

PROPOSED SUGAR SELF-SUFFICIENCY POLICY IN INDONESIA USING SYSTEM DYNAMIC

FINAL PROJECT

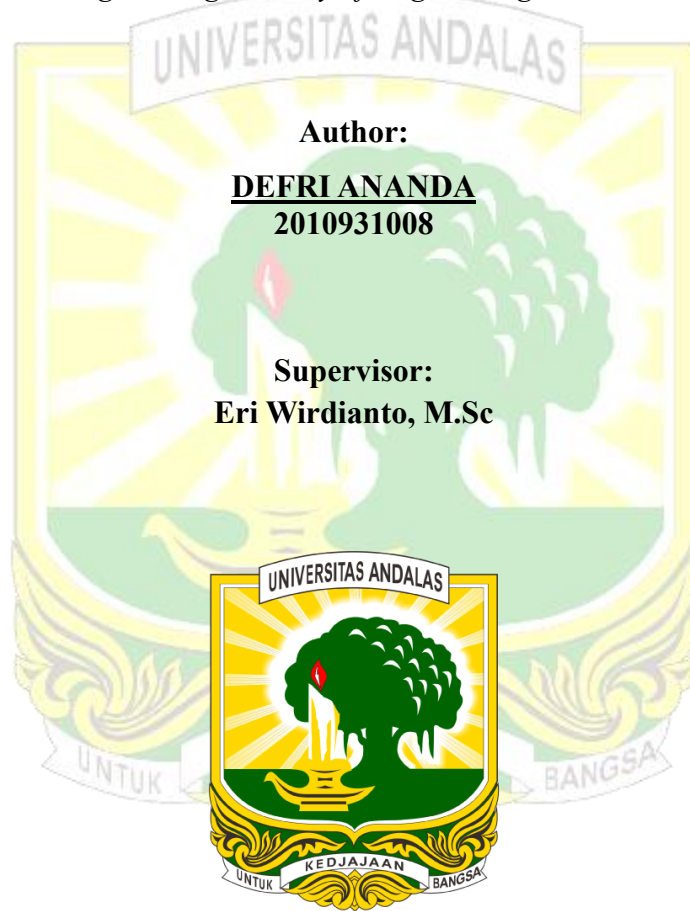


**DEPARTMENT OF INDUSTRIAL ENGINEERING
FACULTY OF ENGINEERING
UNIVERSITAS ANDALAS
PADANG
2025**

PROPOSED SUGAR SELF-SUFFICIENCY POLICY IN INDONESIA USING SYSTEM DYNAMIC

FINAL PROJECT

*As one of the requirements to complete the Bachelor's program in the Department
of Industrial Engineering, Faculty of Engineering, Universitas Andalas*



Author:

DEFRI ANANDA

2010931008

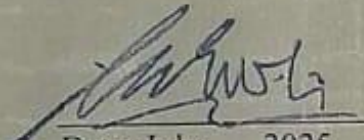
Supervisor:

Eri Wirdianto, M.Sc

**DEPARTMENT OF INDUSTRIAL ENGINEERING
FACULTY OF ENGINEERING
UNIVERSITAS ANDALAS
PADANG
2025**

APPROVAL PAGE

This final project is entitled "**Proposed Sugar Self-Sufficiency Policy in Indonesia Using System Dynamic**" written and submitted by **Defri Ananda** as one of the requirements for obtaining a degree of **Bachelor of Engineering** (Major in Industrial Engineering), has been examined and therefore recommended for approval and acceptance.

