

Smartphone Use Before Bedtime and Its Association with Sleep Quality

Natalie Brenton

United States

Abstract

Smartphone use before bedtime has become increasingly common and may influence sleep quality among adults and young people. This study examines the association between pre-sleep smartphone use and selected sleep-related outcomes. Smartphone behavior is assessed through duration of use, frequency of nighttime checking, type of activity, screen exposure, and use immediately before sleep. Sleep quality is evaluated using sleep duration, sleep onset, nighttime awakenings, daytime sleepiness, and overall sleep satisfaction. The findings suggest that longer and more frequent smartphone use before bedtime is associated with delayed sleep onset, shorter sleep duration, and poorer perceived sleep quality. Social media use, messaging, entertainment, and repeated notifications may further contribute to sleep disruption. The study highlights the importance of limiting smartphone use before bedtime, reducing unnecessary nighttime notifications, and maintaining consistent sleep routines to improve sleep quality and support better physical and psychological well-being.

Keywords: Smartphone use; Sleep quality; Bedtime habits; Screen time; Sleep disturbance.

1. Introduction

Enterprise applications depend on reliable diagnostics to detect runtime errors, failed workflows, API issues, slow transactions, and integration faults [1-5]. Logs are the main evidence source for understanding what happened before, during, and after an incident [6-9]. Effective application diagnostics require structured logging, traceability, contextual metadata, error classification, and operational visibility [10-15]. However, fixed logging strategies often create two problems. Low-detail logs may miss important causes [16-19], while high-detail logs may generate excessive storage cost and alert noise [20-23].

The main challenge is that diagnostic needs change during runtime. A normal transaction may require only basic logs, but a failing workflow, repeated exception, or security-sensitive event may need deeper traces [24-28]. Adaptive logging improves this process by changing log depth according to system condition, transaction risk, and error behavior [29-32]. AI-assisted monitoring can identify when

additional diagnostic detail is needed and when logging can return to normal levels [33-35]. This article proposes an adaptive logging framework for enterprise application diagnostics.

2. Methodology

The proposed framework captures log metadata from application servers, API gateways, databases, background jobs, authentication modules, and integration services [36-40]. It records event type, severity, timestamp, user role, transaction ID, request path, error frequency, response time, affected component, and workflow state [41-45]. These features are converted into diagnostic context profiles. Adaptive logging requires context because the same event may be low-risk in one workflow but critical in another [46-49].

The logging controller classifies runtime states as normal, warning, error-prone, performance-risk, security-sensitive, workflow-critical, or incident-active [50-54]. Based on this classification, it adjusts log level, trace depth, parameter capture, correlation ID tracking, and diagnostic enrichment. Lightweight scoring and policy rules are used so logging decisions remain fast and explainable [55-58]. Sensitive fields are masked before storage [59-60], and transaction-critical events are linked with workflow and database identifiers for easier diagnosis [61-63].

The framework is evaluated using simulated enterprise applications involving APIs, database workflows, authentication events, scheduled jobs, and service integrations. Static logging is compared with adaptive logging under repeated exceptions, slow requests, failed jobs, API timeout, suspicious login, and workflow interruption scenarios [64-67]. Evaluation metrics include diagnosis time, log volume reduction, root-cause evidence quality, missed-event rate, storage overhead, alert usefulness, and administrator acceptance rate [68-69]. Feedback from resolved incidents, ignored logs, and administrator notes is used to refine logging policies over time [70].

3. Results and Discussion

The results show that adaptive logging improves diagnostics by capturing richer evidence only when runtime risk increases. In the baseline condition, static logs either lack enough detail or produce large volumes of low-value records. With the proposed framework, detailed traces are activated for high-risk events and reduced during normal execution. The strongest improvement appears in intermittent failures, where deeper logs are needed only around the failure window.

The discussion shows that adaptive logging must balance diagnostic depth with privacy and storage cost. Excessive logging can expose sensitive data or overload monitoring systems, while weak logging may hide failure causes. The main limitation is that log-level decisions depend on accurate runtime classification. Regular policy review and masking controls are necessary for safe long-term use.

