

1 *Essay (Op-Ed) Commentary*

2 **Pay A Penny Per Use – PAPPU - an economic instrument for** 3 **markets of billions (MOB)**

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16 **Abstract**

17 Socio-economic factors discourage developing and prevent implementing point-of-care tools
18 (SNAPS) for impoverished communities. Economic, environmental, cultural, and ethical
19 paradigms that affect economically disadvantaged users, adds complexity to the process of
20 technology development, integration and deployment in low-income regions around the world.
21 Hazards in the workplace, home, broader community and in the environment, must be detected
22 and measured. Sensor Analytics Point Solutions (SNAPS) is a decision support tool which could
23 play an important role in the prevention and mitigation of human exposure to harmful vectors
24 and agents, for example, supporting decision-making when mercury may be a contaminant in
25 water and spread of tuberculosis. The economic challenges involved in disseminating diagnostic
26 tools in low-income markets are multi-factorial. Promoting systems-as-a-service by lowering the
27 barrier to entry calls for a pay-a-penny-per-use (PAPPU) micro-payment paradigm.

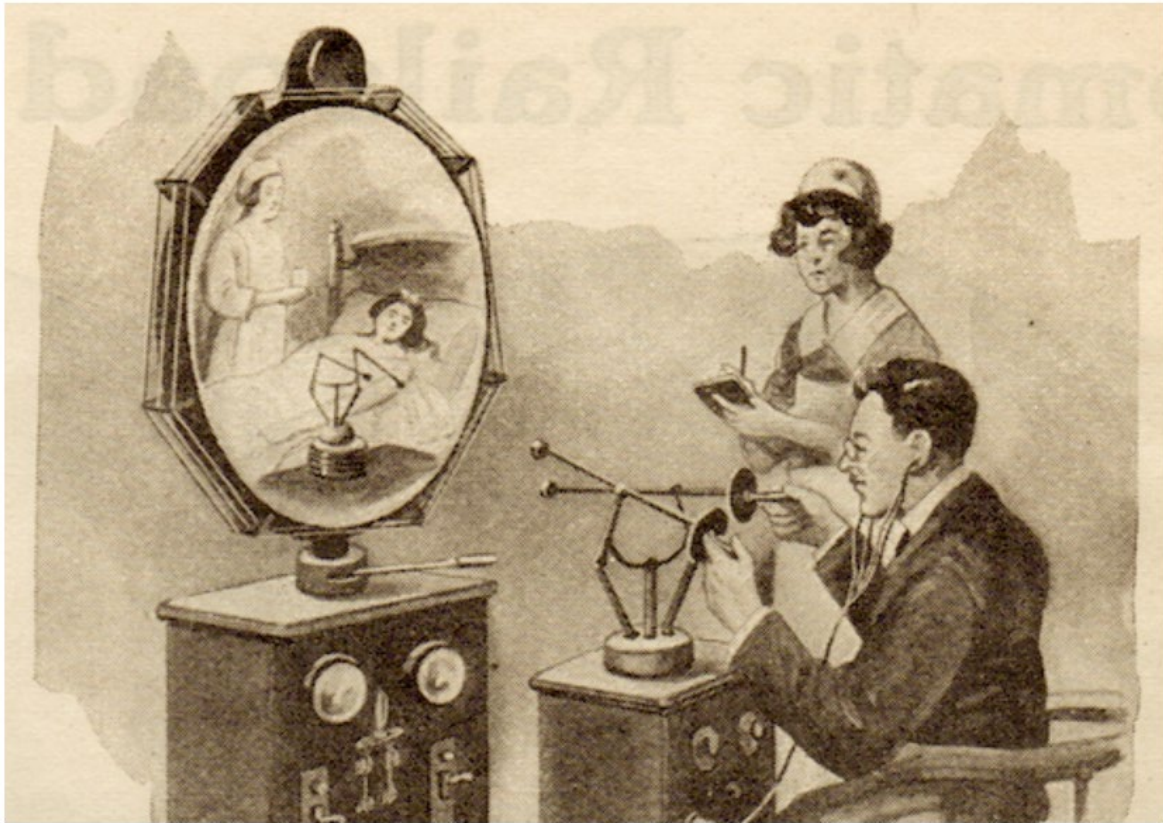
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30 Framing the issue of diagnostic tools in the context of technology leads us to recognize a vast
31 spectrum. On one hand, ideas proposed about 100 years¹ ago (1925) and on the other hand,
32 milestones in computational speed from about 100 days² ago (2019). It may be justifiable to
33 suggest that technological barriers may not be the primary reason why diagnostic tools are still
34 absent from communities under economic constraint. The powerful incentive of lucrative
35 profitability, in the short term, may not be realized if serving impoverished regions. Profit trumps
36 science, in the service of society.

