The Longevity Industry Will Be The Biggest and Most Complex Industry in Human History

The Longevity industry will dwarf all other industries in both size and market capitalization and will require unprecedented sophistication in its approach for assessment and forecasting from the start to neutralize challenges and manifest opportunities.

The Longevity Industry is not just about biotechnology and biomedicine. Rather, it consists of several distinct segments: Geroscience, Biomedicine, AgeTech and Finance. Despite this seemingly clear market segmentation, many of these sectors intersect with various domains of science and technology, such as advanced biomedicine, preventive medicine, digital health, AI, financial systems, pension systems and government national strategies.

One of the biggest challenges in assessing the Longevity industry is the extreme broadness of the sector. Hundreds of sectors, industries and domains of science and technology must be analyzed in order to obtain a concrete and comprehensive understanding of the dynamics, trends and direction of the industry. This situation is entirely unique to the Longevity industry. Due to this extreme level of complexity, realistic assessment and forecasting is extremely challenging, and the methods currently being applied for assessment of the biotech and biomedical industries are completely inadequate.

- The Longevity Industry has both unprecedented levels of multidimensionality and intersectionality and unprecedented prospects for growth and profitability.

- Currently, only the most advanced scientists work on the forefront of Longevity R&D. In the coming years entrepreneurs and investors will gravitate to the Longevity industry, when they realize its extreme potential for growth and profitability, and the fact that it is the most ethical form of business with the potential for the greatest positive impact for humanity.

- These levels of complexity also present substantial risks, given that it significantly complicates the ability of companies, investors and even national governments to anticipate challenges (such as risk of fraud) and recognize opportunities.

- These challenges will be addressed in national Longevity development strategies that various nations are currently devising in response to the pressures of the looming Silver Tsunami.

Though the challenges of realistic assessment and forecasting are great, they are not unsolvable. There already exist established practices for forecasting and assessment in other complex high-tech industries especially taking into account progress in big data analysis and AI for forecasting and modeling which can be adapted for use in Longevity. It is precisely this mission - the formulation of relevant, quantitative analytical frameworks for Longevity industry assessment, benchmarking, forecasting and optimization - that has been a central component in the mission of Deep Knowledge Ventures and it's Longevity-focused analytical subsidiary, Aging Analytics Agency, for the past several years.

This is the first in a series of articles on the Global Longevity Industry which will provide an overview of the scope and dynamics of this area, discuss current challenges and opportunities, and introduce new approaches to tangible and relevant assessment and forecasting.

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LONGEVITY INDUSTRY FRAMEWORK

The Longevity Industry has a broader scope than any other industry, and a concrete understanding of hundreds of distinct sectors, industries and domains of science and technology is required to obtain a comprehensive understanding of the industry's dynamics necessary to make optimal strategic decision making in the face of the sector's overwhelming complexity and multidimensionality.

LONGEVITY INDUSTRY LANDSCAPE

The Longevity Industry landscape has grown in just the past 4 years from a neglected and underfunded domain of R&D into a towering industrial behemoth spanning thousands of active companies across almost every continent in the world. Today, its extreme trajectory of growth and diversification is unquestionable, which is exemplified most prominently by the fact that the topic of Longevity has in the past few years been embraced by the world's top business and financial media brands, by large financial institutions and investment banks, and now, within just the past year, by conservative politicians and parliamentarians.

GEROSCIENCE R&D (Science of Aging)

The first sector of the Longevity industry consists of advanced biomedical approaches to understanding the underlying mechanisms of biological aging, and constructing therapeutics that act upon those mechanisms directly to slow the process of biological aging at its source. It is by necessity the earliest-stage segment of the industry, and the domain farthest away from market-readiness.

P4 MEDICINE (Personalized, Precision, Preventive and Participatory)

The second sector of the Longevity Industry consist of P4 (Personalised, Precision, Preventive and Participatory) Medicine. It consists of the leading edge of advanced biomedicine already at the level of practical, real-world implementation and use. It represents the ongoing shift away from treatment-based one-size-fits-all blockbuster drugs and towards increasingly personalized, precise, preventive and participatory treatments tailored to individual patient cases.

AI LONGEVITY CENTER

As Artificial Intelligence becomes increasingly integrated into every aspect of biomedical R&D and practical implementation of P4 medicine, the rate of progress is set to increase dramatically. In order to expedite this process and leverage the use of AI for Longevity and Preventive Medicine research to its maximum capacity, Deep Knowledge Ventures is currently supporting the establishment of two AI Centers for Longevity in Europe and Asia.

BIOMARKERS OF AGING

This shift from treatment to prevention is ultimately leading to a coming age of Precision Health, where patients are empowered with the tools necessary to become the CEOs of their own health through the application of P4 medicine in response to continuous monitoring of fluctuations in biomarkers of aging for the maintenance of the optimal state of health until the very end of life.

LONGEVITY AND THE AGETECH MARKET

The third sector of the Longevity Industry is the AgeTech market, which consists of all digital, IT and technologically-sophisticated but non-medical products and services that can improve quality of life, enhance psychological well being, mental functionality and neuroplasticity, and increase social activity in the elderly. Due to its reliance on completely market-ready technologies, it is one of the sub-sectors that will see the largest levels of growth and profitability on the shorter-term horizon.

LONGEVITY ADVANCING FINANCIAL INDUSTRY

The fourth sector of the Longevity Industry is the Longevity Financial Industry, which encompasses all the activities and efforts of large financial institutions to neutralize the economic issues of aging population, manifest the opportunities of Healthy Longevity, and enter new markets of AgeTech and WealthTech relating to the one billion people on retirement globally. In the coming years, this sector will become dominated by tradable financial instruments and novel financial derivatives tied to the Longevity Industry's companies, products, services and technologies.

SUPER COMPLEXITY - CHALLENGES AND ISSUES

The high degree of multidimensionality, intersectionality and overcomplexity of the Longevity Industry creates very tangible challenges for realistic and relevant industry assessment, benchmarking and forecasting. This is a very pressing issue considering that this high degree of complexity also creates intensified risks for fraud and other well-intentioned mistakes that could undermine the overall credibility of the industry as a whole.

CHALLENGES FOR GOVERNMENTS AND NATIONS

This extreme level of complexity also poses unique but equally-pressing challenges for governments and nations, who are poised to either sink or swim in the face of the oncoming Silver Tsunami depending on how proactively they deploy broad nation-wide government-led programs to increase Healthy Longevity, decrease the gap between life expectancy and Health-Adjusted Life Expectancy (HALE), and neutralize the economic burdens of an aging population. The extreme levels of multidimensionality of the Longevity Industry pose substantial challenges to the relevant and realistic formulation and execution of such National Longevity Development Plans.

THE NECESSITY FOR NOVEL METHODS OF ANALYTICS

The analytical methods that have proven adequate for the biotech, advanced biomedicine and related industries are not capable of remaining relevant under the pressures of the Longevity Industry's broad scope and extreme levels of complexity and intersectionality. In order to conduct practical and applicable strategic decision making, industry players, as well as governments and nations, need to adopt entirely novel approaches to analytics, assessment and forecasting if they wish to neutralize the challenges of aging population and manifest the opportunities of Healthy Longevity.

TIMELINE AND FORECASTING

The challenges and opportunities described in this article are set to occur not in the distant future. Instead, they are poised to culminate within the next 7-10 years, which means that such novel forms of industry analytics need to be developed and adopted now in order for industry stakeholders and the governments of developed nations to act within their current window of opportunity, and to progress rather than stagnate under the oncoming wave of the Silver Tsunami.

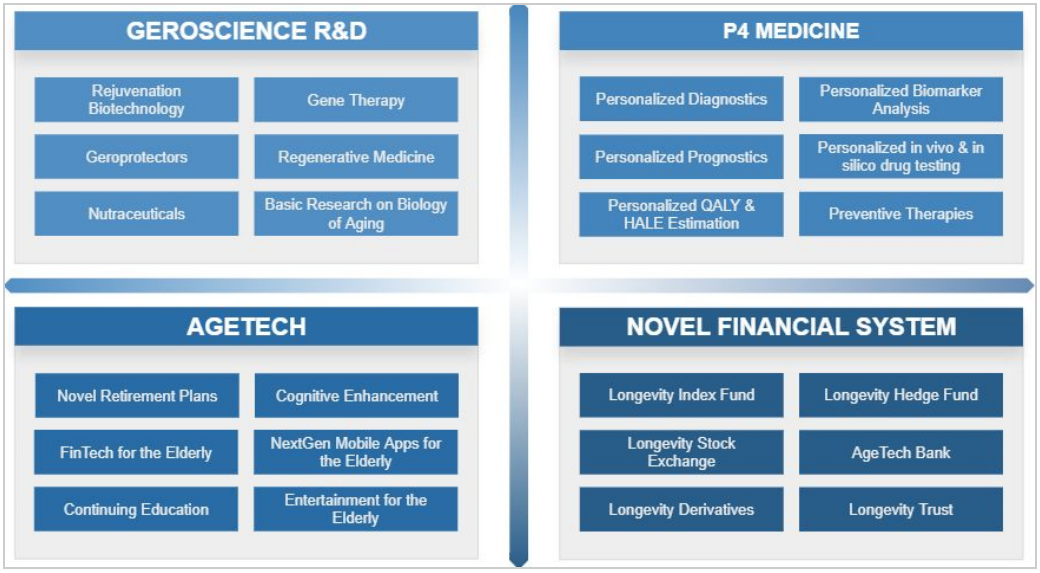
AGENDA 2019 - 2020

Deep Knowledge Ventures will continue to support the ongoing expansion, development and optimization of the global Longevity Industry through its investment activities, the establishment of AI Centers for Longevity, and the launch of the Longevity-focused hybrid investment hedge fund Longevity.Capital. Meanwhile, its analytical subsidiaries Aging Analytics Agency and Deep Knowledge Analytics will continue to develop, expand and refine the relevance and sophistication of their analytical frameworks for Longevity industry assessment, benchmarking and forecasting, while also extending them to additional emerging domains of the Longevity

industry, including the Longevity Financial Industry and government-led National Longevity Development Plans.

