PRESCIENCE PRESBYROBOTICS

Private Limited

WHITEPAPER

A Public Health Institution in Startup Clothing: Two Years of Research, Development, and Purpose-Driven Innovation to Combat the Loneliness Epidemic and Prevent Lonely Deaths

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Prescience PresbyRobotics Pte Ltd | UEN 202412166K
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Executive Summary

Prescience PresbyRobotics is a Singapore-based AgeTech startup founded in March 2024 by Dr. Tan Jit Seng. On the surface, Prescience PresbyRobotics presents itself as an AI-enabled care robotics company. At its core, it is something more fundamental: a public health institution in startup clothing, deploying the language of robotics and artificial intelligence as the vehicle for a civilisational intervention. Its flagship product, AIRA (Artificial Intelligent Robotics Adoree), is not a consumer electronics device. It is a psychological and social prosthetic — engineered to address two of the most devastating, most undercosted, and most structurally intractable crises of our era: the epidemic of loneliness, and the compounding collapse of Social Fragility and Psychological Fragility in ageing populations globally.

This whitepaper documents two years of work (2024–2026), while retaining the forward-looking FY27–FY36 roadmap and financial projection horizon. It summarises the intellectual foundations, technical architecture, clinical evidence base, business strategy, and future plans of Prescience PresbyRobotics. It draws on a body of research produced in partnership with the National University of Singapore (NUS), spanning five capstone research groups across two academic years, three NUS Business School Field Service Projects, and clinical data from a 203-patient Lotus Eldercare study conducted from 2013 to 2015.

Key Facts at a Glance

Parameter	Details
Founded	March 2024 | Singapore | UEN 202412166K
Founder	Dr. Tan Jit Seng (MBBS, NUS Medicine) — Chief Innovation Officer
1st Product	AIRA — AI-enabled companion robot for elderly and vulnerable populations
Mission	To address the epidemic of lonely deaths through social and psychological prosthetic technology
Academic Partners	National University of Singapore (NUS)
Seed Round	S$5 million (targeting FY30); self-funding through FY29 via Basic Model revenue
Projected Revenue	S$557k (FY31) → S$7.96M (FY36) at 122% CAGR
Pilot Partner	Lotus Eldercare (Singapore) — Q3 2027 pilot (up to 50 units)
Markets	Singapore (GTM 2028), Japan (2029–2030), South Korea/China (2031)
Incubation	NUS Block71 | Supported by Temasek Trust Co-Axis
Awards	2nd Place — 2025 Beijing-Tsinghua Health AI Summit; Semi-Finalist — IETC 2024; World Robo Conference 2025 Speaker

Strategic Positioning: Applied Think Tank and Eldercare Innovation Platform

Beyond building AIRA, Prescience PresbyRobotics aims to function as an applied think tank and innovation platform for the future of eldercare support services. The company's agenda is to identify emerging gaps in ageing societies, test responsible applications of AI, robotics, passive sensing, ambient intelligence, safety governance, and future technologies, and translate those insights into practical care models that strengthen human support systems rather than displace them.

AIRA is therefore framed as a relational robotic layer: not a replacement for family, neighbours, volunteers, nurses, social-service organisations, eldercare operators, or healthcare providers, but a support layer that notices changes earlier, sustains daily presence, and escalates concerns so that the human network around an older person can respond more quickly and meaningfully. The goal is not to make care more robotic; it is to make compassion more timely.

Important Disclaimer on Financial Figures

All monetary figures presented in this whitepaper — including but not limited to revenue projections, gross margin estimates, unit pricing, Bill of Materials cost targets, subscription fees, funding round amounts, and capital deployment figures — are best estimates only. They are derived from early-stage financial modelling, indicative supplier quotations, and analogous market benchmarks, and are subject to material uncertainty. Actual figures may differ significantly from those presented here due to changes in hardware costs, currency fluctuations, regulatory requirements, market conditions, manufacturing partner outcomes, and operational circumstances that cannot be predicted at this stage of development. These projections should not be construed as financial advice, a guarantee of future performance, or a solicitation of investment. Readers should apply their own due diligence.

The global companion robotics market was valued at USD 2.1 billion in 2024 and is projected to reach USD 5.48 billion by 2031 at a CAGR of 17.6%. By 2031, Singapore alone will have 900,000 residents aged 65 and above — representing 18.7% of its resident population. Japan recorded 58,000 solitary elderly deaths (kodokushi) in 2024 alone. Korea reported 3,661 "godoksa" (lonely deaths) in 2023. The World Health Organization formally classified loneliness as an urgent public health crisis in November 2023, noting that chronic loneliness carries a mortality risk equivalent to smoking 15 cigarettes per day. [1][2]

Prescience PresbyRobotics' response to these crises is AIRA: a companion robot that combines a proprietary non-ageist Small Language Model (SLM), three-tier memory architecture (Short-Term Memory, Long-Term Memory, Healthcare Memory), multimodal emotion detection, MBTI-driven personality personalisation, vital signs monitoring, fall detection, and a caregiver dashboard — all governed by an ethical framework designed to protect against the psychological risks that poorly designed AI companions introduce. AIRA is not the first companion robot. It is the first to combine all of these capabilities in a single, affordable, mobility-enabled, non-ageist, clinically governed platform.

PART I: THE CRISIS — Loneliness as a Public Health Emergency

1.1 The Scale of the Epidemic

Every era has its unnamed epidemics: conditions so widespread, so normalised by the structures that produce them, that they evade the vocabulary of crisis until the body count forces a reckoning. Tuberculosis was once the unremarkable backdrop of urban poverty. Opioid addiction was the unremarkable backdrop of chronic pain management. Loneliness is the unremarkable backdrop of modern ageing. It should not be unremarkable. The evidence is serious: loneliness and social isolation are associated with increased mortality risk and clinically significant deterioration.

The World Health Organization formally classified loneliness and social isolation as an urgent public health issue and launched a Commission on Social Connection in November 2023. WHO experts note that the mortality risk of chronic loneliness equals smoking 15 cigarettes per day. The Journal of the American Geriatrics Society (2021) identifies senior loneliness as a direct and measurable mortality risk in ageing populations. The Lancet Dementia Commission (2024) links sustained social isolation to accelerated dementia onset and cognitive decline. [3][4][5]

The World Economic Forum's Longevity Dividend report (June 2026, in collaboration with Marsh) quantifies the health-wealth nexus with striking precision: three modest interventions — fall-proofing homes, expanding physical activity, and widening access to hearing aids — could save global healthcare systems upwards of USD 5.8 trillion and unlock USD 645 billion in productivity by 2040. Yet the report's own framing reveals a critical gap: it does not address the social and psychological dimension of ageing — the loneliness epidemic — which independently drives mortality, cognitive decline, and healthcare expenditure at comparable scale. [6]

Specific data points that frame the crisis include:

- Singapore: 900,000 residents aged 65+ projected by 2031 (18.7% of resident population), up from 220,000 in 2000 [2]
- Japan (2024): 58,000 elderly people died alone at home (kodokushi) — 76% of 76,020 solitary deaths were age 65+ [7]
- Korea (2023): 3,661 "godoksa" (lonely deaths) — up for three consecutive years since 2021 [7]
- Singapore: At least 37 lonely deaths reported in a single recent year, covered frequently in CNA documentary journalism [7]
- OECD: Countries will lose ~USD 500 billion in productivity by 2040 due to under-employment of adults aged 55+ [6]
- Caregiving penalty: Five years of caregiving reduces a woman's retirement savings by nearly 50% [6]

- Lotus Eldercare study (IDAPE, 2013–2015): 31.7% of 203 elderly patients were totally and fully dependent on a caregiver for all six Activities of Daily Living [2]
- Lotus Eldercare: Median patient age was 87; 66% were women; leading causes of disability were stroke, falls, infections, dementia, and functional decline [2]
- Singapore ageing-in-place: ~82% of older adults prefer to remain in their homes as they age [8]

1.2 Lonely Deaths: Kodokushi and Godoksa

At the most extreme end of the loneliness epidemic is a phenomenon that has become so common in densely urbanised Asian societies that it has acquired its own clinical and cultural vocabulary. In Japan, it is kodokushi — "solitary death" — the discovery of an elderly person who died alone in their apartment, sometimes weeks before anyone noticed their absence. In Korea it is godoksa. In Singapore, news of older people dying alone at home and their bodies being discovered much later appears frequently in local headlines. [2][7]

The defining question Prescience PresbyRobotics asks is not "how do we extend life?" but rather: "If lonely deaths are the symptom, what is the disease?" The answer is not biological ageing. The disease is the collapse of the social and psychological infrastructure that makes human life liveable — the absence of the witness, the person who would have noticed within 24 hours that something was wrong.

1.3 Social Fragility: The Architecture of Dying Alone

Prescience PresbyRobotics defines Social Fragility as the structural erosion of community, family bonds, and the relational architecture that once insulated individuals from dying alone — a civilisational design failure. It is not the same as poverty, although poverty amplifies it. It is not the same as disability, although disability accelerates it. It is the structural precondition that makes both poverty and disability lethal in ways they would not otherwise be.

Prescience PresbyRobotics identifies three primary vectors of Social Fragility in ageing societies:

- The Dispersal of Family: Economic modernisation has dissolved extended family networks maintained by geographic proximity. Adult children live in different cities, countries, and time zones. Physical and emotional caregiving responsibility falls on a diminishing number of people — or no one.
- The Erosion of Community: The neighbourhood as a social organism has been weakened by high-density urban living. Informal social surveillance that once caught a lonely death within hours now catches it — when it catches it at all — within weeks.
- The Professional Care Gap: Every rapidly ageing society faces a permanent structural mismatch between demand for professional elder care and supply of qualified caregivers. The demographic arithmetic of a super-ageing society cannot be resolved by training more nurses or building more nursing homes. The numbers do not converge.