37



38

39 Diagnosis by Radio³ – Front cover of 1925 February issue of Science and Invention Magazine



The doctor of the future examines a patient (1925)

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41 Source: <https://www.smithsonianmag.com/history/telemedicine-predicted-in-1925-124140942/>

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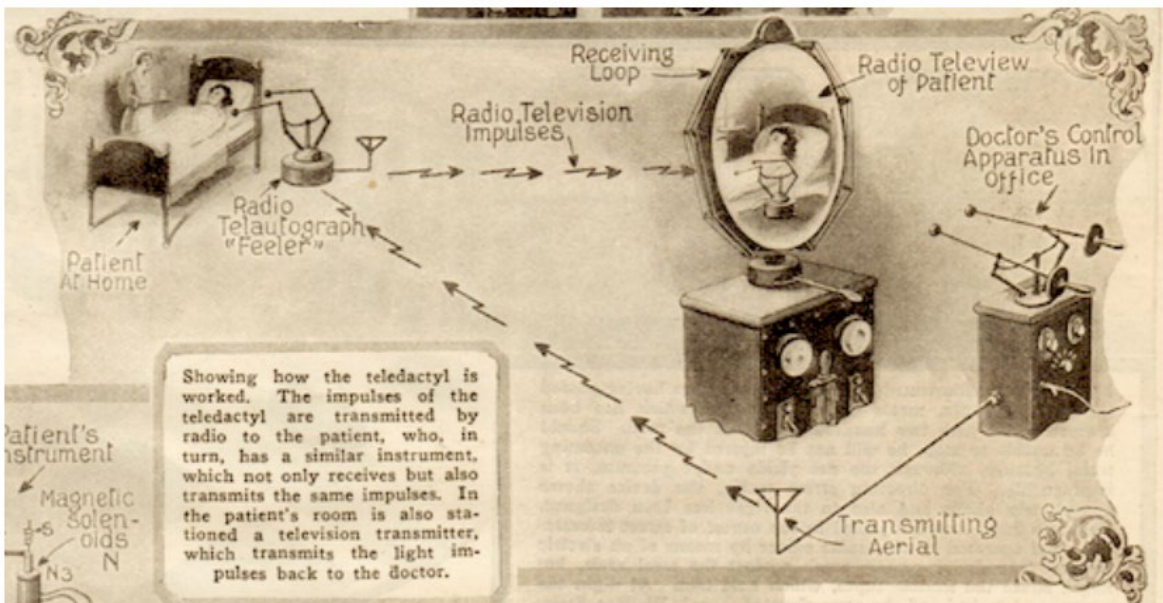


Diagram explaining how the teledactyl was supposed to work (1925)

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44 Source: <https://www.smithsonianmag.com/history/telemedicine-predicted-in-1925-124140942/>

45 Transaction cost⁴ is the over-arching factor⁵ with multiple⁶ interpretations⁷ which appears
46 to be the economic barrier with respect to the reasons⁸ why accelerating the rate of diffusion of
47 diagnostic tools in distressed communities⁹ continues to pose difficult challenges¹⁰ even for
48 basic¹¹ public goods. Despite the advances¹² in development¹³ economics¹⁴, offering incentives¹⁵
49 for adoption and societal actions¹⁶ was a failure, even when the incentive amount was US\$1 in an
50 environment¹⁷ where per capita earning per day was about US\$1.77 or less. The not-so-cryptic
51 lesson is that even benevolent bribes¹⁸ may be ineffective. We must focus on the value to the user
52 or the extent of the benefit to the beneficiary's environment and/or ecosystem (for example,
53 preventing measles in patient 0 may save the entire village from infection and epidemic). However,
54 delivery of value is inextricably linked to cost, unless it is aimed to deliver philosophical messages.

55 In simplified terms, the convergence of cost of product and cost of service leads to transaction
56 cost. A myriad of costs¹⁹ and cost-incurring processes²⁰ are involved but we shall bypass the
57 details. The physical product in this case is the sensor and the service is the solution delivery
58 (SNAPS). Academics cannot control cost but their contribution can impact implementation and
59 use. A low-cost sensor from a lab must be manufactured, calibrated, evaluated and *sufficiently*
60 *scaled* if the outcome can still be claimed as a "low-cost" sensor, capable of delivering value with
61 respect to maintaining a certain pre-agreed quality of service (QoS) in keeping with the KPI (key
62 performance indicators) that the community desires, demands or deems necessary.

63 Scalability may be a nail on the coffin for low-cost sensors. There are no markets of billions on
64 day one because field testing in a limited test bed or small-scale pilot is a pre-requisite. Forced to
65 abandon the benefits from economies of scale, the cost of the physical product escalates until
66 product development and product testing groups can guarantee a working sensor with defined
67 QoS to attain a prescribed set of KPI. Absorbing the cost of product development may not be
68 feasible under conditions of poverty.