LONGEVITY INDUSTRY FRAMEWORK

Most people naturally equate the idea of 'Longevity' with progress in the science of advanced biomedicine - the study of aging with the ultimate aim of delaying its diverse diseases. However, in reality it consists of many more distinct yet intersecting fields.

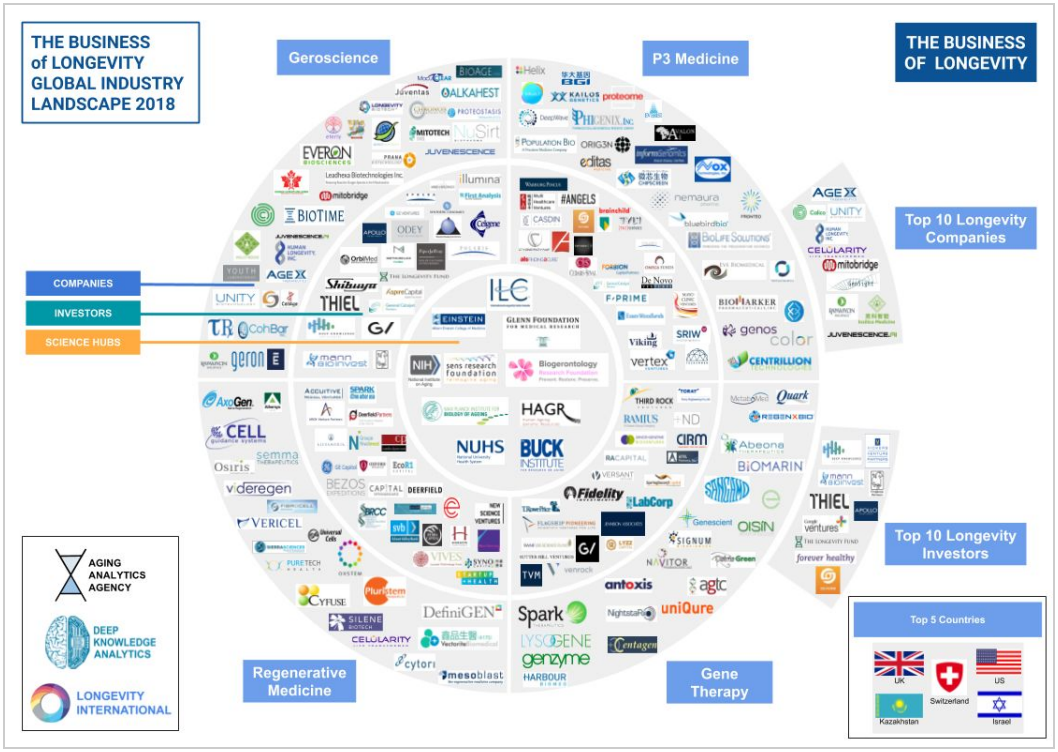


Progress in Longevity is no longer simply a question of progress in geroscience or advanced biomedicine, but now is more driven by the synergistic convergence of intersection of multiple distinct technological sectors and sub-sectors. Throughout the production of its many industry analytical reports and special case studies on the Longevity Industry, Aging Analytics Agency has formulated a broad industry classification framework that categorizes the Longevity Industry into four distinct segments: Geroscience R&D, P4 Medicine, AgeTech and Novel Financial System.

If Longevity only consisted of biomedicine and there were not so many intersections with other industries, then analysis and forecasting might be a comparatively simple task, similar to the analysis of the current biotech industry. But in reality, Longevity inevitably involves a synergy between advanced biomedicine, AI, digital health, financial industry, pension and national healthcare systems, governmental initiatives and even political issues partially related to stagnating economies due to the Silver Tsunami , which together create a very diverse and dynamic ecosystem whose already-rapid pace of progress and diversification only continues to accelerate, creating challenges to concrete understanding and practical forecasting.

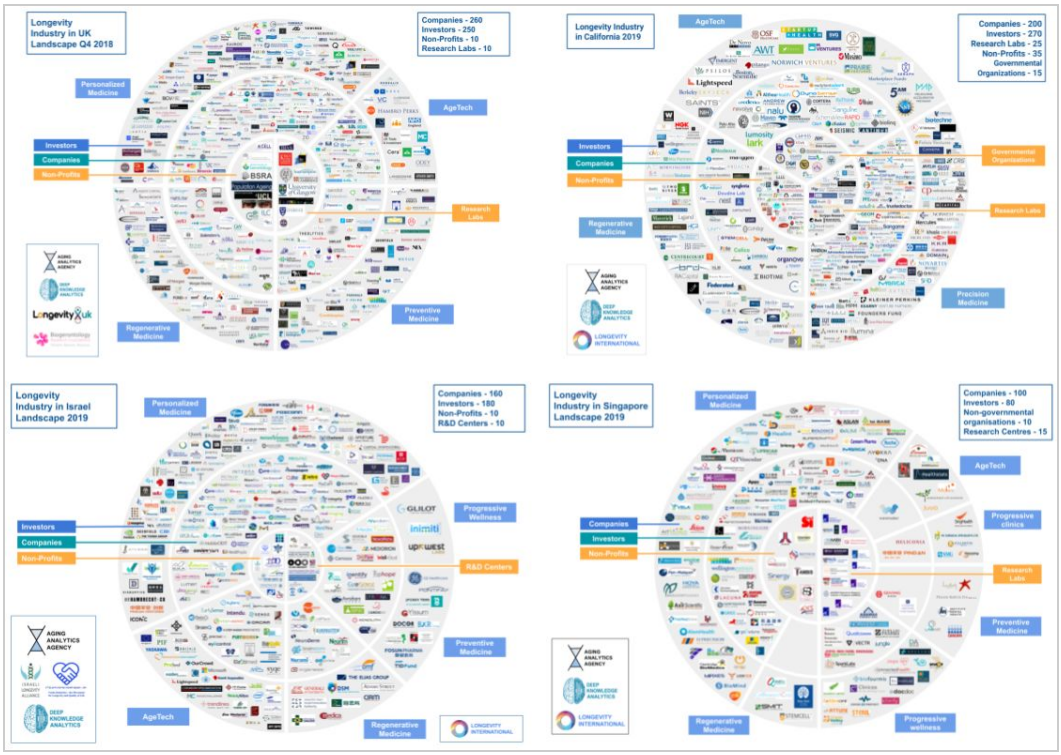
LONGEVITY INDUSTRY LANDSCAPE

The Longevity industry has gone from an underrepresented field of R&D to the rapidly expanding and diversifying frontier of advanced biomedicine. In 2014, Dmitry Kaminskiy predicted the 2018 boom in Longevity Industry investments and activity four years in advance, noting the inevitability of its growth considering the impact it would have on global healthcare systems and the business models of modern medicine, its extreme prospects for profitability and the fact that it is the most ethical form of business, with potential to simultaneously deliver substantial ROIs while providing more benefits to humanity than any other industry in history.



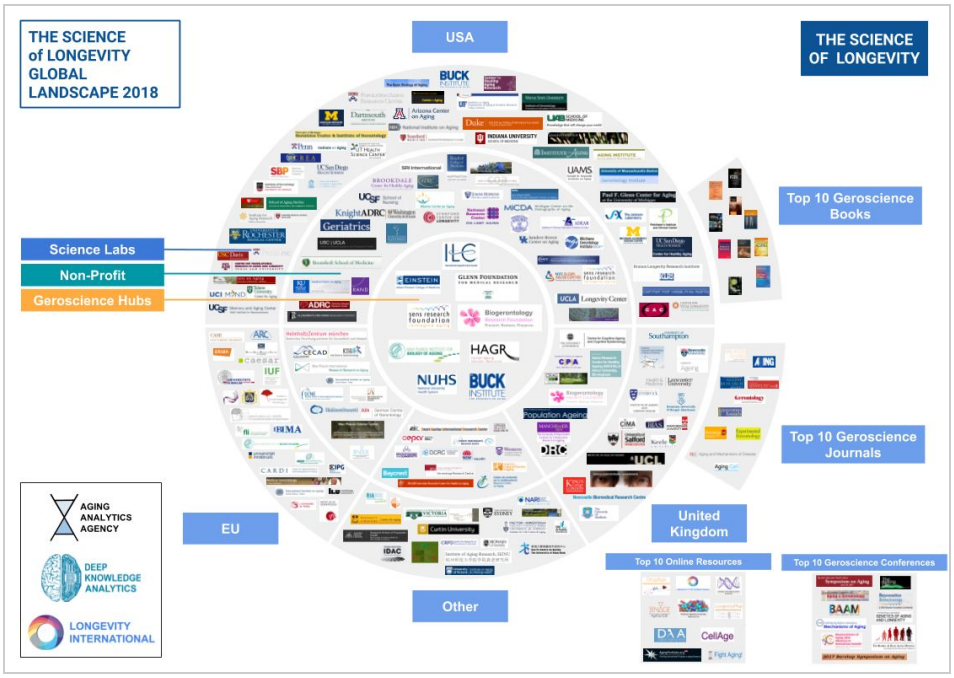
Today, its advanced dynamic of progress and its strong trajectory of growth and diversification is quite obvious, with thousands of Longevity companies active around the globe, dozens of Longevity-focused investment firms, and the fact that in more recent years, it has begun to be embraced by even the most conservative of entities, including top-tier business and finance media brands like The Economist, Financial Times, Bloomberg and others, by large financial institutions and investment banks (who now regularly host conferences and release analytical reports on the topic of Longevity for their institutional and HNWI clients), and even politicians

and parliamentarians (the recent launch of the All-Party Parliamentary Group being perhaps the best example of the recent emergence of Longevity Politics).



