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Original Article

M-Pilot: An Autonomous Intelligent Advisory System with Social IoT (SIoT) Framework for Enhancing QOL

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Abstract - *In the era of Industry 4.o, technological advancements are focused on monetizing and maximizing the growth of the digital economy. This is the transition stage in India from mobile to intelligent and immersive computing. Presently, the major focus is on the personalization of services with emerging technologies that are deeply integrated with existing mobile apps. These technologies aim to build a connected ecosystem through closely connected society and interpersonal interactions. In this scenario, mobile apps associated with Intelligent Personal Assistants (IPA) are gaining momentum to address various user-centric use cases to enhance Quality of Life (QOL). The existing IPAs (Amazon Alexa, Google Assistant, etc.) related to various verticals (Health, Safety, Travel, Family, etc.) have their limitations, such as a lot of interactions with the user, misinterpretation of voice commands, device-specific dependency, no regional language support; vertical-specific applications; no interaction among mobile apps in and among verticals; no personalized assistance and recommendations. This leads to inefficient exploitation of the services offered by existing applications. This paper focuses on a novel framework that addresses the above said drawbacks and can be overcome through the proposed Social Internet of Things (SIoT) architecture by considering mobile apps as things and establishing communication among verticals existing in her/his mobile. The objectives of the proposed framework, M-Pilot, are to connect, communicate, and interoperate among relevant mobile apps in respective verticals to enhance QOL. It takes input from an individual's mobile app metadata, and the outcomes are personalized recommendations, notifications, and assistance.*

Keywords - *Smart City, Industry 4.o, Semantic interoperability, Social Objects (SO), Health.*

1. Introduction

India, with its growing digital economy and pro-digitization, is focusing on a plethora of opportunities available in the exponential technologies such as the Social Internet of Things (SIoT), 5G, Augmented and Virtual Reality, speech recognition with natural language information retrieval, and cognitive science in artificial intelligence, etc. The government is extending its support to make India a technological superpower with digital enablement programs such as Make in India, Digital India, Smart Cities, etc. In the era of Industry 4.o, mobile computing plays a crucial role in monetizing and maximizing the advantages of these technologies. This is the transition stage from mobile computing to intelligent and immersive computing. Now, the major focus is on the personalization of services with emerging technologies deeply integrated with mobile apps as Social Objects (SOs). These technologies aim to create a more closely connected society in terms of interpersonal interactions and to build a connected ecosystem. These technological advances in the generation of consumers, particularly Gen Z and millennials, use SOs widely for entertainment, information, communication with other devices, etc., covering almost every aspect of life. The customer experience-based initiatives are trying to provide more personalization of services. So, the SOs associated with Intelligent Personal Assistants (IPA) are also gaining momentum. New products and services are constantly evolving at an enormous rate to address various customer-centric use cases and enhance Quality of Life (QOL). In conforming to the new technologies and the SOs, IPAs are widely being used to fulfil their information needs and get their regular tasks done. The most popular IPAs capable of performing tasks on behalf of humans are Google Assistant, Apple Siri, Amazon Alexa, Microsoft Cortana, etc. Though the IPAs are taking their stand in automating the users' everyday activities, these act as standalone units and require

guidance from a user at every point in time. The existing IPA applications have limitations, such as they require a lot of interactions with the user to accomplish a task, customized applications according to his/her needs are not provided, and the voice commands given by the user can always be misinterpreted. The device-specific dependency still exists and cannot address the personalized needs with regional language support. Many SOs are available related to various Vertical Objects (VOs) such as Health, Safety, Travel, Family, Financial Services, Home Management, Retailing, etc. There are also various personal assistants in these sectors.

The existing SOs are specific to one VO. Each application is developed for a certain scenario; it might be for a smart grid, smart home, e-health, etc. These highly efficient autonomous units make enormous features possible to support day-to-day activities. The main drawback is that the units cannot communicate (talk) among Social Objects (SOs). This leads to inefficient exploitation of the services offered by existing applications. These drawbacks are addressed through a novel framework based on Social Internet of Things (SIoT) architecture. This is considering all connected SOs as things in IoT. This communication is established among various VO-related applications existing in her/his mobile. This paper focuses on developing an autonomous intelligent advisory **s**ystem called an M-Pilot. It aims to develop a single framework connected to multiple VO for improving the QOL of an individual.

The proof of concept on health scenario, the recommendations, and notifications are based on health issues and metadata collected from various connected mobile SOs, including information related to exercise, food, health history, sleep patterns, EHR records, diagnostic test reports, and other information such as headaches, coughs, colds, allergies, etc. M-Pilot further provides up-to-date electronic health records, which can be accessed for online/offline doctor consultations. The paper is organized as follows. Section II discusses the related work. Section III provides the architecture of M-Pilot through Social IoT. Section IV discusses the methodology of the proposed concept with a sample application scenario. Section V presents implementation challenges, and Section VI concludes the paper.