69 A working sensor delivered to a community as a gift is useless without a visualization system
70 to capture the data from the sensor. Stand-alone visualization devices (for example, blood glucose
71 home monitors with dedicated devices to read the blood glucose "strip" and read out the data) will
72 add inordinate cost to the system. The alternate is to use a mobile phone as a platform to visualize
73 sensor data. Signal transduction from the sensor to the mobile phone calls for multiple layers of
74 tools, technology and software, in addition, the presence of a mobile phone is a pre-requisite. The
75 presence of a mobile phone is contingent upon available cellular and/or wireless infrastructure to
76 support the use of the phone. It may not be prudent to assume the presence of telecommunications
77 infrastructure²¹ despite the penetration²² of such services, globally.

78 Thus, even if a working sensor is at hand, the obvious process of signal to data transition and
79 visualization of the (raw) data (only) involves multiple layers of capital expenses (infrastructure
80 cost) as well as costs due to technologies, hardware and software.

81 Assuming that the above layers are in working order, the sensor data meets a “dead end”
82 upon arrival (visualization). A number (with units) is relevant if there is an index of knowledge
83 and if the number is combined to make sense from the sensor data. For example, the combination
84 of data from mercury contamination (raw sensor data) expressed in terms of hazard quotient²³
85 (HQ) which uses other vital pieces of information to meaningfully converge and deliver HQ
86 number indicating the context, relevance and meaning of the sensor data with respect to *informing*
87 the user about the *health* of the user. The delivery of *information* based on sensor data that drives
88 the *value*.

89 Taken together, the physical product, the sensor, is no longer the focal point of value.
90 Information pertaining to the health of the user is the *service* which delivers the value for the user.
91 Transaction cost, therefore, is no longer a product-based (physical sensor device) entity but the
92 cost of service which must be *feasible* for the service to be delivered, disseminated and adopted
93 (subscribed) by the community. There are other considerations of the broader ecosystem, for
94 example, what if the HQ number suggests immediate attention by a medical practitioner. The
95 confluence of tools can deliver the HQ but execution is an entirely different kettle of fish. Without
96 the support services for execution, the HQ number may be a sign post on the road to morbidity
97 and/or fast-approaching mortality.

98 Overcoming the economic barriers to solution delivery (SNAPS) will be well nigh impossible
99 if the chasm between product and service continues to overshadow the concept of value delivery to
100 the user. The bridge over the chasm is not under construction because it is usually not a corporate
101 priority to invest in long-term return on investment (ROI).

102 However, ROI may not be the insurmountable barrier if the leaders indulged in limited
103 imagination. The economic principle, which may work in impoverished nations, is rooted in
104 micro-finance²⁴ and micro-payments²⁵ with low transaction costs. Eliminating “product sales” to
105 focus on the paradigm shift to “service” which is a *package* of the product with resources (retail
106 mobile banking, infrastructure, telecommunications, cybersecurity²⁶, customer service). Users pay
107 (pennies) *only when they use the service*. The latter lowers the transaction cost and hence the
108 barrier to entry into vast markets of next billion users, albeit, over time, not instantly.

109
110 The economic incentive for democratization of data is the potential to unleash/create new
111 markets for data, information and decision support, for billions of new consumers (users). The
112 **reward** in the lucrative service economy model depends on harvesting the economies of scale

113 where each user (market of billions) may pay one or more “pennies” (micro-payment for pay-per-
114 use services). The **risk** in the service economy is the collection of that “penny” (per use) at the last
115 step of the *seamless* service delivery process, if the user is satisfied with the quality of service (QoS)
116 metrics.

117
118 A plethora of partners are necessary to create and sustain the ecosystem to deliver the
119 *seamless* service. Sharing a fraction of that “penny” with the partners in the ecosystem is not a
120 trivial challenge. If the QoS delivery metrics suffer due to poor performance of any one partner
121 (component), the “penny” may be unpaid if the QoS metric fails to reach a pre-determined value
122 (time, duration, speed, rate, volume). The inability of one provider (weakest link) in the service
123 supply chain can be financially detrimental to all other supply chain partners due to loss of that
124 penny, *albeit, only for that transaction* (unless the partner has a chronic problem, then, it must be
125 excluded from the ecosystem and the entire value network²⁷). Delivery of service is a real-time
126 convergence of operations management which includes (but is not limited to) multiple value
127 chains which must integrate²⁸ the physical supply chain and the financial supply chain with the
128 service supply chain and customer relationship management (expectation from brand image).

129
130 Irrespective of the strength of ideas, the path to adoption is fraught with challenges. Therefore,
131 the hardest pragmatic question, that deserves unvarnished honesty, must ask, will anybody pay to
132 use these tools? The economic barrier is rooted in the economics of technology²⁹ as well as
133 infrastructure and service execution potential in the environment.