GEROSCIENCE R&D

The first segment of the Longevity Industry is Geroscience R&D - the segment of biomedical science and research that aims to treat the root causes of aging. Some of the most early-stage forms of geroscience attempt to treat aging as an engineering issue to be solved using advanced biomedical engineering. These areas are at the very forefront of biotech and biomedicine, and so even these alone require highly specialized approaches to assessment and forecasting, beyond those that have proven adequate for the biotech industry generally.



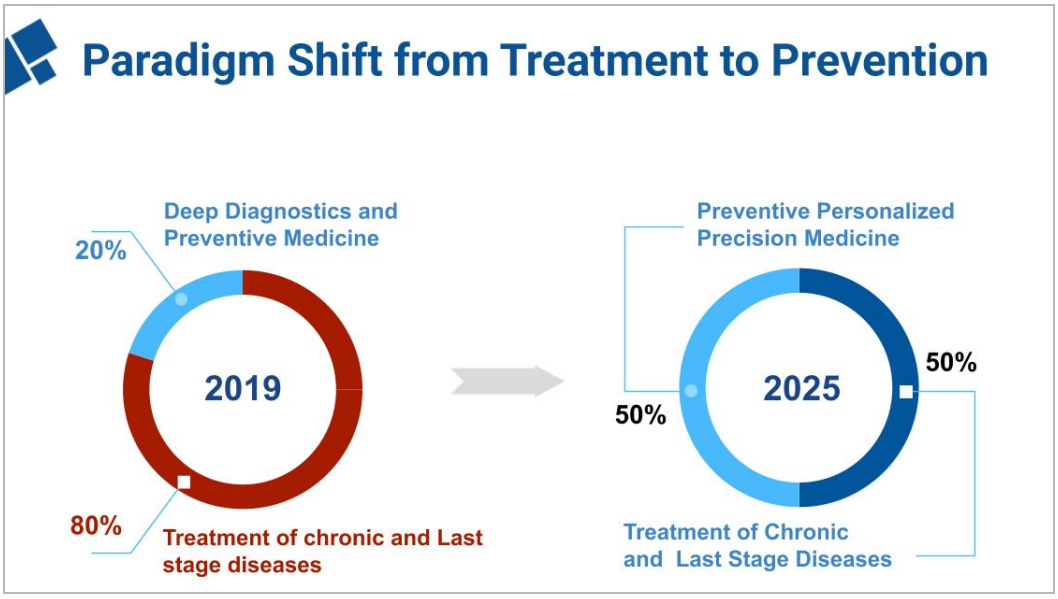
P4 MEDICINE

P4 medicine - preventive, personalized, precision and participatory medicine: leading edge technologies that have already achieved a state of market-readiness and clinical implementation.

This segment has a clear history of paradigm shifts toward greater precision, personalization, prevention and patient participation, driven forward and enabled by advances in biomedicine, data science and Artificial Intelligence. For example, as AI for R&D in drug discovery becomes more sophisticated, drugs will become more customized to specific diseases and even specific patients. Drug development companies will transition from the current form of “blockbuster drugs” (standard drug formulations applicable to many millions of patients) to P4 medicine, tailoring drugs to specific patient cases based on age, gender, ethnicity, state of health and genetics.

The first and second “P” in P4 Medicine are ‘personalized’ and ‘precision’, which refers to the drugs and treatments that will be designed and applied using precise, individually-tailored methods of dosing, cocktail compositions of micro-dosages, and efficient methods of delivery. Such advances also represent a move toward greater prevention (the third “P” in P4 Medicine), and a shift away from reactionary treatment and towards optimized disease prevention applying

micro-dosages of drugs, long before the underlying pathology develops into actual chronic disease. Healthy Longevity means prevention rather than treatment, through the maintenance of optimal states of health via continuous monitoring of disease-associated biomarkers, and micro-adjustments in therapeutic, lifestyle and behavioural regimes to normalize those biomarkers.

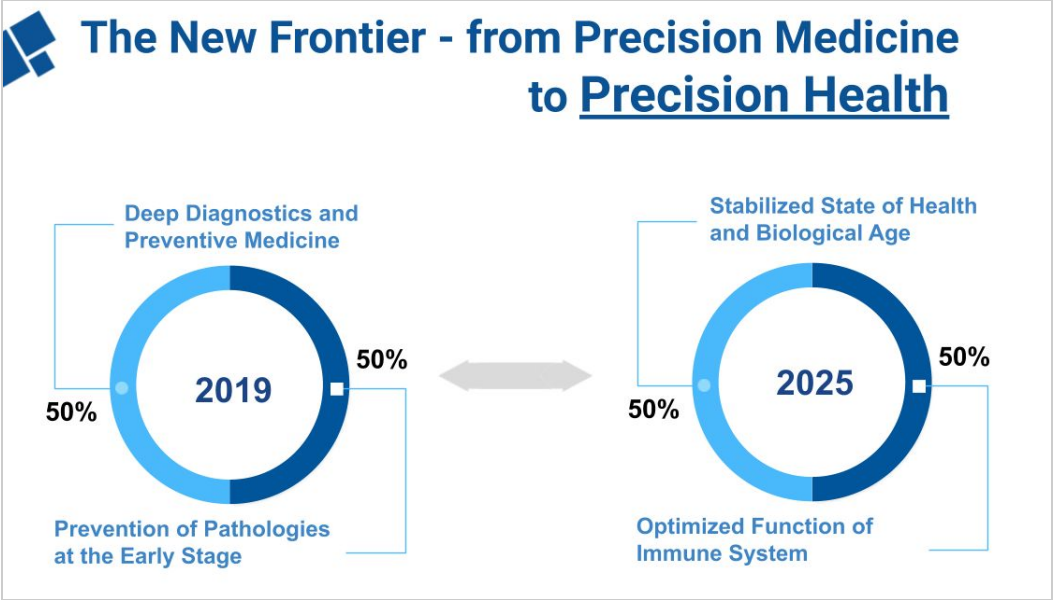


The current state of medicine and healthcare is currently being disrupted by the application of P4 medicine, causing a shift away from "one-treatment-fits-all" blockbuster drugs and towards personalized, precision, preventive and participatory diagnostics, prognosis and therapeutics.

The fourth “P” in P4 Medicine is “participatory”, which refers to the increasingly active role that patients are taking in managing their own health, culminating in a situation where citizens are empowered with the tools, approaches and services capable of enabling continual micro-adjustments to their behavioural, lifestyle and therapeutic regimens in response to continuous AI-empowered monitoring of micro-changes in biomarkers that measure state of health and predict risk of diseases long before their actual onset and progression. *This paradigm is described very precisely in the book “The Patient as CEO: How Technology Empowers the Healthcare Consumer” by Robin Farmanfarmanian.*

These changes are already being embraced by the medical communities and healthcare systems of progressive countries. In coming years, as P4 becomes the new norm, the new

definition of failure will be when patients are forced to get doctors involved. In a world in which P4 medicine triumphs, citizens will have no need to engage with doctors until the very end of life.



Advances in P4 Medicine will converge and culminate in the emergence of a new paradigm of "Precision Health", which denotes the continuous stabilization of health and the maximum-obtainable maintenance of a young biological age via the routine application of P4 medicine in response to ongoing fluctuations in biomarkers of aging and health.

