Build a Direct-To-Consumer Marketing Strategy for a Whole-Genome-Sequencing Service Targeting the Newborns Market

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SUMMARY

CHAPTER 1: INTRODUCTION

MOTIVATION

Precision medicine is an approach to patient care that allows doctors to select treatments that are most likely to help patients based on a genetic understanding of their disease. The concept is based on three pillars: understanding diseases, understanding patients, and adapting treatment of diseases according to patients' features.

As genetic information is the key to understand every patient's unique features, decoding the patient's genomic information by genomic sequencing becomes the foundation for future precision medicine. However, all the technologies and our understanding toward human genomics began less than 20 years ago and the whole genome sequencing (WGS) industry is still struggling to supply affordable and reliable service, which limited WGS to medical and healthcare professional use.

Today, with the ultra-fast pace of technology development, a promising direct-to-consumer (D2C) business can be foreseen in the future. Several key factors will quickly change the whole industry, among which are listed below the three most remarkable:

1. The hallmark of the industry, sequencing cost, has a sharp fall during the last 5 years.

2. The fundamental research in functional genomics to build a solid scientific base on human genomics will be boosted by new technologies.

3. The ubiquitous wearable device will quickly make relevant personal big data available for precision medicine.

On the other hand, the new industry has still uncountable foreseeable or non-foreseeable challenges, including public concern about private data security, ethical issues related to health data usage, the involvement of insurance system to the precision medicine, etc. Even from a technical view, to generate whole omics data in an approachable cost is still challenging, without speaking about series issues of big-data management and general lack of strong scientific evidence.

The market is opening and will grow fast shortly, but future customers in this market know about the innovating industry as little as the industry know them.

Indeed, during the early development of precision medicine in the last decade, most biotech companies focused on 2B business mode, which was pushing new medical or healthcare technology to healthcare establishment or professionals. D2C business took only a thin slice in the total market due to the restrictions and concerns mentioned above and described later in this thesis. However, a few D2C companies did make a remarkable business success with eye-catching technology and delicate marketing strategies. Among them, 23andMe was a real excellent pioneer. With its simple but effective direct-to-customer (DTC) genetic testing and a creative value-delivery chain, 23andMe proposed high-added-value service with well-controlled operational cost and made the first successful B2C business in the field of personalized genome-analysis service. Not only the successful marketing strategy of 23andMe inspired numerous follower companies that are still very active in the genetic-test market of today, but also the issues raised in this case are also valuable for new companies in their future strategy choice.

Facing to the new industry and the booming market, an effective D2C marketing strategy should be delicately designed to bridge them.

PROBLEM STATEMENT

Given little information about D2C business in the industry, more studies are needed to understand the perception of consumers about the new industry and their responses in the current cultural and economic environment.

Moreover, as the whole industry is in an early introduction stage, it's important to follow the current industry trends and adjust future marketing strategy according to potential changes introduced to both the industry and the market.

OBJECTIVES

Although precision medicine is highly technology-intensive industry, this MBA thesis will not rely on heavy technical arguments but will give a view from a business angle by

interrogating the dynamic relationship of players in the current and future market. This thesis will intend to

- give a brief analysis about the WGS industry, but more focusing on the trends that will be brought into sights in the following 5-10 years,
- get direct feedback from potential consumers and industry stakeholders on the D2C service of the new industry.
- and, upon the points above, try to identify the key factors that could be critical for the successful D2C marketing strategies.

STUDY STRUCTURE

The recent study is consistent of the following structures:

Introduction to the industry context (Chapter 2)

Question statement (Chapter 2)

Primary research (Chapter 3)

To deeply and accurately understand the opinions towards current industry and upcoming trends, surveys and interviews will be used for the primary data collection. The targets are doctors, patients and people working in precision medicine-related companies.

Secondary research (Chapter 3)

The public financial report, journal reports and reviews will be the source of secondary data.

Results presentation (Chapter 4 and Appendix)

The raw research results can be found in Appendix. Detailed analysis on the research results was presented in Chapiter 4.

