Mikailalsys Journal of
Mathematics and Statistics

e-ISSN : 3030-816X
p-ISSN : 3030-8399

Index : Harvard, Boston, Sydney University, Dimensions, Lens, Scilit, Semantic, Google, etc

https://doi.org/10.58578/MJMS.v4i3.10202

Laplace Adomian Decomposition Method (LADM) on Approximate Solution to Fractional Order Kidnapping Dynamics

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Article Info:

Submitted:	Revised:	Accepted:	Published:
Jun 10, 2026	Aug 7, 2026	Aug 19, 2026	Aug 24, 2026

Abstract

Fractional-order modeling offers a flexible framework for representing complex kidnapping dynamics through systems of nonlinear differential equations. This study developed a fractional-order compartmental model based on the Caputo derivative and applied the Laplace–Adomian Decomposition Method (LADM) to derive approximate solutions to the resulting nonlinear system. The LADM procedure generated an infinite-series representation that converged to the exact solution of the system. Numerical simulations were subsequently performed using Maple to validate the approximate solutions across fractional-order values ranging from 0.95 to 1.00. A comparison between the fractional-order and classical models showed that the fractional formulation provides greater flexibility in representing system behavior, allowing outcomes in the different compartments to be adjusted by varying the fractional order. The study demonstrates that LADM provides a convergent and computationally effective approach for solving the proposed fractional-order kidnapping model. These findings contribute to the mathematical modeling of kidnapping dynamics by providing an adaptable analytical framework for examining variations in compartmental outcomes that may not be captured as flexibly by the corresponding classical model.

Keywords: Caputo Derivative; Fractional-Order Mathematical Model; Kidnapping Dynamics; Laplace–Adomian Decomposition Method; Nonlinear Differential Equations

Introduction

The Adomian Decomposition Method is a powerful analytical technique used to solve nonlinear differential equations, including those in fractional order models. By the decomposition complex problems into simpler sub problems. ADM facilitates the derivation of approximate solutions for both linear and nonlinear systems. The method has been successfully applied to various biological and physical systems, demonstrating its versatility and efficacy in modelling complex phenomena. Using fractional calculus and Adomian Decomposition Method has yielded significant results across different case models (wikipedia). Fractional calculus has caught the attention of many researchers due to its ability to belabor the dynamical behavior of various physical phenomena. Recent advancements in modeling infectious disease have incorporated fractional calculus to provide more accurate representation of real-world scenarios. Fractional order models, which consider memory effects and non-local interactions, have been applied to various infectious diseases, enhancing the understanding of their dynamics.

Kidnapping is a significant societal challenge with far-reaching consequences for individuals, communities, and government. Understanding the dynamics of kidnapping incidents is crucial for devising effective prevention and intervention strategic. What began as a movement in the Niger Delta to raise awareness about environmental degradation caused by oil activities aimed at drawing the attention of the Nigerian government, the international community, and oil companies, and marked by the kidnapping of foreign and local workers for ransom has now spread across the entire country, including the Federal Capital Territory (FCT), leaving no region untouched by its devastating effects on both victims and society. Kidnapping, terrorism, and banditry have become a significant threat in Nigeria, as in many other African and developing nations, spreading rapidly across every corner of the country and demanding a coordinated response from responsible individuals, groups, and the government. At the local, sub-national, and national levels, as well as through foreign missions, development agencies, and non-governmental organizations, efforts must be intensified to curb this menace in light of the grueling and traumatic experiences faced by its victims. These include, but are not limited to, ransom payments, physical harm, psychological torture, family displacements, severe economic impacts, and in extreme cases, death. Anaiyam et al (2018)

The factors fueling the rise of this 'disease,' now endemic in our society, include unemployment, underemployment, the ostentatious display of wealth by political office holders and their associates in a country with rising poverty levels, government failures to formulate and implement policies that attract investments and create jobs, widespread corruption within law enforcement agencies, and inefficiencies in the security sector, among other issues. Akpan et al (2023)

Mathematical modelling has been pivotal in understanding and learning the ways to curb kidnapping. Various models have been utilized integer-order nonlinear differential equations to stimulate the spread of kidnapping. However, the integer- order ordinary differential equations can't accurately model real-world phenomena compared with the fractional-order ordinary differential equation.