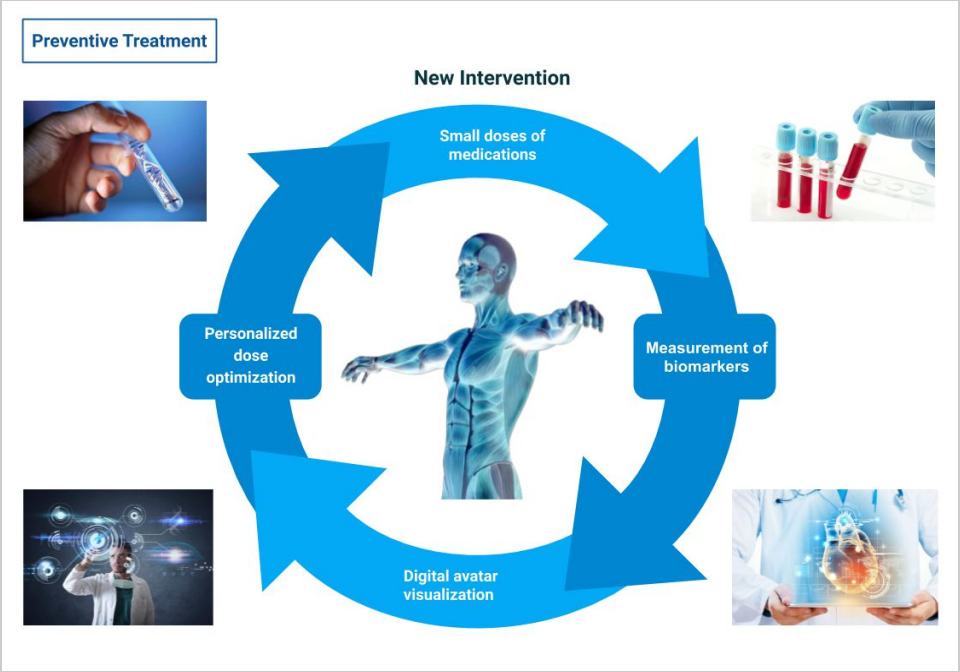
P4 (Personalised, Preventive, Precision and Participatory) Medicine = Precision Health

The term *Precision Health* is becoming increasingly common, and refers to the idea that the ideal and most comprehensive case of P4 Medicine will naturally and inevitably lead to a state of Precision Health, where diseases and other sub-optimal forms of health are delayed for as long as possible, until near the very end of life.

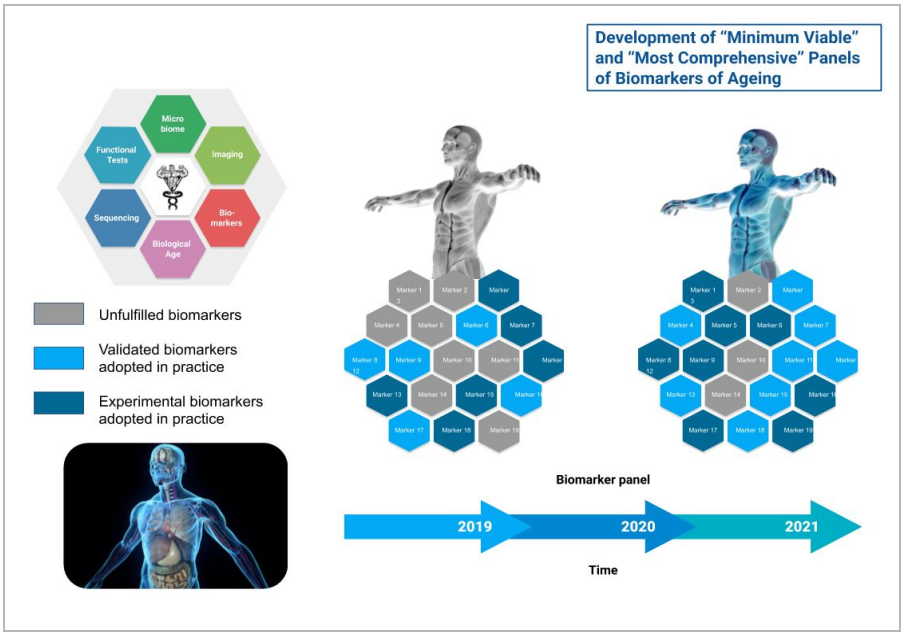
The role of AI in P4 medicine is already remarkably apparent, especially in places such as the UK, USA, Switzerland and Singapore. For example we have seen very proactive efforts by the UK government, both through their AI Industrial Grand Challenge and their aging Industrial Grand Challenge, to rapidly apply AI to preventive medicine, advanced biomedicine and digital

health, and the recent establishment of the All-Party Parliamentary Group for Longevity, where Aging Analytics Agency was proactively involved.

Furthermore, its high degree of complexity necessitates not only innovative frameworks for general benchmarking and forecasting, but also for the general assessment of its technologies' and therapies basic safety and efficacy. Take, for example, the common use of model organisms to assess the safety and efficacy of therapeutics.



Not only do new methods of standard industry benchmarking and forecasting need to be developed to combat the issues of overcomplexity and multidimensionality in the Longevity Industry, but new methods of testing the basic safety and efficacy of Longevity and Precision Health diagnostics, prognosis and therapeutics need to be adapted as well, moving away from the use of model organisms, towards a more human-centric approach. While this works in a good enough way for single diseases, it will become increasingly ineffective when applied to Longevity therapeutics due to the vast genetic difference between the aging processes in model organisms and humans. This situation has created an urgent need for a shift away from model organisms and towards more human-centered approaches for safety and efficacy testing, utilizing comprehensive yet actionable panels of biomarkers of aging in patient populations.



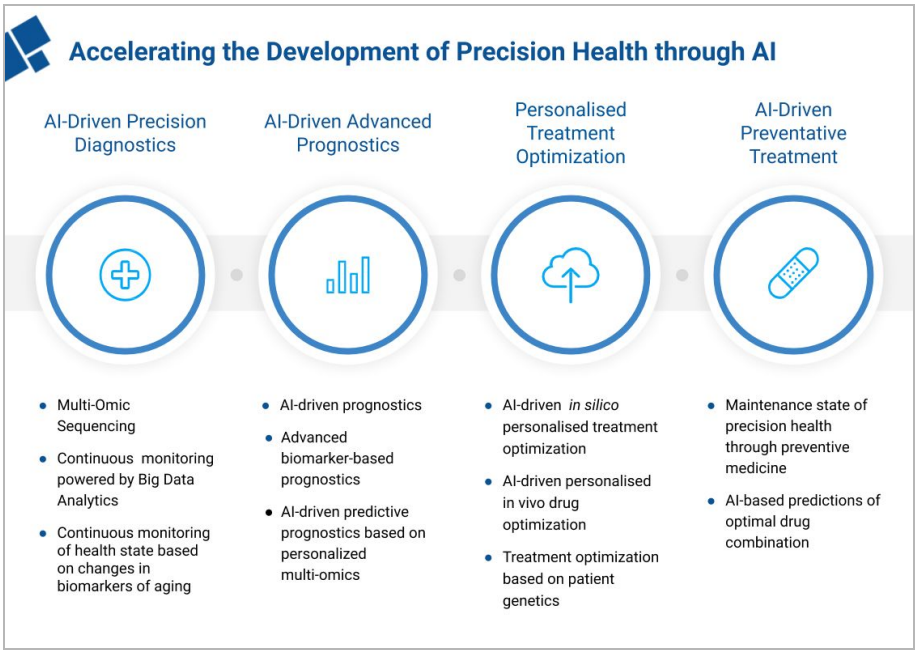
As the Longevity, Preventive Medicine and Precision Healthy industries are grown and developed to scale, we will see an increasing emphasis on the creation and validation of a wide diversity of biomarkers of aging come into use, which will enable the extension of healthspan and the maintenance of optimal health for the majority of citizens' lifespans via continuous, AI-empowered monitoring of fluctuations in personalized biomarkers of aging.

AI LONGEVITY CENTER

One specific development that Deep Knowledge Ventures is currently working on is the establishment of two AI Centers for Longevity in Europe and Asia. The first center will focus on the application of AI for Longevity R&D and the creation and optimization of Precision Health technologies, techniques and protocols. The second center, will focus on so *Lifetime Wellness*, non-medical factors (including financial, psychological and social wellness) that impact quality of life and functionality for seniors, ranging from financial wellness, continuing education, happiness, psychological well being, neuroplasticity and active social involvement. Considering the vast amount of life data and information about citizens being collected in most developed nations by financial institutions, telecom companies, etc., there are a large number of options and avenues for how AI, big data analysis and predictive analytical techniques could utilize that data to create personalized recommendations for how citizens 60 years and older can optimize their lifestyles and behaviours to achieve a high degree of wellness, stability, happiness, social involvement and life activity.

The number of companies, researchers, projects and technologies active in this space (AgeTech, FinTech for the Elderly, Continuing Education, Brain Training, etc.) is significant, and rapidly growing. Therefore, the demand for practical and sophisticated AI-driven approaches for improving and optimizing the products and services in this space is also very high. Therefore dedicated centers focusing on providing companies active in this space with advanced AI-driven support and solutions would generate sizeable revenues by selling and licensing technologies to these companies, and also help to optimize products and services aiming to improve the overall, lifetime wellness of elderly individuals.

There are currently four major AI Centers for Healthcare in various major hubs in the UK, such as the new AI Center for Value Based Healthcare at King's College. However, none of them have a specific focus on Longevity and preventive medicine. While these centers do serve as a proof-of-concept for the viability of an AI Center for Longevity, they do not adequately address the need for a complete AI for Longevity R&D hub capable of developing leading solutions, products and services that apply AI to the specific purpose of extending Healthy Longevity.There are only three entities in the world actively trying to establish an AI Center for Longevity. These include the US-based Buck Institute for Research on Aging, US-based Y Combinator, and the US-based AI Precision Health Institute (AI-PHI) at the University of Hawaii Cancer Center. Only the AI-PHI has actually succeeded in establishing such a center in practice.