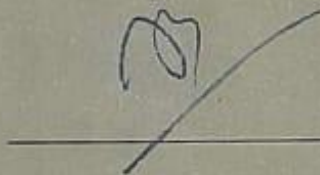

Date: July , 2025

Eri Wirdianto, M.Sc
NIP. 197309211999031001
Supervisor

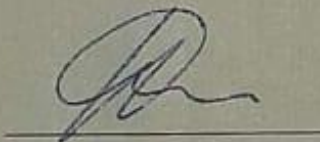
PANEL OF EXAMINER

Approved by the Committee on Final Project Examination
July 9th, 2025

Final Project Examination Date



Ir. Jonrinaldi, Ph.D., IPU., ASEAN Eng., ESLog.
NIP. 197702262006041003
Chair



Wisnel, M.Sc
NIP. 196811171997021001
Member

Accepted and approved in particular fulfilments for the degree of **Bachelor of Engineering** (Major in Industrial Engineering)

Date: July , 2025

Dr. Eng. Desto Jumenno, S.T., M.T.
NIP. 197612182001121003
Chair of Industrial Engineering Undergraduate Program

Date: July , 2025

Ir. Elita Amrina, S.T., M.Eng., Ph.D.
NIP. 197701262005012001
Chair of Industrial Engineering Department

ACKNOWLEDGEMENTS

All praise and gratitude are due to Allah SWT, whose blessings and guidance have enabled the author to complete this Final Project entitled “Proposed Sugar Self-Sufficiency Policy in Indonesia Using System Dynamic”. This Final Project fulfills one of the academic requirements for completing undergraduate studies at the Department of Industrial Engineering, Faculty of Engineering, Universitas Andalas. The successful completion of this project would not have been possible without the support and contributions of many individuals who offered encouragement, guidance, and prayers. In light of this, the author wishes to sincerely express appreciation and heartfelt thanks to:

1. Mr. Eri Wirdianto, M.Sc as the supervisor, for his valuable guidance, feedback, and continuous support throughout the preparation of this Final Project.
2. Ir. Jonrinaldi, Ph.D., IPU., ASEAN Eng., ESLog., Mr. Wisnel, M.Sc, and Mrs. Reinny Patrisina, S.T., M.T., Ph.D., as the examiners, for their insightful comments and constructive evaluations.
3. Dr. Dina Rahmayanti, S.T., M.Eng., as the academic validator, for her time and valuable input in validating the model and findings of this study.
4. Mr. Ridonald, S.E., M.Si., as the practitioner validator, for his professional insights that greatly contributed to the practical relevance of this project.
5. All individuals who have contributed to the completion of this Final Project, whose names cannot be mentioned individually.

Finally, the author hopes this Final Project will be beneficial for academic development and contribute to the design of effective policies toward achieving sugar self-sufficiency in Indonesia.

Padang, 2025

Author

ABSTRAK

Indonesia merupakan negara produsen tebu terbesar kedua di Asia Tenggara dengan total produksi mencapai 27.158.830 ton pada tahun 2023. Meskipun demikian, tingkat ketergantungan Indonesia terhadap impor gula masih sangat tinggi, yaitu antara 64,79% hingga 75,01%. Ketergantungan ini menyebabkan Indonesia rentan terhadap fluktuasi harga dan pasokan gula di pasar internasional, seperti kebijakan pembatasan ekspor dari India, kekeringan serta kebakaran lahan di Brasil, dan peningkatan harga gula global yang signifikan, terutama pada September 2024. Situasi ini menegaskan pentingnya upaya untuk mencapai swasembada gula guna menjaga ketahanan pangan nasional. Penelitian ini bertujuan untuk memberikan rekomendasi kebijakan strategis dalam rangka mencapai target swasembada gula Indonesia pada tahun 2030 melalui pendekatan sistem dinamis.

Pendekatan sistem dinamis dipilih karena mampu memodelkan sistem yang kompleks dan saling berkaitan, serta memungkinkan simulasi kebijakan dalam jangka panjang. Tahapan awal dilakukan dengan memahami sistem secara menyeluruh melalui pengembangan causal loop diagram (CLD), kemudian dilanjutkan dengan pembangunan stock flow diagram (SFD) menggunakan perangkat lunak Powersim Studio 10. Estimasi parameter model dilakukan menggunakan data sekunder dari sejumlah sumber resmi dan terpercaya yang mencakup periode 2010 hingga 2022. Proses verifikasi dilakukan untuk memastikan bahwa struktur model, konsistensi satuan, dan parameter yang digunakan telah sesuai dengan karakteristik sistem dan data historis. Validasi dilakukan baik secara matematis, menggunakan nilai koefisien determinasi (R^2) dan mean absolute percentage error (MAPE), maupun secara substantif melalui masukan dari pakar akademisi dan praktisi. Hasil simulasi current state menunjukkan bahwa nilai Self-Sufficiency Ratio (SSR) tidak pernah mencapai 80%, yang mengindikasikan bahwa Indonesia belum mampu memenuhi kebutuhan gula nasional secara mandiri.