Discussion and conclusion (Chapter 5 and 6)

CHAPTER 2: CONCEPTIONAL FUNDATION

CONTEXT

IMPORTANCE OF PATIENT INFORMATION IN MEDICINE

Medicine has been developed for thousands of years. Although modern medicine has been boosted with the fast development of science in recent 100 years, the concept that cure should be given according to specific patients or indications has never been changed. For doctors, to learn each patient is always the first step before all diagnostics and cures.

Chinese traditional medicine is one of the oldest medicine systems. Doctors use four steps to access patients' wellbeing: Observation, Listening and smelling, Questioning, Palpitations.

Today, diagnostic medicine in Modern medicine is constituted with four great pillars: anatomy (structure: what is there), physiology (how the structure/s work), pathology (what goes wrong with the anatomy and physiology), and psychology (mind and behavior) (Kumar, 2016; Sfetcu, 2014).

A patient typically presents a set of complaints (the symptoms) to the physician, who then performs a diagnostic procedure, which generally includes obtaining further information about the patient's symptoms, previous state of health, living conditions, and so forth. The physician then makes a review of systems (ROS) or systems inquiry, which is a set of ordered questions about each major body system in order: general (such as weight loss), endocrine, cardio-respiratory, etc. Next comes the actual physical examination and other medical tests; the findings are recorded, leading to a list of possible diagnoses. These will be investigated in order of probability.

During the 20th century, all four pillars in modern medicine have been developed so fast that we know better the functionality of human being nowadays than ever.

However, deeper understanding ourselves in physiological and pathological cases made researchers realize that “we” are so different in each other and never any “golden rules” can be used in individual diagnosis.

This incapacity to resolve with our solid medical science comes from how our knowledge system has been constructed. Biomedical research and the practice of medicine, separately and together, are reaching an inflection point: the capacity for description and for collecting data, is expanding dramatically, but the efficiency of compiling, organizing, manipulating these data—and extracting true understanding of fundamental biological processes, and insights into human health and disease, from them—has not kept pace. There are isolated examples of progress: research in certain diseases using genomics, proteomics, metabolomics, systems analyses, and other modern tools has begun to yield tangible medical advances, while some insightful clinical observations have spurred new hypotheses and laboratory efforts. In general, however, there is a growing shortfall: without better integration of information both within and between research and medicine, an increasing wealth of information is left unused. (National Research Council (US) Committee on A Framework for Developing a New Taxonomy of Disease, 2011; Sfetcu, 2014)

STRATIFIED AND PERSONALIZED MEDICINE

To give efficient and effective treatments to the right patients at the right time, one of the solutions is to identify the subgroup of patients with distinct responding capacity to treatment and mechanisms of diseases and study the most effective treatments for each subgroup. This is called stratified medicine (Figure 1).