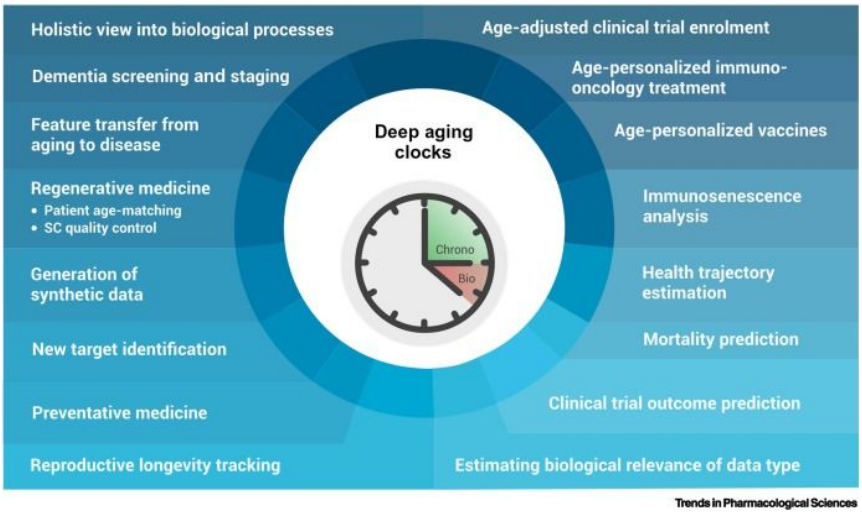


The intensive application of AI to all stages of Longevity and Preventive Medicine R&D has the potential to rapidly accelerate the clinical translation of both validated and experimental diagnostics, prognosis and therapeutics, to empower patients to become the CEOs of their own health through continuous AI-driven monitoring of minor fluctuations in biomarkers, and the rapid development of the global Longevity Industry to scale.

BIOMARKERS OF AGING

One special focus for this new AI Longevity Centers will be the use of AI for the development of an optimal panel of biomarkers of aging - a specific niche where the implementation is lagging behind the science. This is one of the most important diagnostic services that could be offered, and yet it does not receive the attention it deserves compared to the amount of tangible benefits it can deliver.

How do we know when a biomarker is a biomarker of aging? It depends on how it is sourced. The current approach to biomarkers is to take them from people at various stages of a disease's known progress, which in practice means sourcing them from hospital patients. Isolating biomarkers of aging, however, means collecting data which marks the difference between healthy people only, e.g. between the young and even younger, with no traces of any officially recognised diseases. This presents a challenge because whereas hospital patients remain in dedicated areas, and are available for analysis at the doctor's convenience, collecting biomarkers of aging means collecting vast amounts of data from the daily lives of people who have no reason to be in hospital. There are however options available for aggregating such data.



The ongoing shift toward diverse and actionable biomarkers of aging is described very well in a recent scientific article by Alex Zhavoronkov, CEO of Insilico Medicine. Insilico Medicine is the leading company working on this specific topic, and Deep Knowledge Ventures provided Insilico Medicine with its seed funding in 2014.

Also important is the degree of emphasis on achieving a panel of biomarkers which are not only comprehensive but also actionable. A panel of less precise but easily implementable biomarkers of aging would be much better than an extremely precise and comprehensive panel of biomarkers of aging that is too hard or expensive to translate easily into widespread practical use across nations. For example, a panel of aging biomarkers was developed recently which is based on Deep Learning analysis of standard blood biomarkers, which is less precise than the most precise available biomarkers of aging (DNA Methylation clocks), but which is nonetheless precise enough, and can be implemented by any researcher, doctor and clinician that has access to routine blood tests.

As a further example of actionability, consider that biomarkers of aging have been constructed using Deep Learning-based analysis of photographs of mice, which could quite easily be extended to humans. Their accuracy alone is not enough to make them a research priority, but the increasing video capabilities of smart-phones means that these rapid development of photographic biomarkers of aging (e.g. of the face or the eye) could now be a very actionable area of research whose practical level of precision and accuracy will develop quite rapidly in coming years.

However, the use of AI in R&D is lagging behind in its application to geroscience. While there is a small handful of companies that are working at this frontier, the overall proportion in comparison to the total size of the Longevity industry is still quite small. Deep Knowledge Ventures has been identifying and supporting companies working on the frontlines of AI for Longevity since 2014, when it provided the seed funding for Insilico Medicine, now a leader in the application of AI for Longevity research, drug discovery and biomarker development.

LONGEVITY AND THE AGETECH MARKET

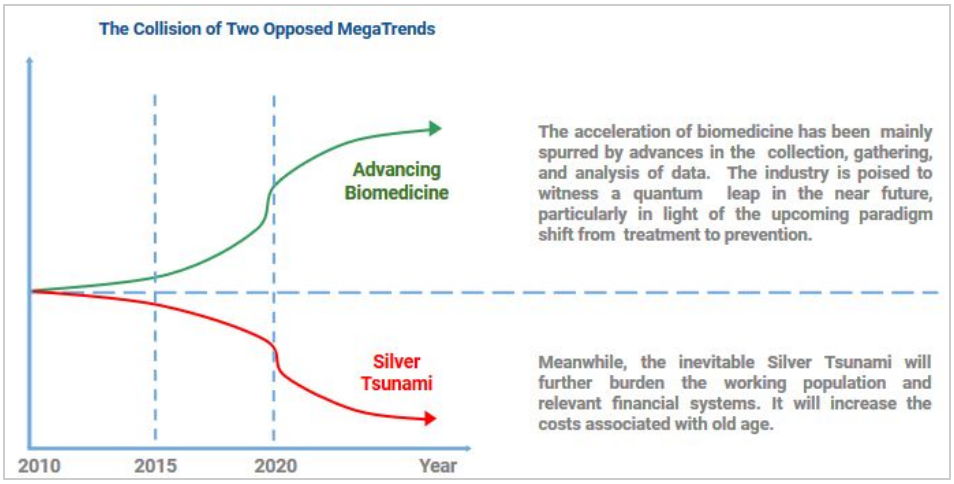
The third segment of the Longevity industry is AgeTech, which broadly refers to all IT and digital technologies that help to maintain greater functionality into older age, and that improve quality of life using non-medical means. This segment of the market is a rapidly growing one, with the number of people in retirement globally growing past 1 billion. This segment also includes such things as advanced and progressive forms of social care, as well as products and services that help to preserve neuroplasticity into older ages.

AgeTech can not slow down biological aging, but it can provide innumerable benefits to retaining functionality and improving the quality of life into older age, enhancing psychological well being, mental functioning and neuroplasticity, and increasing levels of independence and social activity. As such, it is one of the sectors of the Longevity industry poised to grow the most in the shorter-term horizon.

LONGEVITY ADVANCING FINANCIAL INDUSTRY

The final and most recent segment of the Longevity industry is the Longevity Financial sector, which has emerged naturally out of the clear economic and socioeconomic consequences of an aging population and Healthy Longevity for national economies, pension funds, insurance companies and other financial institutions.

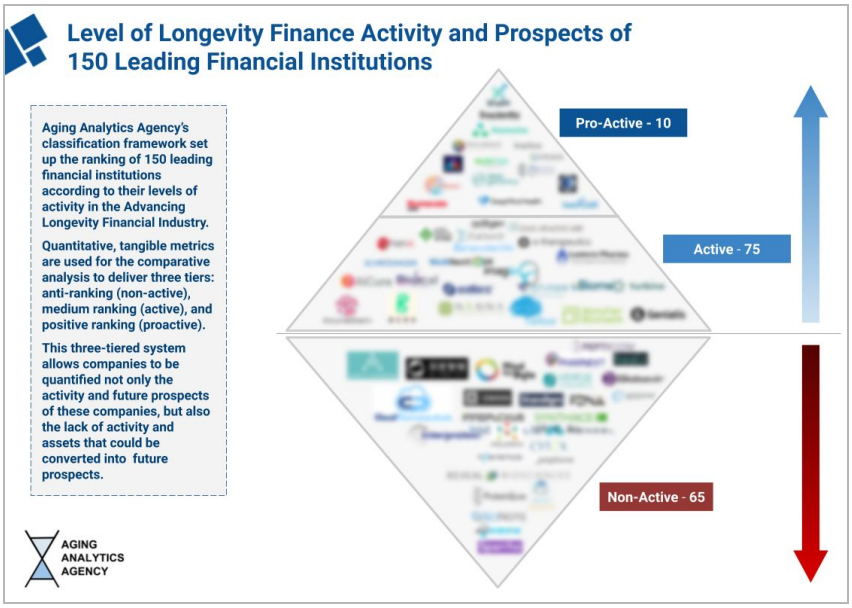
The above factors have combined to produce an inevitable coming paradigm shift in the standard operating procedures, products, services and core business models of global finance within the next 2-5 years.



The present moment in history is characterised by the convergence and oncoming collision of two Opposed Longevity Megatrends: advanced biomedicine, which can increase Healthy Longevity and reduce the burden of aging populations, and the silver tsunami, which threatens to shrink the size of working populations, strain existing age-dependency ratios, and potentially break national healthcare systems if not addressed proactively.