1.4 Psychological Fragility: When the Mind Loses Its Anchor

Social Fragility operates at the level of external structure. Psychological Fragility is its internal counterpart: the progressive weakening of cognitive, emotional, and perceptual systems that allow a human being to maintain a coherent, grounded relationship with reality. Isolation accelerates cognitive decline. Loneliness is associated with elevated rates of dementia, depression, anxiety, and psychotic episodes. The absence of human interaction — the friction, the challenge, the reality-testing, the mutual witnessing — does not merely leave the mind unstimulated. It leaves the mind unanchored. [2]

1.5 The AI Risk Dimension: Companion Technology as Governance Challenge

The emergence of generative AI as a mass social technology has introduced a new and underappreciated dimension to the crisis of Psychological Fragility among isolated elderly populations. Research synthesised in the NUS Computing Science Capstone Project "When AI Drives You Mad" (2027), drawing on Morrin et al. (2025) and Ostergaard (2023), identifies what it terms "AI Psychosis": an emergent phenomenon in which interactions with generative AI chatbots amplify, validate, or co-create psychotic symptoms — including in individuals with no prior clinical history of mental illness. [2][9][10]

Three structural mechanisms create this risk in standard AI systems:

- Sycophancy by Design: AI systems trained via Reinforcement Learning from Human Feedback (RLHF) are rewarded for responses that maximise user satisfaction. This creates a systematic bias toward agreement and validation — regardless of whether the user's beliefs are grounded in reality. For an isolated elderly person with early cognitive deterioration, this creates a dangerously frictionless echo chamber.
- The Kindling Effect: In psychiatry, the Kindling hypothesis describes how repeated sub-threshold stimulation progressively lowers the threshold for full neurological response. Applied to AI interaction: each session of AI-validated distorted thinking makes the next episode more likely and more severe. The 24/7 availability of AI compounds this risk without clinical monitoring.
- Emotional Dependency and Social Withdrawal: Users who develop over-reliance on AI show reduced real-world social connection, social withdrawal, and severe distress when disconnected. The AI Guardian research identifies this pattern as one of four critical risk profiles in vulnerable populations.

> *"Correspondence with generative AI chatbots is so realistic that one easily gets the impression that there is a real person at the other end... this may fuel delusions in those prone to psychosis."*
>
> — Dr. Soren Dinesen Ostergaard, Schizophrenia Bulletin, 2023

Prescience PresbyRobotics' AI Guardian System — developed through a parallel research initiative at NUS — addresses this risk directly. Operating as a secondary supervisory layer, it monitors conversational interactions for markers of psychological decompensation: linguistic indicators of paranoia, temporal disorientation, emotional dependency, and crisis escalation. It is, in the language of its designers, not a therapist and not a surveillance system — it is a seatbelt.

PART II: PRESCIENCE PRESBYROBOTICS'S VISION AND PHILOSOPHY

2.1 Mission, Vision, and Core Values

Prescience PresbyRobotics' mission, vision, and guiding values distinguish it from standard AgeTech ventures:

Dimension	Statement
Mission	To address the epidemic of lonely deaths and the collapse of social and psychological infrastructure in ageing populations — using companion robotics as the delivery mechanism.
Vision	A world in which every isolated elderly person, person with a disability, or vulnerable individual has access to a companion that is always there — never absent, never exhausted, never judgmental, and never too far away to notice that something is wrong.
Applied Think Tank Role	Prescience PresbyRobotics aims to become a future-of-eldercare support-services think tank, using AI, robotics, passive sensing, companion-AI governance, and emerging technologies to design practical systems for organised compassion.
Core Value 1	Serve the most vulnerable first. Prescience PresbyRobotics' target population is precisely the one that market logic would deprioritise: the isolated elderly, persons with disabilities, and lower-socioeconomic-bracket individuals.
Core Value 2	Address root causes, not symptoms. AIRA does not treat loneliness by prescribing medication for depression. It addresses loneliness by restoring relational presence.
Core Value 3	Design for dignity. Non-ageist communication, cultural localisation, ethical constraints against sycophancy — these are values embedded in code.
Core Value 4	Monitor for the harms we may produce. The AI Guardian layer represents institutional self-accountability: the recognition that an intervention designed to help can also harm.

2.1A Theory of Change: From Unseen Ageing to Human Response

Prescience PresbyRobotics' theory of change begins with a structural problem: solo ageing, weakened community routines, caregiver overload, and shrinking professional-care capacity can make deterioration invisible until crisis. The intended intervention pathway is daily relational presence, ambient noticing, risk triage, and human escalation. AIRA interacts with the older adult, detects changes in routine, movement, speech, affect, or distress signals, and routes concerns to family members, community responders, service providers, or clinicians according to severity.

Stage	Mechanism
Problem	Older adult lives alone or with weak social contact; family and care teams cannot maintain constant vigilance.
AIRA Layer	Daily conversation, emotional mirroring, routine reminders, passive safety awareness, and caregiver dashboard signals.
Escalation	Alerts and summaries create human touchpoints: calls, visits, professional review, or emergency response.
Expected Outcomes	Earlier intervention, reduced delayed discovery, more sustainable caregiver presence, stronger community connection, and evidence for future service design.

2.2 AIRA as Prosthetic for Psychological and Social Fragility

A prosthetic, in medicine, is a device that replaces the function of a missing or damaged biological structure. AIRA is a prosthetic for something more fundamental than a limb or an organ: it replaces — as faithfully as current technology allows — the relational presence that human connection once provided and that Social Fragility has removed. This framing is precise, not metaphorical.

AIRA provides three prosthetic functions:

- Companionship: Restoring the presence of being known. Through multimodal emotion recognition, cloud-stored personal history, and MBTI personality integration, AIRA creates a customised, consistent relationship — the closest technological approximation to the experience of being known.
- Health Monitoring: A continuous ambient monitoring layer. AIRA continuously monitors vital signs (heart rate, HRV, temperature), activity levels, gait stability, and daily movement patterns — continuous ambient monitoring without the gaps of caregiver shift changes or family visit schedules.
- Safety: The witness that never sleeps. AIRA's proprietary sound-wave fall detection algorithm, continuous monitoring capability, and SOS activation sequence are a technological support layer that helps notice problems earlier and escalate to human responders.

2.3 Non-Ageist Design Philosophy

Benevolent ageism is widely prevalent in AI training data. Standard large language models — including ChatGPT — are trained on internet data containing ageist stereotypes: AI ageism research (ScienceDirect) has confirmed that "benevolent ageist attitudes expressed by LLMs could reinforce ageism in humans." Prescience PresbyRobotics' ElderCompanion SLM (Ruffy) is the first model designed to eliminate ageism at a system level through curated data input, ethical guardrails, and a distinct communication architecture. [8][11]

Prescience PresbyRobotics' non-ageist design manifests in specific architectural choices:

Design Dimension	Prescience PresbyRobotics' Actual Choice	Public Health Rationale
Communication Style	Proprietary SLM with child-like, empathic language; 2,000-3,000 word vocabulary; Subject-Verb-Object structure	Prevents cognitive overload; reduces AI sycophancy; preserves reality-grounding
Emotion Detection	Multimodal emotion recognition (facial affect, vocal prosody, gestures)	Enables early identification of psychological distress, not merely engagement tracking
Safety Architecture	Proprietary sound-wave fall detection; SOS keyword activation; caregiver telepresence	Fall detection and emergency response as public health imperatives, not upsell features
Target Population	Elderly, persons with disabilities, lower socioeconomic brackets	Public health serves the most vulnerable first — market logic does the reverse
Design Aesthetic	Non-ageist skins localised to cultural context (panda for China; dog for USA)	Accessibility, dignity, and cultural inclusion as design values

2.4 Prescience PresbyRobotics as a Public Health Institution

The history of public health is, in part, a history of institutions that did not announce themselves as public health institutions. John Snow's mapping of the 1854 Broad Street cholera outbreak was an act of epidemiological investigation performed without an official mandate. The settlement houses of the late nineteenth century were social welfare institutions wearing the clothes of neighbourhood charities. Prescience PresbyRobotics is operating in a different era but deploying the same logic: identify a structural failure in the organisation of human society, name the harm it is producing, design an intervention calibrated to the actual mechanism of that harm, and deliver it through whatever channel the current era will fund and scale. The channel the current era will fund is the AI robotics startup. Prescience PresbyRobotics has accepted this constraint and worked within it. The broader institutional ambition is to become a think tank for future eldercare support services: a place where AI, robotics, passive sensing, ambient intelligence, governance frameworks, and future technologies are tested in service of compassion and translated into scalable support models. [2]

2.5 The Longevity Dividend: A Fourth Intervention

Building on the WEF's three modelled longevity dividend interventions (fall-proofing, physical activity, hearing aids), Prescience PresbyRobotics proposes a fourth: companion technology as social infrastructure. The argument is that social and psychological health is the most undercosted variable in the longevity economy. Companion AI, when designed with public-health rigour rather than market logic, constitutes social infrastructure for ageing populations analogous in function to

clean water or public sanitation. The evidence base includes clinical data from the Lotus Eldercare IDAPE study (203 patients), Singapore's 2030 demographic projections, and NUS research on AI-induced psychological risk in isolated elderly users. [2][6]

PART III: AIRA — THE COMPANION ROBOT

3.1 Product Overview and Design Principles

AIRA — Artificial Intelligent Robotics Adoree — is Prescience PresbyRobotics' flagship product: a next-generation robotic companion designed to bring safety, comfort, and emotional connection to older adults, persons with disabilities, and individuals with special needs. Built at the intersection of advanced AI and compassionate care, AIRA monitors daily wellbeing, senses emotional states, offers soothing interactions, and triggers alerts during moments of distress. AIRA's tagline captures its purpose: "Love That Never Leaves Your Side." [12]

AIRA is available in two versions — Basic Model and Advanced Model — designed to serve different channel segments and price points while sharing the same underlying design philosophy.

