User-Centered Design for Custom Workflow Configuration in Video Analytics Systems: A Usability and McCall Quality Evaluation

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ABSTRACT

Artificial intelligence (AI)-based video analytics systems increasingly rely on configurable workflows to manage data processing and model inference; however, many existing visual workflow and low-code approaches remain difficult for operational users due to complex interfaces and technical terminology. This study investigates how a User-Centered Design (UCD) approach can improve the usability of custom workflow configuration in video analytics environments. A node-based workflow interface was developed following a UCD process that includes context-of-use analysis, user requirement specification, iterative design, and evaluation. The usability of the proposed interface was assessed through a formative usability study using the System Usability Scale (SUS), complemented by observational findings from task-based

evaluations, whereas system behavior was examined through structured functional testing interpreted using selected attributes of the McCall quality model, focusing on usability, reliability, and correctness. The evaluation involved operational users of an industrial video analytics platform performing representative workflow configuration tasks, resulting in an average SUS score of 64, indicating acceptable but improvable usability. Further analysis shows that the proposed design supports better workflow comprehension, reduces configuration errors during task execution, and assists users in verifying workflow correctness through validation and preview mechanisms. This study contributes an evaluative perspective that connects user-centered interface design with both perceived usability and functional system behavior in configurable AI workflow systems.

Keywords-custom workflow configuration; User-Centered Design (UCD); System Usability Scale (SUS); McCall quality model; video analytics systems

I. INTRODUCTION

The rapid development of Artificial Intelligence (AI) has significantly increased the complexity of modern video analytics systems, particularly those that rely on configurable workflows to manage data acquisition, preprocessing, and model inference [1, 2]. These modular workflows provide flexibility in combining different processing components. However, configuring such workflows often requires substantial technical understanding, making them difficult for operational users to manage effectively.

To address this issue, several platforms have adopted visual workflow and low-code approaches that allow users to configure AI pipelines through graphical interfaces [3, 4]. Although these approaches reduce technical barriers, previous studies indicate that many workflow interfaces remain technically oriented, making it difficult for users to understand workflow structures, select appropriate modules, and manage configuration dependencies [3]. From a human–computer interaction perspective, interface complexity and poor interaction design can significantly affect system usability and adoption [5, 6]. In AI-enabled systems, these challenges are further amplified by limited transparency and complex configuration processes, which may reduce user trust and increase the likelihood of configuration errors [7].

User-Centered Design (UCD) has been widely applied to improve usability by incorporating user needs directly into the design process. Previous studies have demonstrated its effectiveness in systems with complex workflows, such as decision support systems and public service applications [8, 9]. However, most existing work focuses on relatively static interfaces and does not specifically address dynamically configurable AI workflow environments, where users must actively construct and modify processing pipelines.

In addition to usability considerations, evaluating software quality is essential to ensure that workflow configurations produce reliable and correct system behavior. The McCall quality model provides a structured framework for assessing software quality attributes such as usability, reliability, and correctness [10, 11]. However, the relationship between user interface design decisions and software quality attributes in configurable AI workflows remains underexplored, particularly in real-world industrial systems.

Therefore, this study investigates the use of a UCD approach to improve custom workflow configuration interfaces in video analytics systems. The proposed interface is evaluated through a formative usability study using the System Usability Scale (SUS), complemented by task-based observations, whereas system behavior is examined through structured functional testing interpreted using selected attributes of the McCall quality model.

This study contributes in three main aspects. First, it addresses workflow configuration as a user interaction problem in AI-based video analytics systems, rather than purely a technical pipeline design task. Second, it provides an integrated evaluation approach that combines usability assessment with structured functional evaluation interpreted through a software quality framework. Third, it presents an empirical case study on an industrial video analytics platform, offering practical insights into usability challenges and design considerations in configurable AI workflow environments.

II. RELATED WORK

Research on AI workflows and pipelines has primarily focused on technical aspects such as orchestration, pipeline exploration, and execution efficiency [1, 2]. For example, DSS4EX provides a decision-support framework that enables users to explore AI pipelines through a visual interface; however, the system mainly targets technically skilled users and does not explicitly address usability challenges for operational users [1]. Similarly, studies on data pipeline architectures emphasize scalability, reliability, and computational performance, whereas user interaction and interface usability receive limited attention [2].