Selanjutnya, dilakukan analisis sensitivitas terhadap tujuh variabel terkait produksi gula. Tiga variabel paling berpengaruh dipilih sebagai dasar penyusunan skenario kebijakan, yaitu peningkatan sugar content, perluasan state-owned plantation area, dan peningkatan state-owned productivity. Hasil simulasi menunjukkan bahwa kombinasi skenario peningkatan sugar content dan state-owned productivity merupakan intervensi paling efektif, dengan nilai SSR mencapai 101,66% pada tahun 2030. Peningkatan sugar content dapat dicapai melalui revitalisasi pabrik gula, sementara peningkatan produktivitas dapat dicapai melalui intensifikasi berbasis Good Agricultural Practices (GAP). Oleh karena itu, penelitian ini menyimpulkan bahwa swasembada gula dapat dicapai melalui kebijakan intensifikasi yang terfokus pada sektor perkebunan milik negara yang lebih terkendali oleh pemerintah dan revitalisasi pabrik gula yang masih menggunakan teknologi tertinggal.

Kata Kunci: Gula, Kebijakan, Rantai Pasok, Swasembada, Sistem Dinamis

ABSTRACT

Indonesia is the second-largest sugarcane producer in Southeast Asia, with a total output of 27,158,830 tons recorded in 2023. Despite this substantial production, Indonesia remains highly dependent on sugar imports, with the import ratio ranging between 64.79% and 75.01%. This heavy reliance on imports exposes the country to volatility in the global sugar market, such as India's sugar export restrictions, droughts and plantation fires in Brazil, and the significant increase in global sugar prices peaking with a 10.4% rise in September 2024. These conditions highlight the urgent need for Indonesia to achieve sugar self-sufficiency to strengthen national food security. This research is aimed at providing strategic policy recommendations to help Indonesia reach sugar self-sufficiency by 2030, using a system dynamic approach.

The system dynamic methodology is employed due to its strength in modeling complex and interconnected systems and its ability to simulate long-term policy impacts. The process begins with the development of a causal loop diagram (CLD) to understand the system structure, followed by the construction of a stock flow diagram (SFD) using Powersim Studio 10. Model parameters were estimated using secondary data obtained from various credible and official sources covering the period from 2010 to 2022. Model verification was conducted to ensure structural accuracy, dimensional consistency, and parameter reliability based on historical data. Validation was performed both quantitatively, using the coefficient of determination (R^2) and mean absolute percentage error (MAPE), and qualitatively, through expert input from academic and practitioner stakeholders. The baseline simulation (current state) showed that the Self-Sufficiency Ratio (SSR) never reached 80%, indicating Indonesia's ongoing reliance on imported sugar.

A sensitivity analysis is conducted on seven key production-related variables. The three most influential variables, sugar content, state-owned plantation area, and state-owned productivity, were selected for scenario development. Simulation results revealed that the combined scenario of increasing sugar content and state-owned productivity was the most effective intervention, raising the SSR to 101.66% by 2030. The improvement in sugar content can be achieved through sugar mill revitalization, while productivity gains can be realized through intensification strategies based on Good Agricultural Practices (GAP). Therefore, this study concludes that sugar self-sufficiency can be attained through focused intensification policies targeting state-owned plantations, which are more manageable under government control, and through the modernization of obsolete sugar milling infrastructure.

Keywords: Policy, Self-sufficiency, Sugar, Supply Chain, System Dynamic