The current level of insecurity has severely ruined the country's security architecture, so more information is so needed to address the recent surge in violent criminal attacks in Nigeria. The combination of terrorist and banditry attacks in the country has not only put a significant financial strain on fiscal policy but has also compelled an increase in the amount of money the national government spends on security. Rufai (2021). Along with cattle rustling, kidnapping and kidnapping for ransom were embraced as new tactics. Many impoverished young people from many communities served as informants. Providing valuable intelligence to large financial interest. Umejei (2010). According to the statistics, Abia state sees a huge rate of kidnapping with 110 kidnapping case overall, 58,109 arrests, 41 prosecutions, and one death. Akwa Ibom registered 40 kidnapping instances, 418 arrests, 11 prosecutions, 43 release. Delta recovered 44 kidnapping case, 27 arrests, 31 prosecutions and one death. The study also stated that kidnappers stole over 600 million dollars between July and September 2008 and July 2009. Also, Zamfara over 5000 kidnapping cases were recorded. But beyond statistics being available, it is a known fact that most kidnapping cases are never reported to the police authority for fear of murdering the victims; hence, most families prefer to pay ransom to lose one of their own, Tasiu et al (2024a).

Rahman (2021) developed a Covid-19 model using Laplace Adomian Method (LADM), they study a fractional-order mathematical model describing the spread of the new coronavirus (COVID-19) under the Caputo-Fabrizio sense. Exploiting the approach of fixed point theory, we compute existence as well as uniqueness of the related solution, also Yunus (2022) used Laplace Adomian Method (LADM) formulate and analyze a model on covid 19 outbreak. The possibility of the virus reemerging in the future should not be disregarded, even if it has been confined to certain areas of the world after wreaking such havoc. This is because it is impossible to prove that the virus has been totally eliminated. This research attempts to investigate the spread and control of the COVID-19 virus in Nigeria using the Caputo fractional order derivative.

Tasiu et al (2024b) devise a model on kidnapping: Dynamics and control categorizing kidnappers according to their activities. The author use next generation matrix approach to obtain local stability. The model is divided into six compartments: susceptible individuals (S), informers (I), kidnappers (K), kidnappers soldiers (K_s), kidnappers leaders (K_L), and individuals undergoing rehabilitation (R). The model assesses control strategies by calculating the effective reproduction number. A reproduction number less than 1 indicates the potential eradication of kidnapping activities, while a higher number suggests persistence. The results reveal that eliminating as well as incarcerating kidnappers and their leaders can significantly reduce kidnapping incidents.

Kidnapping being one of the major societal problems, like banditry, cultism, violence and banditry. Mathematicians such as Adamu and Ibrahim (2020), Tasiu et al (2026) and Okoye et al. (2021) have contributed towards eradicating the problem through mathematical modeling, but non of them use Laplace Adomian Decomposition Method (LADM), hence, this work will represent a mathematical model using Laplace Adomian decomposition method and fractional calculus.

Model Formulation

The population is divided into six compartments: susceptible individuals (S(t)), Operators (O(t)), Kidnappers (K(t)), Kidnappers sponsors ($K_s(t)$), Kidnappers leaders

$K_l(t)$),, and Individuals undergoing detention (D(t)). Every compartment symbolizes a different set of individuals who play particular roles and exhibit particular behaviors associated with kidnapping.

The model incorporates various parameters, including recruitment rates (ʌ), death rates (δ), transmission rates between compartments, and probabilities of specific events such as operatives becoming kidnappers or kidnappers becoming leaders, δ is the death due to kidnappers activities, death due to torture and life jail in detention, rate at which susceptible becomes operators, rate at which operators becomes kidnappers. μ natural death rates, ψ rate at which kidnappers become kidnappers sponsors, t is the fraction at which kidnappers become leaders, (1-t) is the probability that not all kidnappers become leaders, σ rate at which all individuals fall back to K(t) from R(t), β is a rate at which kidnappers sponsors moved to detention, ∝ progression from detention back to to susceptible. τ is jail break due to kidnappers operations; . The schematic diagram is represented in Figure 1 below.

