat order, we can start the next discussion by applying the Green Hat for creativity to propose innovative ideas. Then, the Red Hat will express emotions to understand the team's expectations and feelings. Next, the Yellow Hat will provide constructive suggestions for solutions. Following that, the Black Hat will engage in critical thinking to identify potential issues and challenges. Finally, the White Hat will conduct an objective analysis to evaluate the product's situation and limitations.

#### Green Hat (Creative)

Thank you for your suggestions. I have noted the hat order, and I will continue to apply the Green Hat to explore creative ideas.

1. Design Innovation: We could create a product with a unique appearance and functionality. For instance, we could design a stylish smart wristband that not only offers step tracking and heart rate monitoring but also features a fashionable look that can be paired with different outfits, appealing to young people's aesthetic needs.

2. Functionality Innovation: We could design a smart wristband with social functions, allowing users to share their activity data and health status with friends, increasing the product's social appeal and attracting more young users.

3. Marketing Innovation: We can leverage social media platforms for marketing by collaborating with popular KOLs (Key Opinion Leaders) to release short videos that review and showcase the smart wristband, drawing the attention of young users.

These are some of my creative ideas for the new product, and I hope they will be helpful.

#### Red Hat (Emotional)

Thank you all for the discussion. I have some emotional perspectives from the Red Hat point of view:

First, I fully support the creative ideas everyone proposed; they are highly innovative and can attract young people's attention. For example, creating a unique product design and adding social functions can significantly enhance the product's appeal and competitiveness. I also agree with the points raised about costs, technical support, and market acceptance, which are important factors we need to consider during innovation.

Emotionally, I believe our target group —young people aged 18 to 35 —highly values personalization and fashion. Therefore, our product design should focus on fashion and personalization to meet their needs. Additionally, we need to address their social needs by incorporating social functions that make the product more socially engaging and encourage them to use and share it.

Overall, while we innovate, we must also focus on the needs and emotions of our target market to better meet their expectations.

#### Yellow Hat (Positive)

Thank you all for your ideas and discussions. I believe we have achieved some positive results. First, we have clarified our strengths, weaknesses, market opportunities, and potential threats, which provide a foundational direction and guidance for our new product. Second, we have proposed creative ideas for design, functionality development, and marketing strategies, offering more possibilities for our product. At the same time, we have acknowledged that our innovations and optimizations need to be based on an analysis of strengths, weaknesses, market opportunities, and threats, while also considering product costs, technical support, market acceptance, and risk management.

Overall, I believe our discussion has yielded positive outcomes, providing more market opportunities and competitive advantages for our new product. However, we also need to further clarify the needs and expectations of the target market to ensure that our innovations meet their requirements. Additionally, we must focus on the product's quality and performance to ensure stability and reliability in the market.

In the upcoming discussions, I hope we can continue to use the thinking hats to generate new ideas, objectively analyze problems, express emotions and expectations, and engage in critical thinking. At the same time, we need to focus on the needs and emotions of the target market to better address their expectations.

Lastly, I look forward to our new product's success, bringing more market opportunities and competitive advantages to our company.

#### Black Hat (Critical)

Thank you for the discussion. From the critical perspective of the Black Hat, I believe we need to pay more attention to the actual needs of the market when discussing our new product. While we have proposed some innovative ideas, such as eco-friendly designs, smart features, and cross-brand collaborations, these ideas may not necessarily align with the actual needs of young people. For example, they might not be particularly concerned about the product's eco-friendliness or interested in smart home integration.

Furthermore, when innovating, we must also consider the costs and technical challenges. For instance, while eco-friendly designs could add value to the product, they might also incur additional costs and complexity. Similarly, integrating the product with smart home systems requires coordination between brands regarding image and product positioning.

Therefore, when innovating, we need to carefully consider the actual market and technological conditions to ensure that our innovations are feasible and meet market needs.