134
135 The pay-per-use model was epitomized by POTS, the plain old telephone system, where the
136 user paid only the “charge per call” which was reasonably affordable even when the per capita
137 income was low. The capex was an investment from the corporate behemoths, in anticipation.

138
139 In this paper we advocate the complicated “pay a penny per use” (PAPPU) paradigm which
140 re-invents POTS with the qualifier that the user may be able to pay a penny (US one cent) for each
141 use (suggested but *not restricted* to one penny). The “use” may not be a thing, object or tangible
142 product but rather a “process” which we refer to as a service, in this case, SNAPS.

143
144 Will PAPPU ever see the light of the day? A version of PAPPU (pay a penny per **unit**) is
145 evident in the “99 cents hamburger” model and screaming in PayPal’s 2018 revenue³⁰ (\$16 billion
146 from 12 billion transactions, \$1.25 / transaction). The “unit” view of PAPPU may be applicable not
147 only in SNAPS or diagnostics, but energy, water (**units** delivered) and other public goods.

148
149 In another version of advanced PAPPU, if outcomes are dependent on a cascade of sequences
150 in the operational process, then each process may be a “profit center” and may generate a penny in

151 revenue each time the user “touches” the system to extract information (or knowledge). If the
152 economy can bear the economics of PAPPU then systems diffusion and adoption will continue to
153 grow (decades) based on the economy (until saturation, when demand plateaus irrespective of
154 cost).

155

156 The number of sensors, and other data, are likely to intersect with vast number of decisions.
157 The actual *transactional volume* of payments, from ‘micro’ or ‘nano’ payments, are potentially
158 gargantuan. Documenting that the system was “touched” and billing/collecting that one penny is a
159 technical challenge which requires tracking events (think IPv6, as an “indicator” for *system*
160 activity³¹). As mentioned before, the task of segmenting that one penny revenue, between several
161 service providers, is a challenge in “weighted” decomposition/recomposition of events, to
162 distribute earnings based on the degree of contribution of the provider who executed that instance
163 (for example, sensor manufacturer, systems integrator, platform provider, software vendor,
164 analytics, mobile fintech).

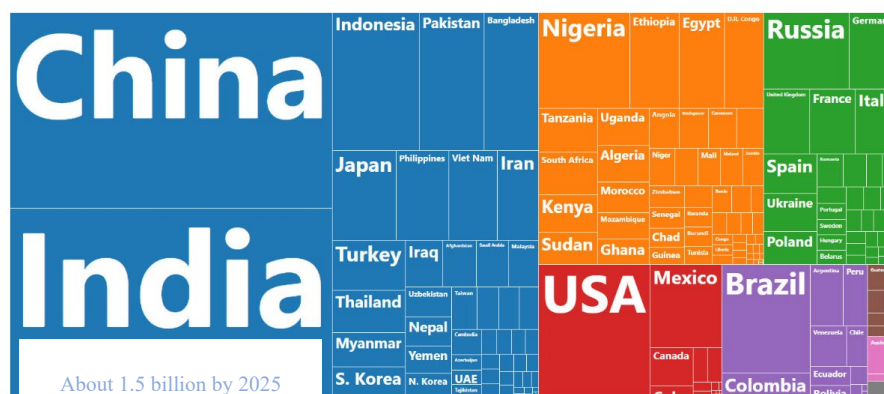
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166 Since no new “physics” is necessary to delineate these processes, it is safe to state that these
167 can be accomplished without any invention but with forward thinking and innovation. It is a déjà
168 vu scenario from the “Store of the Future” (2000-2001, RFID³² track and trace³³) which sputtered
169 and asphyxiated in the face of systems integration challenges, only to be resurrected by Amazon,
170 which, finally, implemented the retail concept in Amazon’s GO³⁴ (September 2018) but still³⁵
171 appears to be in the lag phase.

172

173 Increasingly, the PAPPU paradigm will be the monetization mantra where IoT may be
174 deployed as a digital by design metaphor since sensing and sensors will be ubiquitous. The IoT
175 generation may strive for equality, equity and *égalité* to re-claim their rightful place in society
176 striving for ethical profitability. It may take 20-30 years to overcome the resistance from despots,
177 investors and corporate behemoths, but eventually the infectious spread of the PAPPU paradigm,
178 or some variation of this nano-payment suggestion, may succeed in sowing a critical-mass of
179 practitioners. The concomitant growth of infrastructure (for example, affordable access to low
180 latency, reduced jitter, high bandwidth wireless telecommunications, 5G, trusted mobile banking)
181 may be necessary to pave the road for pursuit of PAPPU. The ability to escape the dead weight of
182 old technology (eg Africa, Asia) may accelerate the implementation of *pay a penny per unit*
183 (PAPPU) as an integral part of the socio-economic fabric of a product-less, service-based
184 economy, which may exclude the tiny population residing in OECD nations and/or the red and
185 green zones in the cartoon show below.