2. Review of Related Work

The ongoing research worldwide suggests that Smart City initiatives can improve key Quality of Life (QOL) factors for city residents. According to the analysis done across 50 cities by McKinsey Global Institute in 2018, it was found that the urban QOL can be improved by 10-30%. The emerging technologies can also be incorporated to have a measurable impact on qualitative factors. World Health Organization (WHO) proposed an international, cross-cultural QOL assessment standard as WHOQOL [1]. This focuses on measuring health-related statistics by including parameters such as traffic, safety, transportation, mobility, entertainment, and community support. According to the Economist's Global Livability Index, 30 indicators are included to enhance the QOL by considering five categories of livability such as safety, health care, environment, education, and infrastructure. The existing research on QOL focuses on processing Big Data and urban services. A realistic architecture for urban planning and decision-making in a smart city equipped with Real-Time Data Processing. Smart cities aim to improve the urban QOL by incorporating sophisticated innovations in transportation, healthcare, and many other VO. An intelligent smart city can evolve by integrating all the fundamental smart components and seamless interoperation [2].

A framework named TCitySmartF is empowered by recent technological advancements, particularly city requirements and dynamics. It incorporates many smart evolving components, best practices, and contemporary solutions. It provides insights and directions for governance to transform cities into smart cities by connecting the physical city and the digital world [3]. A new era of autonomous services research has been initiated. Social IoT (SIoT) is a service-oriented architecture where IoT devices in various VO offer autonomous services and collaborate on behalf of their owners. It interacts and establishes relationships with each other to achieve a common goal. The researchers proposed an SIoT-based model OS architecture to enhance the interactions among various heterogeneous IoT devices. The architecture uses the IoT platforms and efficient OS for advanced SIoT applications that benefit developers [4].

The main reason for the gaining popularity of IPAs is their features parallel their efficiency. The authors reviewed 85 studies and concluded that adaptability, integration, anthropomorphism, multimodality, and context awareness are the mandatory features needed for sophisticated assistance. The IPAs can associate with smart devices, adapt to user preferences over time, observe environmental factors, and become aware; they have multiple interaction modes to some extent, but the ability to ease user interaction with the technology and the anthropomorphic feature needs to be enhanced. Creating wide common-sense databases is also missing in the existing ones. To make IPAs more human-centric, the missing features can be concentrated on designing advanced social smart assistants for the future [5].

The authors developed a thorough literature review and present the main motivations for developing smart devices. The space discovery paradigms and context awareness in smart systems were explored, and up-to-date open research issues along with ongoing social IoT applications in this area are highlighted [6]. A novel IoT-based mobile gateway solution for mobile Health (m-Health) scenarios was proposed. The gateway autonomously collects information about the parameters such as heart rate, user/patient location, and possible fall detection. It forwards the collected information to a caretaker IPA in real time [7]. A framework

is proposed based on the JaCaMo platform for programming and designing smart SOs using cognitive agents and the agents and artifacts environment conceptual model. The main intention of the authors is to report their experience in designing and programming mobile SOs as personal assistant agents to address the context of real-world projects handling various applications [8]. Some authors reviewed the literature on IPAs in ubiquitous environments in the IoT context. The approach of integrating wireless sensor networks with the internet and the heterogeneity of objects with diverse communication protocols was discussed. The challenges faced in improving the learning behavior of IPAs, through direct interactions and with smart objects were stated. The IPAs available in different domains were tabularized. The government of the Russian Federation funded this work through the AMBRO project [9].

With the study of all these works, it is a move to the next level with new emerging technologies like AI and immersive and inclusive computing for improving the quality of life in the form of building efficient smart cities to improve the demands of the urbanizing population. The researchers are contributing a lot in this regard. A sustainable and economically viable Reference Framework was proposed by authors at the Center for Study of Science, Technology, and Policy (CSTEP) for the smart cities mission in India. It guides policymakers and urban practitioners in making critical decisions to provide solutions to India's urban challenges. Enhancing QOL is the main principle for which this framework is developed [10]. An IoT-based framework for smart cities was developed, focusing on major entities like infrastructure, policy, governance, networking, and security to encompass a complete cyber-physical system. A better-customized service to improve the QOL inhabitants of the smart city is the main objective of this framework [11]. India's Smart City Mission (SCM) has worked in collaboration with the Indian Institute of Science (IISc), Bangalore, to create a state-of-the-art data-sharing platform called India Urban Data Exchange (IUDX) for providing secure and controlled sharing of data. This platform aims at taking India to a digitally empowered society by providing a positive impact on citizen's life.