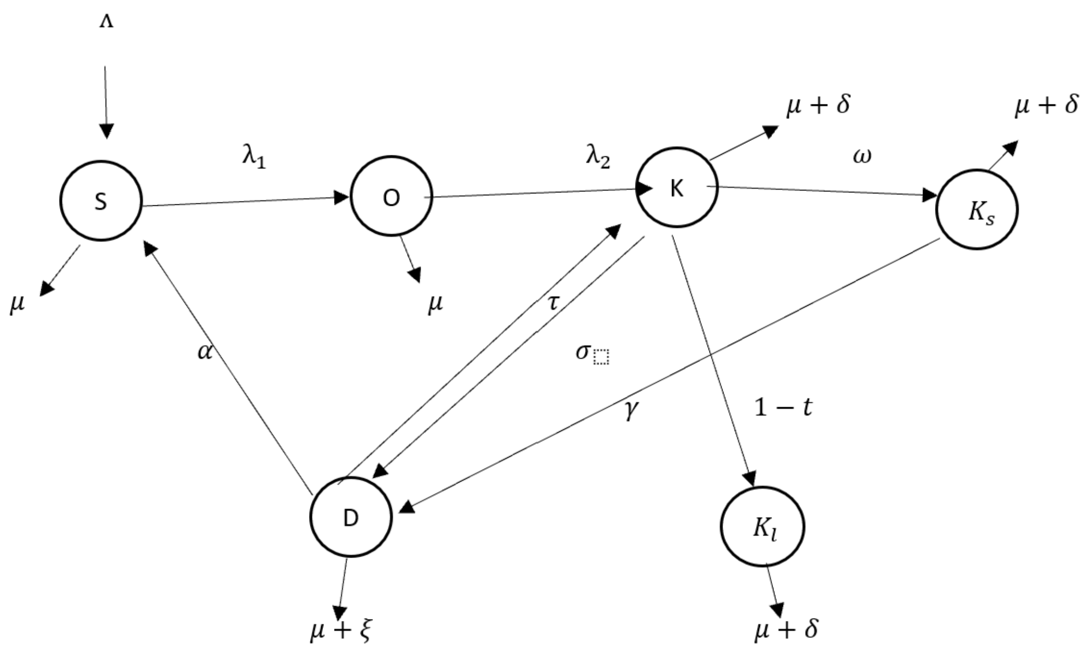

Figure 1: Schematic Diagram of the Kidnapping Network.

Description of Variable and Parameters

Table 1

Variables/parameters	Description
$S(t)$	Susceptible
$O(t)$	Operatives
$K(t)$	Kidnappers
$K_s(t)$	Kidnappers sponsors
$K_l(t)$	Kidnappers leaders
$D(t)$	Individuals undergoing Detention
Λ	Rate of recruitment per-capital (birth or immigration)
λ_1	Rate at which susceptible become Operative
λ_2	The conversion rate from Operators to kidnappers
ω	Progression rate at which individuals leave the kidnappers compartment to join kidnappers sponsor
τ	Jail break
$(1-t)$	The probability that not all individuals' kidnappers become leader.
μ	Natural death
ξ	Death due to torture and life jail in detention
δ	Death rate due to counter kidnappers' activity
α	movement from detention to susceptible
σ	Capturing of kidnappers/ taking them to detention
γ	Rate at which kidnappers' sponsors move to Detention.

Model Equation

The corresponding model representation of the schematic diagram is represented by equation (3.1) to (3.6).

$$\frac{dS}{dt} = \Lambda + \sigma R - eS - \mu S - \lambda_1 S \quad (3.1)$$

$$\frac{dO}{dt} = \lambda_1 S - \mu I - \lambda_2 O \quad (3.2)$$

$$\frac{dK}{dt} = \lambda_2 O + eS + \sigma R - \alpha R - \tau K - \omega K - (1-t)K - (\mu + \delta)K \quad (3.3)$$

$$\frac{dK_s}{dt} = \omega K - \gamma K_s - (\mu + \delta)K_s \quad (3.4)$$

$$\frac{dK_L}{dt} = (1-t)K - (\mu + \delta)K_L \quad (3.5)$$

$$\frac{dD}{dt} = \tau K + \delta K_s - \sigma D - \alpha D - (\mu + \xi)D \quad (3.6)$$