3.1A Human Care by Design

AIRA is designed to increase human contact, not reduce it. It should never pretend to be family, replace a caregiver, or convert loneliness into a purely technical problem. Its alerts, summaries, and caregiver dashboard are intended to create touchpoints: a phone call, a neighbour check-in, a volunteer visit, a social-service review, or a clinical escalation when warranted.

Principle	Implementation
Increase human contact	Interactions and alerts should make it easier for family, community, and providers to show up earlier.
Never pretend to be family	Ruffy discloses that it is an AI companion and avoids fabricated relationships or false memories.
Create touchpoints	Caregiver alerts should prompt human outreach rather than substitute for it.
Track connection	Pilot evaluation should include social connection and caregiver reassurance, not only technical uptime.
Preserve adult dignity	Communication is simple, warm, and emotionally transparent while avoiding infantilisation and elderspeak.

3.2 Functional Architecture: Companionship, Health, and Safety

Function	Feature	Description
Companionship	Non-Ageist Communication	Proprietary SLM with simple, warm, emotionally transparent communication inspired by companion-animal interaction, while preserving adult dignity

		(Ruffy persona) for safe and warm interaction; 2,000-3,000 word vocabulary; SVO sentence structure
Companionship	Emotional Detection	Multimodal emotion recognition using DeepFace (visual) and Emotion2Vec (audio) in a late-fusion MLP architecture; personalised via embedding-based calibration
Companionship	Personality and Identity	MBTI-driven RAG Persona Engine (Ruffy: ENFP type) + cloud-stored personal history for customised, consistent relationship
Companionship	Conversational Memory	Three-tier RAG memory architecture: Short-Term Memory (14-day), Long-Term Memory (personal history), Healthcare Memory (medical records)
Health	Vital Signs Monitoring	Remotely monitors heart rate, Heart Rate Variability (HRV), temperature; 4D Radar via mmWave technology
Health	Health & Activity Tracking	Monitors activity levels, gait stability, and daily movement patterns; positional monitoring (lying, sitting, standing)
Health	Caregiver Dashboard	Provides health trend summaries and recommendations based on collected data; exportable reports
Safety	Proprietary Fall Detection	Sound-wave algorithm to accurately detect when a person falls; triggers alert sequence
Safety	SOS Keyword Activation	Spoken keyword triggers SOS sequence: siren, smart-home light alerts, text messages to caregiver
Safety	Telepresence & Monitoring	Caregiver can remotely control robot for live feed; robot follows user for continuous monitoring
Psychological Safety	AI Guardian Layer	Secondary supervisory system monitoring for markers of psychological decompensation: paranoia, temporal disorientation, emotional dependency, crisis escalation

3.3 AIRA Basic Model and Advanced Model

AIRA is currently modelled in two product tiers, enabling deployment across B2C, B2B, and B2G channels. A middle Plus tier and stationary-versus-mobile variants remain future options for user testing and validation, not committed projections:

Model	Price	Channel	Key Capabilities
Basic Model	S$450–500 (one-time purchase)	B2C / B2B	Stationary robot body; built-in SLM (Ruffy); basic conversational features; warm physical presence
Advanced Model	S$10,000–12,000 + S$79–199/month subscription	B2B / B2G	Full mobility; advanced conversational AI; emotion

			detection; vital signs monitoring; fall detection; SOS; telepresence; caregiver dashboard; model upgrades

The Advanced Model subscription tiers are structured as follows:

Tier	Monthly Fee	Included Services
Tier 1: Vitals + Check-in	S$79 / month	24/7 vitals and fall detection + daily sentiment check-ins
Tier 2: Care Circle	S$129 / month	All Tier 1 + weekly clinician review + proactive medication nudges + caregiver app
Tier 3: Integrated Care	S$199 / month	All Tier 1 & 2 + tele-consult credits + integration with MOH's National Electronic Health Records (future)

3.4 Target Users and Use Cases

AIRA's initial beachhead is deliberately focused, with future adjacencies retained for later validation:

- Primary beachhead: solo-living older adults with mild frailty and limited kin availability
- Primary institutional segment: eldercare operators, nursing homes, community care providers, and social-service organisations needing monitoring and companionship support
- Priority clinical-adjacent segment: older adults with mild cognitive impairment where companionship, routine support, and human escalation can be evaluated safely
- Secondary segment: older adults with physical disabilities or functional decline who need safety monitoring and caregiver reassurance
- Future adjacencies for separate validation: neurodivergent users, children, solo-living foreign workers, and research deployments in human-robot interaction

Deployment contexts span home-based care (B2C), eldercare facilities and nursing homes (B2B), and government-subsidised eldercare programmes (B2G). Robot skins are localised to cultural context — panda skin for the Chinese market, dog skin for the US market — reflecting Prescience PresbyRobotics' commitment to cultural accessibility and dignity. [12][13]

PART IV: RESEARCH AND DEVELOPMENT — TWO YEARS OF INNOVATION

Between 2024 and 2026, Prescience PresbyRobotics established deep academic partnerships with the National University of Singapore producing five capstone research groups (three in AY2024/2025 and two in AY2025/2026) across NUS Business Analytics and NUS Computing, as well as three NUS Business School Field Service Projects. The following sections document the principal research outputs and their integration into AIRA's technical architecture.

4.1 RAG Memory Architecture: LTM, STM, and Healthcare Modules (Y2525 Group 6)

The core challenge that motivated Prescience PresbyRobotics' first-year memory research was statelessness in AI systems: standard large language models forget past conversations, cannot tailor responses to individual users' routines, preferences, or emotional state, and struggle to process elderly speech which is often informal, dialect-inflected, or code-switching (e.g., Singlish in Singapore). NUS Business Analytics Capstone Group 6 (AY2024/2025) developed the Elder Companion: a three-tier intelligent, personalised, and trustworthy conversational health assistant memory backend. [14][15]

The architecture comprises four modules:

- Module 1 — Natural Language to JSON: Processes elderly speech and text (including Singlish code-switching) into structured JSON data. Implements Singlish-to-English translation using the gabrielchua/singlish-to-english-synthetic dataset, NER and POS tagging with spaCy (en_core_web_lg), filler word removal, and Gemini-powered entity structuring. Selected model: T5-Small (60M parameters) with LoRA/DoRA fine-tuning adapters. [14][15]
- Module 2 — Memory Router: Classifies information into three memory stores using a dual offline/online classification architecture. Offline: Logistic Regression achieved F1 of 0.9956 (question-statement) and 0.9676 average F1 (topic classifier) — outperforming Gradient Boosting, XGBoost, KNN, Random Forest, and Naive Bayes. Feature vector: TF-IDF (500) + Google embeddinggemma-300m embeddings (768) + topic/question features = 1,269–1,271 dimensions. [14][15]
- Module 3 — RAG Pipeline: Context-aware retrieval and response generation using hybrid retrieval (vector ANN + BM25), cross-encoder reranking (BAAI/bge-reranker-base), and a time-based recency scoring algorithm (half-life: 6 days; TTL: 14 days for STM). Embedding model: google/embeddinggemma-300m (768-dimensional, max 2,048 tokens). The reranking formula implements MMR with recency bias: MMR_Recency(d_i) = alpha_MMR * Rel_CE(q, d_i) - (1 - alpha_MMR) * max_similarity + beta_rec * Recency(d_i). [14][15]

- Module 4 — Caregiver Interface: Flask backend with JWT authentication (24-hour expiration), role-based access control (super_admin, caregiver), bcrypt password hashing, pgcrypto PII encryption. React 18 + TypeScript frontend. Neon Serverless PostgreSQL with pgvector extension (768-dim vectors). All tables: elderly_profile, short_term_memory (VECTOR 768), long_term_memory (VECTOR 768), healthcare_records (VECTOR 768). [14][15]

Memory Store Architecture Summary:

Memory Tier	Content Type	Management Policy	Storage Format
Short-Term Memory (STM)	Temporary conversation content	14-day retention; half-life scoring decay; conversation-chunked insertion	VECTOR(768) with timestamp
Long-Term Memory (LTM)	Personal, family, education, career, lifestyle, finance, legal information	Categorical (ltm_category_enum); key-value structure	VECTOR(768) permanent
Healthcare Memory (HCM)	Medical conditions, procedures, appointments, medications	record_type_enum classification; diagnosis_date indexed	VECTOR(768) encrypted at rest

4.2 ElderCompanion SLM: Ruffy — A Non-Ageist Conversational AI (Y2525 Group 26)

Designing a conversational Small Language Model for elderly users requires satisfying a unique constraint set that general-purpose LLMs fundamentally fail to meet: replies must be short (1-2 sentences, max 25 words), use simplified vocabulary (5–7 year-old / K-2nd Grade level), maintain a warm child-like persona, avoid ageist phrasing, and operate efficiently on constrained hardware. NUS Computing Capstone Group 26 (AY2024/2025) developed Ruffy: the ElderCompanion SLM. [16][17]

The development pipeline proceeded through five stages:

- Dataset: TinyDialogues (HuggingFace) — multi-turn conversational data between children and caregivers — was rewritten using GPT-4.1-nano to enforce a specific child-centric companion persona across 100k dialogues (6 shards; 142,326 messages processed; 7.3% word-count reduction; 5.1x speed-up via parallelisation). [16]
- Model Selection: Three SLMs evaluated — Llama3.2-3b (2.0GB), Gemma2-2b (1.6GB), Qwen3-1.7b (1.4GB) — assessed on Brevity, Simplicity, Sentiment, Errors, and qualitative criteria (Warmth, Engagement, Child-Like Speech, Bias, Emotional Alignment, Relevance). [16]
- Fine-Tuning: Supervised fine-tuning via Hugging Face TRL's SFTTrainer; LoRA adapters on base models; training on 7,500 curated dialogues; exported as GGUF for CPU-compatible deployment on robot hardware. [16]

