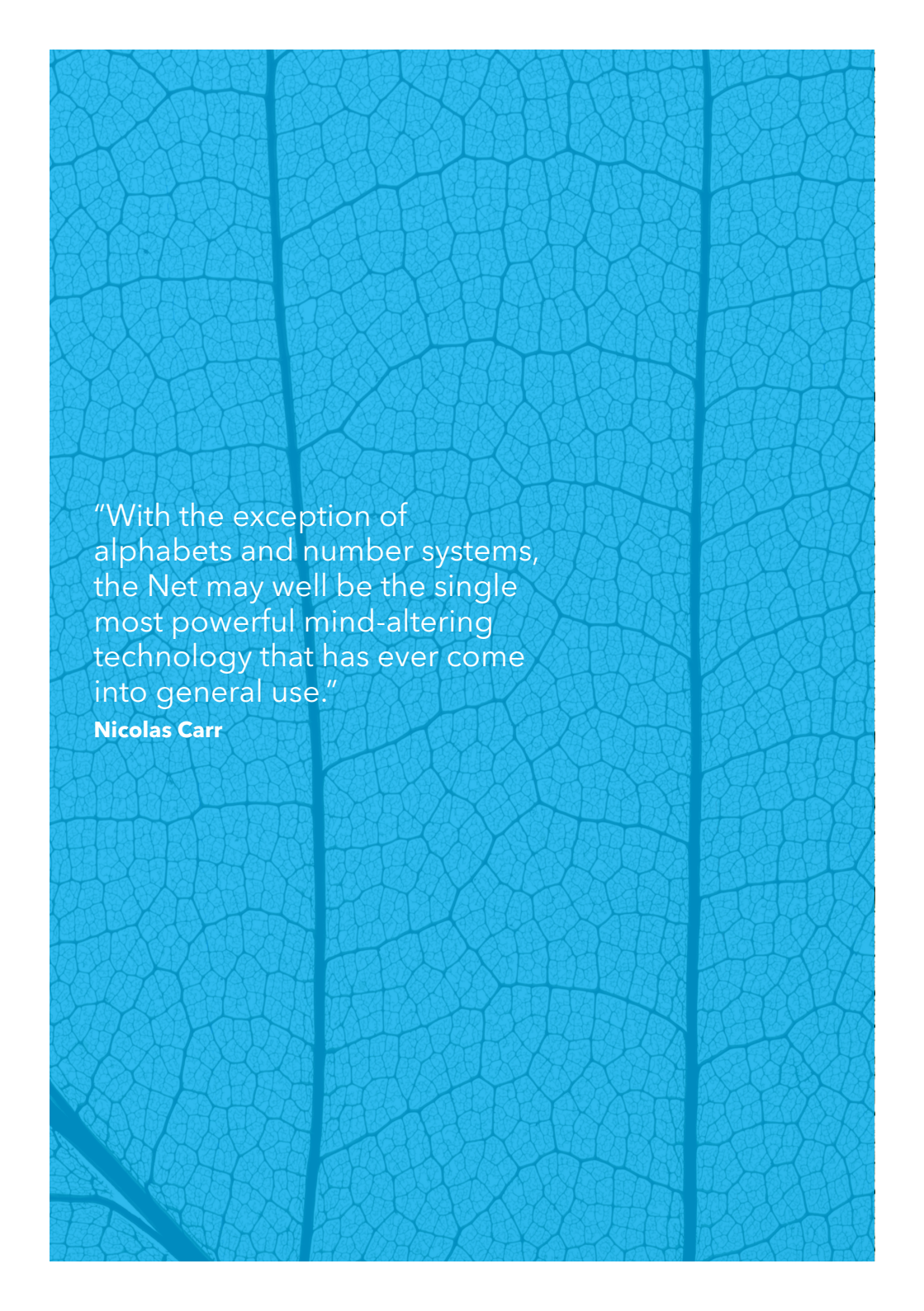**LIFE SCIENCES**

INTERNET
OF PEOPLE

REBOOTING HEALTHCARE

SAFER, SMARTER, GREENER

"With the exception of alphabets and number systems, the Net may well be the single most powerful mind-altering technology that has ever come into general use."
Nicolas Carr

GREAT LEAPS FORWARD

Today we live in a digital, connected world where about 80% of the population worldwide owns a mobile phone, whereas only 70% owns a toothbrush[1]. In 2014, the number of mobile gadgets in the world exceeded the number of people [2]. In the next three years, the number of global mobile phone users is expected to pass five billion, and half of them will be carrying a smart phone [3].