Where $\lambda_1 = \frac{\beta_1 K}{N}, \quad \lambda_2 = \frac{\beta_2 K}{N}$

We have

$$S(t) = \Lambda + \sigma R - eS - \mu S - \frac{\beta_1 K_s}{N} \quad (3.7)$$

$$O(t) = \frac{\beta_1 K}{N} - \mu I - \frac{\beta_2 K}{N} \quad (3.8)$$

$$K(t) = \frac{\beta_2 K}{N} O + eS + \sigma D + OK + \omega K - (1-t)K - (\mu + \delta)K \quad (3.9)$$

$$K_s(t) = \omega K - \gamma K_s - (\mu + \delta)K_s \quad (3.10)$$

$$K_L(t) = (1-t)K - (\mu - \delta)K_L \quad (3.11)$$

$$D(t) = \tau K + \gamma K_s - \sigma D - \alpha D - (\mu + \xi)D \quad (3.12)$$

Using Laplace

$$L(S(t) = L\{\Lambda + \sigma D - eS - \mu S - \frac{\beta_1 K_s}{N}\} \quad (3.13)$$

$$L(O(t) = L[\frac{\beta_1 K}{N} - \mu - \frac{\beta_2 K}{N}] \quad (3.14)$$

$$L(K(t) = L[\frac{\beta_2 K}{N} O + eS + \sigma R + OK + \omega K - (1-t)K - (\mu + \delta)K] \quad (3.15)$$

$$L(K_s(t) = L[\omega K - \gamma K_s - (\mu + \delta)K_s] \quad (3.16$$

$$L(K_L(t) = L[(1-t)K - (\mu - \delta)K_L] \tag{3.17}$$

$$L(D(t) = L[\tau K + \gamma K_s - \sigma D - \alpha D - (\mu + \xi)D] \tag{3.18}$$

We have the Caputo fractional order derivative of a function y to be $D^{\beta}_{0+}y(t) = \frac{1}{\Gamma(n-\beta)}\int_0^1 (t-s)^{n-\beta-1}\, y^n(s)ds.$ Where $n = [\beta] + 1$ $and\ [\beta]\ represent\ the\ integer\ part\ of\ \beta. in\ particular\ 0 < \beta < 1\ the\ fractional\ order\ derivative\ becomes\ D^{\beta}q(t) = \frac{1}{\Gamma(n-\beta)}\int_0^1 \frac{y(s)}{(t-s)^{\beta}}\, y^n(s)ds.$

Taking the Laplace of both side and the inverse we have

$$S^{-1} = \frac{1}{s}\ so\ S^B L(S(t)) = S(t)\ and\ L^{-1}\{\frac{1}{S^{\beta}+1}\} = \frac{t^{\theta}}{\Gamma(\beta+1)}$$

Therefore,

$$S(t) = \sum_{n=0}^{\infty} S_n, \quad O(t) = \sum_{n=0}^{\infty} O_n, \quad K(t) = \sum_{n=0}^{\infty} K_n, \quad K_s(t) = \sum_{n=0}^{\infty} K_{s_n},$$

$$K_L(t) = \sum_{n=0}^{\infty} K_{L_{n,}}, D(t) = \sum_{n=0}^{\infty} D_n \tag{3.19}$$

The first three polynomial are given by

$$X_0 = K_0(t), S_0(t) \tag{3.20}$$

$$X_1 = K_0(t), S_1(t) + K_1(t), S_0(t) \tag{3.21}$$

$$X_2 = K_0(t), S_2(t) + K_1(t), S_1(t) + K_2(t), S_0(t) \tag{3.22}$$

$$S_0 = n_1, O_0 = n_2, K_0 = n_3, K_{s_0} = n_4, K_{L_0} = n_5, R_0 = n_6 \tag{3.23}$$

This means

$$L(S_1) = \left[\frac{\beta_1 X_0}{N} - \Lambda + \alpha R_0 - eS_0 - \mu S_0\right]\frac{t^{\theta}}{\Gamma(\beta+1)} \tag{3.24}$$

$$L(O_1) = \left[\frac{\beta_1 X_0}{N} - \mu O_0 - \frac{\beta_2 X_0}{N}\right]\frac{t^{\theta}}{\Gamma(\beta+1)} \tag{3.25}$$

$$L(K_1) = \left[\frac{\beta_1 X_0}{N} O + eS + \sigma D + OK + \omega K - (1-t)K - (\mu+\delta)K_0\right]\frac{t^{\theta}}{\Gamma(\beta+1)} \tag{3.26}$$

$$L\left(K_{s_1}\right) = \left[\omega K_0 - \omega K_{s_0} - (\mu + \delta)K_{s_0}\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.27)$$

$$L\left(K_{L_1}\right) = \left[(1 - t)K_0 - (\mu - \delta)K_{L_0}\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.28)$$

$$L(D_1) = \left[\tau K_0 + \gamma K_{s_0} - \sigma D_0 - \alpha D_0 - (\mu + \xi)D_0\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.29)$$