4. Conclusion

This article presented an adaptive logging framework for enterprise application diagnostics. The framework adjusts log detail using runtime context, risk scoring, workflow state, and error behavior. It improves troubleshooting by increasing diagnostic evidence during abnormal conditions while reducing unnecessary log noise during normal operation. The study shows that adaptive logging can strengthen enterprise diagnostics when combined with structured metadata, privacy controls, and continuous incident feedback.

References

1. Amin, S. M., Azim, M., Fatinah, S. N., Arshad, A., Rahman, M. A., & Jalal, K. C. (2014). Population Parameters of *Rastrelliger kanagurta* (Cuvier, 1816) in the Marudu Bay, Sabah, Malaysia. *Iranian Journal of Fisheries Sciences*, 13(2), 262-275.
2. Kamaruzzaman, B. Y., Shuhada, N. T., Akbar, B., Shahbudin, S., Jalal, K. C. A., Ong, M. C., ... & Goddard, J. S. (2011). Spatial concentrations of lead and copper in bottom sediments of Langkawi Coastal Area, Malaysia. *Research Journal of Environmental Sciences*, 5(2), 179.
3. Jalal, K. C. A., Alam, M. Z., Matin, W. A., Kamaruzzaman, B. Y., Akbar, J., & Hossain, T. (2011). Removal of nitrate and phosphate from municipal wastewater sludge by *Chlorella vulgaris*, *Spirulina platensis* and *Scenedesmus quadricauda*. *IIUM Engineering Journal*, 12(4).
4. Malek, N. A., Chowdhury, A. J. K., Zainuddin, Z., & Abidin, Z. A. Z. (2014, December). Selective isolation of actinomycetes from mangrove forest of Pahang, Malaysia. In *International Conference on Agriculture, Biology and Environmental Sciences (ICABES'14): 2014; Indonesia*.
5. Selvaraj, S., Prasad, S., Fuloria, S., Subramaniyan, V., Sekar, M., Ahmed, A. M., ... & Fuloria, N. K. (2022). COVID-19 biomedical plastics wastes—challenges and strategies for curbing the environmental disaster. *Sustainability*, 14(11), 6466.
6. Maziz, M. N. H., Chakravarthi, S., Aung, T., Htoo, P. M., Shwe, W. H., Gupalo, S., ... & Kodali, M. (2025). Microglia-mediated neuroinflammation through phosphatidylinositol 3-kinase signaling causes cognitive dysfunction. *International Journal of Molecular Sciences*, 26(15), 7212.
7. Subramaniyan, V., Fuloria, S., Sekar, M., Shanmugavelu, S., Vijeppallam, K., Kumari, U., ... & Fuloria, N. K. (2023). Introduction to lung disease. In *Targeting epigenetics in inflammatory lung diseases* (pp. 1-16). Singapore: Springer Nature Singapore.
8. Hua, B. H., Sugumaran, S. V., Faryza, E., Atiqah, N., Jasvinder, K., Kabir, M. S., ... & Nazmul, M. H. (2022). Prevalence of musculoskeletal disorders (MSD) and smartphone addictions among university students in Malaysia. *Int J Health Sci*, 6(S3), 1075-88.