These initiatives are meant for beneficiaries such as government departments, city management/operations, system integrators, solution providers, software and application developers, other industry players, start-ups, academia, and most importantly, the Citizens to ensure the integrated growth [12]. To cope with the socio-economic impact, the India Urban Data Exchange Platform (IUDX) and Open Smart Cities Consortium India (OSCI) have emerged to deal with the cyber-physical revolution. The exchange of data across various platforms is the key to building a foundation for a data economy. The use cases addressed here are connecting fire, traffic, and hospitals for rapid and effective response. It highlights the significance of data sharing in allowing collaboration between departments within a city. The application receives real-time data from fire departments and hospitals and forwards it to the police dept. Data and application-level connectivity are needed to make the emergency response application use case possible [13]. Innovation in the technologies should be used to improve the efficiency of health systems during pandemics. This is evident during COVID-19 as the extent of usage of mHealth initiatives in India during the pandemic has increased dramatically. The authors reviewed 346 SOs related to the health domain. mHealth applications (SOs) have been utilized to improve access to testing and contact tracing, create public awareness, support frontline workers, etc. For tracking personal health, there are Symptom trackers and self-risk assessment SOs; for client health records, there are SOs for Longitudinal tracking of user's health status. Teleconsultation and testing appointment SOs are available.

For public health notifications, there are contact tracing and Hotspot identification SOs. A notable finding by the authors is that delivering quality health services with integrated teleconsultation options and pre-existing health conditions within these SOs would be an excellent choice [14]. A scheme D-TMSA was proposed based on various social relationships in allocating green signals to maximize the traffic flow passing through an intersection. D-TMSA is a SIoT-based traffic congestion management to control the congestion and improve traffic flow between the vehicles, commuters, and the Road Side Units using social, behavioral and preference-based relationships. It uses dynamic structuring to reduce the traveling time of vehicles on the road network to maximize non-conflicting traffic flow [15]. According to KPMG, India report 2019, the government plans to develop a connected smart IoT-based system for the country's needs and to improve the QOL of the citizens. The concept of smart spaces, embedding digitization and smartness in every sector, has gained large traction in India [16].

Mobile apps can record and share food and potential dishes in social, collaborative computing. Recognizing healthy diets is a significant and difficult issue in dish health assessment. Because taste is one of the determinants of better healthy dish choices among the general public, the authors focused on dish image recognition using the Hand-Deep Local–Global Net (HDLGN). To improve deep features, a dish image annotation was built using an SIoT system. Local and global mechanisms are combined to develop a taste recognition model. As a result, it encourages the consumption of healthier foods while reducing the consumption of unhealthy foods in daily diet guidance [17]. The most important component for meeting the needs of smart cities is ubiquitous connectivity among users. This could be made possible by integrating human social behaviors with physical Internet of Things (IoT) systems. As the applications of social IoT systems shift from information dissemination to user

entertainment, computation offloading becomes increasingly important to reduce application execution delays. The authors discussed architectures, real-time decision-making, and energy-conscious approaches to collaborative edge computing in Social IoT systems [18]. Creating a highly connected, personalized, patient-centric health ecosystem is the need of the day that governments worldwide have to focus on. This can be made possible using Wearable IoT (WIoT). WIoT can be utilized in the early diagnosis of diseases and for tracking by inspecting systemic infection sources. Wearable devices may alert patients and doctors of possible COVID-19 symptoms before a severe illness.

The authors emphasized information sharing and interoperability issues, objective, sensitive systems, and the algorithms to identify COVID-19 symptoms [19]. The exoskeleton, a popular means of rehabilitation, can be a boon to paralyzed patients. With the evolution of smart cities using AI-IoT-enabled connected communities, this Smart Exoskeleton System (AI-IoT-SES) is a new assistive model that has become an important component in serving the physically challenged community. The authors described an exoskeleton design for the physically impaired to enable communication in smart cities using IoT platforms to exchange data from the intelligent sensors with the remote location of the caretaker to monitor the real-time movement and navigation of the exoskeleton and AI-powered navigation. They could acquire desirable precision with minimal errors in tracking the target [20].

2.1. Current IPA Limitations

One key limitation is context awareness and personalization, as most IPAs operate within isolated ecosystems and struggle to seamlessly integrate cross-domain data for user-specific recommendations. They primarily rely on rule-based or statistical learning approaches that often fail to adapt dynamically to evolving user preferences and real-time contextual changes. Semantic interoperability remains challenging, as different apps and IoT devices use varied data formats and communication protocols, preventing smooth cross-platform intelligence. IPAs lack advanced decision-making capabilities beyond basic task execution, limiting their effectiveness in complex advisory scenarios such as personalized healthcare, finance, and smart city applications. These limitations highlight the need for more autonomous, adaptive, and cross-domain intelligent systems that can provide more efficient, secure, real-time, and context-aware recommendations.