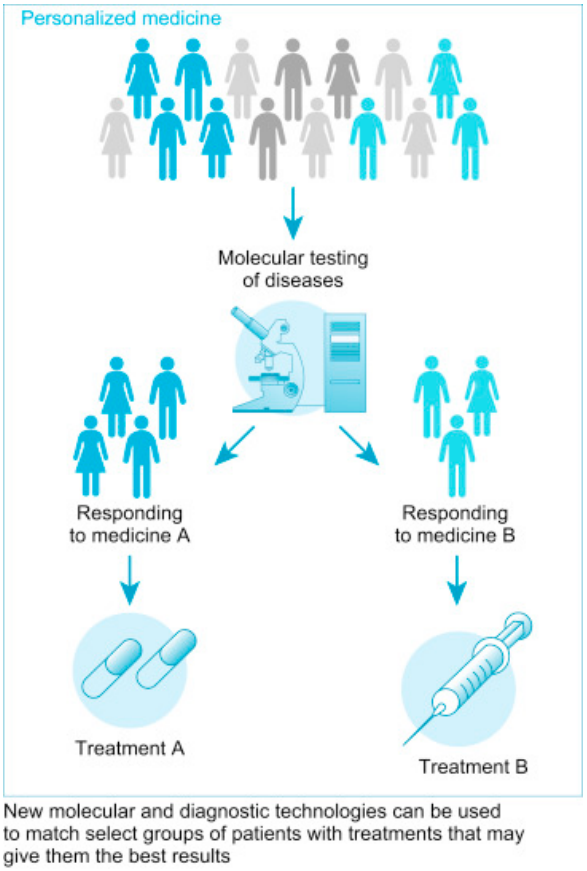

Figure 1: Concept of stratified and personalized medicine. (Johnston et al., 2018; Kumar, 2016)

Individuals respond to treatments differently based on their general health state, the functional capacity of organs, even metabolism speed of each cell. Thus stratified medicine is based on the knowledge on a whole panel of molecular biology, cell biology, and biochemistry knowledge. With the boost of life science developed during the 20th century, stratified medicine has been a big success in offering more effective treatments to some of severs diseases. Moreover, a stratified approach helps develop a deeper mechanistic understanding of these sub-groups, which can lead to the identification of novel targets and treatment strategies.

Current breast cancer management is indeed the fruit of stratified medicine developed during the last 20 years. In fact, instead of treating all the breast-cancer patients with all the same chemotherapy, the patients are classified into 3 subgroups according to the response of tumors to estrogen and progesterone hormone (Italiano, 2011). Recent oncology reports support this

strategy by showing estrogen and progesterone receptor expression is distinct between all 3 groups. By distinguishing the biology response to the drugs, physicians could give much more effective cure strategy to patients of each subgroup, i.e. chemotherapy, hormonal therapy or targeted therapy. This more indication-against method avoids maximum side effects introduced by treatments.

PERSONAL HEALTH INFORMATION IN MODERN AND FUTURE MEDICINE

If stratified medicine is already a current form of precision medicine, when the concept of stratified medicine is combined with personal health information in depth, that will be the future precision medicine that we are now working hard to achieve.

> *"It is more important to know what sort of person has a disease, than to know what sort of disease a person has." - Hippocrates*

Even the concept of future precision medicine is not new, Hippocrates also assessed several factors, such as a patient's constitution, age, and build, and the time of year to help his decision-making when prescribing treatment. The knowledge that patients with similar symptoms can have different diseases, and that not all patients with the same disease respond equally to treatment was well known, even in Hippocrates' time. Entering in the 21st century, personalized medicine uses all available patient's information. Current digital revolutions, such as "Big Data" and "artificial intelligence", help personalized medicine applicable with large amount daily health data and huge computing capacity for giving a relevant prediction on personal health state or disease development (Hulsen et al., 2019).