The global finance industry is currently worth several tens of trillions of dollars, and for the last 50 years it has been marked by a distinct lack of innovation, a resistance to embracing technological change, and to re-tuning business models in a manner that is relevant for the dynamic of scientific and technological progress. But we can already see fundamental changes taking place specifically due to innovations in Longevity. As the industry grows, certain parts of it will naturally become commoditized. In the coming years we will see the formation of specialized stock exchanges for Longevity companies, and the creation of marketplaces for tradable financial instruments and derivatives based on the Longevity companies, technologies, products and services.

Deep Knowledge Ventures and Aging Analytics Agency consider this topic particularly important, and are working on it in various ways. We are for example launching a Longevity-focused hybrid hedge fund Longevity.Capital, which will utilize data-driven analytical assessment and forecasting frameworks combined with novel innovations in InvestTech adapted specifically for Longevity, as well as the concept of a specialized Longevity Stock Exchange, Index and marketplace for tradable financial instruments and derivatives tied to the Longevity sector.



Aging Analytics Agency's MindMap of the top 150 financial institutions with relevant activities in the Longevity sphere, classified into several subcategories including Banks, Asset Management Firms, Pension Funds, Insurance Companies and Reinsurance Companies.

SUPER COMPLEXITY - CHALLENGES AND ISSUES

As all these changes progress, the number of points at which these sectors intersect increases. This progress obviously will not be driven by advances in a single technological domain or sector. Each of the necessary breakthroughs will occur at an intersection of two, three or more technologies.

The overall size, complexity and market capitalization of Longevity, is set to dwarf all other industries, from real-estate to energy and many, many others. As a consequence, the challenges and opportunities that is poses to its participants and stakeholders with also grow. Its ongoing growth will eventually reach an inflection point where many of the holder's of the world's wealth recognize the opportunity in front of them, and understand that they have the chance to participate in something uniquely profitable that can deliver greater benefit to humanity than any other in history. Momentum will multiply and the industry will experience self-perpetuating growth.

This will attract manpower at an exponential rate. For various types of professional, a working life outside the expansive industry will be inconceivable. Longevity already attracts the best and

brightest scientists and medical professionals working today, as it is already the forefront of biotechnology and biomedicine. As the borders of Longevity expand to incorporate more of the above-mentioned sectors and related sectors, we will see the most skilled entrepreneurs migrate to the Longevity sector.

In order to be productive, entrepreneurs entering Longevity will need to be highly skilled, intelligent, and adhere to a rigorous ethical code, as the repercussions of both fraud and honest mistakes in this industry are greater than in others. There will come a day when it will be almost unthinkable for any business professional or investor to not be actively involved in Longevity, considering its scope and benefits.

Due to its complexity, the Longevity Industry requires extremely sophisticated analytical frameworks for assessment and forecasting. This becomes increasingly important as it progresses and grows, because the scope for costly mistakes increases proportionately. Many such mistakes will be made with good intentions as a simple result of the sheer complexity of the Longevity landscape and the difficulties of forecasting, but there will also be room for actual cases of fraud, as exemplified by the Theranos scandal.

Due to the fact that it will be an industry dwarfing all others in the history of mankind in its size, the cost and overall repercussions of such mistakes will also be of an unprecedented size and scale. In order to prevent such outcomes, and neutralize the likelihood of a Longevity boom and bust, participants in Longevity need to utilize approaches to assessment, forecasting and strategic decision making precise enough to match its level of complexity.

CHALLENGES FOR GOVERNMENTS AND NATIONS

In addition to the risk of costly mistakes, this level of complexity also creates challenges and opportunities for developed nations and their governments, which are currently facing extreme economic pressures on their healthcare systems, social security systems, pension funds, and national economies due to the rapid acceleration of aging populations.

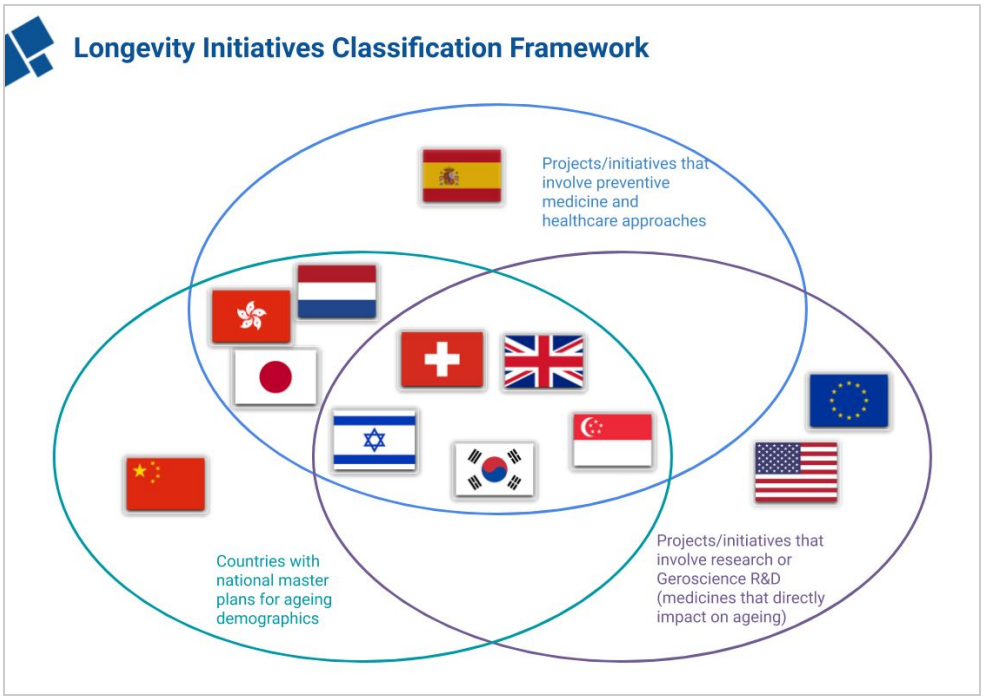
Developed nations are set to either sink or swim in the face of the oncoming Silver Tsunami, and their success depends on how proactively they deploy broad, well-funded national plans to extend Health-Adjusted Life Expectancy and financial reform to neutralize the economic pressures of their aging populations. They have the opportunity to transform the deficit-model of aging into the opportunity and asset-model of Healthy Longevity.

Most developed nations already have the technological means to increase HALE through preventive medicine, advanced biomedicine, socioeconomic policy and lifestyle changes. There is no great need for the further development of many experimental new technologies or therapies any time soon. What governments really need to do at this stage is simply perform the necessary initial diagnostic analysis via the use of panels of biomarkers of aging, executed on a scale at least in the millions. The missing element is not biomedicine or biotechnology, but the aggregation and analysis of huge amounts of health data. It is not a medical or biotech problem, but a big data analytics problem.

Such government-led projects, if properly implemented, would be the greatest source of developed nation's health and wealth, and should be considered as a matter of the highest national importance, implemented with the urgency and rigour of the Manhattan Project (the 1939 American nuclear weapons program completed in 6 years) or Apollo Program (program for the world's first lunar landing completed in 8 years). With the current pace of development of science and technology, these projects could be developed in 5-7 years.

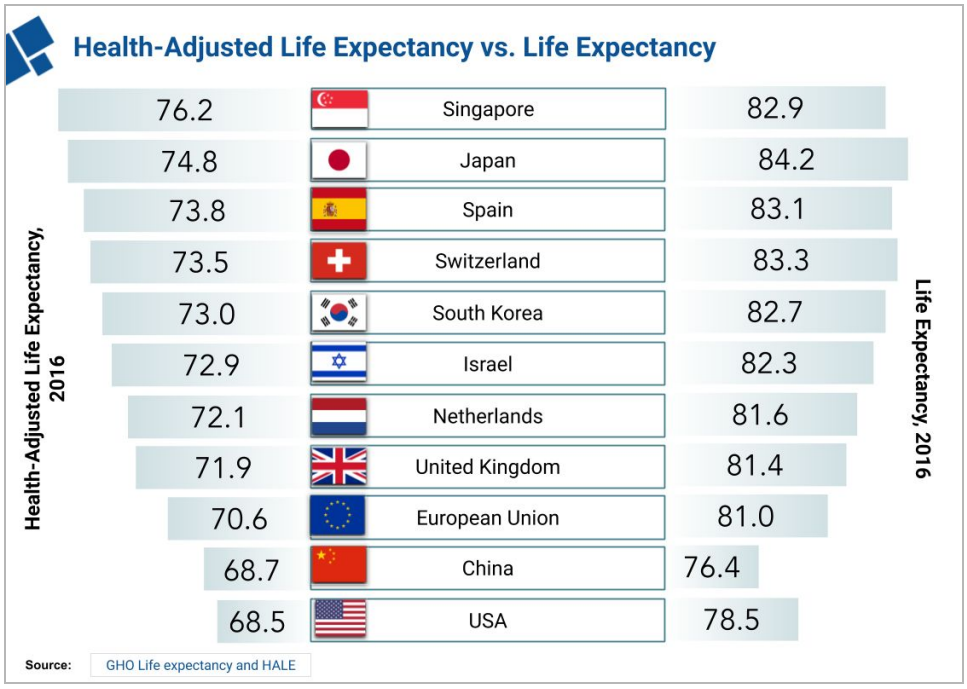
90% of digitized data globally was collected during just the last 2 years, and this rate is only going to increase, and increasing HALE can be largely considered as a data collection. In most instances the technologies pushing forward the Longevity frontier have reached roadblocks which can only be cleared by government coordination. So realistically, the roadblocks to progress are not scientific or technological, but political.