3. Research Gap

Current IPAs lack seamless integration across different domains, making providing holistic, personalized, and autonomous support difficult. Exact recognition of the voice commands of the user is always a question as, in many cases, they may be misinterpreted. Additionally, existing Social Objects (SOs) in the Social Internet of Things (SIoT) are largely restricted to specific Vertical Objects (VOs), such as health, safety, travel, finance, and home management, without effective cross-communication. Each application is developed for a certain scenario; it might be for a smart grid, smart home, e-health, etc. These highly efficient autonomous units make enormous features possible to support day-to-day activities. The main drawback is that the units cannot communicate (talk) among social things (SOs). This results in fragmented digital assistance, where users must interact with multiple applications separately, leading to inefficiencies in task automation and decision-making.

3.1. The Research Gap Identified is

- Interoperability between IPAs and SOs seems minimal, as there are no effective cross-communication mechanisms. Lack of a unified system to collect and process data from SOs.
- Personalized responses based on an individual's real-time needs, habits, and regional language support are deficient.
- A universal framework that integrates multiple VOs into a single system to analyze user health data holistically, offering recommendations based on exercise, diet, medical history, and real-time health metrics is missing.
- Current IPAs require frequent user input and guidance, limiting their autonomy.

The research problem, therefore, is the lack of an integrated, autonomous, and intelligent advisory system that can leverage the interconnectivity of SOs within the SIoT framework to provide comprehensive, cross-domain, and personalized support to users in real time.

3.2. The Novelty of the Work

The novelty of this work lies in the development of M-Pilot, an Autonomous Intelligent Advisory System that integrates Social IoT (SIoT) principles with semantic interoperability to provide personalized, cross-domain recommendations across various Vertical Objects (VOs) such as health, wealth, travel, safety, entertainment, and family. Unlike traditional mobile applications that operate in isolated silos, the proposed framework enables seamless data sharing and interoperability between diverse Social Objects (SOs). This allows for context-aware, real-time personalized services tailored to individual users by leveraging the interconnectivity of sensors, applications, and cloud-based services. The system's ability to generate high-impact personal data has implications for government policies, smart city initiatives, and quality-of-life improvements. The proposed framework aims to develop an M-Pilot system, including Exploratory Analysis, the development of an M-Pilot system by establishing semantic interoperability between various VOs like In-Mobile, On-Site, or in the cloud. Hence, this aims to establish a flow of information from intra-connected and interconnected SOs among various VOs. M-Pilot results in high-impact individual data to enhance the efficiencies of urban services and empower citizens.

4. Social Internet of Things

The proposed Social IoT (SIoT) framework consists of various layers to establish a deeply interconnected system, as shown in Figure 1. The proposed concept of exploiting SIoT for recommendation services among various VOs mentioned in the architecture consists of 5 layers. The interoperability between various VOs, which are in In-Mobile (TripIt, Healthify Me, Besafe, Flipboard, Amazon Prime, Big Basket, etc.), On-Site (Road Side Units, Check-in-kiosks, e-health-kiosks, e-toll, etc.) or in the cloud (Bank cloud).

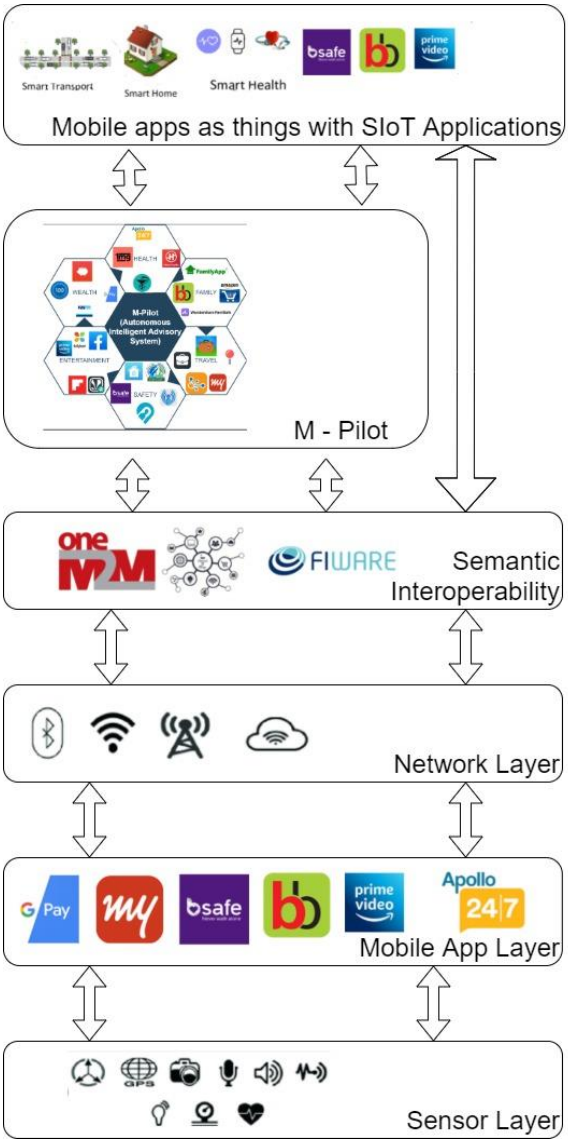

Fig. 1 The architectural view of M-Pilot

4.1. Sensor Layer

It contains various sensors and is responsible for sensing and collecting information from the SOs present on the user's mobile device. This layer contains various heterogeneous devices, such as sensors and actuators, RFIDs, and cameras, which work in alliance with the SOs.