In January 2016 the internet – which has now been connecting people digitally for 25 years – reached an all-time high of nearly 4.2 billion users [4].

This rapid emergence of digitalization is reshaping both the world and our behaviour, and it will only continue to accelerate. The amount of daily data created in 2012 had doubled by 2015, and will continue to double by 2018. This opens up novel possibilities for value creation in business, but a transformation of business models is needed to optimize performance in the "big data" era[5].

For example, data feeds and analytics dashboards will augment and become integrated into existing customer-facing services. The massive amount of data available has already had significant implications and changed the competitive landscape in many safety-critical industries, such as healthcare.

As a result, healthcare is clearly moving away from 20th century practices: from a focus on managing patients' diseases based on population averages, we are now seeing a person-centred approach managing the overall health of an individual throughout the life journey[7].

Already today, we are becoming a part of a global ecosystem – the **Internet of People** – where both our health data and our knowledge more broadly are stored.

At DNV GL, our vision is one where healthcare creates value by delivering services that are free from preventable harm, personalized to individual needs, seamless in delivery, effective, efficient and with equitable access.

In this way healthcare will be safer, smarter and person-centred and it will support each of us achieving our maximum well-being[11].
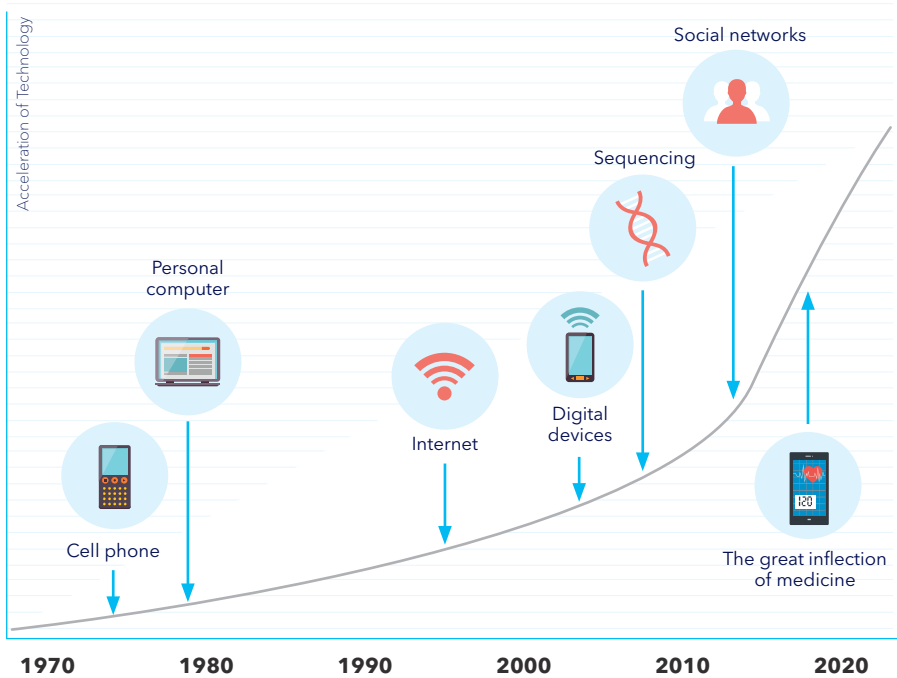
Digital infrastructure, cloud-based storage, digital ecosystems and platform economies have the potential for the largest convergence of technology in healthcare's history (Figure 1)[8-10].

This global transformation is very likely to change healthcare forever. The complexity and abundance of the opportunities arising are astonishing and unpredictable. Capitalizing on this transformation requires adaptability and engagement from global stakeholders (such as patients, providers, suppliers, regulators). Our common challenge will be finding effective ways to enable transformational practices and technologies to achieve safe and sustainable person-centred healthcare for all, while striving to keep people in control of their own information and contextual integrity.

This Viewpoint paper, which is based on extensive research and global stakeholder engagement, aims to initiate and navigate global dialogues on trends, risks and opportunities around the adoption of the Internet of People in healthcare. DNV GL is inviting you to actively participate in these explorations and dialogues.

We are conducting an online survey, **www.dnvgl.com/internet-of-people**, and workshops involving all of you, as healthcare stakeholders, to gather more insights and novel perspectives.