Taking the Laplace of the R.H.S and inputting values we have

$$S_1 = \left[\Lambda - \frac{\beta_1 n_2 n_1}{N} + \alpha n_6 - e n_1 - \mu n_1\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.30)$$

$$O_1 = \left[\frac{\beta_1 n_3}{N} - \mu n_2 - \frac{\beta_2 n_3}{N}\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.31)$$

$$K_1 = \left[\frac{\beta_2 n_3 n_2}{N} + e n_1 + \sigma n_6 - n_2 n_3 + \omega n_3 - (1 - t)n_3 - (\mu + \delta)n_3\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.32)$$

$$K_{s_1} = \left[\,\omega \mathrm{n}_3 - \omega n_4 - (\mu + \delta)n_4\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.33)$$

$$K_{L_1} = \left[(1 - t)n_3 - (\mu - \delta)n_5\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.34)$$

$$D_1 = \left[\tau n_3 + \gamma n_4 - \sigma n_6 - \alpha n_6(\mu + \xi)n_6\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.35)$$

For

$$S_2 = \left[\frac{\beta_1 X_0}{N} - \Lambda + \alpha DD_0 - eS_0 - \mu S_0\right]\frac{t^{\theta}}{\Gamma(\beta + 1)}$$

$$S_2\Bigg[\beta n_3\left[\Lambda - \frac{\beta_1 n_2 n_1}{N} + \alpha n_6 - e n_1 - \mu n_1\right]$$

$$+ (n_1 \left[\frac{\beta_2 n_3 n_2}{N} + e n_1 + \delta n_6 + n_2 + n_3 + \omega n_3 - I - n_3\right] - (\mu + \delta)n_3 - \Lambda$$

$$+ \alpha(\tau n_3 + \delta n_4 - \sigma n_6 - \Lambda n_6 - (\mu + \xi)n_6) - e(\Lambda - \frac{\beta_1 n_2 n_1}{N} + \alpha n_6 - e n_1$$

$$- \mu n_1)\Bigg]\frac{t^{2^{\theta}}}{\Gamma(2\beta + 1)} \qquad (3.36)$$

$$O_2 = \left[\frac{\beta_1 X_1}{N} - \mu O_1 - \frac{\beta_2 K_1}{N}\right]\frac{t^{\theta}}{\Gamma(\beta+1)}$$

$$O = \left[\beta\left(n_2 - \left(\Lambda - \frac{\beta_1 n_2 n_1}{N} + \alpha n_6 - e n_1 - \mu n_1\right) + \frac{\beta_1 K_0}{N} I + eS_0 + \delta D_0 + I_0 K\right.\right.$$
$$= \xi K - (1-t)K - (\mu+\delta)K_0\Big) n_3) - \mu\frac{\beta X_0}{N}$$
$$\left. - \frac{\beta X_1}{N}\right]\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \qquad (3.37)$$

$$K_2 = (\omega K_1 - \omega k_{s_1} - (\mu+\delta)K_{s_1})\frac{t^{\theta}}{\Gamma(\beta+1)}$$

$$K_2 = \left(\omega\left(\frac{\beta_2 n_3 n_2}{N} + e n_1 + \sigma n_6 - n_2 n_3 + \psi n_4 - (1-t)n_3 - (\mu+\delta)n_3\right) - \omega(\psi\omega\right.$$
$$\left. - K_{s_0}(\mu+\delta)K_{s_0}\right) - (\mu+\delta)\omega K_0 - \omega K_{s_0}$$
$$\left. - (\mu+\delta)K_{s_0}\right)\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \qquad (3.38)$$

$$K_{s_2} = (\omega K_1 - \delta K_{s_1} - (\mu+\delta)K_{s_1})$$

$$K_{s_2} = (\omega(\frac{\beta_2 n_3 n_2}{N} + e n_1 + \sigma n_6 - n_2 n_3 + \omega n_3 - (1-t)n_3 - (\mu+\delta)n_3$$
$$- \alpha\big(\omega n_3 - \psi n_4$$
$$- (\mu+\delta)(n_3 - \omega n_4 - (\mu-\delta)n_3)\big)\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \qquad (3.39)$$

$$K_{L_2} = (1-t)K_1 - (\mu-\delta)K_{L_1}$$

$$K_{L_2} = (1-t)\left[\frac{\beta_2 n_3 n_2}{N} + e n_1 + \sigma n_6 - n_2 n_3 + \omega n_3 - (1-t)n_3 - (\mu+\delta)n_3\right.$$
$$\left. - (\mu-\delta)\big((1-t)n_3 - \mu - \delta\big)n_5\right]\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \qquad (3.40)$$

$$D_2 = \left[\tau K_1 + \gamma K_{s_1} - \sigma D_1 - \alpha D_1 - (\mu+\xi)D_1\right]\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \qquad (3.41)$$