4.2. Mobile App Layer

It contains apps in various VOs like health, travel, wealth, entertainment, safety, and family. These SOs communicated with the sensor layer for information and established social relationships and friendship circles. The actuated information is forwarded to the network layer to utilize this information by SIOT services.

4.3. Network Layer

It comprises private wireless networks, public mobile networks, satellite networks, wifi, and the internet. The data received is forwarded to the next layer for processing. All the SOs in the mobile app network, at present, are working in one VO. Each application is developed for a certain scenario; it might be for smart travel, smart home, e-health, etc. These highly efficient autonomous units make enormous features possible to support day-to-day activities. The proposed SIoT-based M-Pilot requires data sharing among different VOs to provide a service.

4.4. Semantic Interoperability Layer

To share the data among various VOs, semantic interoperability is required. OneM2M and FIWARE are interoperability platforms that can be used to share data among multiple VOs.

5. Proposed Autonomous Intelligent Advisory System Framework with SIoT

5.1. Proposed Concept

The proposed work aims primarily at 5 VOs such as health, wealth, family, entertainment, safety and travel. The schematic diagram of the proposed project, M-Pilot, is given in Figure 2.

Fig. 2 The schematic diagram of the M-Pilot

In each VO, according to the preliminary study, a few of the SOs were identified along with the services provided. The focused VOs considered in this project are health, family,

travel, safety, entertainment, and wealth. Each VO comprises multiple related SOs working with inbuilt sensors and providing specific services. A few are listed below.

5.1.1. Health

It consists of SOs such as Apollo 24/7, healthifyme, 1 mg, EMR/EHR Health Records, Health Log, etc. Some sensors that can be used are gyroscope, touch sense, magnetometer, GPS Sensor, accelerometer, biosensors or image, pH or chemical sensors, etc. For example, the Healthify Me app is a health and fitness app. It can track calories, diet plans, Dietician advice and appoint trainers. Apollo 24/7 is an online doctor consultation, user can now consult top doctors in India via video/audio call/chat within 15 minutes on the Apollo 24/7 app.

It is an integrated platform that stores all health records being generated physically or digitally across the Apollo ecosystem. Health Log app provides an extremely flexible logging system, making it easy to keep track of any health-related information. 1mg is an online medical store that provides medical needs, such as viewing medicine details, online medicine purchases, book lab tests and health check-ups, and online doctor consultations. The Fitnesspal app logs exercise stats, records caloric intake and recommends changing eating habits to meet personal health goals.

5.1.2. Family

It consists of SOs such as Big basket, Amazon, Fami Safe, Big Basket, and Swiggy. Some of the sensors that can be used are pressure sensors, tracking weight sensors, motion sensors, etc., with voice and image as inputs. For example, Fami Safe is the parental control app to control screen time, track real-time location and detects inappropriate content on kids' devices. The Family App allows connecting the whole family members. Life 360 App Protect and connect the people who matter most with all safety features for life at home, on the web, and on the go. Everything is in one place. The Swiggy app is for ordering food, groceries, and other essentials online. Big basket is India's leading online supermarket shopping app. Amazon is the shopping app that provides the ultimate shopping experience.

5.1.3. Travel

It consists of SOs such as TripIt, Make my Trip, Trip Case, Pin Traveller, Ola, etc. Some of the associated sensors are GPS sensors, geo-location sensors, etc. For example, MakeMyTrip is trusted by Indians to plan their holidays. Search and book flights, hotels, train or bus tickets, taxi cabs, rental cars and activities.

Trip It is a travel planner that allows syncing travel plans to the calendar. Trip Case is a travel Organizer that organizes all of the trip details and travel plans into one streamlined itinerary. It can manage flight itineraries, hotel bookings, and rental car reservations in one app. The Pin Traveler app keeps a pin on all the places one has visited. The Ola app is to book cabs and autos to reach the destination.