To reduce technical barriers, low-code and no-code approaches have been introduced to support the configuration of complex systems through graphical interfaces [3]. Several visual workflow platforms demonstrate potential in improving operational efficiency by allowing users to construct pipelines without programming [4]. However, prior studies indicate that visualization alone does not guarantee improved usability if the interface design does not align with users' mental models or workflow comprehension needs [3, 6].

From a human–computer interaction perspective, UCD has been widely applied to enhance usability by incorporating user needs into the design process. Previous studies report that UCD can significantly improve usability and user acceptance in systems with complex workflows, such as clinical decision support systems and public service platforms [8, 9, 12]. Nevertheless, these studies generally focus on relatively static interaction environments and do not specifically address dynamically configurable AI workflow systems, where users must actively construct and modify workflows.

In terms of system evaluation, usability is commonly assessed using instruments such as the SUS and usability frameworks based on ISO standards [13, 14]. Meanwhile, software quality is often evaluated using models such as the McCall quality model [10, 11]. Although these approaches are well established, they are typically applied independently. The integration of usability evaluation with structured software quality assessment to analyze configurable AI workflows remains limited.

In addition, recent studies in video analytics and AI-based systems have increasingly focused on feature extraction, anomaly detection, and model performance optimization. While these works contribute significantly to improving analytical capabilities, they primarily address algorithmic performance and system accuracy, with limited emphasis on user interaction and workflow configuration usability.

Therefore, unlike previous studies that focus primarily on technical performance or isolated usability evaluation, this study addresses workflow configuration as a user interaction problem in AI-based video analytics systems. The proposed approach integrates UCD with usability evaluation using the SUS and complements it with structured functional evaluation interpreted through the McCall quality model. This integration provides a more comprehensive perspective on how interface design influences both user experience and system behavior in configurable AI workflow environments.

III. METHODOLOGY

This study is motivated by practical challenges encountered in Nedo Vision, an industrial video analytics platform used for occupational safety monitoring. In this system, users are required to configure custom workflows by combining multiple processing components, such as AI models, preprocessing steps, and conditional alert mechanisms. Although the platform provides configuration tools, users often experience difficulties in understanding workflow execution order, managing configuration parameters, and identifying dependencies between processing stages.

To address these challenges, this study investigates how a UCD approach can improve the usability of workflow configuration. The focus of this study is on the design and evaluation of the workflow configuration interface rather than the underlying AI model implementation.

A. User Centered Design Process

The design of the workflow configuration interface follows the UCD approach to ensure that the system aligns with user needs and operational contexts [8, 9]. The process consists of four main stages:

1. Understanding the context of use
2. Specifying user requirements
3. Designing the workflow interface
4. Evaluating the design against user needs

These stages guide the development of a workflow interface that is easier for users to understand and operate, as shown in Figure 1.

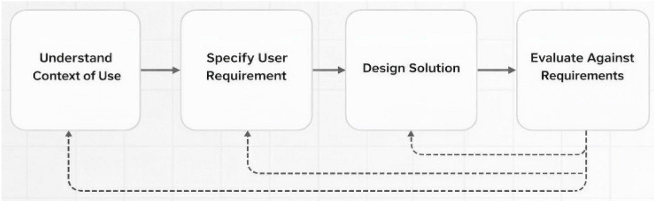

Fig. 1. UCD process applied in workflow interface development.

1) Understand Context of Use

At this stage, user characteristics and interaction contexts were analyzed. The primary users are operational staff, including AI engineers and IT engineers, who are responsible for configuring monitoring workflows. Although these users have technical backgrounds, they reported difficulties in managing complex workflows, particularly in understanding execution flow and configuration dependencies.

In the operational environment, users interact with several system features before configuring workflows. These include selecting AI models and preparing datasets using automated labeling tools. However, the main complexity arises when these components must be combined into a single workflow configuration.

To better represent user characteristics, a user persona was developed as an artifact in the UCD process. The persona represents a typical system operator responsible for configuring monitoring workflows, as shown in Table I.