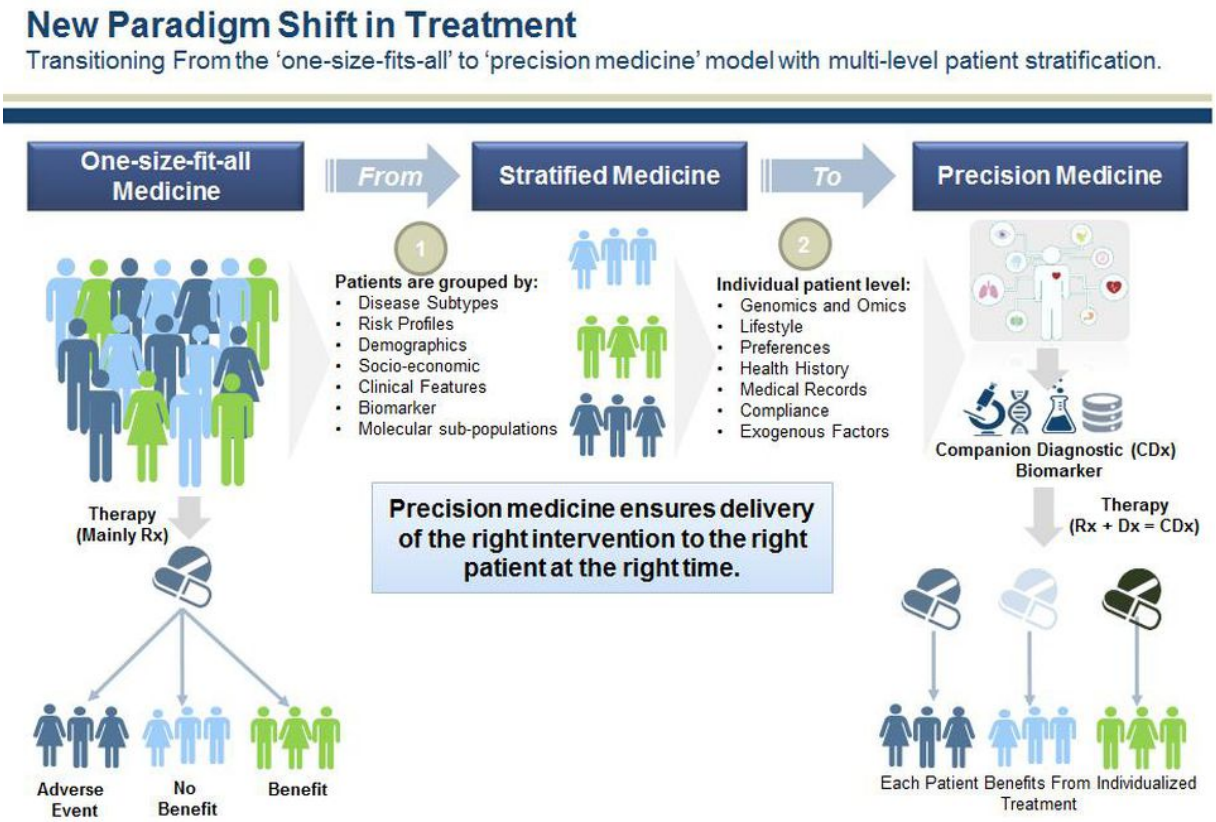

Figure 2: Transformation from conventional medicine to stratified and precision medicine (Modified from (Das, 2017).

The human genome is before all the most important and most relevant personal health information, as it contains almost all the genetic information of one individual and encodes almost the behaviors how cells function in its whole life. The precision medicine in the 21st century predominately uses genetic information to tailor treatment.

The concept of P4 medicine was introduced in 2014. This extends the concept of personalized medicine, migrating from a reactive treatment of a disease to the proactive management of a patient's health. The P4 medicine considers a model of healthcare that is predictive, preventive, personalized and participatory (Hood & Friend, 2011) (Figure 3).