186



187

188 *PAPPU may evolve as a preferred business model for the global economy by lowering the barrier to*
 189 *entry into markets where people are surviving on about \$2 per day. The impact may be especially*
 190 *profound on healthcare, agroecosystem for production of food including all forms of basic public*
 191 *goods or FEWS (food, energy, water, sanitation). Twenty years ago, China's economy was a tenth the*
 192 *size of the United States. In 2019, it is two-thirds as big. In 2039, on the current trajectory, it will be*
 193 *more than 10% bigger. India will have leapfrogged Japan and Germany to claim the No. 3 spot in the*
 194 *global rankings. Vietnam will be closing in on the top 20. PAPPU can help the global leapfroggers.*

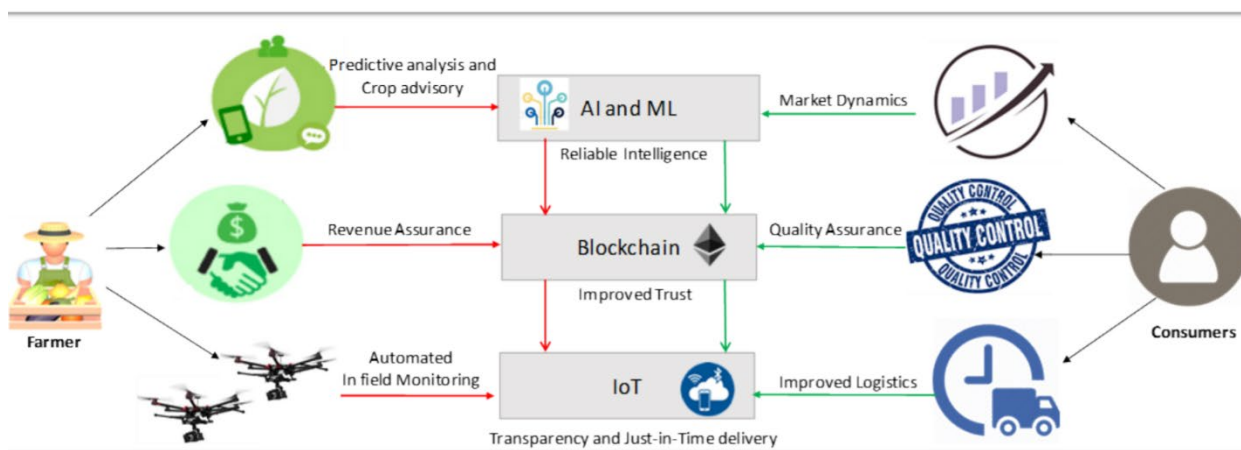
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196 PAPPU is inextricably linked to mobile payments, distributed banking and digital finance.
 197 Idiots will jump on this discussion to claim PAPPU is incomplete unless “blockchain” is integrated
 198 in the process. Blockchain³⁶ hype-mongers are worse than snake oil sales. The adage or aphorism
 199 “hammer in search of a nail” seems too respectful in view of the torrent of garbage that is spewed
 200 in the name of blockchain. However, trust³⁷ in any transaction is undeniably central. Therefore, it
 201 is important for PAPPU to provide tools to ensure safety of the payment system and other steps
 202 where verification guarantees are related to the service or product (for example, food safety and
 203 security). But, informed organizations may not, blindly, consider blockchain security for PAPPU.

204

205 Whether and how and in what form the concepts in blockchain may be helpful, remains to be
 206 seen. It is not entirely useless and such “solutions on steroids” may deserve a place in society to
 207 counter the unethical practices that rapidly multiply in financial operations. However, such
 208 specific examples of use, and value of blockchain, may not be *generalized* as a solution for *all* levels
 209 of transactions. It is deceitful and malicious for blockchain proponents to tarnish all verticals and
 210 industries using the broad brush of finesse that is rampant in the financial industry. Blockchain is
 211 erupting into an euphemism for avarice, for the people involved in the process of marketing tools
 212 for blockchain. It is an anathema for >80% of the world trying to survive beyond the gluttonous
 213 grip of tools and technologies of dubious value. Blockchain is certainly not a panacea. There may
 214 be other³⁸ low-cost ways to achieve safety, security, identification and authorization.

215



216
217

218 *Chacun voit midi à sa porte – hammer in search of a nail. Deliberate misrepresentation and forced*
219 *peddling³⁹ of blockchain at the “center of the world” of operations.*

220
221

222 *It is not necessary for individuals in trains, planes and automobiles to wear an armor-suit. The*
223 *safety belt is sufficient, although it may not be enough, in certain instances. The latter is the risk*
224 *that emanates from the rewards due to progress, which society has, and will continue to, shoulder.*
225 *Rather than feeding people, the burden of blockchain will starve the hungry, where food is most*
226 *needed, by increasing cost of operations. Imposing rules and regulations will secure profit for the*
227 *blockchain industry, deliver little for food safety and deprive nations from food.*

228 The capital expenses (capex) necessary for synergistic service integration (SNAPS-like
229 systems) are small when compared to blockchain⁴⁰, the gargantuan waste⁴¹ on hype even by
230 developing nations⁴² and projects⁴³ which may take decades to lift⁴⁴ our lives, if the future⁴⁵ still
231 need such services.