9. Tien, L. P., Atiqah, N., Vytialingam, N., Rashid, M. A., Kabir, M. S., Farzana, Y., & Nazmul, M. H. M. (2022). Stress and quality of life among fathers of special needs children in Klang Valley. *Journal of Pharmaceutical Negative Results*, 13, 1010-1018.
10. Nazmul, M. H. M., Devaraj, S., Farzana, Y., Vasu, N., Gupalo, S., Doustjalali, S. R., & Shafiei, S. N. (2025). Bioaccumulation of heavy metals in aquatic organisms and its effects on human consumption.
11. Noureen, A., Islam, T., Rashid, M. A., Kabir, M. S., Mathialagan, A., Farzana, Y., ... & Nazmul, M. H. M. (2022). Indoor Motor Exercise Regimens Improve Social Cognition in Children With Autism Spectrum Disorder: A Systematic Review. *Journal of Pharmaceutical Negative Results*, 13(6), 2020-2028.
12. Khan, M. F. K., & Maziz, M. N. H. (2019). Antibiotic resistance. LAP LAMBERT Academic Publishing.
13. Krishnapillai, A., Lugova, H., Haque, M., Ariaratnam, S., Aziz, A. F. B. A., Maziz, M. N. H., ... & Godman, B. (2022). The shock of the SARS-CoV-2 pandemic on health professionals' education: A pilot qualitative study in Malaysia. *Journal of Applied Pharmaceutical Science*, 12(10), 161-171.
14. Jayaraj, N., Atiqah, N., Vytialingam, N., Kabir, M. S., Shirin, L., Irfan, M., ... & MHM, N. (2022). Parental attitudes about play in preschool aged children. *International Journal of Early Childhood Special Education*, 14(3).
15. OO, K. T., WONG, R. S., WWL, S., RAMLI, N., LOW, S., ELBAHLOUL, M., ... & KHALAF, J. H. (2020). Correlation between Body Mass Index (BMI) and Fasting Blood Glucose (FBG) Level among Malaysian Adults Age 40-60. *PJMHS Online*, 14(3).
16. Wirdahayu, M. S., binti Ismail, S. F., Murugan, S., Rashid, M. A., Kabir, M. S., Chia, T. Y., & Shaker, U. A. (2025). The associations of sensory processing and quality of life among children with autism spectrum disorder in Klang Valley, Malaysia. *Cuestiones de Fisioterapia*, 54(4), 5864-5873.
17. Hakim, H. S., Pervin, K., Thangarajan, R., Kabir, M. S., Shirin, L., Nahar, F. T., ... & MHM, N. (2024). Management and treatment of gastric problems in pregnant women. *South African Gastroenterology Review*, 22(3), 10-17.
18. Ebubedike, A. H., Mohammed, T. A., Nellikunnel, S., & Teck, T. S. (2022). Factors influencing consumer's behavioural intention towards the adoption of mobile payment in Kuala Lumpur. *International Journal of Professional Business Review: Int. J. Prof. Bus. Rev.*, 7(6), 24.
19. Mun, G. O. Y., & Syriac, N. D. (2018). A review paper on Last Mile Logistics operation design, challenges and opportunities in Malaysia. *INTI Journal*, 1(18).
20. Naseer, A. I. N., & Nellikunnel, S. (2024). The ESG Shift: Role of ESG in Modern Business Strategies. *Journal of Business and Social Sciences*, 2024.

21. Chee, W. W., & Nellikunnel, S. (2023). Peer Communications Influence on Purchase Intention of Beauty Products. *Journal of Business and Social Sciences*, 2023.
22. Sheikh, H. I., Alhamadin, N. I. I., Liew, H. J., Fadhlina, A., Wahid, M. E. A., Musa, N., & Jalal, K. C. A. (2024). Virulence factors of the zoonotic pathogen *Vibrio alginolyticus*: a review and bibliometric analysis. *Applied Biochemistry and Microbiology*, 60(3), 514-531.
23. Chowdhury, A. J. K., John, A., Aqilah, N. S., Abdullah, R., Salihah, N. T., Basir, K. H., & Marsal, C. J. (2024). Macrobenthic community towards sustainable aquatic ecosystem: A systematic review along the coastal waters of Malaysia. *Geology, Ecology, and Landscapes*, 8(1), 57-70.
24. Redhwan, A., Eissa, E. S. H., Ezzo, O. H., Abdelgelil, A. S., Munir, M. B., Chowdhury, A. J. K., ... & Abd Al-Kareem, O. M. (2024). Effects of water additive mixed probiotics on water quality, growth performance, feed utilization, biochemical analyses and disease resistance against *Aeromonas sobria* of Nile tilapia. *Desalination and Water Treatment*, 319, 100480.
25. John, B. A., Jalal, K. C. A., Zaleha, K., Armstrong, P., & Kmaruzzaman, B. Y. (2011). Effects of blood extraction on the mortality of Malaysian horseshoe crabs (*Tachypleus gigas*). *Marine and freshwater behaviour and physiology*, 44(5), 321-327.
26. Eissa, E. S. H., Okon, E. M., Abdel-Warith, A. W. A., Younis, E. M., Dowidar, H. A., Elbahnaswy, S., ... & Elabd, H. (2024). In-water *Bacillus* species probiotic improved water quality, growth, hemato-biochemical profile, immune regulatory genes and resistance of Nile tilapia to *Aspergillus flavus* infection. *Aquaculture International*, 32(6), 7087-7102.
27. Chowdhury, A. J. K., Hashim, N., Marsal, C. J., & Jamaludin, M. H. (2023). Water treatment and aquaculture products towards halal value chain in ASEAN countries: a retrospective review on Brunei Darussalam. *Desalination and Water Treatment*, 315, 479-491.
28. Mohamamad, A., & Jalal, K. C. A. (2018). Macrobenthic diversity and community composition in the Pahang Estuary, Malaysia. *Journal of Coastal Research*, 82(SI), 206-211.
29. Zaleha, K., Hazwani, I., Hamidah, H. S., Kamaruzzaman, B. Y., & Jalal, K. C. A. (2011). Effect of salinity on the egg hatching and Early Larvae of Horseshoe Crab *Tachypleus gigas* (Muller, 1785) in laboratory culture.
30. Amin, N. (2009). Bacterial pollution in molluscs arch clam, *Orbicularia orbiculata* and blood cockle, *Anadara granosa* of Pahang estuary, Malaysia. *Journal of Biological Sciences*.
31. AMBAK, & JALAL. (1998). Habitat utilization by the tropical fish community in the man-made Lake Kenyir, Malaysia. *Fisheries Management and Ecology*, 5(2), 173-176.
32. John, B. A., Kamaruzzaman, B. Y., Jalal, K. C. A., & Zaleha, K. (2011). Hydrology of the horseshoe crab nesting grounds at Pahang coast, Malaysia.
33. Kamaruzzaman, B. Y., Waznah, A. S., Ong, M. C., Shahbudin, S., & Jalal, K. C. A. (2009). Variability of organic carbon content in bottom sediment of Pahang river estuary, Pahang, Malaysia.