5.1.4. Safety

It consists of SOs such as Besafe, my safety pin, Get Home Safe, Disha, Home security monitor, etc. The associated sensors that can be used are compass sensors, accelerometer sensors, and image sensors. For example, Disha SOS is a step toward the safety of women and citizens in an emergency by the Andhra Pradesh government. My Safeti pin is a Personal Safety app for making safer decisions about mobility based on the safety score of an area. The Get Home Safe app is for personal safety, reminding people about check-in or sending a fail-safe alert when it does not go according to plan. bSafe app- Never Walk Alone is one of the most advanced and reliable personal safety SOs. It uses technology to prevent crimes like violence, sexual assaults, and rape, as well as creates evidence in cases where it has already occurred. Home Security Monitor System: A Surveillance Camera is an anti-thief system for guarding and monitoring the house. Connects any two devices to turn them into the perfect anti-thief system.

5.1.5. Entertainment

It consists of SOs such as Flip board, Daily Hunt, Prime Video, YouTube, Facebook, etc. Location sensors, mood sensors, time and touch-sensitive sensors, social media sensors, etc. For example, Amazon Prime Video makes the daily commute more fun with the option to watch movies online or download them to watch on the go, anytime, anywhere. Flipboard provides news on any topic, and Daily hunt is an Indian app that allows news and videos to stay updated with the latest regional and local trends. Facebook Connect with friends and family and meet new people on your social media network to share what's happening in your world. Jio Saavn is the best way to listen to millions of songs, radio, and podcasts. YouTube lets one see what the world is watching, from the hottest music videos to the trending in gaming, entertainment, news, and more. Book My Show app brings booking tickets for movies, concerts, live event streaming, and activities at the hit of a single click with unmatched entertainment.

5.1.6. Wealth

It consists of SOs such as Money manager, Paytm, Google Pay, etc. Motion Sensors, touch sensors, wireless magnetic sensors, IR sensors, optical sensors, etc. For example, Paytm sends and receives money directly from any phone number or bank account. Money Manager is a financial planning, review, expense tracking, and personal asset management app for Android. Personal and business financial transactions can be noted generate spending reports, review the daily, weekly and monthly financial data, and manage the assets. Timely Bills is the money manager and expense tracker app that tracks daily expenses, pays bills on time, stays within budget, and tracks savings. Google Pay is a simple and secure payment app.

5.2. Implementation of Advisory System

Implementing the proposed framework for an Autonomous Intelligent Advisory System is based on metadata of mobile applications using SIoT architecture. It focuses majorly on five VOs such as health, wealth, family, entertainment, safety and travel. The development of M-Pilot starts with establishing the connected SIoT system with semantic interoperability with appropriate communication protocols and designing an automated intelligent advisory system in personalized scenarios. The implementation steps are given in Algorithm 1.

Algorithm 1: M-Pilot: Autonomous Intelligent Advisory System
Input: {V1, V2, V3,…Vn}; n number of VOs for k number of users
m number of SOs
s number of connected inbuilt sensors in each app (In-Mobile)
<hp > attributes of personal health profile
Met_CA: Metadata of connected SOs

Output: An automated intelligent advisory system in personalized VO.
Method:
Step 1: Choose the VO and connect SOs with inbuilt sensors.
Step 2: Read Met_CA from metadata-connected SOs.
Step 3: Integrate <Met_CA> and <hp> from connected SOs
Step 4: Convert metadata into a numerical vector named Personal Record (PR)
Step 5: Apply Rule-Based predictions on PR
Step 6: Derive Recommendation/Personalized Advises on selected VO

Sample Application Health Scenario:
A sample application considering the Health VO Scenario is shown in Figure 3. In this scenario, the vertical Object (VO) is the health
Social Objects (SO)→Apollo 24/7, Healthify Me, 1 mg, EMR/EHR Health Records, Health Log, Big basket, Amazon, Fami Safe, Big basket, Swiggy, etc.
Relationship objects→Social App Network
Semantic Interoperability→FIWARE

Consider a person named Ram who uses a Social IoT based M-Pilot system for his health-related recommendations and notifications. The metadata has been collected from the connected SOs and their EHR records by considering the following tasks.

- Task 1 : Ram wakes up and does exercise, which is taken care of by Fitness Pal. It keeps track of Ram's exercise stats and records calories burnt. Based on personal health goals, he recommends Ram change his eating habits.
- Task 2 : While doing a complicated workout, Ram feels a mild pain in his chest. Immediately, Apollo 24/7 tracks his health vitals through the wearable devices he has. The symptom tracker advises Ram based on his vitals and symptoms and books for lab tests and preventive health check-ups for a home pick-up.
- Task 3 : His Social IoT Health Networks activates the Health Log App, and any health-related information, such as headaches, cramps, coughs, colds, allergies, etc., are noted. The severity as well as kind of pains are also recorded.
- Task 4 : The diagnostic test reports are taken by the Ram Online doctor consultation feature in Apollo 24/7, which connects the call to top doctors in India via video/audio call or chat.
- Task 5 : Up-to-date digital health records for online consultations can be retrieved using the EHR/EMR Health Records App.
- Task 6 : Upon observing the patterns from the Sleep Monitor App and Health Log App, the reports taken from the EHR Records app show that the doctor prescribes medicines in the online consultation.
- Task 7 : The medicines are made available through the 1 mg app, and the Social IoT health Recommendation system notifies Ram of using medicines at regular intervals according to the prescription.
- Task 8 : Healthify Me gets inputs from all these SOs through the Social IoT network and recommends a specialized diet plan, which lets him easily manage dietary health conditions and help the overall immune system fight viral and bacterial infections. It also helps Ram find health advice and recipes and motivates him toward a healthy lifestyle.