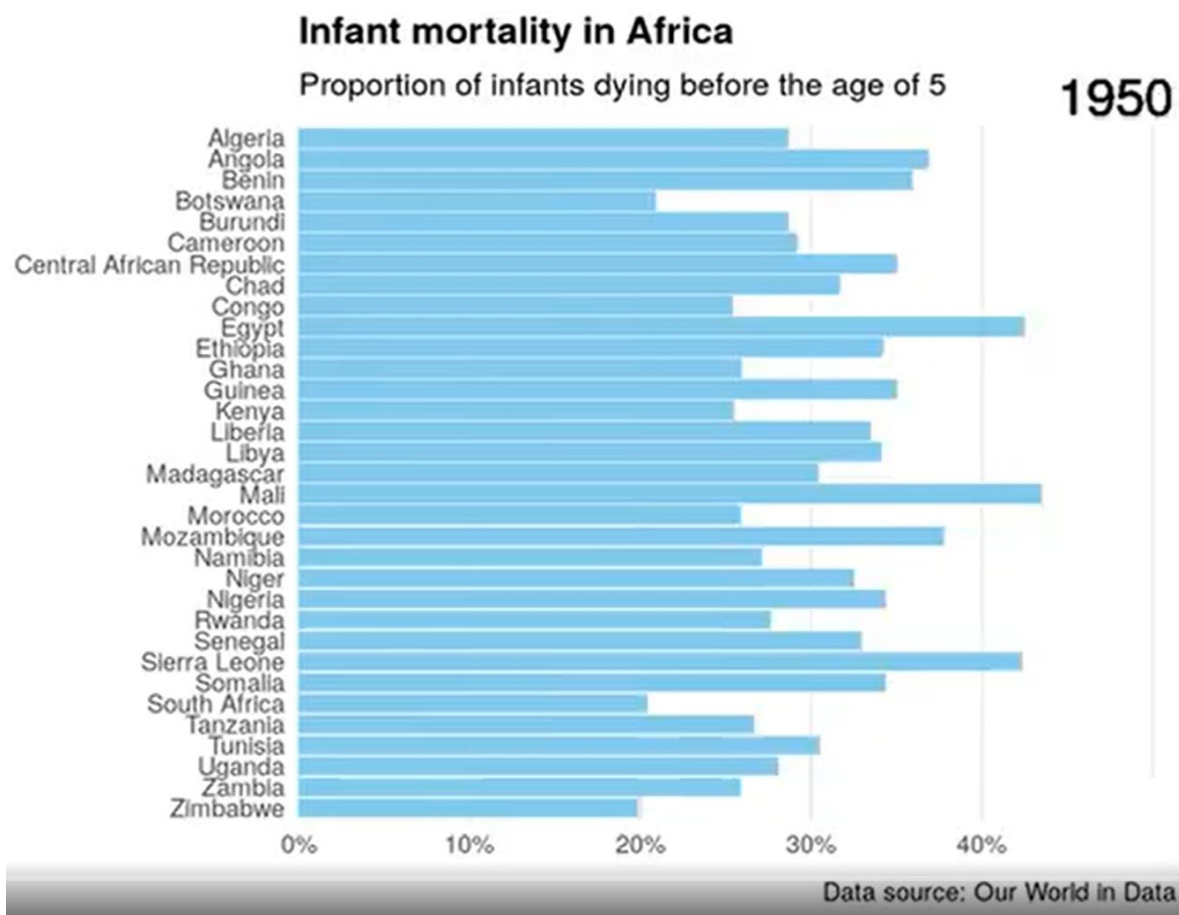
232 One modus operandi to overcome the economic barriers is perhaps to create a PAPPU PPP
233 (public-private partnership) as a global consortium with an altruistic fervor to pay and pave for the
234 synergistic integration, to promote SNAPS in FEWS. The challenge is to bring to the table global
235 organizations, benevolent individuals⁴⁶ and thoughtful governments, who may choose to lead this
236 effort to channel science to serve society, for the less fortunate, in non-OECD nations. This is a
237 challenge of true leadership but most so-called leaders are self-serving⁴⁷ pathetic⁴⁸ narcissists⁴⁹.

238 In summary, we need new eyes, unbridled imagination and a moral fabric of synergistic
239 solutions that can wrap around, not to isolate, but to protect, provide and promote remediable⁵⁰
240 injustices.

