

**ANALISIS TEKNO EKONOMI DAN PERANCANGAN OPTIMALISASI SISTEM
PENGENDALIAN PROSES PADA MESIN MIXING SUSU MAKAN BERGIZI GRATIS DI
CV. CITA NASIONAL**

*(Techno-Economic Analysis and Optimization of Process Control System on Milk Mixing
Machine for Free Nutritious Meal at CV. Cita Nasional)*

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ABSTRACT

The Free Nutritious Meal (MBG) program is a national priority program requiring consistent and standardized milk product quality standards. This study aimed to develop a mathematical model of the relationship between mixture proportions and Total Solid using the Ordinary Least Squares (OLS) method, determine the optimum formula using minimize cost with Excel Solver Simplex LP, and design a Process Flow Diagram (PFD) and Ratio Control system for industrial-scale production at CV. Cita Nasional. Three mixture components were optimized: fresh milk (85–90%), ADC (9–14%), and CMC (0.5–1.5%) with Total Solid (TS) as the response variable. Modeling was performed using OLS linear regression with the LINEST function in Microsoft Excel, and statistical validation was conducted using IBM SPSS Statistics. The modeling results yielded the equation $TS = 0.071490 \times \text{Milk} + 0.502241 \times \text{ADC} + 0.348380 \times \text{CMC}$ with $R^2 = 0.970$, Adjusted $R^2 = 0.966$, and a significant F-test ($p < 0.001$). ADC had the most dominant influence on Total Solid with a coefficient of $\beta_2 = 0.502241$. The optimum formula obtained using Excel Solver Simplex LP was Fresh Milk 88.5701%, ADC 10.9299%, and CMC 0.5000%, with a predicted Total Solid of 12.00% and a raw material cost of Rp 11,632.16/L. This formula yields a cost saving of Rp 1,306.18/L compared to the maximum Total Solid formula, with a potential national-scale saving of Rp 1.86 trillion per year. The production PFD was designed using a Ratio Control system with ratio constants $K_1 = 0.123404$ for ADC and $K_2 = 0.005645$ for CMC relative to the fresh milk master stream, supplemented by an OLS-based Optimizer as supervisory control updating ratio values every 30 minutes. Investment feasibility analysis showed NPV = Rp 173,721,749, IRR = 36.67%, and Payback Period = 2.15 years. This study is limited to a composition range of fresh milk 85–90%, ADC 9–14%, and CMC 0.5–1.5% based on 16 laboratory-scale experimental runs, assuming a linear relationship among components and raw material prices during the study period; generalization beyond this range and period requires further investigation.

Keywords: *Techno-economic Analysis, Milk Mixing, Ordinary Least Squares (OLS), Process Flow Diagram, Ratio Control, Simplex LP, Total Solid*