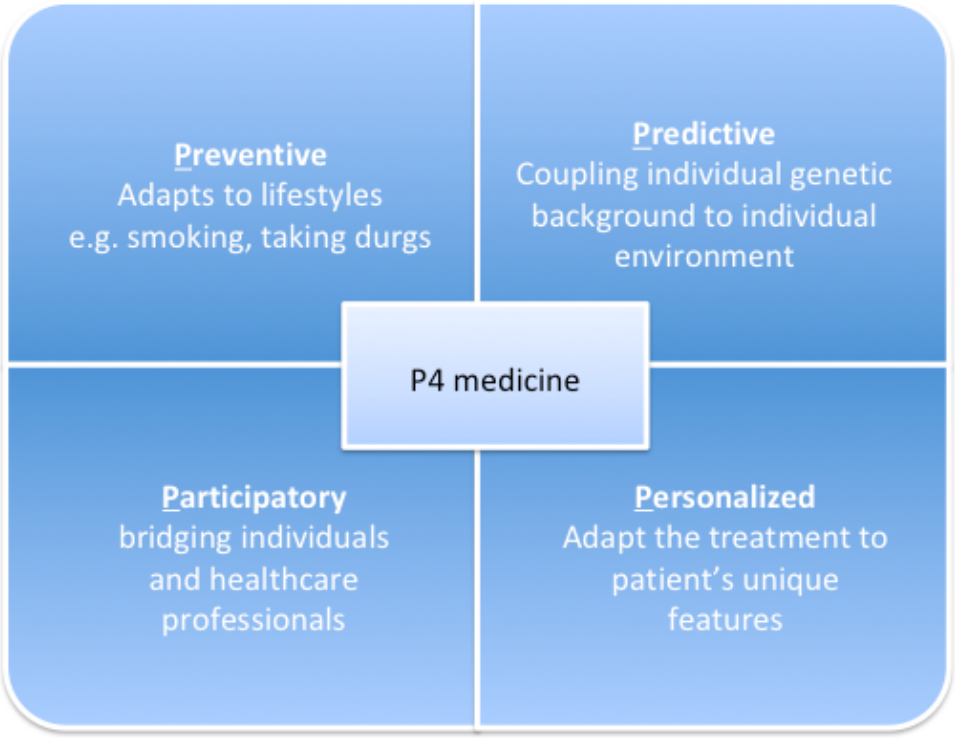

Figure 3: Four pillars of P4 medicine (Adapted from Servant et al., 2014).

The P4 medicine considers a model of healthcare that is predictive (considering the genetic background of the individual and his/her environment), preventive (adapting lifestyle, taking prophylactic drugs), personalized (tailoring the treatment to the individual's unique features, such as the patient's genetic background, the tumor's genetic and epigenetic landscape, his/her life environment) and participatory (many options about healthcare which require in-depth exchanges between the individual and his/her physician). P4 medicine, therefore, extends the concept of personalized medicine (Servant et al., 2014).

GENOMIC SEQUENCING SERVICE IN PRECISION MEDICINE:

This thesis will focus on genome sequencing service with next-generation sequencing (NGS) technology, which is one of the most important pillars supporting future precision medicine. Genome is one's most important health information. Information about the genome gives a detailed genetic background of the individual. Thus the plus value of this service will offer consumers each one of every detail of their genome sequence.

The whole technologies and genomics industry was begun with the Human Genome Project (HGP). HGP was initiated by the U.S. National Institutes of Health (NIH) and began with large-scale sequencing pilot trials on E. coli, M. capricolum, C. elegans and S. cervisae. The eventual success of the HGP later allowed it to be used as a model by the NIH for large-scale genomics research projects. With project developing, scientists developed more and more efficient sequencing methods, in which we marked technology milestone like the sequencing company 454 Life Sciences was founded in 2001. 454 was a key developer of Next-generation sequencing technology that improved on traditional Sanger sequencing.

On February 15, 2001, the NIH and Celera published the finished draft of the Human Genome Sequence simultaneously in the journals Nature and Science, respectively. This event marked the culmination of a decade-long sequencing effort involving hundreds of sequencers and multiple sequencing centers. However, many more questions were asked based on the first human genome draft. Scientists realized immediately much more complexity was hidden behind this result. To answer all these questions, much more information should be obtained, which mean more genomes should be sequenced.

With the advent of low-cost, Next-generation sequencing, many large-scale genomics projects were launched. Typical of these was the 1,000 Genomes Project by the NIH, which was launched in 2008. This project uses Next-generation DNA sequencing to study the genetic variability of humans on a large scale. Projects such as this have been a major impetus for innovation and growth in the sequencing industry.

In 2009, Correlagen launched CardioGenScan, a diagnostics test that uses Next-generation sequencing. This marked a key milestone in translating sequencing technology into clinical applications.

CURRENT INDUSTRY – CLINICAL SERVICE

In 2012 and 2013, the NGS clinical industry began to develop real momentum, highlighted by the acquisition of Intelligent Biosystems by Qiagen (2012), the startup of two diagnostics ventures by Illumina and Life Technologies (2013), and the acquisition of Verinata Health (2013).