Jahn Henry Løvaas,
Executive Director – Life Sciences
DNV GL

Acceleration of Technology

Social networks

Sequencing

Personal computer

Internet

Digital devices

Cell phone

The great inflection of medicine

1970   1980   1990   2000   2010   2020

Figure 1. Timing of digital advances for digitalization of healthcare in the past 40 years[8].

Internet of People in healthcare
WHAT AND WHY?

In the past few decades we have witnessed striking innovations and technological advancements in healthcare, which have contributed positively to the longevity of the world population. Due to improved medication, vaccinations, diagnostic testing, disease treatments and surgeries, as well as safer water supply and better food quality, the global life expectancy at birth today is almost 75 years, compared to only 46 years in 1955 [12]. Although this increased longevity of life is something to celebrate, it also means that the need for healthcare and related services will significantly increase due to a growing and aging population.

Factors such as newly emerging disease patterns, the impact of climate change, inequitable healthcare access, a poor safety record, an increase in diagnosable health conditions and in the ability to treat these conditions will also add to this growing need. As a result, health systems are becoming more and more hyper-complex, sub-specialized and expensive[7, 13].

Today, the delivery of healthcare is fragmented due to these ever growing needs and limited resources[14]. As a result, "business as usual" for healthcare is no longer sustainable[11]. Technological advancements have been perceived as a key enabler in the pursuit of safe and sustainable person-centred healthcare for all.

The new era of Internet and information technologies is paving the way for innovative models of healthcare delivery. The possibility to collect, store, analyze and integrate a massive amount of personal data has transformed the internet into the **Internet of People**.

Internet of People refers to the digitalization of relationships between people, and the collection, processing and application of personal data. It forms a network of collective intelligence and stimulates interactive communication among our digital selves through digital devices, the internet and sharing of data.

In healthcare, this connectivity and sharing of digital selves enables improved and more *Personalized, Predictive*, *Participatory* and *Preventive care* – the four 'Ps' of healthcare – for the individual, a group or the population in general.

"We are all now connected
by the Internet, like neurons
in a giant brain".
Stephen Hawking

The four 'Ps' of healthcare [15] will enable each of us to have a life-long health plan that combines health promotion and early intervention, based on our individual risk factors[11]. Technology development and Internet of People solutions can create powerful tools in healthcare and may enable healthcare to reach the ideal breakthrough: behavioural changes [16].

For example, internet-enabled solutions and devices like wearable sensors allow continuous real time monitoring of vital physiologic functions (e.g. heart rate, blood glucose etc.). These can help to prevent, monitor and eventually support treatment of health conditions outside healthcare institutions. Implantables, injectables and swallowed nanobots can travel through the bloodstream and send their findings back to an exterior sensor, allowing physicians to get a better profile of the patient and detect dangerous diseases. Medical imaging provides high resolution anatomical and functional information. Social networks offer supportive communities where individuals receive comfort, insights, and leads on new treatments and represent an effective platform for healthcare professionals to share ideas, experiences and new research results. Digital platforms are allowing seamless data and knowledge transfer in the digital health ecosystem, sequencing of an individual's germline DNA, RNA, microbiome, showing unique variations found in genes, and the existence of epigenomes.

These are just some examples of existing and upcoming technologies and their significant influences in healthcare delivery. These examples rely on digital data collection and storage to build digitalized intelligence that can benefit every one of us. This extensive digitalized knowledge of individuals is progressively reshaping how healthcare will be delivered in the near future [17].

Conceptual relationships

DRIVERS AND TRENDS
for Internet of People

The emerging paradigm shift in healthcare environments, driven by societal changes, advanced technology and digitalization, is transforming healthcare from doctor-centred to person-centred and from hospital to home care. The lines of boundaries between home, formal healthcare institutions and after care are blurring, making room for integrated healthcare systems with higher quality standards. Reduced funding is necessitating novel business and care delivery models. This is supported by faster internet connections, smartphones, emerging platforms and evolving payment models. Volumes of data and information flows between all participants are rapidly increasing, as are the numerous internet-enabled personal and medical devices. For example, personalized electronic health records have been a vital tool to reduce errors, and technology has to be embedded into simpler processes in order to underpin the new healthcare regimes [18].