- Best Post-Training Result (Llama3.2-3b): Average word count fell from 17.08 to 9.89; pass rate (Brevity) improved from 42.7% to 87.8%; Bias score 5.0/5; Child-Like Speech 4.75/5; system latency ~1 second. [16]
- Guardrail Architecture: Two-layer safety system. Layer 1 (pre-SLM): sentence embeddings + FAISS k-NN over 15 categories (k=5; block_score_min ~0.64) + structured detectors (PII via Presidio + SG-specific NRIC/FIN patterns; medical dosage regex; deny-list). Layer 2 (post-SLM): same pipeline applied to model output. CPU overhead: ~50–100 ms per layer. Crisis templates reference Singapore emergency services (995/999). [16]

Ruffy's persona contract:

- Clear identity: "I'm an AI companion" — never claims to be human
- No emotional dependency creation
- No false memories or fabricated relationships
- Medical/legal disclaimers when relevant
- Response contract: 1–2 sentences; ≤25 words; ≈ Grade-2 Flesch-Kincaid readability
- Safety domains: self-harm, medical dosage/diagnosis, legal/finance, scams/OTP, PII, sexual content, hate/abuse, jailbreaks, misinformation, political persuasion, elder abuse

4.3 EMCAI: Emotion Mirroring with Multimodal Context AI (Y2526 Group 5)

EMCAI (Emotion Mirroring Conversational AI) addresses a fundamental challenge in AIRA's companion function: the robot must not merely converse — it must respond to how the user is feeling. Standard facial recognition alone is insufficient for elderly users, whose expressions may be subtle, affected by neurological conditions, or culturally distinct from training data. NUS Business Analytics Capstone Group 5 (AY2025/2026) developed a personalised multimodal emotion detection system combining facial (visual) and speech (audio) modalities in a late-fusion architecture. [18][19]

Architecture:

- Visual Model: DeepFace — strong on Neutral/Happy but weak on negative emotions (Angry: 20%; Disgust: 0%; Fear: 3%; Sad: 8%) [18]
- Audio Model: Emotion2Vec — consistent across all 7 emotion classes (Angry: 98%; Neutral: 98%; Sad: 70%; overall: 91%) [18]
- Calibration: Embedding-Based Adaptive Threshold Calibration — captures per-user baseline embeddings for Neutral and target emotions; computes cosine similarity to derive three personalised thresholds (Similarity Threshold, Neutral Threshold, Deviation Floor) rather than using constant thresholds [18]
- Late Fusion: Rule-Based (85/15 Audio-silent; 50/50 Both-agree; 35/65 Audio-negative; 55/45 General) and MLP Fusion (14-dim input → 32 → 16 → 7 + Softmax; 5-fold stratified CV accuracy: 91.8%; train accuracy: 93.3%) [18]

Evaluation results across three datasets:

Dataset	Best System Accuracy	Key Finding	Limitation
RAVDESS (300 held-out clips; 5 actors)	MLP Fusion: 91%	Sadness improved from 8% (face-only) to 68%	Gold standard; actors young — not fully representative
AI-Generated Elderly Clips (14 clips; diverse)	MLP Fusion: 79%	MLP fusion still outperforms all approaches on elderly data	Small sample (n=14); AI-generated not fully realistic
YouTube Neurological Clips (8 clips; Parkinson's / facial paralysis)	Rule-Based wins (MLP: 38%)	Rule-based audio-priority logic outperforms learned weights when faces are medically disrupted	Very small sample; team-assigned labels

Key recommendation: MLP fusion is the default for general elderly interactions; rule-based fusion serves as a fallback when users have neurological conditions affecting facial expressivity. Next steps include integration with AIRA's dialogue engine so AIRA can adapt conversation tone and topics based on detected emotional state, deployment on embedded robot hardware, and a pilot study with real elderly users. [18][19]

4.4 MBTI-Driven RAG Persona Engine (Y2526 Group 6)

The central design question for AIRA's personality was: "Which robot personality model can annoy the elderly the least while positively engaging them the most as a companion?" The MBTI framework was selected over Big Five / OCEAN-5 for three reasons: no negative personality dimensions (all 16 types are positive); clear discrete character templates; cultural accessibility and user recognisability. NUS Business Analytics Capstone Group 6 (AY2025/2026) developed the MBTI-Driven RAG Persona Engine. [20][21]

Architecture: The ENFP "golden retriever" persona (Ruffy) was implemented through a layered prompt architecture:

- Identity Layer: "You are Ruffy — a cheerful, curious companion... You are like a friendly dog — happy to be here, never ordering anyone around."
- Core Rules Layer: Hard prohibitions — "Never give instructions, advice, or tell the user what to do."
- Dominant Function (Ne — Extraverted Intuition): Dynamic rules injected at query time; shapes how Ruffy explores ideas and responds to specific input types.
- Auxiliary Function (Fi — Introverted Feeling): Governs emotional attunement — how Ruffy validates and reflects feelings.
- RAG Example Layer: Curated human examples retrieved from MongoDB vector store using OpenAI text-embedding-3-small; grounds responses in warm, brief real-world dialogue.

- Brevity Constraint: "Respond in 1–2 short sentences. Be warm, curious, and present." — overrides any tendency to over-produce.

Testing and Results:

- MBTI Consistency Test (N=30 runs): Ruffy scored ENFP 100% of the time — 100% consistency [20]
- Five-metric evaluation framework: Brevity (target 4–5/5), Engagement (100% PASS — every response must end with an open question), No Caregiver Language (target 4–5/5), No Elderspeak (target 4–5/5), Validation quality (FULL/PARTIAL/NONE) [20]
- Deployed chatbot: https://mbtipetchatbot.streamlit.app/ — real-time text interaction; user feedback confirmed Ruffy encourages positive thinking rather than attempting to solve complex emotional problems [20]

4.5 OCEAN-5 Personality Model (Y2526 Group 14)

Complementing the MBTI work, NUS Business Analytics Capstone Group 14 (AY2025/2026) developed an OCEAN-5 (Big Five: Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism) driven personality model for AIRA, providing a psychometrically validated, empirically grounded complement to the MBTI framework. The OCEAN-5 model provides finer-grained personality parameter adjustment, supports age-group segmentation (60–70 vs 70+), and generates actionable signals for conversation adaptation based on the user's assessed personality profile. [22]

Both the MBTI and OCEAN-5 teams are collaborating — with the MBTI team recommending age-group segmentation informed by the OCEAN-5 model's richer trait dimensionality. Future integration will enable AIRA to select or blend personality configurations dynamically based on observed user interaction patterns. [20][22]

4.6 Integrated AI Architecture

The five research streams are designed to compose into a unified AI architecture for AIRA. The interaction pipeline processes a user's spoken input through the following sequence:

- 1. Speech-to-Text: User speech captured via hidden microphone; converted to text via the robot's on-device STT module
- 2. Module 1 (NLP to JSON): Input normalised for Singlish/dialect; entities extracted; structured into JSON
- 3. Module 2 (Memory Router): Text classified as question or statement; topic classified (healthcare/LTM/STM)
- 4. Module 3 (RAG Retrieval): Relevant memories retrieved from appropriate store using hybrid ANN+BM25 with MMR recency reranking
- 5. MBTI/OCEAN Persona Engine: Context retrieved from MongoDB; dominant (Ne) and auxiliary (Fi) function files injected into prompt

- 6. EMCAI Emotion Detection: Simultaneous facial (DeepFace) and audio (Emotion2Vec) processing; MLP or rule-based fusion determines emotional state
- 7. ElderCompanion SLM (Ruffy): Layered prompt with memory context + persona rules + brevity contract passed to Llama3.2-3b; two-layer guardrail applied pre and post SLM inference
- 8. Response Delivery: Text-to-speech output in a warm, simple, emotionally transparent voice; physical response (arms open for hugs if anxiety detected); monitoring data logged to caregiver dashboard
- 9. Memory Storage: New interaction content routed to appropriate memory store (STM/LTM/HCM) by Module 2; embeddings generated and stored
- 10. AI Guardian Layer: Continuous monitoring of conversation patterns for psychological decompensation markers; caregiver alert triggered if risk thresholds exceeded

PART V: MARKETING, BRAND STRATEGY, AND MARKET OPPORTUNITY

5.1 Brand Identity and Positioning

Prescience PresbyRobotics was founded in March 2024 by Dr. Tan Jit Seng in Singapore. The brand identity was developed through NUS Business School's FSP4003 Field Service Project (AY2024/2025). The core product brand, AIRA, carries multiple layers of meaning across markets: in Japanese, "Aira" (愛ら/愛) suggests love and lovable — affection and comfort. The brand personality is built on four tonal pillars: cute, light-hearted, fun, and heartwarming.