Where

$$S_{n+1} = \left[\frac{\beta_1 X_n}{N} - \Lambda + \alpha D_n - eS_n - \mu S_n\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.42)$$

$$O_{n+1} = \left[\frac{\beta_1 X_n}{N} - \mu O_n - \frac{\beta_2 X_n}{N}\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.43)$$

$$K_{n+1} = \left[\frac{\beta_1 X_n}{N} O + eS + \sigma R + OK + \psi K - (1 - t)K - (\mu + \delta)K_n\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.44)$$

$$K_{s_{n+1}} = \left[\omega K_n - \omega K_{s_n} - (\mu + \delta)K_{s_n}\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.44)$$

$$K_{L_{n+1}} = \left[(1 - t)K_n - (\mu - \delta)K_{L_n}\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.46)$$

$$D_{n+1} = \left[\tau K_n + \gamma K_{s_n} - \sigma D_n - \alpha D_n - (\mu + \xi)D_n\right]\frac{t^{\theta}}{\Gamma(\beta + 1)} \qquad (3.47)$$

$where, n_1 = 20{,}000,\ n_2 = 2000, \quad n_3 = 300, \quad n_4 = 1200, \quad n_5 = 1\ n_6 = 1000,$

$$\Lambda = \frac{1}{18250}, \quad \lambda_1 = 0.4,\ \lambda_2 = 0.6, \quad \beta = 0.4, \quad \xi = 0.035,$$

$$\tau = \frac{16}{30}, \quad \gamma = \frac{1}{7}, \quad \sigma = 0.09, \quad \delta = \frac{35}{1000}, \quad \alpha = \frac{13}{37500},$$

$$\mu = \frac{1}{60X35}, \quad N = -2.375, \quad \omega = 0.8$$

The Laplace -Adomian decomposition Method (LADM) gives the approximate solution in terms of an infinite series presented as follows;

$$S(t) = S_0 + S_1 + S_2 \ldots S_n \qquad (3.48)$$

$$O(t) = O_0 + O_1 + O_2 \ldots O_n \qquad (3.49)$$

$$K(t) = K_0 + K_1 + K_2 \ldots K_n \qquad (3.50)$$

$$K_s(t) = K_{s_0} + K_{s_1} + K_{s_2} \ldots K_{s_n} \qquad (3.51)$$

$$K_L(t) = K_{L_0} + K_{L_1} + K_{L_2} \ldots K_{L_n} \qquad (3.52)$$

$$D(t) = D_0 + D_1 + D_2 \ldots D_n \qquad (3.53)$$

Substituting the value, we have

$$S(t) = S_0 + S_1 + S_2 \dots S_n$$

$$S(t) = 20{,}000 - 6725\frac{t^{\theta}}{\Gamma(\beta+1)} + 700968160\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \quad (3.54)$$

$$O(t) = O_0 + O_1 + O_2 \dots O_n$$

$$O(t) = 2000 - 121727\frac{t^{\theta}}{\Gamma(\beta+1)} + 1.244410^{28}\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \quad (3.55)$$

$$K(t) = K_0 + K_1 + K_2 \dots K_n$$

$$K(t) = 300 + (3092010)\frac{t^{\theta}}{\Gamma(\beta+1)} + 3.04X10^{12}\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \quad (3.56)$$

$$K_s(t) = K_{s_0} + K_{s_1} + K_{s_2} \dots K_{s_n}$$

$$K_s(t) = 1200 - 900077342\frac{t^{\theta}}{\Gamma(\beta+1)} + 3.627X10^{10}\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \quad (3.57)$$

$$K_L(t) = K_{L_0} + K_{L_1} + K_{L_2} \dots K_{L_n}$$

$$K_L(t) = 1 - 165.1\frac{t^{\theta}}{\Gamma(\beta+1)} + 30408368\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \quad (3.58)$$

$$D(t) = D_0 + D_1 + D_2 \dots D_n$$

$$D(t) = 1000 + 238.410\frac{t^{\theta}}{\Gamma(\beta+1)} + 67.3374\frac{t^{2^{\theta}}}{\Gamma(2\beta+1)} \quad (3.59)$$