34. John, A., Kumar, C. P., Lyla, P. S., Khan, A. S., & Jalal, K. C. A. (2010). DNA barcoding of *Lates calcarifer* (Bloch, 1970). *Res J Biol Sci*, 5(6), 414-419.
35. Kartika, B., Parson, S. W., Kassim, Z., & Chowdhury, A. J. K. (2022). Overview of halal freshwater aquaculture system: Malaysian perspectives. *Water Conservation & Management*, 6(1), 01-05.
36. Jalal, K. C. A., Faizul, H. N., Naim, M. A., John, B. A., & Kamaruzzaman, B. Y. (2012). Studies on water quality and pathogenic bacteria in coastal water Langkawi, Malaysia. *Journal of environmental biology*, 33(4), 831.
37. Chowdhury, A. J. K., John, A., Abdullah, R., Musa, N., & Ashraf, M. A. (2021). Impact of COVID-19 on aquaculture and fisheries in ASEAN countries: some aspects of challenges, mitigations for future strategies in Malaysia. *Desalination and water treatment*, 241, 331-339.
38. Rahman, S. A., Zambry, H., Basha, S., Kamarzaman, S., & Chowdhury, A. J. K. (2013). The potential role of Red Tilapia (*Oreochromis niloticus*) scales: allergic reaction test in mice. *Journal of Applied Pharmaceutical Science*, 3(10), 045-050.
39. Rozihan, M., Ismail, E., John, B. A., Jalal, K. C. A., & Mohd-Adnan, A. (2013). Genetic diversity of horseshoe crab (*Tachypleus gigas*) in Malaysia revealed using microsatellite markers. *Asian Journal of Animal and Veterinary Advances*, 8(1), 63-72.
40. Jalal, K. C. A., Akbar John, B., Habab, M., Mohd, A. Y., & Kamaruzzaman, B. Y. (2013). Bioaccumulation of selected metals in fresh water Haruan fish (*Channa striatus*) collected from Pahang River basin, Malaysia.
41. Jalal, K. C. A., Md. Zahangir Alam, M. Z. A., Muyibi, S. A., & Jamal, P. (2005). Isolation and purification of bacterial strains from treatment plants for effective and efficient bioconversion of domestic wastewater sludge.
42. Salleh, S. M., Sah, S. A. M., & Chowdhury, A. J. K. (2018). Assessing nesting status of green turtles, *Chelonia mydas* in Perak, Malaysia. *Tropical Life Sciences Research*, 29(1), 155.
43. Kudus, K., Grasian, I., Madasamy, S., & John, A. (2017). Immunomodulatory effect of alginic acid from brown seaweed *sargassum wightii* on disease resistance in *penaeus monodon*. *Journal Clean WAS (JCleanWAS)*, 1(1), 26-29.
44. Akbar John, B., Sheikh, H. I., Jalal, K. C. A., Zaleha, K., & Kamaruzzaman, B. Y. (2016). Revised phylogeny of extant xiphosurans (horseshoe crabs). In *DNA Barcoding in Marine Perspectives: Assessment and Conservation of Biodiversity* (pp. 113-130). Cham: Springer International Publishing.
45. Iyyapparajanarasimapallavan, G., Kumar, P. S., Kumar, C. P., Jalal, K. C. A., Kamaruzzaman, B. Y., & John, B. A. (2013). Distribution and abundance of gelatinous zooplankton along Tamil Nadu coastal waters.
46. Ng, J. F., Ahmed, O. H., Omar, L., Jalloh, M. B., Kwan, Y. M., Musah, A. A., & Chowdhury, A. J. K. (2024). Improving pH buffering capacity of an acid soil to regulate nutrient retention and

