



Sensor-based entrepreneurship: A framework for developing new products and services

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Abstract As the Internet of Things (IoT) begins to dominate the technology landscape, there will be new products and services that will become technically and financially feasible. Internet technologies and advancements in social interaction tools have led to an increase in the use of the crowd as a provider of business solutions. Yet, we have seen a mere fraction of the possibilities of crowdsourcing technologies. This is because most of the development, discussion, and research around crowdsourcing has focused on active-input crowdsourcing. However, the real transformative pressure will come from passive sources of data generated primarily by developing and growing sensor technologies. This next generation of crowdsourcing will be a game changer for entrepreneurial opportunities. As crowdsourcing systems proliferate, more input will be acquired from sensors, artificial intelligence, bots, and other devices. As a result of this explosion, the variety of product and service opportunities will swell as entrepreneurs become more aware of technologies merging—such as the combination of crowdsourcing, sensors, and big data into a new type of entrepreneurship: sensor-based entrepreneurship. The purpose of this research is to contribute by (1) clarifying the next generation of crowdsourcing and (2) developing and presenting a framework to help sensor-based entrepreneurs plan, develop, and map their new products and services.

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1. Sensors lead to new types of products

Imagine a scenario in which you have signed up for car insurance. When the paperwork is completed, your agent places a small box half the size of a pack

of cigarettes under your dashboard. You think nothing of it and frankly forget about it soon after you leave his office. Six months later, you get a letter from your agent. In the envelope is a refund check for several hundred dollars. It seems that you have been rewarded because you have been driving safely according to the insurance company's standards. But how did they know how safe you have been? It turns out that the small box is a telematics device full of sensors that capture and transmit data

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deemed relevant to whether you have been driving safely. Your insurer has created a new, valuable service by collecting your data and customizing a service for you. Progressive Insurance, Allstate, and many other insurers are offering similar services already.

Six months later, you get another letter from your car insurance company. Knowing what you received 6 months ago, you quickly open the envelope. However, to your surprise, instead of another refund check, you read that your insurance rates are being increased. You are perplexed because you think you have continued to be a safe driver. It seems that you have been tagged for higher rates because the insurance company has combined the data from all its clients in the area and deemed your neighborhood an unsafe place to own a car. Your creative insurance company has again created a new service, but in this case it has aggregated the data at a higher level and crowdsourced a new service.

Now, think about the smart home. For many, this may not be so challenging since the smart home has been a reality (in part) since the introduction of thermostats. However, as the number of sensors in the home and in-home appliances balloon, the possibilities for new tailored and customized services will also increase. For example, even today we can control our lighting, heating, cooling, security, lawn maintenance, cleaning, and music digitally and remotely. Most recently, cooking appliances have been brought online and connected. Smart refrigerators are joining smart TVs in the home as well. All of this exists, and we are still at an early stage of products and services that use our own data to make our lives more convenient in some ways.

What if your mobile device could fight disease and illness? The TrackYourTinnitus project does just that (Pryss, Reichert, Langguth, & Schlee, 2015). Tinnitus is a ringing in the ear condition that may affect up to one in five people. Currently, there are no effective therapies. The TrackYourTinnitus project uses a mobile phone app and sensors to help assess ambient background noise. By combining the data, the app creates longitudinal data sets that aggregate the individual's demographic and clinical characteristics together with the user's response to specific therapeutic interventions. As a result, the app facilitates evidence-based treatment suggestions for individual patients. In other words, this technology allows for clinical trials (i.e., evidence-based medicine) at a low cost that leads to individual treatments.

Think of the possible healthcare and medical solutions that could be created using this type of sensor technology to acquire and analyze huge

datasets and conduct clinical trials. What possible illnesses or diseases could be treated using these cutting-edge diagnostic and therapeutic management techniques? Advancements in technology—including sensor technology, big data, and bandwidth—accompanied by creative business models, are enabling entrepreneurs to sense, collect, analyze, and aggregate data in previously unimagined ways to produce value-adding services for consumers and industrial customers. Let the revolution begin!

As the Internet of Things (IoT) begins to dominate the technology landscape, there will be many new products and services that will become technically and financially feasible. Recently, internet technologies and advances in social interaction tools have led to a sharp increase in the use of the crowd as a provider of business solutions. For example, the use of the crowd and crowdsourcing in services such as Wikipedia, Challenge.gov, reCAPTCHA, InnoCentive, Waze, Threadless, Kickstarter, eYeka, TopCoder, CrowdFlower, MTurk, and Kaggle have blossomed. Yet, we have seen only the tip of the iceberg in terms of possibilities of crowdsourcing technologies. This is because most of the development, discussion, and research around crowdsourcing have focused on active-input crowdsourcing. However, the real transformative pressure will come from passive sources of data generated primarily by the development and growth of sensor technology.

1.1. Internet of Things

According to McKinsey (Bauer, Patel, & Veira, 2014), IoT:

Refers to the networking of physical objects through the use of embedded sensors, actuators, and other devices that can collect or transmit information about the objects. The data amassed from these devices can then be analyzed to optimize products, services, and operations.

Put another way, IoT is the interworking of devices (i.e., things that are connected remotely for data exchange and analysis). When I refer to sensors, I am speaking broadly about GPS, Bluetooth, RFID, and other related devices that can provide access to real-time information. The expected and desired result is more efficient problem solving and value creation. As the phenomenon of IoT grows quickly, and subsequently is being referred to as the third wave in internet development, it is impossible to predict its eventual size and impact accurately. However, given this large but uncertain

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