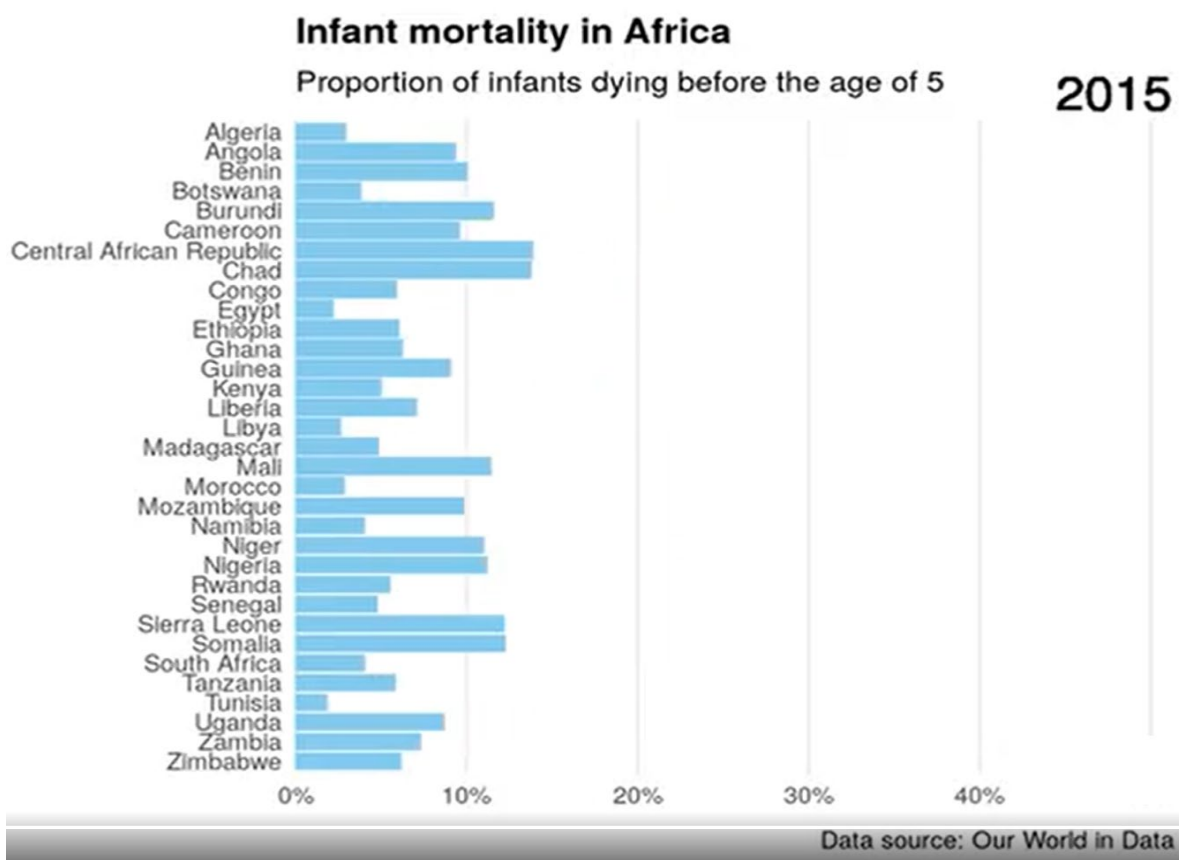
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242

WHY SNAPS AND PAPPU ARE WORTH⁵¹ ALL⁵² THE EFFORT?