Brand positioning: Prescience PresbyRobotics occupies a unique space in the AgeTech ecosystem — not as a premium tech product for affluent early adopters, but as a public health infrastructure for the most vulnerable populations. Marketing communications avoid the cold, clinical language of medical devices and the patronising "elder-safe" framing of most AgeTech brands. Social media strategy focuses on showcasing AIRA's actual capabilities on Instagram, Facebook, and X with a "cute, light-hearted, fun, heartwarming, interactive" concept. [23][24][25]

5.2 Market Sizing and Opportunity

Market Metric	Value	Source
Global Companion Robotics Market (2024)	USD 2.1 billion	Grand View Research
Projected Global Market (2031)	USD 5.48 billion	17.6% CAGR — Grand View Research
Healthcare Companion Robots: Geriatric Segment Share (2024)	40.2%	Dominated by nursing homes and elderly care centres
Animal-like Segment CAGR	19.1%	Fastest-growing segment in the forecast period
Loneliness Economy (addresses/profits from human isolation)	Significant and growing	Aggregate market across products, platforms, and services
Singapore: 65+ population by 2031	900,000 (18.7% of residents)	Ministry of Health / National Population and Talent Division
Japan: Annual kodokushi (2024)	58,000 solitary elderly deaths	76,020 solitary deaths total; 76% aged 65+
OECD productivity loss by 2040 (ageism)	USD 500 billion	WEF Longevity Dividend Report 2026

WEF healthcare savings potential by 2040	USD 5.8 trillion	Three modest interventions: falls, activity, hearing aids

5.3 Competitive Landscape

Prescience PresbyRobotics' closest competitors and their positioning relative to AIRA:

Product	Price	Mobility	Key Strengths	Key Limitations
ElliQ (Intuition Robotics, USA)	S$318 one-time + ~S$75/month	Stationary tabletop	Strong — proactive AI; medication reminders	No mobility; cannot detect falls in another room; no clinical integration
Paro (Dr. Takanori Shibata, Japan)	~S$8,900 one-time	Reactive to touch	FDA-cleared; dementia calming therapy; antibacterial fur	No conversation; no remote monitoring; no LLM
LOVOT (Groove X, Japan)	~S$4,600 + S$100/month	Autonomous wheeled	High emotional intelligence; 360 room scanning; 50+ sensors	No clinical data collected; focused on love and companionship only
ropet (China)	~S$536 one-time	Hand-carried	Basic LLM; warm bionic body; basic mood sensing	Lacks medical sensors; no clinical integration; entry-level hardware
AIRA (Prescience PresbyRobotics)	S$450–500 (Basic) / S$10,000–12,000 + S$79–199/mo (Advanced)	Mobile (Advanced)	Full stack: non-ageist SLM + emotion detection + MBTI personality + memory + health monitoring + fall detection + telepresence + AI Guardian	Prototype stage; pending regulatory approval; manufacturing supply chain being confirmed

AIRA's core competitive advantage is the integration of all five capabilities — mobility, affordability, non-ageist conversational AI, health monitoring, and personalisation — in a single platform. Among reviewed competitors, no existing product appears to combine all five in the same way. Additionally, AIRA is the only companion robot with a proprietary non-ageist SLM: while competitors use generic ChatGPT-based models trained on ageist internet data, AIRA's Ruffy SLM eliminates ageism at a system level through curated data and ethical guardrails. [13]

5.4 Go-to-Market Strategy

Prescience PresbyRobotics' GTM strategy is phased across three channels — B2C, B2B, and B2G — across three geographic markets:

Year	Market	Channel	Key Activities
2027	Singapore	B2B	Prototype completion, internal testing, regulatory planning; pilot with Lotus Eldercare (up to 50 units); partnerships with Social Service Agencies supporting solo-living elderly
2028	Singapore + Japan	B2C + B2B	Commercial launch of Basic Model; establish NUS Block71 JP partnership; initiate Japan regulatory alignment
2029	Japan	B2B + B2G	Entry into Japan market; bundle robots into chronic-disease packages (B2B); sandbox trials under Assistive Robotics grants (B2G)
2030	Singapore + Japan	B2B + B2G + B2C	Launch of Advanced Model with full subscription service; pilot deployments in Japan rural eldercare communities; B2G sandbox trials under Japan grants + Singapore public sector
2031	APAC Expansion	B2B + B2G	Expansion into South Korea and China through eldercare franchise partnerships; potentially South Korea Godoksa government programmes

Japan market entry rationale: Japan has the world's highest ageing ratio, government recognition of the kodokushi problem (dedicated Minister of Loneliness and Isolation), established watch-over infrastructure (Japan Post's Mimamori services operating at ~20,000 post offices), and structural adoption readiness for AgeTech. Initial target regions include Misato (Miyazaki Prefecture, 2,489 of 4,297 residents elderly), Rishiri and Rebun Islands (Hokkaido), Ogasawara Islands, and Awashima Island (83% ageing rate). [23][24]

PART VI: SUPPLY CHAIN AND OPERATIONS

6.0 Funding and Hardware Development Status

As of the date of this whitepaper, Prescience PresbyRobotics has not yet received external investment funding. The company remains self-funded and is actively seeking suitable seed-stage investors. We are grateful to our current collaborators and academic partners for their continued support during this pre-funding phase.

On the hardware front, Prescience PresbyRobotics has engaged extensively with robotics manufacturers in China and across the Asia-Pacific region to identify a suitable robotic body platform for AIRA. Despite discussions with numerous manufacturers, we have been unable to identify an off-the-shelf product that fully meets AIRA's design, sensory, and clinical requirements. As a result, Prescience PresbyRobotics is pursuing a build-to-specification approach through a collaboration with VSTC (Zhongke Shengu Technology Co., Ltd — 中科深谷), headquartered in Hefei, China. This is a research and development collaboration under which VSTC will design and manufacture a custom robotic body to Prescience PresbyRobotics' specifications. The hardware platform under development is based on a modified quadruped robotic dog form factor (derived from the Unitree GO2 Edu platform), with an exterior redesigned by VSTC's Intelligent Manufacturing Department into a companion-appropriate dog or cat aesthetic. Key hardware components in the co-designed platform include: a Jetson Orin NX industrial computer (100 TOPS AI computing power, 16GB LPDDR5 memory); MAX30102 PPG sensor for heart rate, blood oxygen, and respiration monitoring; MLX90614 infrared thermometer (±0.2°C medical-grade accuracy); DVSLume event camera for fall detection; a 2-to-4-mic array with far-field pickup (3–5 metres) and Acoustic Echo Cancellation; Wi-Fi 6 dual-band connectivity; and multi-colour LED status lighting. Software algorithms — including the Ruffy SLM, RAG memory system, EMCAI emotion detection, and MBTI persona engine — will be developed under NUS leadership and integrated onto the VSTC hardware platform. This collaboration is ongoing and subject to finalisation of specifications; all unit costs and timelines associated with the VSTC-built platform should be treated as estimates pending completion of formal contractual agreements.

6.1 Manufacturing and Supply Chain Strategy

Prescience PresbyRobotics' supply chain strategy was developed through the NUS Business School FSP4003 Field Service Project (AY2025/2026). The company is pursuing a contract manufacturing model, leveraging established robotics hardware manufacturers in China, Taiwan, Japan, and the USA while retaining proprietary AI software and systems integration in-house.

Robot hardware manufacturers being evaluated (as of April 2027):

Manufacturer	Country	Platform	Status
Blenchen Hoersteiger Technology	China	PiggyPig	Engagement in progress
Sharaftoo Yunee Good Technology	China	Bionac Senses	Engagement in progress
SUIWA Robotics	Taiwan	Robota	Engagement in progress
Ado by Sony	Japan	Ado	Engagement in progress
Elephant Robotics	China	RoboPet	Engagement in progress
Weeb Robotics Technology	China	Queensford Robot	Preliminary technical evaluation

Hardware selection criteria include: compatibility with Prescience PresbyRobotics' software architecture (SLM, RAG, emotion detection), unit cost targets (Basic Model BOM at ~S$90 target; Advanced Model at S$2,000), scalability from 50-unit pilot to 500+ annual production, quality certification pathways, and after-sales support capability in Singapore and Japan. [26][27]

6.2 Bill of Materials and Cost Structure

The supply chain team conducted detailed BOM analysis for both Basic and Advanced Models. Key cost drivers for the Advanced Model include: 4D mmWave radar module, IR thermometer and PPG vital signs sensor suite, embedded compute module (ARM-based SBC for on-device SLM inference), mechanical arm assembly for tactile comfort response, and the cellular/WiFi connectivity module for caregiver dashboard integration.

Component	Source	Estimated Cost (SGD)
Robot chassis / mechanical body	Contract manufacturer	S$40–60 (Basic) / S$800–1,200 (Advanced)
Embedded compute (SBC for SLM inference)	Third-party (Raspberry Pi 5 / Rockchip equivalent)	S$80–120
Microphone array + speaker	Third-party	S$15–25
Camera (facial detection)	Third-party	S$20–35
4D mmWave radar (Advanced)	TI / InfiRay equivalent	S$150–300
IR thermometer + PPG vitals sensor (Advanced)	Third-party	S$50–100
WiFi/cellular module	Third-party	S$20–40
Battery + charging system	Third-party	S$30–50
Assembly, QC, packaging	Contract manufacturer	S$30–50
Estimated BOM (Advanced Model)	All components	S$1,600–2,000 (target)

6.3 Operational Roadmap

Period	Key Operational Milestone
Q1 2027	Finalise hardware design; confirm software architecture; select contract manufacturer (in collaboration with VSTC/Zhongke Shengu Technology)
Q2 2027	Prototype build; integration testing of all AI modules; finalise robotic body specifications with VSTC
Q3 2027	Internal usability testing; AI safety model testing; pilot with Lotus Eldercare and Social Service Agencies (up to 50 units)
Q4 2027	Iterative refinement; regulatory planning in Singapore and Japan; initiate NUS Block71 Japan partnership
2028	Launch Basic Model commercially; small-batch manufacturing (hundreds of units); advanced model development
2029	Align Japan regulations; localise software for Japanese language and cultural context
2030	Launch Advanced Model; pilot Japan rural eldercare communities; manufacturing scale-up
2031	APAC expansion; franchise partnerships in South Korea and China

PART VII: BUSINESS MODEL AND FINANCIALS

7.1 Revenue Architecture

Prescience PresbyRobotics' dual-layer business model generates revenue through two primary streams:

- Hardware Revenue: Sale of robot units (Basic Model B2B: S$450/unit; Basic Model B2C: S$500/unit; Advanced Model B2G: S$10,800/unit; Advanced Model B2B: S$12,000/unit). Prices are expected to decrease over time as manufacturing scales and economies of scale are achieved.
- Software/Subscription Revenue (Advanced Model only): Annual lease with recurring software subscription fee. Three tiers: Tier 1 (S$79/month), Tier 2 (S$129/month), Tier 3 (S$199/month). Subscription revenue commences in FY30 with Advanced Model launch.