Based on a review of documents, papers, and reports of large global consulting organizations and academia [5, 19-25], we conclude that the following trends are likely to help the Internet of People disrupt healthcare delivery in the next years to come:

Ubiquitous sensors

Cheap, wearable and online sensors, devices and software applications enable us to monitor and analyse our own health in greater detail, gathering increasing amounts of personal health data and analytics.

Blurring of traditional segment boundaries

Companies and organizations are seeking new opportunities outside their traditional market segments.

Personal device suppliers are investing in the health and well-being market, healthcare providers may offer their own "apps", computer manufacturers are offering diagnostics by artificial intelligence, and so on.

Digital trust

The increasing amount of sensitive, personal data in the hands of new and existing actors will grow demand for cyber security and regulations.

New digital ecosystems

New configurations of product and service providers jointly offer new value to the market.

For example, various technology platforms in liaison with device providers, "app" providers and medical experts are offering new value in the health and well-being market.

Automation

More diagnostics, decisions and advice will be provided by "intelligent" systems based on personal and group-related health data and analytics.

Technology induced behavioral change

New technology is inducing behavioural changes faster than regulatory bodies are able to react with new legislation and rules to protect consumers and prevent big international actors from establishing a monopoly-like market dominance.

Self-service and personalization

People and organizations prefer self-service if they can get access to more personalized services at the time and location of their choice. With improvements in user experience, the threshold of using advanced self-service systems is lowered.

Connectivity 24/7

Mobility, connectivity and cloud-based services enable the collection and centralized processing of individual and population-based data.

Network-based business models

Digital services such as social media, search engines, online auctions and advertisements are available free of charge. The business model of these companies is to offer access to the data trail generated by their users to other organizations.

Internet of People offers
OPPORTUNITIES TO HEALTHCARE

The Internet of People focuses on collective efforts to encourage and stimulate an interconnection between the owning and sharing of data, technology, individuals and healthcare workers.

The Internet of People thus will enable us to co-create new models of care that are participatory, predictive, personalized and focused on illness prevention. This will result in increased efficiency and effectiveness of health systems, and the creation of true value in the digital era for the benefit of all healthcare stakeholders.

This is achieved by breaking down fragmentation, increasing accessibility, reducing costs and improving patient safety and experiences, as well as making healthcare more equitable.

On a personal level, embedding the Internet of People into individual lives offers direct benefits such as improved medical outcomes, higher quality of life, and reduced healthcare costs. For example, in a recent report Goldman Sachs [26] points out that the "digital revolution" can save over $300 billion in healthcare spending in the USA. This would mostly be within non-communicable disease management through improved care coordination, site-of-care efficiency, lifestyle improvement, reduction in overtreatment, and higher medication adherence.

On an organizational level, the Internet of People has the potential to improve patient safety and quality of care by automating management systems and supporting clinical decision-making processes. For example, hospitals can provide a more responsive and agile ecosystem

by providing real time, interactive communication between health workers and patients.

On the level of society more broadly, digital devices (sensors, networks, smart devices, computation, etc.), services (e.g. personalized medicine) and platforms (e.g. healthcare forums) can significantly influence people's choices and eventually change habits. Digital health can serve as a communication platform among healthcare stakeholders, aid in disease management, patient compliance and tracking of outcomes. When digital devices transmit vital medical information in real-time, hospitals can operate more efficiently and patients can receive better care. For example, additional data collected from sensors, health trackers and a patient's diary can help his or her care providers to monitor their vital signs and exercise patterns and determine their personalized risk for heart attack or stroke [24].

As the Internet of People (r)evolution arrives, it brings with it an element of risk. Healthcare stakeholders including regulators, providers, suppliers, payers and patients must tackle these issues together. Some of these risks are discussed in the next section.