At the same time, we must focus on the product's quality and performance to ensure its stability and reliability in the market. If we neglect the core product, our innovations may lose significance.

These are my critical thoughts, and I hope they will help the discussion.

#### White Hat (Objective)

Thank you all for the discussion. From an objective perspective, the innovative ideas we proposed for design, functionality, and marketing strategies indeed have potential. However, we also need to consider some potential challenges and issues.

First, regarding product design, although we proposed ideas such as eco-friendliness and smart features, we need to assess whether these elements truly meet the needs of young people. If these features are not appealing, they may negatively affect the product's market performance.

Second, regarding functionality development, we discussed cross-brand collaboration, such as with sports shoe brands. However, cross-brand partnerships require careful coordination of brand images and product positioning, and if not handled properly, it could lead to negative outcomes.

Lastly, in terms of marketing strategies, we proposed using social media platforms for promotion. However, when selecting social media platforms, we need to consider the activity levels and usage habits of our target users to enhance the effectiveness of our marketing.

In summary, while our innovative ideas show promise, we need to pay closer attention to market and user demands and address practical issues in implementation. In the next round of discussion, we can continue analyzing these ideas using different thinking hats to find the best strategy for product innovation.

**Question 4: "Please continue the analysis. Summarize the previous responses, redefine the unresolved problems, and specify the sequence of hats to be used."**

#### Blue Hat (Management)

Based on the previous discussion, we can summarize the following points:

1. The Green Hat (Creative) proposed innovative ideas for product design, such as incorporating eco-friendly elements and smart features. 2. The White Hat (Objective) provided an objective analysis of the creative ideas, focusing on feasibility, costs, and technical challenges. 3. The Black Hat (Critical) offered a critical analysis of the creative ideas, addressing market demand, costs, and technical implementation difficulties. 4. The Red Hat (Emotional) emphasized that the design should focus on fashion and personalization. 5. The Yellow Hat (Positive) highlighted the need for the product design to meet the demands of the target market. 6. The Yellow Hat (Positive) also addressed concerns regarding product quality and performance, focusing on stability and reliability in the market. 7. The Black Hat (Critical) further addressed concerns about product quality and performance, emphasizing stability and reliability in the market.

However, there are still some unresolved issues from the discussion:

1. How can we accurately understand and capture the needs and expectations of the target market? 2. How can we balance product innovation with product quality and performance?

To address these questions, we will need to further utilize the functions of the thinking hats:

1. **Red Hat (Emotional):** Express conclusions and opinions, convey emotions and intuition to better understand the needs and expectations of the target market. 2. **Yellow Hat (Positive):** Consider the problem positively, expressing optimistic and constructive viewpoints, summarizing ideas to help better balance product innovation with product quality and performance.

Based on the issues and the functions of the different thinking hats, the most reasonable sequence of hats should be:

1. Red Hat (Emotional) 2. Yellow Hat (Positive) 3. White Hat (Objective) 4. Black Hat (Critical) 5. Green Hat (Creative)

In the upcoming discussion, we will follow this sequence to continue our analysis and aim to find the best product innovation strategy.

#### Green Hat (Creative)

Thank you for the discussion. I will now continue to propose some new creative ideas from the Green Hat perspective:

1. **Sustainable Packaging:** We can design packaging using eco-friendly materials, reducing the use of plastic. The packaging can also display information about the product's lifespan and recycling instructions to enhance its eco-friendly image, appealing to environmentally-conscious young people.

2. **Customization Services:** We could offer personalized customization options, allowing users to choose the product's color and features according to their preferences, thereby meeting their individual needs.

3. **Community Engagement:** We could create an online community where users can share their fitness experiences, exchange tips, and even invite professional trainers to provide online guidance. This would enhance the product's social appeal and attract more young users to engage.

These are some of my new ideas for the product, and I hope they will be helpful.

### White Hat (Objective)

Thank you for the creative ideas. From an objective perspective, your ideas in terms of design, functionality, and marketing strategies are indeed innovative. However, we also need to pay attention to some potential challenges and issues.