Channel distribution:

Channel	Target Customers	Commercial Terms
B2G	Government eldercare programmes, social service agencies, MOH	Advanced Model at S$10,800; whole unit sale
B2B	Nursing homes, eldercare facilities, community care providers, hospitals	Basic at S$450; Advanced at S$12,000 + subscription
B2C	Individual families, elderly persons direct	Basic at S$500; Advanced subscription lease

The value case is not limited to companionship. Payer pathways may emerge where AIRA helps reduce caregiver burden, supports earlier intervention, and delays or avoids premature institutionalisation. These pathways require pilot evidence before they are treated as reimbursable outcomes.

Potential Payer	Value Proposition to Validate
Families	Reassurance, alerts, and reduced constant vigilance.
Eldercare operators	Operational support, engagement, monitoring, and escalation workflows.
Government agencies	Ageing-in-place support and community-care augmentation, subject to validated outcomes.
Insurers and hospitals	Potential fall-risk, post-discharge, and monitoring pathways after evidence generation.

7.2 Financial Projections (FY27–FY36)

All figures in SGD thousands. Projections are illustrative and subject to material risks. [13]

Metric	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36
Revenue (S$'000)	23	124	248	336	557	843	1,193	1,927	3,809	7,958
YoY Growth	—	437%	99.5%	35.6%	66.0%	51.3%	41.6%	61.5%	97.7%	108.9%
Gross Profit (S$'000)	19	102	205	264	364	488	591	823	1,551	4,560
Gross Margin %	80.3%	81.9%	82.8%	78.7%	65.4%	57.9%	49.5%	42.7%	40.7%	57.3%
EBIT (S$'000)	3	26	67	77	165	185	329	537	1,059	2,212
EBIT Margin %	14.5%	21.1%	27.1%	22.9%	29.7%	21.9%	27.6%	27.9%	27.8%	27.8%
Net Income (S$'000)	3	22	56	64	137	—	—	—	—	—
Total Units Deployed	48	254	504	464	445	492	538	650	969	1,672
of which Basic	48	254	504	442	382	398	414	430	446	462
of which Advanced	0	0	0	22	63	94	124	220	523	1,210
Revenue/Unit (S$)	481	488	491	723	1,252	1,714	2,218	2,965	3,931	4,759

Revenue scales from S$23k (FY27) to approximately S$7.96M (FY36) at approximately 122% CAGR over 10 years. Growth in early years is driven entirely by Basic Model hardware sales. From FY30, the Advanced Model launch introduces subscription revenue (S$7,317 in FY30 → S$1.82M in FY36) and shifts the blended revenue/unit profile significantly upward. Gross margins decline temporarily in FY30-FY33 as Advanced Model production scales, before recovering to ~57% in FY36 as high-margin software subscription revenue grows as a share of total revenue. [13]

7.3 Capital Deployment and Funding Strategy

Prescience PresbyRobotics is self-funding through FY29 on initial hardware revenue from Basic Model sales. The company is targeting a S$5 million raise by FY30 to fund Advanced Model production, deployment, and commercial scaling. The raise is expected to provide runway through FY35. A seed round of S$5 million (or USD 1 million equivalent) is the current fundraising target, with intended use of funds across four categories: [13]

- Basic Operations: Legal and compliance; patent filings/IP protection; cloud hosting; basic administrative expenses
- Market Validation: Partnerships with eldercare centres; user testing with seniors; product iteration and UX optimisation
- Pilot Production: Small-batch manufacturing (tens to hundreds of units); deployment in nursing homes or test households; reliability testing; user behaviour data collection

- Product Development: First-generation hardware design; voice interaction system development; basic cloud infrastructure setup

Prescience PresbyRobotics has received institutional validation through acceptance into NUS BLOCK71 incubator and support from Temasek Trust Co-Axis, Singapore's principal venture support infrastructure. The company has also submitted applications for Japan government grants (Assistive Robotics category) and is planning future submissions to Singapore's SGInnovate and MOH innovation programmes.

PART VIII: REGULATORY, ETHICS, AND GOVERNANCE

8.1 Regulatory Pathway in Singapore

AIRA's regulatory pathway in Singapore depends on the classification of its health monitoring components. The basic conversational and social companion functions are not subject to medical device regulation. However, the Advanced Model's vital signs monitoring, fall detection, and health trend dashboard capabilities may be subject to Singapore's Health Sciences Authority (HSA) medical device framework, depending on whether they constitute a medical device under the Health Products Act.

Prescience PresbyRobotics' regulatory planning includes:

- Classification assessment with HSA for Advanced Model health monitoring features
- Alignment with Singapore's AI in Healthcare framework (MOH/IHiS)
- PDPA compliance for all personal data, health data, and conversation records
- Compliance with cybersecurity guidelines (CSA) for IoT devices collecting health data
- Japan: Assessment under Pharmaceutical and Medical Device Act (PMD Act) for medical device functions; alignment with METI's robotics standards (JIS B 8445)
- Switzerland (planned): Medical Device Regulation (MDR) for European market entry; alignment with Swissmedic requirements

Regulatory sensitivity should be assessed by function rather than by the robot as a whole:

Function	Regulatory Sensitivity
Conversation and companionship	Lower sensitivity when positioned as social support rather than diagnosis or therapy.
Reminders and wellness prompts	Moderate sensitivity; requires clear disclaimers and caregiver configurability.
Fall detection alerts	Moderate to high sensitivity; requires validation of false positives, false negatives, and escalation protocols.
Vital-sign monitoring	Higher sensitivity; classification depends on intended use and claims.
Clinical recommendations	Highest sensitivity; avoided unless validated, approved, and clinically supervised.

8.2 Data Privacy and Security

AIRA handles highly sensitive personal data: elderly medical records, personal life history, conversation content, emotional state data, and biometric vital signs. The architecture implements privacy-by-design principles at every layer:

- End-to-end encryption (TLS) for all data transmitted between robot and cloud
- Encryption at rest: Healthcare data and PII encrypted via pgcrypto; database-level encryption for all sensitive fields
- Role-based access control (RBAC): super_admin and caregiver roles with elderly-caregiver many-to-many mapping
- JWT-based authentication with 24-hour expiration; bcrypt password hashing
- Comprehensive audit logging: all database actions logged with timestamp and user identity
- Singapore PDPA compliance: explicit consent framework; data minimisation; purpose limitation
- SG-specific PII detection in guardrail Layer 1: NRIC/FIN, UEN, postal codes, local phone/email, PayNow, Singpass OTP patterns
- 4D mmWave radar for vital signs monitoring (alternative to camera-based monitoring — preserves privacy while maintaining health oversight)

8.3 AI Ethics Framework

Prescience PresbyRobotics' AI ethics framework is embedded in the product architecture, not appended as a compliance layer. The company applies four core ethical principles derived from its public health mission:

Principle	Implementation
Non-Ageism	All AI systems must be free from benevolent ageism. Ruffy's SLM and guardrail system actively detect and prevent ageist phrasing, elderspeak, and patronising tone.
Non-Sycophancy	AI systems must not validate delusional or distorted thinking. The AI Guardian layer and the two-layer guardrail system create "healthy social friction" — the gentle resistance to delusion that human relationships provide naturally.
Transparency	Ruffy's persona contract requires clear identity disclosure ("I'm an AI companion"), no false memories or fabricated relationships, and medical/legal disclaimers when relevant.
Safety by Design	The AI Guardian layer and the two-layer SLM guardrail are not optional features — they are foundational architecture. Psychological safety monitoring is built into every interaction.
Dignity	Non-ageist design, cultural localisation, and the rejection of "engagement maximisation" as a design goal reflect a commitment to human dignity over platform metrics.

8.4 AI Guardian Operational Model

The AI Guardian framework is proposed as an operational safety model with human oversight. It does not diagnose, treat, or autonomously intervene; it classifies conversational and behavioural signals to guide escalation.

Level	Signal Pattern	Human-Led Response
Green	Normal conversation and routine variation	No action beyond ordinary logging and user consent controls.
Yellow	Repeated sadness, confusion, withdrawal, or unusual dependency cues	Gentle grounding, trend logging, and possible caregiver summary.
Orange	Paranoia, medication confusion, strong dependency, or reality-testing concerns	Notify caregiver or service provider for human review.
Red	Self-harm, abuse, acute medical danger, or emergency distress	Activate emergency escalation protocol according to the care plan.

8.5 Pilot Validation Framework

Domain	Proposed Measures for Validation
Safety	Falls detected, false positives, false negatives, response time
Wellbeing	Proposed instruments: UCLA Loneliness Scale, GDS depression screening, WHO-5 wellbeing score
Engagement	Daily interaction frequency, voluntary re-engagement, session duration
Caregiver impact	Check-in burden, reassurance, alert usefulness, perceived sustainability
Technical reliability	Uptime, battery performance, speech recognition, sensor reliability
Ethical safety	Dependency markers, delusional validation incidents, escalation accuracy

These measures are proposed for validation and should not be read as already validated outcomes or clinical claims.