RISKS TO ADOPTING
the Internet of People

Realizing the potential of Internet of People means minimizing and managing risks related to human, social, political/regulatory, legal/ethical, technological and financial risks:
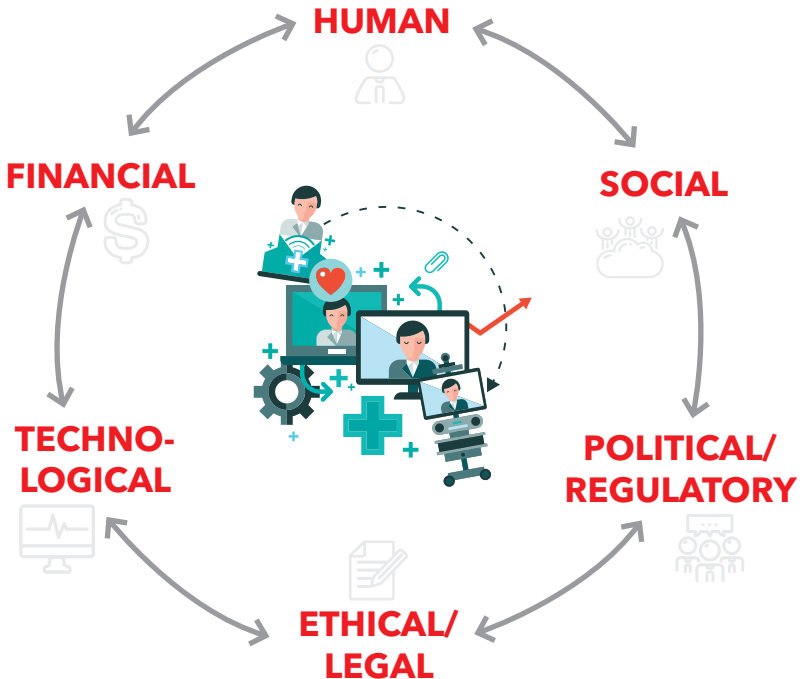

Figure 2. Risks to adopting the Internet of People in healthcare

The healthcare sector is characterized by the human factor, and by an inherently conservative culture. Innovation is required as much as desirable behavioral changes of both providers and service users.

Social risks to adopt Internet of People are associated with concerns about trust, privacy and the appropriate processing of individual data collected through mobile apps or solutions by, for example, individuals, application developers, health workers, advertising companies, and public authorities [26]. The increase in the number of internet-connected devices has increased the number of entry points into (personal) data systems which are loaded with sensitive patient and financial information. Individuals generally accept to release data about themselves in return for a value service, but they generally feel they lack control of their own data, hence they are more and more reluctant to

share their data when this is optional. This represents an increasing risk to data sharing. This type of information is also prone to cyber-crime. Ensuring healthcare cyber security is a top priority if healthcare is looking into full utilization of Internet of People [23, 27].

Political risks and lack of unified standards hinder seamless interoperability of health information systems such as electronic health records by being the bottleneck to data sharing. Joe Biden, who recently shared his son's personal story of battling cancer, has called for better data sharing by stating that … "based on the simple proposition that data and technology can have an incredible impact on saving people's lives. We should open up more of the data held by federal government to drive progress." [28]. Cross-border data flow and transmissions, different national and international data protections laws and policies has also inhibited the adoption of Internet of

"DNV GL is committed to contribute to future person-centred healthcare through development of safe and secure digital solutions".

Pierre C. Sames
Senior Vice President
DNV GL - Group Technology and Research Director

People. Currently, there is not much oversight of Internet of People and there are many potential implications (e.g. adequate technology infrastructure, operability, compliance standards), of Internet of People that will require some form of regulatory oversight.

The use of digital intelligence in healthcare will undoubtedly continue to raise **ethical considerations**, such as should service users have the ability and right to ask for remove

their data and what kind of digital footprints do they leave behind. In case of damage to patient health, involved stakeholders lack legal clarity on the liability risks and the ways to mitigate those [26].

Technological risks to the adoption of Internet of People can be reflected in the uncertainty, various levels of accuracy and reliability of Internet of People devices' sensors and operating systems as well as how the data are collected, processed and

used. Poor data quality can endanger the entire value of the Internet of People ecosystem because it may be rejected by the users [27, 29] and in worst case lead to erroneous decisions which can have fatal results for the individual as well as larger groups. Thus, good data-quality, data-transmission and data-analysis are crucial to use the potential of digitalized healthcare and eventual failure may threaten patient safety.

Current reimbursement policies present a major **financial barrier** to Internet of People, as they are primarily arranged for face-to-face medical treatment and do not always take outcome measures into account, i.e. value of quality of life. This lack of financial rewards limits the physician interest upon reliance on new technologies that can potentially improve the well-being of a patient.
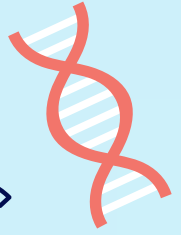
T TRENDS