In Switzerland for example, the state of research into precision medicine procedures is very advanced and yet the fragmented healthcare system makes nationwide coordination and harmonisation of biobanks, electronic clinical information systems and clinical data management infrastructures difficult.



Aging Analytics Agency's National Longevity Development Plans Global Overview (First Edition) report contains a comprehensive analysis of the strength, relevance and proactivity of various countries' government-led efforts at projects and initiatives to reduce the economic burden of an aging population and manifest the opportunities of Healthy Longevity.

Yet government initiatives are appearing up all over the globe that will not only better coordinate technological progress and overcome such barriers to progress, but also directly influence Healthy Longevity, and the probability of living long enough to benefit from advances P3 and regenerative medicine. These range from the industrial strategies of Britain and Japan, to the elderly care banks of Switzerland, to the places of continued learning for the elderly in China, to the WHO-certified 'Age-Friendly Cities' cropping up on every continent.



As can be seen from the findings of Aging Analytics Agency's *National Longevity Development Plans report* the gap between life expectancy and Health-Adjusted Life Expectancy (HALE) varies widely among developed countries, and can be seen as a direct result of the relevance and proactivity of their efforts to embrace the paradigm shift from treatment to prevention and from Preventine Medicine to Precision Health.

THE NECESSITY FOR NOVEL METHODS OF ANALYTICS

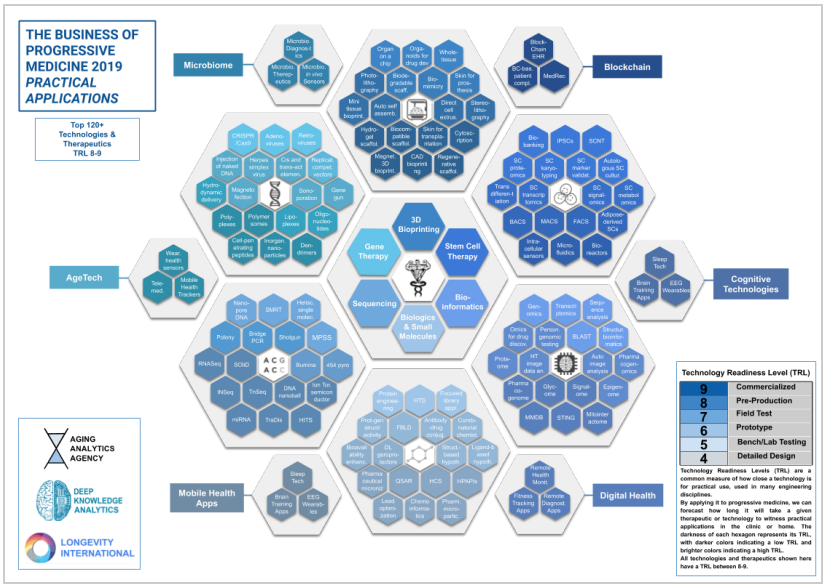
Thus, we can see quite clearly that Longevity's scope both for growth and profitability, as well as the various complexities that make assessment and forecasting difficult, are truly unprecedented. Analysing it means not only analysing the intersections between geroscience research and development, regenerative medicine, P4 medicine, AgeTech, and finance, and also parameters as diverse as the national development plans and financial systems of countries, in relation to the nationwide Health-Adjusted Life Expectancy (HALE) of those countries, an analysis encompassing hundreds and even thousands of parameters of this vast and sprawling emerging global industry.

TIMELINE AND FORECASTING

It would be a mistake to assume that these changes belong to the remote future. Our current methods of predictive analysis inform us that it is quite reasonable, for example, to expect the approaches and business models underlying precision health to become the norm in developed countries by the year 2027-2030, and that in some countries and regions, significant elements behind this approach may be in place as early as 2024-2025.

And while the industry does indeed require new forms of analysis and forecasting to match its runaway complexity, this does not mean that such solutions cannot be created over the next several years, or that they are not already being created today. This is made easier by the fact that there are already existing methods of technological and scientific assessment practiced in other high-tech industries, such as the use of Technology Readiness Levels in aerospace for assessing how close to market-readiness certain technologies are, or scenario analysis in politics and warfare.

There are also similar assessment practices in the fields of AI, machine learning, deep learning and big data analysis, such as the use of synthetic data and metadata (i.e. synthetic data extrapolated from existing data when such data cannot be directly measured) to benchmark, assess and extrapolate existing trends into the future.

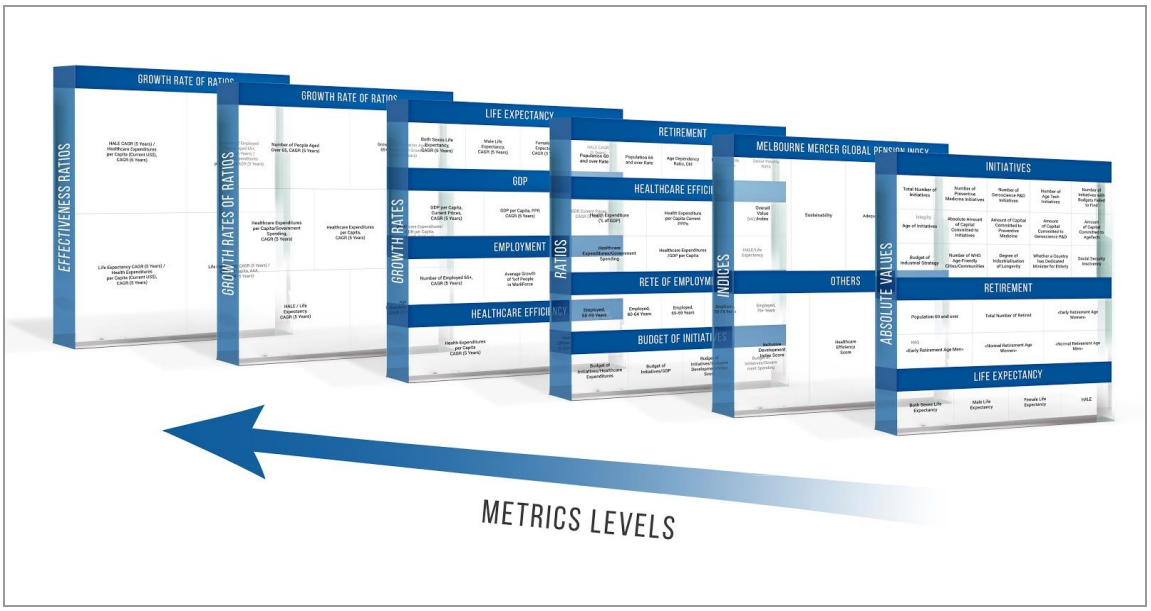


The quantitative and tangible assessment of technologies, methods, therapies and companies within the Longevity space necessitates the use of novel approaches to technological, scientific and industry benchmarking, utilizing methodologies like Technology Readiness Levels (TRLs), which use the expertise of science and technology professionals to assess the market-readiness of products and services, and forecast when their clinical translation will become a reality. While the level of complexity is increasing, the pace of progress in technologies, tools and techniques for assessing and forecasting is also increasing. If proactive measures are applied, the levels of precision and efficiency of such methods can be made to keep pace with the increasing complexity.

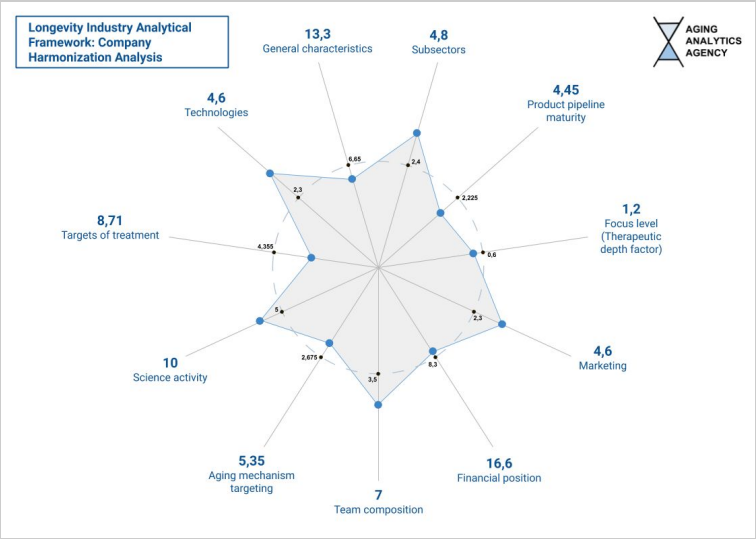
In order to neutralize these challenges and unleash the industry's potential, Aging Analytics Agency and Deep Knowledge Analytics have been working over the course of the past five years on designing and validating increasingly sophisticated and multidimensional approaches to industry analytics, to serve as the leading tools and solutions for strategic decision making, with the aim of developing such frameworks to the levels necessitated by the rapidly complexifying nature of the global healthcare system.