TABLE I. USER PERSONA REPRESENTING OPERATIONAL WORKFLOW USERS

Attribute	Description
Persona name	Yoyo
Role	IT Engineer
Organization context	Enterprise environment (integrated monitoring system)
Experience level	More than 5 years in IT systems and video surveillance
Goal	Operational configuration of complex and flexible workflows
Need	Clear visualization of workflow structure and configuration dependencies
Main frustration	Difficulty managing complex workflow configurations through existing interfaces

2) Specify User Requirements

Based on the context-of-use analysis, several usability issues were identified in the existing workflow configuration interface. Users reported difficulties understanding workflow order, interpreting technical terminology, and managing multiple configuration parameters simultaneously.

These findings were translated into design requirements for the proposed workflow interface. The objective was to create a configuration process that is easier to understand while reducing the cognitive load experienced by users, as shown in Table II.

TABLE II. SUMMARY OF IDENTIFIED USABILITY ISSUES

Aspect	Key findings
Workflow comprehension	Users struggle to understand process order
Terminology	Technical terms confuse non-expert users
Configuration	Too many parameters in a single step

3) *Design Solution*

Based on the identified requirements, a node-based visual workflow interface was designed. The interface organizes workflow configuration into staged steps, allowing users to construct workflows gradually rather than configuring all parameters at once.

The design also includes validation mechanisms to prevent invalid configurations and workflow preview features to help users understand the expected execution process. These features aim to improve workflow comprehension and reduce configuration errors, as shown in Figure 2.

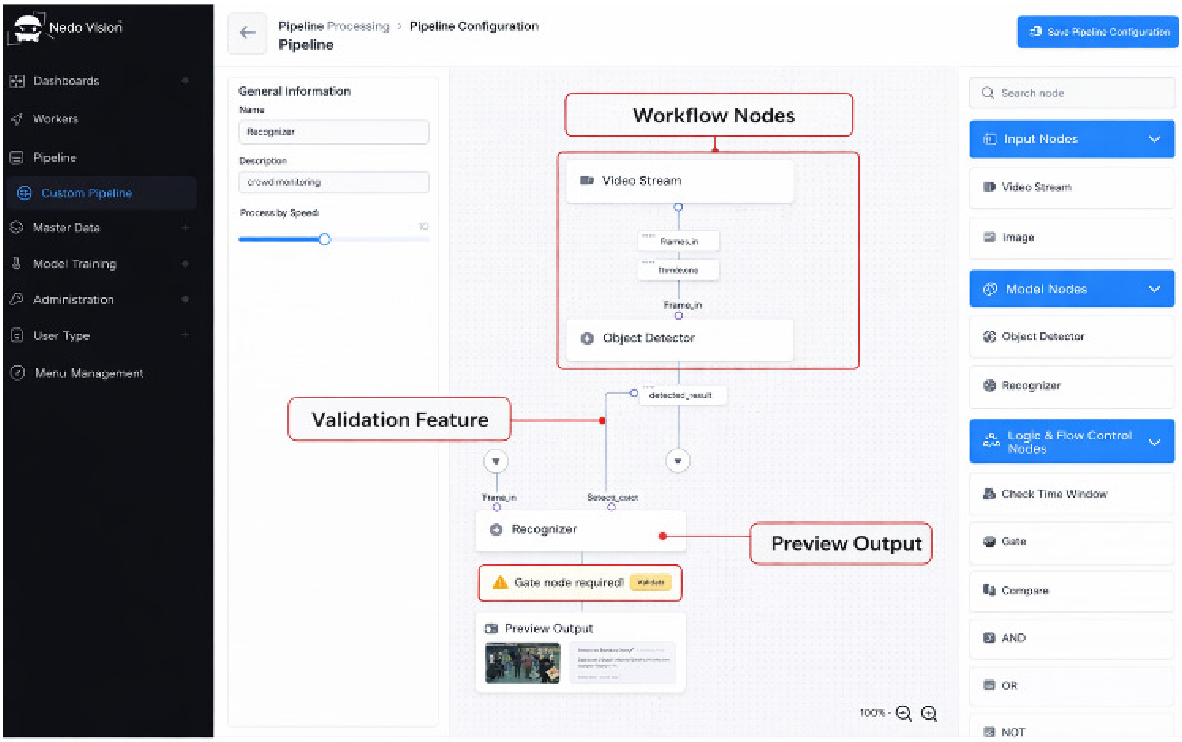

Fig. 2. Node-based custom workflow interface.