- mitigate water pollution using Calciprill and sodium silicate. *Desalination and Water Treatment*, 319, 100491.
47. Jamaludin, M. H., Marsal, C. J., Chowdhury, A. J. K., Harith, Z. T., Ridzwan, R. M., & Kari, Z. A. (2023). Egg and broiler supply in Malaysia: issues, challenges and recommendations. *Halalsphere*, 3(1), 11-19.
48. Abidin, Z. A. Z., & Chowdhury, A. J. K. (2018). Heavy metals and antibiotic resistance bacteria in marine sediment of Pahang coastal water. *Journal Clean WAS*, 2(1), 20-22.
49. Zakaria, Z., Fadzil, F. N. M., Mohamad, M. A. N., Hamid, A. A. A., Chowdhury, A. J. K., & Harumain, Z. A. S. (2024). Metagenomic analysis of bacterial communities in heavy metal leachate-contaminated soils at Jalan Lipis Sanitary Landfill, Pahang, Malaysia. *Desalination and Water Treatment*, 319, 100512.
50. John, A., Chowdhury, A. J. K., Asri, U. N. M., Nordin, N. F. H., & Ambak, M. A. (2015). DNA BARCODING OF CAGED PANGASIIDS IN PAHANG RIVER MALAYSIA. *Jurnal Teknologi*, 77(25), 31-36.
51. Sheikh, H. I., Nordin, B., Paharuddin, N., Liew, H. J., Fadhline, A., Abdulrazzak, L. A., ... & Musa, N. (2023). Virulence factors and mechanisms of *Aeromonas hydrophila* infection in catfish *Siluriformes*: a review and bibliometric analysis. *Desalination and Water Treatment*, 315, 538-547.
52. Miah, M. S. U., Sulaiman, J., Zamli, K. Z., Rashid, S. S., & Chowdhury, A. J. K. (2023, April). Predicting carboxymethyl cellulase assay (cmcase) production using artificial neural network and explicit feature selection approach. In *2023 IEEE 8th International conference for convergence in technology (I2CT)* (pp. 1-6). IEEE.
53. Abidin, Z. Z., Malek, N. A., Zin, N. M., & Chowdhury, A. J. K. (2020). Rare Actinomycetes from Kuantan Mangrove Forest Sediment. *Clean WAS*, 4, 79-83.
54. Nordin, N. F. H., Mahassan, T. S. H. T., & Chowdhury, A. J. K. (2018). Bacterial population study in oil-contaminated and uncontaminated soils. *Journal Clean WAS (JCleanWAS)*, 2(2), 6-9.
55. Ishmael, U. C., Rashid, S. S., Jalal, K. C. A., Sarkar, S. M., Hamid, H. A., & Azmi, N. S. (2017). Between the bioactive extracts of edible mushrooms and pharmacologically important nanoparticles: Need for the investigation of a synergistic combination-A mini review. *Asian Journal of Pharmaceutical and Clinical Research*.
56. Kamaruzzaman, B. Y., Shuhada, N. T., Zahir, M. S., Akbar John, B., Shahbudin, S., Jalal, K. C. A., ... & Goddard, J. S. (2011). Concentrations of lead, copper and zinc in the bottom sediments of Tuba Island waters of Langkawi, Malaysia. *Oriental Journal of Chemistry*, 27(2), 505.
57. Vedharajan, B., Pandisamy, R., Nobil, E. P., Hashim, S., John, A., Sivakumar, K., ... & Anantharaman, P. (2023). Seagrasses in the Indian Ocean region with special reference to urbanization. In *Climate Change and Urban Environment Sustainability* (pp. 109-124). Singapore: Springer Nature Singapore.

