*Journal of Quality Measurement and Analysis* *JQMA* 18(2) 2022, 13-28
*e-ISSN:* 2600-8602 *http://www.ukm.my/jqma*

# STUDY OF TRANSMISSION OF TUBERCULOSIS BY SIR MODEL USING RUNGE-KUTTA METHOD

**(**Kajian Transmisi Tuberkulosis oleh Model SIR Menggunakan Kaedah Runge-Kutta)

FARAH LIYANA AZIZAN, SARATHA SATHASIVAM*, MAJID KHAN MAJAHAR ALI, THING CHEE HONG & CLEMENT HII KIING YION

*ABSTRACT*

This project is conducted to see the prediction of the transmission of the tuberculosis disease's trend with demography and without demography. It is carried out by the SIR model with the Runge-Kutta fourth-order technique using mathematical modelling to analyse Tuberculosis transmission. Furthermore, this project examines the Tuberculosis disease prediction performance of the two SIR models by comparing the data and also to predict the future trend of Tuberculosis transmission in Malaysia in the year 2021 by calculating its incidence rate for each 100 thousand people. We discovered that combining the SIR Model with demography improves the prediction of Tuberculosis disease spread. We also discovered that the higher the transmission rate, the lower the incidence rate per 100 thousand people, and the higher the incidence rate per 100 thousand people, the lower the recovery rate. As a result, it is acceptable to argue that these variables play a significant impact in determining epidemic growth rates.

*Keywords*: Runge-Kutta; SIR model; Tuberculosis disease

*ABSTRAK*

Projek ini dijalankan untuk melihat ramalan penularan trend penyakit tuberkulosis dengan demografi dan tanpa demografi. Ia dijalankan oleh model SIR dengan teknik Runge-Kutta tahap empat menggunakan pemodelan matematik untuk menganalisis penularan Tuberkulosis. Selain itu, projek ini mengkaji prestasi ramalan penyakit tuberculosis bagi dua model SIR dengan membandingkan kedua-dua data dan juga untuk meramalkan trend masa depan penularan Tuberkulosis di Malaysia pada tahun 2021 dengan mengira kadar kejadian bagi setiap 100 ribu orang. Kami mendapati bahawa menggabungkan Model SIR dengan demografi menambahbaik ramalan penularan penyakit Tuberkulosis. Kami juga mendapati bahawa semakin tinggi kadar penularan, semakin rendah kadar penyakit setiap 100 ribu orang, dan semakin tinggi kadar penyakit setiap 100 ribu orang, semakin rendah kadar pemulihan. Kesimpulannya, pembolehubah ini memainkan kesan yang signifikan dalam menentukan kadar pertumbuhan wabak

*Kata kunci*: Runge-Kutta; model SIR; penyakit tuberkulosis

## References

Abdul Halim N. 2013. Tuberculosis model: A mathematical analysis. Masters Thesis. Universiti Malaya.

Adamu H.A., Muhammad M., Jingi A. & Usman M. 2019. Mathematical modelling using improved SIR model with more realistic assumptions. *International Journal of Engineering and Applied Sciences (IJEAS)* **6**(1): 64–69.

Bahari M.F., Utami R. & Rosyida A. 2022. SIR model for the spread of Tuberculosis in Kudus Regency. *World Scientific News* **163**: 128–138.

Becker N. 1979. The uses of epidemic models. *Biometrics* **35**(1): 295.

Churchyard G., Kim P., Shah N.S., Rustomjee R., Gandhi N., Mathema B., Dowdy D., Kasmar A. & Cardenas V. 2017. What we know about Tuberculosis transmission: An overview. *The Journal of Infectious Diseases* **216**(suppl_6): S629–S635.

Iskandar T., Chaniago N.A., Munzir S., Halfiani V. & Ramli M. 2017. Mathematical model of tuberculosis epidemic with recovery time delay. *AIP Conference Proceedings 1913(1)*, pp. 020021.

Khan M.A., Ahmad M., Ullah S., Farooq M. & Gul T. 2019. Modeling the transmission dynamics of tuberculosis in Khyber Pakhtunkhwa Pakistan. *Advances in Mechanical Engineering* **11**(6): 1687814019854835.

Kousar N., Mahmood R. & Ghalib M. 2016. A numerical study of SIR epidemic model. *International Journal of Sciences: Basic and Applied Research* **25**(2): 354–363.

Ministry of Health Malaysia. 2016. *National Strategic Plan For Tuberculosis Control*. Putrajaya: Disease Control Division, Ministry of Health Malaysia.

Ndiaye B.M., Tendeng L. & Seck D. 2020. Analysis of the COVID-19 pandemic by SIR model and machine learning technics for forecasting. *arXiv preprint arXiv: 2004.01574*.

Side S., Utami A.M. & Pratama M. I. (2018). Numerical solution of SIR model for transmission of tuberculosis by Runge-Kutta method. In *Journal of Physics: Conference Series 1040(1)*, pp. 012021.

Widyaningsih P., Nugroho A.A. & Saputro D.R.S. 2018. Susceptible infected recovered model with vaccination, immunity loss, and relapse to study tuberculosis transmission in Indonesia. *AIP Conference Proceedings 2014(1), pp. 020121*.

World Bank. 2020. Tuberculosis treatment success rate (% of new cases) - Malaysia. https://data.worldbank.org/indicator/SH.TBS.CURE.ZS?locations=MY (15 December 2021).

World Health Organization. 2021. Tuberculosis. https://www.who.int/news-room/fact-sheets/detail/tuberculosis (2 January 2022)

*School of Mathematical Sciences*
*Universiti Sains Malaysia*
*11800, USM, Penang*
*MALAYSIA*
*E-mail: afliyana@unimas.my, saratha@usm.my*, majidkhanmajaharali@usm.my, cheehong98@student.usm.my, clementhiikiingyion@student.usm.my*

*Centre for Pre-University Studies*
*Universiti Malaysia Sarawak*
*94300, Kota Samarahan, Sarawak*
*MALAYSIA*
*Email: afliyana@unimas.my*

Received: 27 January 2022
Accepted: 21 May 2022

*Corresponding author