4) *Evaluate Against Requirements*

The evaluation follows a formative usability study to assess how well the proposed interface supports workflow configuration tasks. The evaluation combines subjective usability assessment with observational findings and structured functional testing.

B. *Participants and Procedure*

The evaluation involved six internal participants from PT Sindika, including AI engineers and IT engineers who regularly interact with the Nedo Vision platform. These participants represent operational users responsible for workflow configuration tasks.

In addition, early-stage requirement analysis involved external industry respondents to capture real-world needs and usage contexts.

During the evaluation session, participants were asked to perform representative tasks, including:

- configuring a custom workflow,
- selecting and integrating AI models,
- validating workflow outputs.

Each session lasted approximately 30–45 min, including task execution and questionnaire completion. Participants had prior exposure to the system environment but were not involved in the interface design process.

C. *Usability Evaluation Using System Usability Scale*

Usability was assessed using the SUS, a widely used instrument for evaluating perceived usability [13, 14]. The SUS questionnaire consists of ten items measured on a five-point Likert scale. Scores were calculated using the standard SUS formula to produce a value between 0 and 100.

The SUS results provide an indication of perceived usability and user confidence in performing workflow configuration tasks.

D. Functional Evaluation Using McCall Quality Model

To complement usability evaluation, functional testing was conducted and interpreted using selected attributes of the McCall quality model, focusing on correctness, reliability, and usability.

A total of sixteen functional test scenarios were designed, including:

- positive test cases (valid workflow execution),
- negative test cases (invalid configurations),
- repeated execution scenarios (stability testing),
- sanity checks for critical components.

Correctness was evaluated by verifying whether workflow outputs matched expected results. Reliability was assessed through system stability during repeated executions and error handling. Usability, in the context of McCall's model, was interpreted based on SUS results and observed user interaction.

Table III shows the relationships among McCall's quality attributes, the evaluated aspects, and concrete evidence of evaluation implementation in the context of a UI/UX custom workflow.

TABLE III. MAPPING OF MCCALL QUALITY ATTRIBUTES TO EVALUATION APPROACH

McCall attribute	Evaluation aspect	Evidence
Correctness	Output conformity	Workflow validation
Reliability	Stability	Repeated execution
Usability	Ease of use	SUS & observation

E. Supporting System Interface

To provide system context, two supporting interfaces are presented: AI Model Creation and Auto Labeling. These interfaces are part of the overall platform but are not included in the usability evaluation. Their inclusion aims to clarify the operational environment of the workflow configuration process.

1) AI Model Creation Interface

The Add New AI Model interface in Figure 3 allows users to upload and manage AI models that will later be used as processing components in the workflow configuration stage. The interface provides fields for defining model metadata and associating trained models with the system repository.

2) Automated Labeling Interface

The Auto Labeling interface in Figure 4 supports automated dataset annotation prior to workflow execution. Users can define labeling parameters and review generated annotations before integrating the labeled data into workflow configurations.