In June 2012, Qiagen, a diagnostic company, acquired Intelligent Biosystems (IBS), a Next-generation sequencing company. The acquisition is part of a strategy by Qiagen to enter the NGS clinical market with complete end-to-end workflow solutions.

In January 2013, Illumina led an effort to start up a clinical NGS venture using a coalition of diverse institutions and laboratories. Called GeneInsight-Illumina Network, the venture will develop clinical applications using Illumina's MiSeq benchtop sequencer.

Also in January 2013, Life Technologies formed a start-up company called Claritas Genomics, which will use the Ion Proton benchtop platform to develop new diagnostics.

In October 2013, Roche began a withdrawal from the NGS instrument industry, staged over two years. This marks the maturing phase of this industry as well as consolidation by two companies, Illumina and Life Technologies.

In 2016, several countries approved and funded large-scale population genomics projects. In December 2016, in the United States, the 21st Century Cures Act became law. This Act includes $1.4 billion in funding for the Precision Medicine Initiative and $1.8 billion for the Cancer Moonshot project. China committed up to $10 billion to fund a precision medicine initiative for over 15 years. France also committed to investing approximately $700 million to fund sequencing centers in that country that will sequence 235,000 genomes per year beginning in 2020.

The global NGS diagnostic market is shown in the Table 1. The total value of the market is estimated to be nearly $3.2 billion in 2017, and it is growing at a CAGR of 27.0% to reach a forecast market size of $10.5 billion in 2022.

Indication	2015	2016	2017	2022	CAGR% 2017-2022
Cancer	669.5	778.1	838.8	4,093.20	37.3
Complex disorders	140.8	178.8	293.1	1,355.20	35.8
Mendelian disorders	225.3	273.4	309.5	1,094.50	28.7
Reproductive health	1,197.50	1,513.10	1,733.60	3,307.80	13.8
Transplant	13	14.5	16.6	683.5	110.3
Total	2,246.10	2,757.90	3,191.60	10,534.20	27

Table 1: Global Next-Generation Sequencing Diagnostic Market, by Disease Type ($ Millions, from BCC research report). Source: BCC Research

The primary applications for NGS diagnostics include cancer ($838.8 million in 2017) and reproductive health ($1.7 billion in 2017).

The NGS cancer diagnostics market is growing at a CAGR of 37.3%, and it is forecast to reach a global value of $4.0 billion in 2022. The market for cancer diagnostics is driven by the increasing clinical value of genetic information for diagnosing, screening and treating the disease.

Early cancer detection and monitoring to detect relapse, or drug resistance, are particularly high growth areas in this market segment.

The NGS reproductive health market is growing at a CAGR of 13.8% and is forecast to increase from $1.7 billion in 2017 to $3.3 billion in 2022. The growth in this segment is primarily due to the success of noninvasive prenatal screening tests for high-risk pregnancies. Market penetration into average-risk pregnancies is forecast to occur during the next five years, further driving growth.

BCC Research forecasts that the Mendelian disorders market will grow at a high CAGR of 28.7% to reach a global value of $1 billion in 2022. The Mendelian disorders market is well-suited to NGS platforms due to the diverse genetic nature of these disorders and the need for analysis technologies that can examine wide regions of the genome.

To be noted, this huge and fast developing market is only for clinical applications. D2C market is near to zero if any, some pioneers start to make remarkable presence (see following sections).

D2C GENETIC TESTING SERVICE

As listed above, genetic testing is demanded through healthcare providers such as physicians, nurse practitioners, and genetic counselors. Healthcare providers determine which test is needed, order the test from a laboratory, collect and send the DNA sample, interpret the test results, and share the results with the patient. Often, a health insurance company covers part or all of the cost of testing.

Direct-to-consumer genetic testing is different: these genetic tests are marketed directly to customers via television, print advertisements, or the Internet, and the tests can be bought online or in stores. Customers send the company a DNA sample and receive their results directly from a secure website or in a written report. Direct-to-consumer genetic testing provides people access to their genetic information without necessarily involving a healthcare provider or health insurance company in the process.