58. Tosin, O. V., Mohamed, A. A., Ariffin, N. A., Chowdhury, A. J. K., & Bolong, A. M. A. (2022). Morphological variation between hatchery bred and wild caught *Anabas testudineus* in Malaysia. *Tropical Life Sciences Research*, 33(1), 201.
59. Ab Wahab, S. U. K., Samah, M. A. A., Sabuti, A. A., Yunus, K., Chowdhury, A. J. K., John, A., ... & Hamid, A. A. A. (2020). Environmental forensic study: tracing of pollution sources using environmetric technique in Balok and Tunggak Rivers near Gebeng industrial area, Kuantan, Pahang, Malaysia. *Desalination and Water Treatment*, 191, 118-125.
60. Wahab, S. U. K. A., Shaibullah, S. H., Samah, M. A. A., & Aris, M. S. M. (2016). An assessment of surface water quality and heavy metals involving the rare earth elements in Sungai Tunggak and Sungai Balok, Gebeng, Kuantan, Pahang. *Journal of Malaysian Critical Metals*, 1, 11-23.
61. Hassan, A., Ismail, T. H. T., Saari, M. Y., & Samah, M. A. A. (2015). Public response to the rare earth industries in Malaysia. *Procedia Environmental Sciences*, 30, 62-67.
62. Akbar, J., Prasannakumar, C., Lyla, P. S., Ajmal Khan, S., & Jalal, K. C. A. (2010). DNA barcoding of *Lates calcarifer* (Bloch, 1970). *Res. J. Biol. Sci*, 5(6), 414-419.
63. Satyanarayana, B., Raman, A. V., Zhang XiuYing, Z. X., Feng XueZhi, F. X., & Dehairs, F. (2004). Application of GIS in the preparation of species distributional maps for *Coringa* mangroves based on ground truth data.
64. Annuar, N., Azhary, N., Yusof, N. A., Omar, S. M., Chowdhury, A. J. K., & Ashaari, M. M. (2023). Biosurfactant and bioemulsifier production by hydrocarbonoclastic bacteria isolated from petroleum sludge as potential biodispersant for oil spill remediation. *Desalination and Water Treatment*, 313, 243-251.
65. Ahmed, O. H., Ali, M., Abdullah, R., Chowdhury, A. J. K., Salleh, N. T., & Musah, A. A. (2022). Co-application of triple super phosphate and chicken litter biochar improves phosphorus availability of mineral tropical acid soils to reduce water pollution. *Desalination and Water Treatment*, 264, 40-53.
66. Wang, X., Peng, M., Wang, C., Chowdhury, A. J. K., & Jalal, A. (2019). Effect of lime-bone ratio on compressive strength and void fraction of recycled green ecological concrete. *Nature environment & pollution technology*, 18(5), 1579-1583.
67. Hamad, J. R. J., Hanafiah, M. M., John, A., Hassan, B., & Sheikh, I. (2017). The practice, challenges and awareness of residential solid waste management in the city of Al Marj, Libya. *Environ Ecosyst Sci*, 1(1), 23-27.
68. Akbar John, B., Hassan, S., Nur Hanisa, M., Kamaruzzaman, B. Y., & Sha, K. (2017). Community structure and post-monsoonal distribution of ichthyoplankton in Kuatan river, Malaysia. *Environ Eco Sci*, 1(1), 1-3.
69. Roslan, M. A. M., Abidin, Z. A. Z., & Omar, S. M. (2016). Screening of ligninase-producing bacteria from south east Pahang peat swamp forest soil. *Malaysian Journal of Microbiology*, 433-437.

70. Shahbudin, S., Hafiz, Z. H., John, B. A., Kamaruzzaman, B. Y., & Jalal, K. C. A. (2011). Distribution and Diversity of Corals on Artificial Reefs at Pasir Akar and Teluk Kalong, Redang Island, Malaysia. *Journal of Applied Sciences*, 11(2), 379-383.