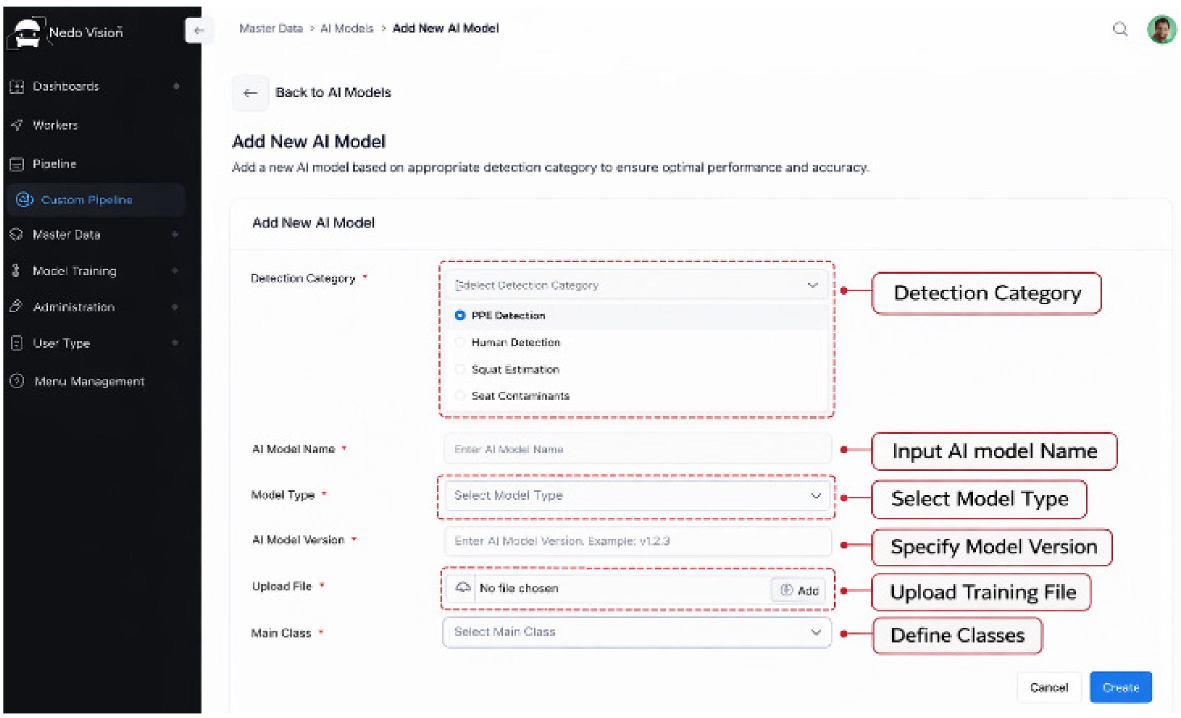

Fig. 3. AI model creation interface (supporting system).

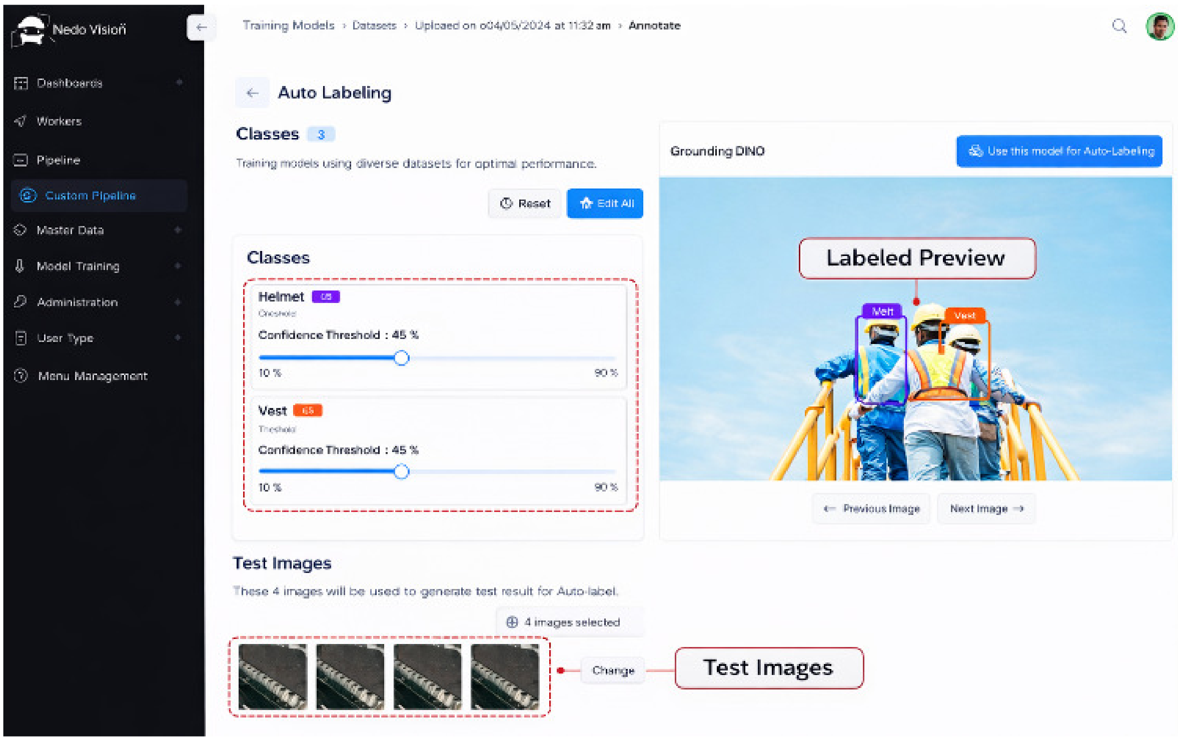

Fig. 4. Auto-labeling interface (supporting system).