Self-service and personalization

Blurring of traditional segment boundaries

Network-based business models

! RISKS

Financial

Political/regulatory

Human

Ubiquitous sensors

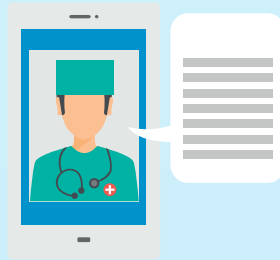**New digital ecosystems**
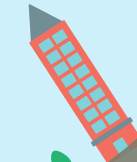
Connectivity 24/7

Digital trust

Technology induced behavioral change

Automation

Social

Ethical/Legal

Technological

"Tackling complexity, especially from a technological and process perspective, is what DNV GL excels at – and has an excellent track record of doing – in complex, safety-critical industries. We enable trust in these industries by taking a systems approach to the technology and man-machine interfaces involved and applying a risk-based approach to manage and prioritize the most important risk factors.

Time has now come for DNV GL to focus on probably the most complex 'systems' on Earth – us human beings. Focusing on the adaption of technologies contributing to sustain and preserve human life is a visible and tangible way of giving effect to our vision: Global impact for a safe and sustainable future"

Jahn Henry Løvaas
Executive Director, Life Sciences DNV GL

CO-CREATING THE WAY FORWARD

In today's era of exponentially increasing data, information, and ubiquitous digitalization, the Internet of People is a disruptive force in the future of healthcare.

In order to unleash the potential and opportunities that the Internet of People offers for more participatory, preventive, predictive and personalized healthcare, while effectively addressing concerns and risks, we see extensive collaboration as a necessity. Only collectively can we have a global impact, and that requires the ideas of many. We need to take a systems approach and overcome public scepticism by engaging all stakeholders as we integrate the Internet of People into healthcare delivery models.

The process of collecting, structuring, storing, analyzing, interpreting and utilizing sensitive human data requires sharp and clear social, ethical and juridical considerations.

DNV GL is committed to supporting the integration of the Internet of People into healthcare, and to take proactive participation in healthcare transformation.

DNV GL is determined to create and maintain trust and confidence between stakeholders. By taking the third party assurance role, DNV GL will strive to ensure that all Internet of People users receive safe, reliable and trustworthy solutions. DNV GL brings in not only objectivity, but also multidisciplinary expertise and proven knowledge and experiences to manage risks in safety-critical industries.

Dear Stakeholder,
we need to hear <u>your</u> opinions and views on the following topics:

- Which Internet of People trends you are most excited about and why?

- Which are the biggest risks to adopting the Internet of People in healthcare?

- How can healthcare overcome risks to adopting the Internet of People?

- How can healthcare utilize the Internet of People for a safe and sustainable future for all?

You can support the adoption of the Internet of People and co-create the future of healthcare by voicing your most honest opinions and views in our online survey www.dnvgl.com/internet-of-people

Regardless of your participation in the survey, you can send an email to eva.turk@dnvgl.com if you wish to receive our upcoming White Paper.

The White Paper will summarize survey findings and report the conclusions and predictions from some of the sector's leading professionals on the topic, gathered through our stakeholder engagement activities.

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WHAT IS...

DIGITAL SELF: A virtual representation of our selves. An important concept in the Internet of People where wireless tools all the time stream vital signs like heartbeat, blood pressure and respiration into the cloud, where software could analyze it and alert health workers to potential anomalies and looming crises.

DIGITAL ECOSYSTEM: A distributed, adaptive, open socio-technical system with properties of self-organisation, scalability and sustainability inspired from natural ecosystems. Digital ecosystem models are informed by knowledge of natural ecosystems, especially for aspects related to competition and collaboration among diverse entities.

PLATFORM ECONOMY: A medium which lets others connect to it and create value externally with digital partners and communities of users. Platform economies can be found in a growing number of industries such as social networking (Facebook, LinkedIn); internet auctions and retail (Amazon, eBay); urban transportation (Uber, Lyft), mobile payment (Vipps, Square) and healthcare: Philips Healthsuite platform with three different cloud partners: Salesforce. com, Amazon AWS IoT, and Alibaba Cloud).

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DNV GL
Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. DNV GL is a leading provider of classification, certification, verification and training services. With our origins stretching back to 1864, our reach today is global. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.

As a world-leading certification body, DNV GL helps businesses assure the performance of their organizations, products, people, facilities and supply chains through certification, verification, assessment, and training services. We also deliver deep insight and pragmatic support to major companies enabling them to build effective sustainability strategies. Partnering with our customers, we build sustainable business performance and create stakeholder trust.