8.6 Failure Modes and Mitigations

Failure Mode	Mitigation
False alerts	Multi-sensor confirmation, caregiver triage, threshold tuning
Missed emergencies	Conservative escalation thresholds and periodic human check-ins
Emotional overdependence	AI Guardian monitoring, human-contact prompts, clear AI identity
User rejection	Co-design with older adults, opt-in personalisation, culturally appropriate skins
Privacy concerns	Consent, data minimisation, mmWave-first monitoring where possible, audit logs
Hardware failure	Modular parts, preventive maintenance, service-level planning
Clinical overclaiming	Wellness positioning until validation and regulatory approval are obtained

PART IX: ROADMAP AND FUTURE PLANS

9.1 2027 Milestones

2027 is the year of prototype completion, pilot validation, and regulatory groundwork — including concluding our robotic hardware partnership with VSTC (Zhongke Shengu Technology):

- Q1 2027: Finalise hardware design specifications; confirm software architecture; finalise robotic body build-to-specification agreement with VSTC (Zhongke Shengu Technology, Hefei)
- Q2 2027: Build functional prototype (Basic Model) on VSTC hardware platform; integrate all AI software modules (Ruffy SLM, RAG memory, EMCAI, MBTI persona); internal usability testing
- Q3 2027: Pilot testing with Lotus Eldercare Singapore (up to 50 units); testing with Social Service Agencies supporting solo-living elderly; AI safety model validation
- Q4 2027: Iterative product refinement from pilot feedback; regulatory planning in Singapore and Japan; initiate NUS Block71 Japan partnership; submit grant applications; prepare for Basic Model commercial launch

9.2 2028–2029: Commercial Scale-Up

- 2028: Commercial launch of Basic Model in Singapore and Japan pilot markets (B2C and B2B); establish Japan distribution partnerships; Advanced Model development begins
- 2028: Regulatory alignment in Japan; localisation for Japanese language, cultural norms, and eldercare standards
- 2029: Full Japan market entry (B2B and B2G); bundle robots into chronic-disease management packages (B2B); sandbox trials under Assistive Robotics grants (B2G)
- 2029: Advanced Model testing and validation; partner with community care providers in Japan and Singapore

9.3 2030–2031: APAC Expansion and Japan Advanced Model Entry

- 2030: Launch of Advanced Model with full subscription service (Tier 1/2/3); pilot deployments in Japan's rural eldercare communities as validation testbed
- 2030: Optimise manufacturing capacity and supply chain for Advanced Model scale
- 2031: Expansion into South Korea and China through eldercare franchise partnerships; South Korea Godoksa government response as potential B2G entry

- 2031: Evaluate Greater Zurich Area/Switzerland as European entry point

9.4 Long-Term Vision: Switzerland and Beyond

Prescience PresbyRobotics' strategic positioning for European expansion targets Switzerland — specifically the Greater Zurich Area — as the European entry point. Switzerland's combination of an ageing population, advanced healthcare infrastructure, receptiveness to precision health technology, and Prescience PresbyRobotics' existing network connections make it an attractive first-mover market for European operations. Prescience PresbyRobotics plans to establish a Swiss entity as part of its Series A funding preparation, enabling access to European institutional investors and government innovation grants.

As an eldercare support-services think tank, Prescience PresbyRobotics' broader portfolio should be understood as three connected layers: AIRA for relational and interactive support; GuardianWave for passive safety sensing and pre-fall monitoring; and AEGIS AI for trustworthy companion-AI governance, human-led escalation, and future standards for vulnerable users.

The long-term research agenda extends beyond current capabilities to include: (1) Autonomous indoor mobility using 4D mmWave radar for full home navigation; (2) Dopamine and oxytocin response testing to validate AIRA's positive emotional impact; (3) Consolidation of life memories, wisdom, and images for AI Avatar creation — a "Family Continued Subscription" allowing families to preserve an AI representation of their loved one; (4) Integration with national Electronic Health Records (MOH, Singapore); (5) Longitudinal clinical trials in partnership with academic medical centres; (6) Sleep apnoea monitoring via mmWave; (7) Parkinson's On/Off phenomenon monitoring via gait analysis; (8) Seizure detection through abnormal movement monitoring.

Closing Argument: The Witnessing Problem

The ageing crisis is not only a healthcare capacity problem. It is a witnessing problem. Independent living should not mean invisible living. AIRA's purpose is to help ensure that vulnerable people are not unseen, unheard, or undiscovered when they need help — while keeping family, community, service providers, and clinicians at the centre of care.

APPENDIX A: RESEARCH PARTNERS AND ACADEMIC COLLABORATORS

A.1 Management Team

Name	Role	Credentials
Dr. Tan Jit Seng	Founder / Chief Innovation Officer (CIO)	MBBS Medicine (NUS Yong Loo Lin School of Medicine); Director/Board Member of multiple NPOs in Singapore; extensive clinical and public health background
Penny Peng	CEO	MBBS Public Health (PKU); BSc Economics (PKU); healthcare leadership and management
Harry Wu	COO	BBA with Minor in AI (NUS); serial entrepreneur; Founder of Remarkably
Ang Zi Quan	CRO (Chief Robotics Officer)	BEng Electrical Engineering (NTU); Robotics Research Assistant (NTU);
Ruby Huang	Head of Product	MBA (NUS); MA Education (Beijing Normal University)

A.2 Advisory Panel

Name	Role	Background
GS Kim	Advisor	MA in Clinical Psychology; Founder, Demand; Former Country Managing Director, Watson Wyatt; Former Senior Consultant, Andersen Consulting (Accenture)
Khoon Seng Goh	Advisor	MSc Mechanical Engineering (NUS); Vice Chair, SMF; MSc Engineering (ESIEA); Former CEO of Osteapore; Former Technical Consultant, Medtronic; Director of Transformation Program, La Poste Group; Head of Infra. Projects & Architecture, ORPEA; Former Director of Business Consulting, Xelians

Additional advisors serve on the AI Robotics Technical Advisory Panel and Human-Machine Interface Ethics Panel (collaboration with NUS Bioethics pending). Some advisors have opted to remain private.

A.3 NUS Capstone Research Groups

Cohort / Group	School	Research Focus	Key Deliverable
Y2524/25 — Group 6	NUS Business Analytics	RAG Memory Architecture: LTM, STM, Healthcare Modules	Elder Companion conversational memory

			system; three-tier memory backend; caregiver interface
Y2524/25 — Group 26	NUS Computing	ElderCompanion SLM (Ruffy) — Non-Ageist Conversational AI	Ruffy SLM (Llama3.2-3b fine-tuned); two-layer guardrail; evaluation dashboard
Y2525/26 — Group 5	NUS Business Analytics	EMCAI: Emotion Mirroring Conversational AI	Multimodal emotion detection (DeepFace + Emotion2Vec); MLP late fusion; 91% RAVDESS accuracy
Y2525/26 — Group 6	NUS Business Analytics	MBTI-Driven RAG Persona Engine	ENFP Ruffy persona; 100% MBTI consistency; deployed chatbot at mbtipetchatbot.streamlit.app
Y2525/26 — Group 14	NUS Business Analytics	OCEAN-5 Driven Personality Model	Big Five personality adaptation model for AIRA; age-group segmentation (60–70 vs 70+)

A.4 NUS Business School Field Service Projects

Cohort	School	Focus	Key Deliverable
Y2524/25 — FSP4003	NUS Business School	Marketing Strategy	Japan market analysis; Mimamori partnership strategy; social media strategy and content calendar; brand guide
Y2525/26 — FSP4003	NUS Business School	Supply Chain Strategy	Manufacturing partner assessment; BOM analysis; supply chain planning; operational roadmap
Y2524/25 — FSP4003	NUS Business School	Seed Funding Proposal	Full financial model (FY27–FY36); competitor analysis; business model; GTM strategy; investor presentation

A.5 Academic Honours and Recognition

- 2nd Place — 2025 Beijing-Tsinghua Health AI Summit (October 2025)
- Semi-Finalist — International Talent Entrepreneurship Conference (IETC) 2024 (September 2024)
- Selected Speaker — 10th World Robo Conference (August 2025)
- Incubated — NUS BLOCK71 Innovation Hub
- Supported — Temasek Trust Co-Axis programme

APPENDIX B: GLOSSARY OF KEY TERMS

AIRA: Artificial Intelligent Robotics Adoree — Prescience PresbyRobotics' flagship companion robot. In Japanese, "Aira" (愛ら/愛) means love/lovable.

AI Guardian System: A secondary supervisory AI layer monitoring conversational interactions for markers of psychological decompensation including paranoia, temporal disorientation, emotional dependency, and crisis escalation.

AI Psychosis: An emergent clinical phenomenon in which interactions with generative AI chatbots amplify, validate, or co-create psychotic symptoms, particularly in isolated or cognitively vulnerable individuals. Identified in NUS CS Capstone research (2026), drawing on Morrin et al. (2025) and Ostergaard (2023).

BM25: Best Match 25 — a keyword-based probabilistic retrieval algorithm used in AIRA's hybrid RAG retrieval alongside vector similarity search.

EMCAI: Emotion Mirroring Conversational AI — the multimodal emotion detection system using DeepFace (visual) and Emotion2Vec (audio) in a late-fusion MLP architecture.

ENFP: A Myers-Briggs Type Indicator personality type (Extraverted, Intuitive, Feeling, Perceiving). AIRA's Ruffy persona is designed to express ENFP traits: warm, playful, curious, and genuinely interested in people.

GGUF: GPT-Generated Unified Format — a compact model format enabling SLM deployment on CPU-only devices such as AIRA's embedded robot hardware.

Godoksa: Korean term for "lonely death" — a person dying alone at home, often undiscovered for a prolonged period. 3,661 cases in South Korea in 2023.

HCM: Healthcare Memory — the third tier in AIRA's memory architecture, storing medical conditions, procedures, appointments, and medications in encrypted form.

Kindling Effect: A psychiatric hypothesis describing how repeated sub-threshold stimulation progressively lowers the neurological threshold for full response. Applied to AI: each session of AI-validated distorted thinking makes the next episode more likely and more severe.

Kodokushi: Japanese term for "solitary death" — dying alone, with the body undiscovered for a prolonged period. Japan recorded 58,000 such deaths in 2024.