This interface serves as a preparation stage for workflow execution rather than being directly involved in workflow editing.

F. Mapping User Needs to Design Decisions

The proposed interface design directly reflects the usability issues identified in earlier stages of the UCD process. Table IV summarizes the relationship between user needs and the implemented design decisions.

TABLE IV. MAPPING USER NEEDS TO DESIGN DECISIONS

User need	Design decision	UX impact
Easy-to-understand workflow	Staged visual flow	Reduced cognitive load
Error prevention	Input validation	Fewer configuration errors
Output clarity	Workflow preview	Increased user confidence

IV. RESULTS AND DISCUSSION

A. Usability Evaluation Results

The usability evaluation of the proposed workflow configuration interface involved six internal participants from PT Sindika, including AI engineers and IT engineers who regularly interact with the Nedo Vision platform. Although the participants have technical backgrounds, they were not directly involved in the design process of the proposed interface.

During the evaluation, participants were asked to perform representative workflow configuration tasks, including constructing a custom workflow, integrating AI models, and validating workflow outputs. After completing the tasks, participants filled out the SUS questionnaire to evaluate their interaction experience.

The SUS scores obtained from the respondents are summarized in Table V.

TABLE V. SUS EVALUATION RESULT

Metric	Value
Average SUS score	64
Interpretation	Marginally acceptable

The results indicate that the proposed interface achieved an average SUS score of 64. Based on standard SUS interpretation, this score falls within the marginally acceptable range and is slightly below the commonly referenced benchmark of 68. This suggests that while the interface is usable for operational users, there are still interaction challenges that affect overall usability performance.

To better understand user perception, the SUS scores were analyzed at the individual level (Table VI).

TABLE VI. SUS SCORE PER RESPONDENT

Respondent	Role	SUS score
R1	AI engineer	70.0
R2	IT engineer	65.0
R3	AI engineer	62.5
R4	IT engineer	50.0
R5	IT engineer	75.0
R6	IT engineer	62.5

The individual scores range from 50 to 75 in Table VI, indicating moderate variability in usability perception. Participants with higher scores reported that the visual workflow representation helped them understand the system structure more easily, whereas lower scores were associated with difficulties in navigating multi-step configurations and interpreting certain interaction elements.

Although the number of participants is relatively small, this study adopts a formative usability evaluation approach, where small sample sizes are commonly used to identify key usability issues in early-stage design.

B. Analysis of Usability Dimensions

To provide deeper insight, SUS responses were grouped into several usability dimensions, including learnability, perceived complexity, interaction consistency, and user confidence.

In Table VII, the analysis shows that users were generally able to understand the workflow configuration process after initial interaction, indicating acceptable learnability. However, several usability issues were identified.

TABLE VII. SUMMARY OF SUS DIMENSIONS ANALYSIS

SUS dimension	Related items	Mean range	Interpretation
Learnability	Q3, Q7, Q10	3.17–3.33	Moderately easy to learn
Complexity	Q2, Q8	2.67–2.83	Perceived as manageable
Consistency	Q5, Q6	2.17–4.00	Minor consistency issues
Confidence	Q1, Q9	3.00–3.83	Positive user confidence

First, interaction consistency issues were observed in the arrangement of configuration steps and parameter inputs, which required users to adapt repeatedly across different stages. Second, perceived complexity remained a challenge when users needed to manage multiple parameters within a single workflow configuration. These findings explain why the SUS score remains below the benchmark value.

Despite these limitations, users reported increased confidence in understanding workflow structures due to the node-based visual representation. The staged configuration approach also reduced cognitive overload compared to traditional parameter-based configuration.

C. Observational Findings from Task Execution

In addition to SUS results, observational findings during task execution provide further insight into usability performance.

During the evaluation sessions, participants demonstrated:

- fewer configuration errors after initial interaction,
- reduced trial-and-error iterations when constructing workflows,
- improved ability to interpret workflow execution through visual representation.

These observations suggest that the proposed interface supports users in understanding workflow structures and reduces common configuration mistakes, even though certain interaction aspects still require refinement.

D. Interpretation Using the McCall Quality Model

The evaluation results were further interpreted using selected attributes of the McCall quality model, focusing on usability, reliability, and correctness, as shown in Table VIII.