Dozens of companies currently offer direct-to-consumer genetic tests for a variety of purposes. The most popular tests use genetic variations to make predictions about health, provide information about common traits, and offer clues about a person's ancestry. The number of companies providing direct-to-consumer genetic testing is growing, along with the range of health conditions and traits covered by these tests. Because there is currently little regulation of direct-to-consumer genetic testing services, it is important to assess the quality of available services before pursuing any testing.

Other names for direct-to-consumer genetic testing include DTC genetic testing, direct-access genetic testing, at-home genetic testing, and home DNA testing. Ancestry testing (also called genealogy testing) is also considered a form of direct-to-consumer genetic testing.

With so many companies offering direct-to-consumer genetic testing, it can be challenging to determine which tests will be most informative and helpful to you. When considering testing, think about what you hope to get out of the test. Some direct-to-consumer genetic tests are

very specific (such as paternity tests), while other services provide a broad range of health, ancestry, and lifestyle information.

- Major types of direct-to-consumer genetic tests include:
- Disease risk and health
- Ancestry or genealogy
- Kinship
- Lifestyle

To be noted, FDA regulates heavily D2C testing. In 2015 the FDA even banned D2C genetic testing because of the risk of misuse of patients' genetic information. Currently only authorized genetic testing can be marketed D2C ("Direct-to-Consumer Tests (U.S. Food & Drug Administration)," 2019). Rarely D2C genetic testing service has been successfully marketed, with a few exceptions such as 23andMe.

With its simple but effective direct-to-customer (DTC) genetic testing and a creative value-delivery chain, 23andMe proposed high-added-value service with well-controlled operational cost and made the first successful B2C business in the field of personalized genome-analysis service. However, 23andMe encountered also regulation issues with FDA and concerns about misuse of customer's health data during 2013-2015, which perturbed heavily its business growth and overall business layout. Lessons from 23andMe are meaningful: not only the successful marketing strategy of 23andMe inspired numerous follower companies that are still very active in the genetic-test market of today, but the concerns raised are also valuable for new companies in their future strategy choice.

RESEARCH MOTIVATION

ONCOMING OPPORTUNITY WITH HUGE MARKET

Looking back to the short history of precision medicine, the industry relied strongly on two key factors:

1. sequencing technology;
2. scientific knowledge base.

Sequencing technologies defined the cost and general reliability of service in industry while the application of technologies relies on our genomics knowledge. The industry cannot advance without either of them. However, both sequencing technology and scientific knowledge base are bearing a huge evolution in present, indicating an explosive market could be expected very shortly.

History of precision medicine started only from April 2003, with the completion of the Human Genome Project which laid the foundation for systematically studying the human genome, which entails delivering the right drug at the right time to the right patient by specifically targeting the molecular events that are responsible for the disease (Budin-Ljøsne & Harris, 2015). Our knowledge about genomics has been accumulated amazingly fast since then.

Technology development speed up genomics research

Since the commercial introduction of next-generation sequencing (NGS) platforms from 2005 onwards, sequencing costs have rapidly declined. This has led to an exponential increase in primary and secondary biological databases (Zou et al., 2015). Researchers have harnessed computational algorithms and software programs to retrieve and analyze this big data to design linkage and association mapping studies to generate molecular tools. This helps to identify novel biomarkers for diagnostic tools and to stratify medicines (Wang & Sarwal, 2015).

The development of PM in oncology has been fueled by the development of targeted biological therapies in which treatment can be stratified according to the molecular profile of

the tumor (McGowan et al., 2014). Researchers have begun to develop bioinformatics tools to help guide future drug development and treatment decisions. Researchers at the National Institutes of Health (NIH) recently received a $2.8-million grant to develop a protein ontology virtual reference library of proteins that can be used for ontology mapping to analyze and integrate gene-disease-drug information to improve understanding of cancer and to identify potential diagnostic and therapeutic targets.

These new efforts will speed up sequencing technologies in the near future, and most importantly, they will boost the new findings in genomics science.