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- ¹ <https://www.smithsonianmag.com/history/telemedicine-predicted-in-1925-124140942/>
- ² <https://www.nature.com/articles/s41586-019-1666-5.pdf>
- ³ <http://www.isfdb.org/cgi-bin/pl.cgi?297302>
- ⁴ <https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1468-0335.1937.tb00002.x>
- ⁵ <https://www.jstor.org/stable/2778934>
- ⁶ https://eprints.lib.hokudai.ac.jp/dspace/bitstream/2115/47727/1/EJHU_40_41.pdf
- ⁷ <https://www.nobelprize.org/prizes/economic-sciences/1991/coase/facts/>
- ⁸ <https://www.nobelprize.org/prizes/economic-sciences/2009/williamson/facts/>
- ⁹ <https://ia800109.us.archive.org/15/items/PoorEconomicsByAbhijitV.BanerjeeEstherDuflo/Poor%20Economics%20by%20Abhijit%20V.%20Banerjee%2C%20Esther%20Duflo.pdf>
- ¹⁰ <https://www.worldbank.org/en/news/speech/2018/04/10/rich-and-poor-opportunities-and-challenges-in-an-age-of-disruption>
- ¹¹ www.un.org/waterforlifedecade/waterandsustainabledevelopment2015/pdf/Water_technology_tool_paper_final.pdf
- ¹² <https://www.nobelprize.org/prizes/economic-sciences/1998/sen/facts/>
- ¹³ <https://www.nobelprize.org/uploads/2019/10/press-economicsciences2019-2.pdf>
- ¹⁴ <https://link-springer-com.libproxy.mit.edu/article/10.1007/s11186-019-09352-6>
- ¹⁵ <https://www.bmj.com/content/340/bmj.c2220>
- ¹⁶ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2826809/pdf/nihms84074.pdf>
- ¹⁷ <https://economics.mit.edu/files/5579>
- ¹⁸ <https://www.fastcompany.com/1768537/esther-duflo-bribes-indias-poor-health>
- ¹⁹ <https://www.jstor.org/stable/3172846>
- ²⁰ <https://faculty.chicagobooth.edu/jeffrey.russell/research/risk.pdf>
- ²¹ <https://reader.elsevier.com/reader/sd/pii/S0360319914008489?token=EAAA5E51E0C120A02510201D67A674FE61DB1E41149F0EF9F5FB76047675CE69FBE915A2123368418AEBBDB2E574E823>
- ²² <https://data.worldbank.org/indicator/it.NET.user.ZS>
- ²³ McLamore, E.S., S.P.A. Datta, V. Morgan, N. Cavallaro, G. Kiker, D.M. Jenkins, Y. Rong, C. Gomes, J. Claussen, D. Vanegas, E.C. Alocilja (2019) SNAPS: Sensor Analytics Point Solutions for Detection and Decision Support. *in press*. (SNAPS <https://dspace.mit.edu/handle/1721.1/56253>)
- ²⁴ <https://qz.com/1089266/the-inventor-of-microfinance-has-an-idea-for-fixing-capitalism/>
- ²⁵ <https://doi.org/10.1016/j.sbspro.2012.09.007>
- ²⁶ <https://nvlpubs.nist.gov/nistpubs/ir/2019/NIST.IR.8269-draft.pdf>
- ²⁷ <https://dspace.mit.edu/handle/1721.1/41908>
- ²⁸ <https://www.emerald.com/insight/content/doi/10.1108/IJOPM-04-2012-0131/full/html>
- ²⁹ <http://bit.ly/Economics-of-Technology>
- ³⁰ <https://investor.paypal-corp.com/news-releases/news-release-details/paypal-reports-fourth-quarter-and-full-year-2018-results>
- ³¹ <https://dspace.mit.edu/handle/1721.1/41902>
- ³² <https://www.rfidjournal.com/articles/view?154>

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- ³³ <https://www.rfidjournal.com/articles/view?399>
- ³⁴ <https://www.bloomberg.com/news/articles/2018-09-19/amazon-is-said-to-plan-up-to-3-000-cashierless-stores-by-2021>
- ³⁵ <https://www.theverge.com/2019/9/10/20857921/amazon-go-rollout-delay-cashierless-convenience-stores-whole-foods>
- ³⁶ <https://www.wired.com/story/theres-no-good-reason-to-trust-blockchain-technology/>
- ³⁷ <https://www.jstor.org/stable/20752121>
- ³⁸ <https://dspace.mit.edu/handle/1721.1/102893>
- ³⁹ <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8598784>
- ⁴⁰ <https://www.forbes.com/sites/michaeldelcastillo/2019/04/16/blockchain-50-billion-dollar-babies>
- ⁴¹ <https://www.forbes.com/sites/gilpress/2019/07/26/this-week-in-ai-stats-7-4-billion-invested-in-ai-startups-in-q2>
- ⁴² <https://www.entrepreneur.com/article/336254>
- ⁴³ <https://www.fool.com/investing/2019/10/14/why-is-porsche-teaming-up-with-boeing-on-flying-ca.aspx>
- ⁴⁴ <https://www.fool.com/investing/2019/10/18/why-boeing-volkswagen-and-uber-are-working-on-flyi.aspx>
- ⁴⁵ www.usatoday.com/story/tech/2019/10/16/porsche-teaming-up-with-boeing-on-flying-cars/40315231/
- ⁴⁶ <https://www.povertyactionlab.org/>
- ⁴⁷ <https://www.space.com/20317-apollo-moon-rocket-engines-bezos.html>
- ⁴⁸ <https://www.businessinsider.com/fabulous-life-of-billionaire-jack-dorsey-taking-square-public>
- ⁴⁹ <https://www.forbes.com/sites/ericjackson/2013/09/16/the-top-25-most-narcissistic-ceos-in-tech>
- ⁵⁰ <https://dutraeconomicus.files.wordpress.com/2014/02/amartya-sen-the-idea-of-justice-2009.pdf>
- ⁵¹ <https://ourworldindata.org/>
- ⁵² <https://twitter.com/i/status/1133017748882243584>

Which is something altogether different from the ordinary. Such work does not refute the ordinary. It is, simply, something else. Its labor requires a different outlook—a different set of priorities.

From UPSTREAM by MARY OLIVER