Aging Analytics Agency's 3-D Longevity Industry Analytical Framework, whose production was necessitated by the complexities of the sector, and required in order to obtain a tangible and pragmatic understanding of the industry in order to structure investment strategy in a relevant way.

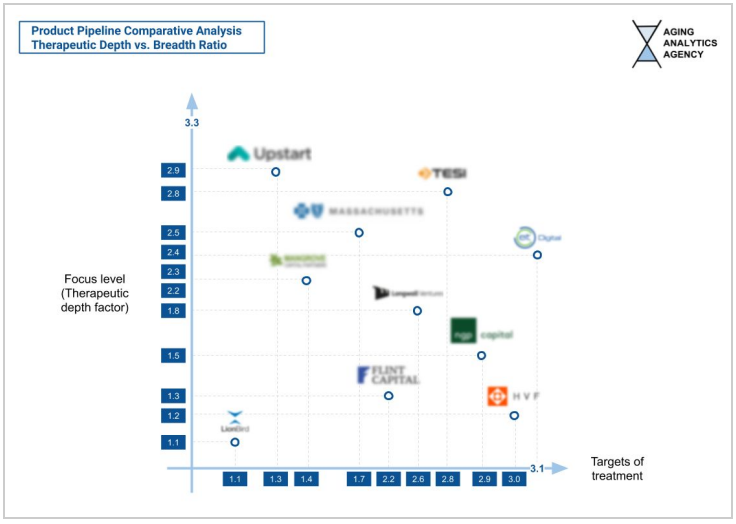
They have been applying systematic methodologies to create different types of analytical frameworks that define and classify distinct scientific domains, technologies and applications very clearly, in a way that allows them to be quantitatively compared, continually refining them to maintain their relevance against the changing dynamics of the industry sectors.



The metrics developed for and used in Aging Analytics Agency's National Longevity Development Plans: Global Overview 2019 report are broken down into 6 distinct layers, with specific ratios being derived from 1st layer metrics, specific metric ratios and growth rates of ratios being derived from 3rdth-layer metrics, effectiveness measures being derived from 4th layer metrics, and effectiveness measure growth rates being derived from 5th layer metrics. To address the political dimension, Aging Analytics Agency has begun to direct significant resources to the production of sophisticated open-access and proprietary analytics on the topics of Longevity governance and governmental development plans, and to the intersection of Longevity and the advancing financial industry of pension funds and insurance companies, and the global market of financial instruments and derivatives related to so-called "Longevity Risk".



The proprietary reports of Aging Analytics Agency utilize a variety of insightful comparative analyses, including company harmonization analyses showing how companies compare in terms of the ratio of their strengths in key areas including scientific validation, business development, marketing, financial position, executive management composition, technology pipelines and other relevant domains. In a similar manner, Aging Analytics Agency is currently working on the production of a proprietary analytical report focused on the intersection of Longevity, AgeTech and finance, a domain that is dominated by an even higher degree of complexity than government-led national Longevity development initiatives.



The proprietary analytical reports of both Aging Analytics Agency and Deep Knowledge Analytics utilize a variety of insightful comparative analyses, including comparison charts showing the ratio of therapeutic breadth to therapeutic depth of companies' product and service pipelines.

AGENDA FOR 2019-2020

Aging Analytics Agency and Deep Knowledge Analytics have continued to refine these comparative analysis systems over the past several years, refining the specific metrics used to conduct its market studies, as well as the mathematical formulas used to combine them, and the advanced visualization techniques used to make their forecasts, ranking and determinations as clear as possible. They will continue to increase and enhance the breadth, depth and overall re-tunability of these analytical frameworks, and to extend them to additional relevant domains, including benchmarking of projects and initiatives in the realms of the Longevity Financial Industry and Longevity politics, governance and national development plans.

It was necessary to begin the process of developing these analytical frameworks early, and to continue to evolve the approaches used for assessment, benchmarking and forecasting continuously, in step with the rapidly shifting dynamics of Longevity. We are now standing at the dawn of a golden age of flourishing machine learning and self-improving AI that will deliver significant progress in the development of comprehensive yet actional panels of biomarkers of aging, and rapidly-intensifying dynamics of progress on the forefront of preventive medicine, precision health and advanced biomedicine. These will form the central metrics of a vast, multi-faceted industry which will swallow up surrounding industries including biotechnology and finance. Its end product is, after all, humanity's most valuable asset upon which all other assets depend: years of healthy functional active life.

Deep Knowledge Ventures will continue its mission to strategically assist, support, and optimize the trajectory of development of the global Longevity Industry industry by supporting the ongoing work of its two analytical subsidiaries, Aging Analytics Agency and Deep Knowledge Analytics, as well as by supporting the establishment of AI Centers for Longevity, and the launch of the Longevity-focused hybrid hedge fund Longevity.Capital.

Major Conclusions

- While the challenges to reliable assessment, benchmarking and forecasting posed by the increasingly complex and multi-faceted industry are daunting, they are not insurmountable. It simply requires the rapid development of sophisticated, quantitative

methods of analysis. And is exactly what Deep Knowledge Ventures and its Longevity-focused analytical subsidiary, Aging Analytics Agency, has set out to do over the past five years.

- More recently, these organizations have analysing not only the biomedical aspects of Longevity but also novel Longevity-related financial frameworks, instruments and derivatives, novel InvestTech for forecasting and due-diligence within Longevity, and analysis of proactivity, strength and relevance of various nation's government-led national Longevity development plans.

- Longevity has stronger prospects for growth than any industry in history, but its high degree of complexity poses substantial challenges and risks. Specifically, the risk of fraud, such as that experienced in gene therapy for example, the effects of which could be drastic, and set the industry's progress back substantially. This is why we urgently need analytical frameworks that can enable assessment and optimization now, rather than later.

- Similarly, if national governments intend to progress rather than stagnate under the pressures of the oncoming Silver Tsunami, decrease the gap between their life expectancy and Healthy-Adjusted Life Expectancy, and transform the problem and deficit-model of aging into the opportunity and asset-model of Longevity, they need to embrace the development of such analytical frameworks, and utilize them to proactively prioritize Healthy Longevity as a major component of their national agendas.

NEXT ARTICLES

In composing this article, we struggled to maintain a balance between comprehensiveness and conciseness, and ultimately found it necessary to produce an article that, while long, still manages to deliver precise and actionable summaries of the entire scope of the Longevity Industry. In order to offset the overall length of the article, as well as its density of content and information, we have provided concise section summaries, as well as an introductory overview and a list of major points and conclusions at the end, to give readers both a high-level and highly-detailed overview of its major insights. This article is intended to serve as a broad yet actionable introduction to the entire scope of the Longevity Industry, its challenges and opportunities, and the novel approaches that must be formulated and adopted in order to neutralize the challenges and manifest the opportunities inherent in the Silver Tsunami, transforming the problem of aging population into the potential and promise of Healthy Longevity. The next articles in this series will discuss and examine each of these topics, challenges and opportunities in greater depth and breadth.

In the upcoming articles in this series, we will cover in greater detail each of the major sections presented in this article, including a deeper dive into the science of aging, advancing financial industry with a focus on insurance companies and pension funds, government national Longevity development plans, and such crucial specific technologies and segments as AI for R&D on biomarkers of aging. To subscribe click the subscribe button at the top of the page. We're interested in your feedback. Please leave your comments in the comments section.

This article was written by Margaretta Colangelo and Dmitry Kaminskiy.

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Click here to follow the Deep Knowledge Group on LinkedIn.

Deep Knowledge Ventures is a leading investment fund focused on the synergetic convergence of DeepTech, frontier technologies and technological megatrends, renowned for its use of sophisticated analytical systems for investment target identification and due-diligence. Major investment sectors include AI, Precision Medicine, Longevity, Blockchain and InvestTech. @DeepTech_VC

Deep Knowledge Analytics is the DeepTech analytical arm of Deep Knowledge Ventures, specialising in forecasting on the convergence of technological megatrends, conducting special case studies and producing advanced industry analytical reports on the topics of Artificial Intelligence, DeepTech, GovTech, Blockchain, FinTech and Invest Tech. Its Pharma Division is the leading analytical entity specifically focused on deep intelligence of the pharma industry and the AI for Drug Discovery sector, and serves as the main source of market intelligence and analytics for AI-Pharma, a specialized hybrid hedge fund**.** @DK_Analytics

Aging Analytics Agency is the world's premier provider of industry analytics on the topics of Longevity, Precision Preventive Medicine and Economics of aging, and the convergence of technologies such as AI and Digital Health and their impact on healthcare. The company provides strategic consulting services in fields related to Longevity, and currently serves as the primary source of analytics for the specialized hybrid hedge fund Longevity.Capital, as well as the UK All-Party Parliamentary Group for Longevity. @AgingAnalytics

Longevity.Capital is a specialized Longevity-Focused Hedge Fund with enhanced liquidity that uses hybrid investment technologies to combine the profitability of venture funds with the liquidity of hedge funds, significantly de-risking the interests of LPs and providing the best and most promising Longevity companies with relevant amounts of investment.