With all this information, high-impact health-related data was collected from sensor-actuated connected social objects. Based on the previously accumulated data the, personalized recommendations for a particular day can be notified.

5.3. Practical Examples of M-Pilot's Applications

5.3.1. Family & Home Automation: Connected Smart Living

- Scenario: Arjun, a working parent, uses M-Pilot for family and home management.
- How it works: O M-Pilot connects Fami Safe to monitor his children's screen time and location.
- Using data from Big Basket & Amazon, M-Pilot suggests grocery purchases based on consumption patterns.
- If Arjun forgets to lock his doors, M-Pilot integrates with Home Security Monitor and automatically locks them via IoT-enabled smart locks.
- During emergencies, it enables video monitoring and sends real-time alerts to security personnel.

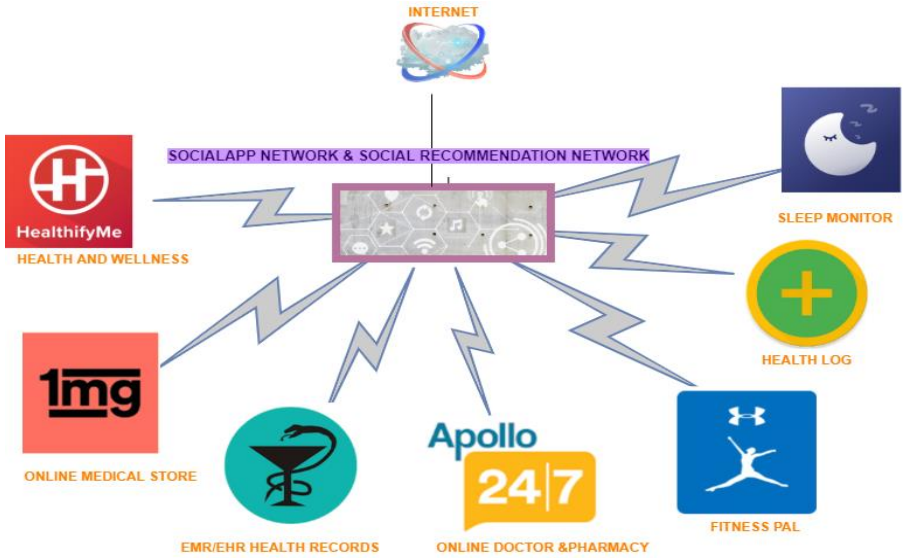

Fig. 3 Sample application of SIoT in VO health

5.3.2. Entertainment: Personalized Media & Mood-Based Suggestions

- Scenario: Priya, a movie enthusiast, wants personalized entertainment options.
- How it works: O M-Pilot tracks her interests from Flipboard, YouTube, and Prime Video.
- Based on her mood (detected via smart wearables and social media activity), M-Pilot suggests relevant movies or music.
- It reserves movie tickets via Book My Show and pre-orders snacks from Swiggy for home delivery.

5.3.3. Travel: Smart Itinerary Planning & Safety Assistance

- Scenario: Sita, a frequent traveler, relies on M-Pilot to plan and optimize her trips.
- How it works: O M-Pilot pulls her itinerary from TripIt and tracks flights via MakeMyTrip.
- On arrival, it suggests the best transport option (Ola, Uber) based on real-time traffic and cost.
- If she arrives late at night, M-Pilot integrates safety apps (Be Safe, My Safety Pin) to assess the safety of her location and suggest alternative routes.
- If she enters a low-safety zone, M-Pilot alerts her emergency contacts and suggests switching to a safer travel option.

6. Implementation Challenges of SIoT-Based Autonomous Intelligent Advisory System

The implementation challenges of M-Pilot are recognized as Identification of SO, Semantic Interoperability, and Connectivity. In general, the devices or objects in various platforms have to work in collaboration. Hence, selecting an operating system will be a challenging task. M-Pilot is a SIoT system comprising heterogeneous objects from different vendors; the connectivity and interoperability must be critically monitored. The processes should run with almost no delay time. The SO, their relationships, and the applications or services might change based on user requirements.