Table 2 Parameter of the Variables

S/N	Variables	Hypothetical values	Source
1	S	300000	Tasiu et al (2024a)
2	O	700000	Tasiu et al (2024a)
3	K	1500000	Tasiu et al (2024a)
4	K_s	20000	Tasiu et al (2024a)
5	K_L	5000	Tasiu et al (2024a)
6	D	30000	Tasiu et al (2024a)

Table 3

S/N	Parameters	Parameter Value	Source
1	Λ	$\frac{1}{18250}$	Benjamin et al 2024
2	λ_1	0.4	Benjamin et al 2024
3	λ_2	0.6	Benjamin et al 2024
4	μ	0.017	Benjamin et al 2024
5	β	0.4	Benjamin et al 2024
6	ξ	0.0035	Benjamin et al 2024
7	σ	0.09	Benjamin et al 2024
8	N	-2.375	Calculated
9	ω	0.0008	Benjamin et al 2024
10	n_1	20,000	Benjamin et al 2024
11	n_2	2000	Benjamin et al 2024
12	n_3	300	Benjamin et al 2024
13	n_4	1200	Benjamin et al 2024
14	n_5	1	Benjamin et al 2024
15	n_6	1000	Benjamin et al 2024
16	γ	$\frac{1}{7}$	Benjamin et al 2024
17	α	$\frac{13}{37500}$	Benjamin et al 2024
18	θ	0-1	Controls
19	τ	0.0007	Benjamin et al 2024

Results and Discussion

The simulation of the fractional order was carried out with a view to make a classical integer order comparism

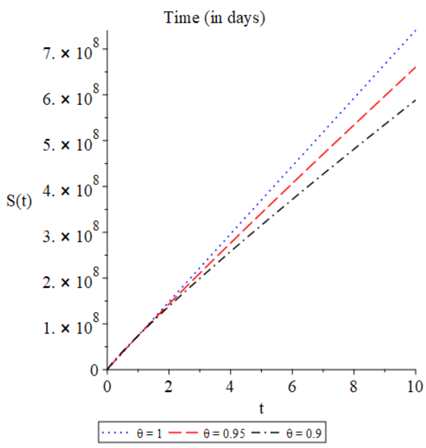

Fig 2. The graph of the susceptible individual with variation in θ.

Fig 2. shows the graph of susceptible individuals while varying in θ, and it is observed that as the order of the fractional derivative θ is increasing the, number of the susceptible individuals to kidnapping increases.

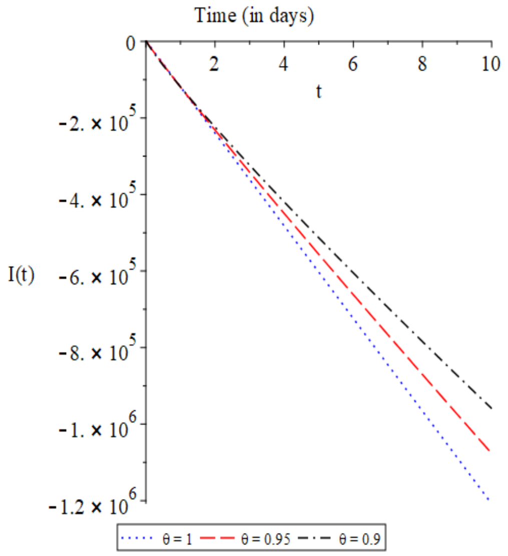

Fig 3. The graph of the operators with variation in θ.

Fig 3. Depicts the graph of operators while varying in θ and it was observed that as the order of the fractional derivatives θ increases, the number of the operators decreases.

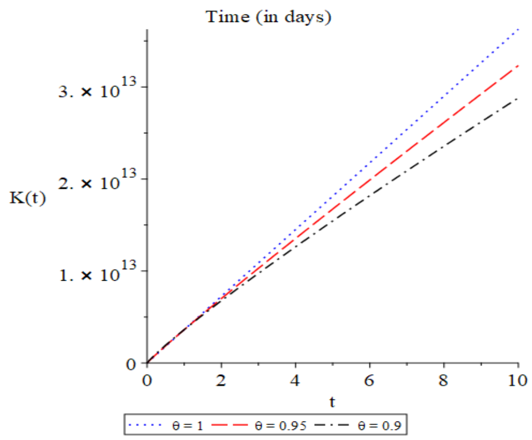

Fig 4. graph of the Kidnappers with variation in θ.