TABLE VIII. IMPACT OF UCD-BASED DESIGN ON MCCALL QUALITY ATTRIBUTES

Attribute	UX contribution	Interpretation
Correctness	Workflow preview & validation	Supports users in verifying output
Reliability	Input validation	Helps prevent invalid configurations
Usability	Visual workflow design	Improves comprehension

The results indicate that the proposed interface contributes to supporting software quality attributes from a user interaction perspective.

The workflow preview feature allows users to verify whether configurations produce expected outputs, thereby supporting perceived correctness. Input validation mechanisms help prevent invalid configurations, contributing to more stable system operation. Meanwhile, the node-based visual workflow and staged configuration approach improve usability by enhancing workflow comprehension.

However, it is important to note that these improvements are primarily related to user interaction and perceived system behavior, rather than direct changes to the underlying software functionality. This distinction ensures that the interpretation remains aligned with the original scope of the McCall quality model.

E. Discussion

The findings highlight that designing workflow configuration interfaces using a UCD approach can improve usability in complex AI systems. However, the results also reveal a trade-off between usability and flexibility.

While staged configuration and guided interaction simplify the system for users, they may limit flexibility for advanced users who prefer more direct configuration mechanisms. This trade-off has also been observed in previous human–computer interaction studies.

Moreover, the study relies primarily on subjective usability assessment (SUS), supported by observational findings. Objective performance metrics such as task completion time and error rate were not quantitatively measured, which limits the ability to provide a fully comprehensive usability evaluation.

In addition, video analytics systems inherently involve privacy considerations, particularly in the processing of visual data. Although this study focuses on usability aspects, future work should also consider privacy-aware interface design to ensure responsible deployment.

Furthermore, the evaluation was conducted within a specific industrial platform (Nedo Vision), which may limit the generalizability of the findings to other domains. Nevertheless, the usability issues identified, such as workflow complexity and configuration difficulty, are common challenges in AI-based systems, suggesting that the proposed design approach may still be applicable in similar contexts.

V. CONCLUSION

This study investigates the application of a User-Centered Design (UCD) approach to improve the usability of custom workflow configuration in Artificial intelligence (AI)-based video analytics systems. The proposed node-based workflow interface was designed to support users in understanding workflow structures and configuring processing pipelines more effectively.

The usability evaluation, conducted as a formative study using the System Usability Scale (SUS), resulted in an average score of 64, indicating marginally acceptable usability. Although the score is slightly below the commonly referenced benchmark, further analysis shows that the proposed design supports improved workflow comprehension, reduces configuration errors during task execution, and enhances user confidence through visual representation and validation mechanisms.

In addition to usability evaluation, the study provides an integrated perspective by interpreting user interaction findings through selected attributes of the McCall quality model. The results indicate that interface design plays an important role in supporting users in verifying workflow correctness, preventing invalid configurations, and improving interaction clarity.

This study contributes by framing workflow configuration in AI-based systems as a user interaction problem, proposing an integrated evaluation approach that combines usability and functional perspectives, and presenting an empirical case study in an industrial video analytics environment.

However, this study has several limitations. The evaluation was conducted with a small number of internal participants, which may introduce bias and limit the generalizability of the findings. In addition, the usability assessment primarily relies on subjective measures (SUS), supported by qualitative observations, without incorporating quantitative performance metrics such as task completion time or error rate. Furthermore, the study is based on a single industrial platform, which may limit applicability to other domains.

Future work will focus on conducting evaluations with a larger and more diverse group of users, including non-technical users, to better assess usability across different user profiles. In addition, future studies will incorporate objective usability metrics, such as task completion time and error rate, to provide a more comprehensive evaluation. Longitudinal studies will also be considered to examine how usability evolves over time, as well as the development of adaptive interfaces that can accommodate both novice and advanced users in configurable AI workflow systems.

DECLARATION OF COMPETING INTERESTS

The authors declare that they have no competing interests.

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DATA AVAILABILITY

The data used in this study are available from the corresponding author upon reasonable request.

AI USE AND DECLARATION OF GENERATIVE AI USE

Generative AI tools were used only for language refinement and editorial assistance during manuscript preparation. All scientific content, analysis, interpretations, and conclusions remain the responsibility of the authors.

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