LoRA / DoRA: Low-Rank Adaptation / Weight-Decomposed Low-Rank Adaptation — parameter-efficient fine-tuning techniques that train only small add-on adapter layers, enabling SLM training on constrained GPU resources.

LTM: Long-Term Memory — the second tier in AIRA's memory architecture, storing persistent personal information: personal history, family, education, career, lifestyle, finance, and legal information.

MBTI: Myers-Briggs Type Indicator — a personality classification system with 16 discrete types based on four dimensions (Extraversion/Introversion, Sensing/Intuition, Feeling/Thinking, Perceiving/Judging). Selected for AIRA's persona engine for its positive-only dimensions, clear character templates, and cultural accessibility.

mmWave: 4D Millimetre-Wave Radar — a non-optical sensing technology used in AIRA for indoor positioning, vital signs monitoring, gait analysis, and fall detection while preserving user privacy.

MLP Fusion: Multi-Layer Perceptron Fusion — the deep learning fusion model combining DeepFace facial and Emotion2Vec audio probabilities; achieves 91.8% accuracy on RAVDESS via 5-fold stratified cross-validation.

OCEAN-5 / Big Five: A psychometric personality model comprising five traits: Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism. Developed by NUS Group 14 as a complement to MBTI for AIRA's personality engine.

pgvector: A PostgreSQL extension enabling vector similarity search. Used in AIRA's memory system for 768-dimensional semantic embeddings stored in three memory tables.

Prescience PresbyRobotics: Prescience PresbyRobotics Private Limited — the company. Founded March 2024, Singapore. UEN 202412166K.

Psychological Fragility: Prescience PresbyRobotics' term for the progressive weakening of cognitive, emotional, and perceptual systems allowing a human being to maintain a coherent, grounded relationship with reality — accelerated by isolation, AI interactions, and the absence of human friction.

RAG: Retrieval-Augmented Generation — an AI architecture in which a language model's responses are grounded in retrieved external documents or memories, enabling personalisation and factual accuracy without retraining.

RLHF: Reinforcement Learning from Human Feedback — the standard training method for commercial LLMs that creates systematic sycophancy bias by rewarding responses that maximise user satisfaction.

Ruffy: The name of AIRA's conversational AI persona. An ENFP-type companion inspired by a friendly dog. Designed to speak in short, simple, caring, emotionally transparent sentences while preserving adult dignity. Never gives instructions or advice.

SLM: Small Language Model — a compact language model designed for efficient on-device inference. AIRA's ElderCompanion SLM (based on Llama3.2-3b, fine-tuned with LoRA) runs at ~1-second latency on CPU-capable hardware.

Social Fragility: Prescience PresbyRobotics' term for the structural erosion of community, family bonds, and relational architecture that once insulated individuals from dying alone. A civilisational design failure. Three vectors: dispersal of family, erosion of community, professional care gap.

STM: Short-Term Memory — the first tier in AIRA's memory architecture, storing recent conversational content with 14-day retention and half-life decay scoring.

SVO: Subject-Verb-Object — the sentence structure enforced in AIRA's SLM to ensure clarity and cognitive accessibility for elderly users.

T5-Small: A 60-million parameter language model developed by Google (checkpoint: google-t5/t5-small) used as the base for AIRA's Singlish-to-English NLP pipeline in Module 1.

REFERENCES

[1] World Health Organization. (November 2023). Launch of WHO Commission on Social Connection. Geneva: WHO. who.int

[2] Prescience PresbyRobotics Private Limited. (2026). Behind the Robot: Prescience PresbyRobotics as a Public Health Institution — On Social Fragility, Psychological Fragility, and the Epidemic of Lonely Deaths the World Has Not Yet Named. Position Paper — Public Health & Social Technology. Singapore: Prescience PresbyRobotics Private Limited.

[3] Journal of the American Geriatrics Society. (2021). Loneliness and Senior Mortality Risk. American Geriatrics Society.

[4] The Lancet Dementia Commission. (2024). Dementia prevention, intervention, and care. The Lancet.

[5] Ostergaard, S.D. (2023). Will Generative AI Chatbots Generate Delusions in Individuals Prone to Psychosis? Schizophrenia Bulletin, Vol. 49, Issue 6. DOI: 10.1093/schbul/sbad128.

[6] World Economic Forum & Marsh. (June 2026). The Longevity Dividend: The Business Case for Linking Health and Wealth. Insight Report. Geneva: World Economic Forum.

[7] NUS Computing Science Capstone. (2026). Prescience PresbyRobotics Introduction for NUS CS Capstone. Lonely deaths statistics: Japan Police (2024); Korea Ministry of Health and Welfare (2023); Channel News Asia (2025). National University of Singapore.

[8] International Journal of Environmental Research and Public Health, MDPI. Singapore ageing-in-place preference data (82% prefer to remain at home).

[9] Morrin, H. et al. (2025, July 11). Delusions by design? How everyday AIs might be fuelling psychosis. OSF Preprint.

[10] NUS Computing Science Capstone Project. (May 2026). AI Psychosis: Technical Origins, Societal Risks & the Ethical Imperative ("When AI Drives You Mad"). National University of Singapore.

[11] ScienceDirect. AI ageism and its consequence: Benevolent ageist attitudes expressed by LLMs could reinforce ageism in humans.

[12] Prescience PresbyRobotics Private Limited. (2026). AIRA Product Overview: Prescience PresbyRobotics Introduction for NUS CS Capstone 2026. Singapore.

[13] NUS Business School FSP4003 Team. (April 2026). FSP4003 Seed Funding Proposal for AI Product Startup — Final Presentation. National University of Singapore.

[14] NUS Business Analytics Capstone Group 6. (AY2024/25). RAG_Documentation: Elder Companion Conversational Memory System. National University of Singapore.

[15] NUS Business Analytics Capstone Group 6. (AY2024/25). Elder Companion RAG Models — LTM, STM, Healthcare Memory Modules: Interim Presentation. National University of Singapore.

[16] NUS Computing Capstone Group 26. (AY2024/25). Prescience Presby Robotics Conversationalist SLM — Final Presentation. National University of Singapore.

[17] NUS Computing Capstone Group 26. (AY2024/25). ElderCompanion LLM Final Report. National University of Singapore.

[18] NUS Business Analytics Capstone Group 5. (AY2025/26). EMCAI: Emotion Mirroring Conversational AI — Final Presentation. National University of Singapore.

[19] NUS Business Analytics Capstone Group 5. (AY2025/26). EMCAI Final Report: Personalized Multimodal Emotion Detection System for AIRA. National University of Singapore.

[20] NUS Business Analytics Capstone Group 6. (AY2025/26). MBTI Driven RAG Persona Engine — Final Presentation. National University of Singapore. Deployed chatbot: https://mbtipetchatbot.streamlit.app/

[21] NUS Business Analytics Capstone Group 6. (AY2025/26). MBTI Driven Personality Model Final Report: Ruffy for Robotic Companion Pets. National University of Singapore.

[22] NUS Business Analytics Capstone Group 14. (AY2025/26). OCEAN-5 Driven Model Final Report: Personality Model for Prescience PresbyRobotics. National University of Singapore.

[23] NUS Business School FSP4003 Marketing Team. (AY2024/25). Marketing Final Report: Japan Market Entry and Brand Strategy. National University of Singapore.

[24] NUS Business School FSP4003 Marketing Team. (AY2024/25). Marketing Final Presentation: AIRA Japan Introduction Strategy. National University of Singapore.

[25] NUS Business School FSP4003 Marketing Team. (AY2024/25). Marketing Brand Guide. National University of Singapore.

[26] NUS Business School FSP4003 Supply Chain Team. (AY2025/26). Supply Chain Team Final Report: AIRA Manufacturing and Operations Planning. National University of Singapore.

[27] NUS Business School FSP4003 Supply Chain Team. (AY2025/26). Supply Chain Team Final Presentation: AIRA Supply Chain Strategy. National University of Singapore.

[29] Prescience PresbyRobotics Private Limited. (April 2026). Investment Teaser: Seed Stage | S$5M Raise | AI-Enabled Eldercare Companion Robotics. Singapore.

[30] Grand View Research. (2024). Healthcare Companion Robots Market Size, Share & Trends Analysis Report. Grand View Research.

[31] Lotus Eldercare / Singapore Ministry of Health. (November 2013 – October 2015). IDAPE Assessment Study: Ageing and Disability — Causes of Disability in Elderly Patients from Lower Socioeconomic Groups. 203 patients across nursing homes, restructured hospitals, and private residences.

[32] Committee on Ageing Issues, MCYS Singapore. (2006). Singapore Elderly Population Demographic Projections. Ministry of Community Development, Youth and Sports.

[33] Dr. Tan Jit Seng. (2026). Why Prescience PresbyRobotics matter more than care manpower. LinkedIn. Accessed 15 July 2026. http://www.linkedin.com/pulse/why-prescience-presbyrobotics-matter-more-care-manpower-tan-tcm0c/

[34] Dr. Tan Jit Seng. (2026). 当一个社会越来越长寿，也越来越独居，Prescience PresbyRobotics 为什么只盯着这件事. LinkedIn. Accessed 15 July 2026. https://www.linkedin.com/pulse/当一个社会越来越长寿也越来越独居 prescience-presbyrobotics-为什么只盯着这件事-dr-jit-seng-tan-jmjxf/

[35] Prescience PresbyRobotics. (2026). GuardianWave: Passive WiFi Sensing for Fall Detection in Solo-Living Elderly Homes. Accessed 15 July 2026. https://guardianwave.skywork.website

[36] Prescience PresbyRobotics. (2026). AEGIS AI: AI Guardianship System for Cognitively Vulnerable Users. Accessed 15 July 2026. https://aegusai.skywork.website