Fig 4. Shows the graph of the kidnappers while varying in θ, and it was observed that as the order of the fractional derivatives increases, the number of kidnappers increases.

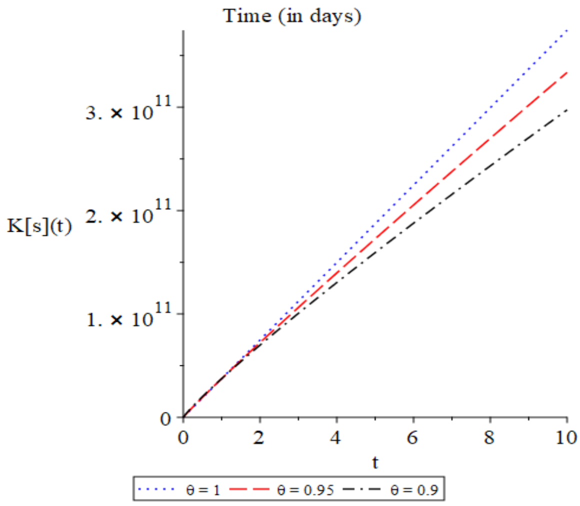

Fig 5. Graph of Kidnappers sponsors with variation in θ.

Fig 5. Depicts the graph of Kidnappers Sponsors with variation in θ, It is observed that as the order of the fractional derivatives increases the number of the kidnapper sponsor increases.

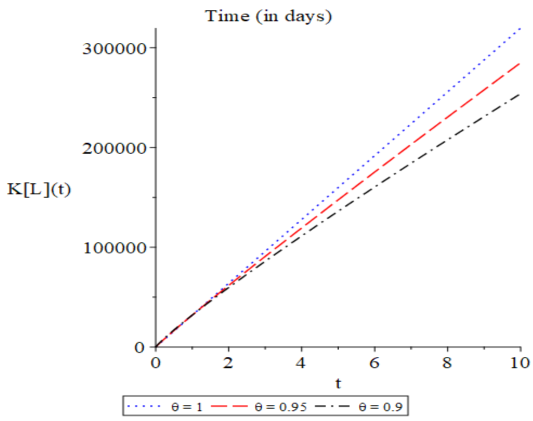

Fig 6. The graph of kidnapper Leader with variation in θ.

Fig 6. Depicts the graph of Kidnapper Leader varying in V θ, it is observed that as the order of the Fractional derivatives increases, the number of the Kidnapper Leader increases.

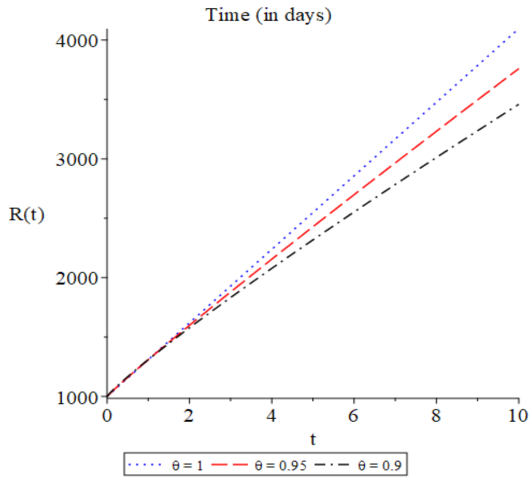

Fig 7. The graph of individuals under detention with variation in θ.

Fig 7. Depicts the simulation of individuals under detention varying in θ, it is observed that as the order of the fractional derivatives increases the number of individuals under detention increases.

Conclusion

This work provided clear understanding of the concept of kidnapping and kidnappers activities. Some social problems have been highlighted by many researchers such as cultism, corruption and terrorism however, Laplace adomian decomposition method have been used. the result of this work can further be extended to other social problems and infectious disease. Therefore, plans will be made to incorporate other variables and parameters.

Recommendation

1. It is impossible to vanquish kidnappers group without reducing the strength of their suppliers

2. Security personnel should increase their operations to all affected areas

3. Government and non-govermental organizations should implement a policy that will support youth with skills and acquisitions to prevent them from joining kidnapping groups.

Conflict of interest: I assured that there is no any conflict of interest

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