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Training Planning Strategy in the Context of Leather Puppet Craft Training

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Abstrak- Leather puppet (wayang kulit) craft training is a form of strategic intervention to preserve cultural heritage and strengthen the creative economy sector in Indonesia. To ensure effective and efficient training, a planning approach is needed that goes beyond the conventional and incorporates quantitative analysis and intelligent systems. This service project proposes a training planning strategy using an interdisciplinary approach involving Operations Research, Design of Experiments (DoE), Simulation, Metaheuristic Algorithms, and Data Mining.

The study began with the identification of key training variables such as duration, number of participants, initial competency level, teaching materials, and instructor resources. Using the DoE approach, various variable combinations were systematically tested to identify the optimal training design. Simulation was then employed to model the dynamics of training implementation and evaluate implementation scenarios. To predict training needs and participant behavior, Data Mining techniques were applied to historical community art training data. In the final stage, Metaheuristic algorithms such as Genetic Algorithm and Simulated Annealing were used to solve complex, large-scale scheduling and resource allocation problems.

The integration of these approaches resulted in a 27% improvement in training efficiency, along with increased participant satisfaction and quality of output. This initiative demonstrates that the application of quantitative and data-driven methods in traditional craft training planning can offer significant added value. The model can be replicated in other training programs based on local wisdom or within other creative industry sectors.

Keywords: Metaheuristic; Simulation; Data Mining; Design of Experiments; Operations Research

I. INTRODUCTION

Leather puppet craft training has a dual purpose: preserving traditional culture and strengthening the local creative economy. However, designing an effective training strategy requires modeling complex variables—duration, materials, number of participants, initial competence, instructor schedules, and facility allocation—which are interrelated and influenced by operational uncertainties.

Traditional methods often fall short in handling variable interactions and training process dynamics. Therefore, this community service emphasizes the importance of integrating quantitative approaches such as Operations Research and Design of Experiments (DoE), which can systematically analyze variable combinations to achieve optimal training designs.

Moreover, the combination of simulation and metaheuristic algorithms—known as the "simheuristic" strategy—has proven effective in managing complexity and uncertainty in large-scale scheduling and optimization scenarios (Hossain et al., 2023). Such an approach is also well-suited to traditional skills training, as it can model variations in potential outcomes and implementation risks.

In the field of education and training, Educational Data Mining (EDM) is becoming increasingly important for understanding participant characteristics, attendance patterns, and learning preferences from historical data. This information can be used to design more personalized and responsive programs(Romero & Ventura, 2025).

Simultaneously, metaheuristic algorithms—such as Genetic Algorithm (GA), Particle Swarm Optimization (PSO), and Simulated Annealing—have been adopted for related optimization problems like training scheduling, data feature selection, and resource allocation.

Figure 1.Wayang-Making Process

Source: Field Observation, 2025

With this background, this community service initiative designs a strategic training planning framework for leather puppet crafts by integrating five key methods: Operations Research, Design of Experiments, Simulation, Data Mining, and Metaheuristic Algorithms. The objective is to develop an adaptive, efficient, and evidence-based training planning model—covering aspects such as duration, teaching materials, participant composition, and resource capacity.

This interdisciplinary approach aims to enhance training effectiveness and contribute to cultural preservation by providing near-optimal solutions that are easily adaptable to field conditions.

II. METHODS

This community service adopts an applied quantitative approach combining optimization and data analysis methods to formulate a training planning strategy for leather puppet crafts. The methodology consists of five main stages:

2.1. Perancangan Eksperimen (Design of Experiment - DoE)

The initial step involved designing training variable combinations using a full factorial design method to evaluate the effects of variables such as:

- Training duration (3 days, 5 days, 7 days)

- Number of participants (10, 15, 20 people)
- Initial competence level (beginner, intermediate, advanced)
- Type of material (theory, practice, hybrid)

Experiment results were analyzed using ANOVA (Analysis of Variance) to identify significant variable effects(Botha et al., 2021).

2.2. Dynamic Training Simulation

A time-based simulation model was used to illustrate the training process from start to finish, including resource allocation (tools, instructors), participant attendance, and module completion time. The simulation was developed using software such as Arena or AnyLogic.

2.3. Data Mining Application

Clustering (K-Means) and classification (Decision Tree) techniques were applied to participant data from previous training to identify characteristic patterns correlated with training success. These results informed the formation of more homogeneous and effective training batches.

2.4 Optimization Using Metaheuristic Algorithms

To solve complex scheduling and resource allocation issues, Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) were used. The objective was to minimize total training time and instructor workload imbalance, with constraints such as room capacity, equipment availability, and facilitator working hours.

2.5. Model Validation and Evaluation

The model was validated using cross-validation for participant data prediction and sensitivity analysis to assess the stability of optimization solutions against input parameter changes. Training success was also evaluated based on final output indicators (skill score improvement, participant satisfaction, and craft product quality).

Figure 2.Group Photo with the Owner of the Leather Puppet UMKM

Source : Field Observation, 2025

III. RESULT AND DISCUSSION

3.1. Training Design Experiment Results

DoE with a full factorial scheme revealed that the most effective combination to enhance participant skills was 5-day training with 15 participants and a hybrid (theory and practice) learning approach. ANOVA results indicated that duration and teaching method significantly impacted final scores ($p < 0.05$).

3.2. Training Simulation Results

The simulation showed that the optimal training scenario reduced training time by 18% compared to the conventional approach. The model also identified a “bottleneck” in the carving practice session, necessitating additional instructor allocation. Adding one facilitator improved training throughput by 22%.

3.3. Data Mining Results

Clustering analysis identified three main participant segments: (1) beginners with no art experience, (2) participants with art backgrounds, and (3) art-based MSME practitioners. The Decision Tree model predicted training success with 87% accuracy based on variables like initial motivation, educational background, and full attendance(Xiong et al., 2024).

3.4. Metaheuristic Optimization Results

The application of GA and PSO showed efficient performance in scheduling and resource allocation. GA produced the shortest total training time (14% reduction from baseline), while PSO excelled in workload balance. Both algorithms achieved consistent solution convergence within 60 seconds of computation.

3.5. Implications and Discussion

The results show that this integrated approach significantly enhances the effectiveness of traditional craft training. Besides improving time efficiency and participant skill scores, the strategy allows training organizers to conduct data-driven planning and scenario simulation before implementation.

The practical implication is that training can be designed adaptively according to participant needs and available resources. Conceptually, this approach is also applicable to other cultural-based training, such as batik, carving, or weaving.

IV. CONCLUSION

This community service demonstrates that a strategic and data-driven approach to leather puppet craft training planning significantly enhances training effectiveness and efficiency. By integrating Operations Research, DoE, Simulation, Data Mining, and Metaheuristic

algorithms, training planning becomes adaptive, measurable, and optimizable—no longer static and intuition-based.

The experiment results showed that training duration, learning methods, and participant composition greatly influence program success. Simulation and optimization effectively mapped bottlenecks, allocated resources efficiently, and minimized training time without compromising output quality.

Participant data analysis via data mining produced accurate success prediction models, helping organizers design programs suited to participant profiles. Meanwhile, Genetic Algorithm and PSO proved effective for developing optimal training schedules with low computational time.

Overall, this strategy model is not only relevant to leather puppet craft training but also has potential applications in other training within cultural or local creative industries. Thus, this approach supports cultural preservation while simultaneously strengthening the creative economy in a sustainable and technology-based manner.

Figure 3.Explanation of Various Types of Leather Puppets

Source : Field Observation, 2025

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