6.1. Identification of SO

M-Pilot relies on metadata collected from various SOs related to VOs. Data management and analytics are challenges associated with selecting relevant and compatible SOs. With an appropriate selection of SOs, ambiguity can be avoided.

6.2. Semantic Interoperability

One key aspect of M-Pilot is to provide interoperability between various SOs, which are health VO (Apollo 24/7), Family VO (Family360), and travel VO (OLA). Hence, M-Pilot aims to support the flow of SO information from interconnected SOs in VO and intra-connected SOs among various other VOs. The main challenge is to see that information must be blended to generate overall actions to increase efficiency with personalized recommendations based on contextual and cognitive intelligence for improving the QOL of the individual.

6.3. Connectivity

The connectivity among SOs in SIoT as things contain friendship circles of SOs. M-Pilot uses this SIoT data to build and maintain social relationships and profiles between people and things and between things and things that behave like social circles.

This is a major challenge in developing an automated intelligent advisory system that could have all the required information readily available, minimizing the delay and improving user experience. Few of the challenges of M-Pilot are discussed; however, there is a chance that new challenges may occur during implementation.

6.4. Technical Feasibility and Interoperability Challenges in Implementing the Framework

Implementing M-Pilot as an intelligent advisory system faces significant technical feasibility and interoperability challenges. One major issue is data integration across diverse platforms, as various applications use different data formats (JSON, XML, CSV) and communication protocols (REST APIs, MQTT, Graph QL), leading to data silos. Ensuring AI model adaptability across multiple verticals such as health, travel, and finance are another challenge, as models trained for one domain may not generalize well to others. Real-time decision-making in critical scenarios, such as health monitoring or financial fraud detection, requires low-latency processing, which can be constrained by cloud dependency. Moreover, context awareness and multimodal interactions introduce complexity, as M-Pilot must process voice, text, images, and sensor data while maintaining semantic consistency. Employing multimodal AI models can enhance contextual understanding, ensuring accurate and personalized recommendations.

7. Conclusion

Table 1. Proposed research with existing research findings

Aspect	Existing Research	Proposed Research
Social IoT (SIoT) Integration	Existing SIoT frameworks primarily focus on IoT-based networking and device-to-device communication, often lacking cross-platform integration for diverse applications. (e.g., IoT-based smart healthcare, smart homes, and smart transport operate independently).	M-Pilot extends SIoT by enabling interoperability between multiple Vertical Objects (VOs) (health, wealth, family, entertainment, safety, travel) using metadata-driven data sharing and intelligent recommendations.
Semantic Interoperability	Prior studies have proposed semantic web technologies, OneM2M, and FIWARE for improving data exchange in IoT-based environments. However, implementations often remain restricted to a single domain.	M-Pilot enhances cross-domain semantic interoperability, allowing mobile apps from different VOs to communicate effectively and provide integrated, personalized recommendations.
Personalization and AI-based Recommendations	Traditional recommendation systems focus on isolated sectors, such as AI-driven personalized healthcare, financial advisory, or smart transportation. However, they often lack holistic user context integration.	M-Pilot combines data from multiple SOs and VOs, leveraging rule-based AI predictions to provide real-time, context-aware, personalized advisory services across multiple life domains.
Use of Mobile Meta Data	Most existing mobile-based IoT research focuses on single-app optimization or device-to-device interactions without leveraging multi-app metadata for broader intelligence.	M-Pilot aggregates and analyzes metadata from multiple mobile apps, enabling multi-dimensional recommendations (e.g., health monitoring influencing travel plans or financial habits affecting lifestyle choices).

The proposed M-Pilot (an autonomous intelligent advisory system) aims to connect, communicate and interoperate among relevant social objects (mobile apps) of respective verticals. A unified framework with SIoT can interact with social objects to extract up-to-date data from mobile app metadata and create enhanced and updated electronic health records.

It provides an enhanced service as a personal assistant with personalized recommendations and access to the EHRs for further online/offline doctor consultations. This paper provides the design of a concept on health scenario social IoT framework by connecting with relevant mobile apps and discusses various challenges incorporated in implementation.

Through this, high-impact individual data can be created, which is a good source for governments to increase the quality and effective delivery of services, enhance the efficiencies of urban systems and empower citizens (e-health, smart transport, e-participation, e-services, e-government, etc.). It can be attached to government health-related policies. In the future, it can be implemented as a unified framework for multiple verticals.

7.1. Recommendation

In the context of the current status, the main motive of India's Smart Cities Mission is to achieve higher economic growth by improving the living conditions in the country to see it as a technological superpower. According to the "Imagine a New Connected World" report by KPMG in Oct 2019, the India Mobile Congress (IMC) focuses on creating an intelligent India through a new connected world. The proposed framework addresses the mission of India's Smart Cities and India Mobile Congress.

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