First, regarding product design, although we proposed ideas such as eco-friendly elements and smart features, we need to consider whether these elements truly meet the needs of young people. If these elements do not appeal to them, it could affect the product's market performance.

Second, regarding functionality development, we suggested ideas like cross-brand collaboration with sports shoe brands. However, cross-brand partnerships require careful coordination of brand images and product positioning. If the collaboration is not managed properly, it could negatively impact the product.

Lastly, regarding marketing strategies, we proposed using social media platforms for promotion. However, when selecting social media platforms, we need to consider the activity levels and usage habits of the target audience to enhance marketing effectiveness.

In summary, while our creative ideas are innovative, we need to further consider market and user demand, as well as address practical issues in implementation. In the next discussion, we can continue analyzing these ideas from the perspectives of the different thinking hats to find the best product innovation strategy.

### Black Hat (Critical)

Black Hat (Critical):

I believe that the innovative ideas and analysis we previously proposed are valuable, but there are also some issues and limitations. First, when innovating the product, we need to pay closer attention to the market's needs and trends to ensure that our innovations align with market demand. Second, when considering product innovation, we need to carefully evaluate the costs and feasibility of technical implementation to ensure that our innovations are realistic.

Additionally, we need to consider the product's performance and quality. While product innovation is crucial for increasing value and competitiveness, if the product's performance and quality are not ensured, market performance and user experience will also suffer.

Therefore, when innovating, we need to comprehensively consider market and user demand, costs and technical feasibility, as well as product performance and quality. In the following discussion, we can continue analyzing these aspects from the perspectives of the different thinking hats to find the best product innovation strategy.

**\*\*White Hat (Objective):\*\*** Thank you for the critical thinking. From an objective perspective, your viewpoints are indeed very practical and helpful. When innovating, we certainly need to comprehensively consider market and user demand, costs and technical feasibility, as well as product performance and quality.

In the next discussion, we can continue analyzing from the different thinking hat perspectives to find the best product innovation strategy. Additionally, we could invite more team members to join the discussion to gather more opinions and suggestions.

**\*\*Yellow Hat (Positive):\*\*** Thank you all for the discussion and ideas. I believe we have already achieved some positive results, but we still need to further clarify the needs and expectations of the target market to ensure our innovations meet their expectations.

At the same time, we must also focus on product quality and performance to ensure stability and reliability in the market. While innovating, we cannot neglect the core product; otherwise, our innovations may lose their significance.

Lastly, I hope that our discussions can continue, with new ideas and suggestions emerging, so we can find the best product innovation strategy.

#### Red Hat (Emotional)

Red Hat (Emotional):

I believe the product innovation ideas proposed during the discussion are highly creative and valuable. These ideas can help us better meet the needs and expectations of our target market. Additionally, these ideas can enhance the product's value and competitiveness, providing more market opportunities and advantages for our company.

From an emotional perspective, these innovation ideas are appealing, capable of sparking enthusiasm and creativity. For example, incorporating eco-friendly elements allows us to feel a sense of social responsibility, while smart features and cross-brand collaborations give us a sense of technological and fashion appeal.

However, we must also recognize the challenges these innovation ideas may bring in terms of costs and technical implementation difficulties. Therefore, during the process of innovation and optimization, we must carefully consider these factors to ensure our innovations are feasible and meet the needs of the market and young consumers.

Overall, I believe our discussion has already yielded some positive results, providing more market opportunities and competitive advantages for our new product. However, we still need to further clarify the needs and expectations of the target market to ensure our innovations can meet their demands.

In the following discussion, I hope we can continue to use the thinking hats to propose new ideas, objectively analyze problems, express emotions and expectations, and conduct critical thinking. At the same time, we should focus on the needs and emotions of the target market to better address their expectations.

Finally, I look forward to the success of our new product, bringing more market opportunities and competitive advantages to our company.