Digital revolution:

Living with the fast technology development, some new terms, such as digital healthcare, big data, personalized/precision medicine, genomic medicine, mobile healthcare devices, appear more and more often in our sight. Behind these words is a definitive revolution to our conventional concept of healthcare and medicine, digital healthcare.

The applications of digital healthcare would be extended to very large sense. Today, thanks to the fast paces of the digitalization process in our daily life, biotechnology and Internet development, digital medicine starts already changing significantly our habits and behaviors. Some applications have already been realized, such as digital medical dossier, remote patient monitoring, personalized health guidance, personalized diet coaching, etc. The current business is heavily based on Internet technology and mobile applications.

Sequencing price dropping

A key dividend of the Human Genome Project was to drive down the cost of DNA sequencing by five orders of magnitude (100 000-fold) in 15 years. To put this transformation in perspective, Moore's law describes the progressive increase in computer speed over the last several decades as doubling in performance every 18 months. From 2001 to 2007, the decrease in genome sequencing cost followed Moore's Law, but after 2008, the drop in DNA sequencing cost sank far faster.

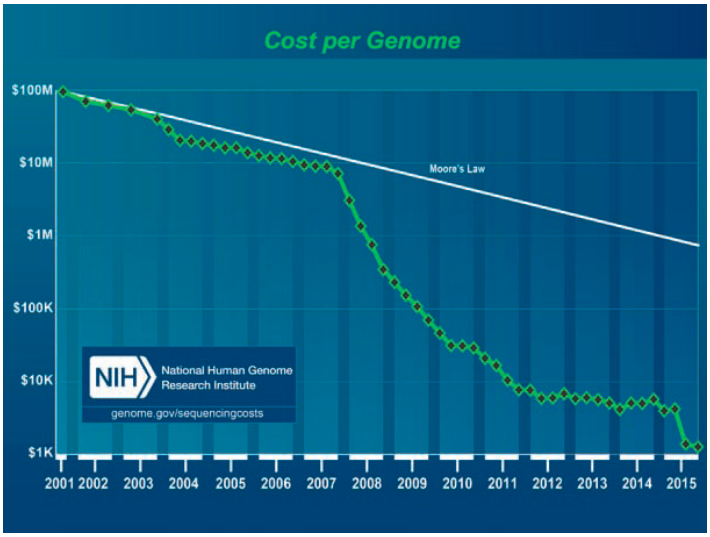

Figure 4: Decline of genome sequencing cost (green diamonds) compared to Moore's Law. (Source: https://www.genome.gov/27565109/the-cost-of-sequencing-a-human-genome/)

Year	Single Genome Sequencing Cost
2001	$95,000,000
2003	$40,000,000
2005	$14,000,000
2007	$7,000,000
2009	$70,000
2011	$8,000
2013	$5,000
2015	$1,000
2017	$100

Table 2: Cost to Sequence a Single Human Genome, 2001-2017 ($, BCC research report)

Based on this observation, it's not hard to remark that with the ultra-fast pace of technology development, the challenges of today will quickly become opportunities of tomorrow. Today's technological evolution will quickly change several key factors in the whole industry:

1. The hallmark of the industry, sequencing cost, has a sharp fall in the last 5 years. It becomes quite plausible to imagine that everyone will soon get access to his or her whole genomic information, maybe in form of a key ring or just an ID in database.

2. The revolutionizing high-throughput analysis in biotechnology is dramatically accelerating the fundamental research in functional genomics and will establish a solid scientific base for medical/prognostic use of personal genomic information.

3. Moreover, increasing use of the wearable device with real-time connection and high-sensitiveness biosensors, which is happening today in our lives, will quickly make relevant personal big data available for real-time monitoring, healthcare, as far as personalized medical services, precision risk management, and customized prevention.

Combining all these changes, it's not difficult to identify tremendous business opportunities in near future, but certainly for only those who will have got fully prepared for that with enough know-how and an appropriate angle to slide in.

D2C MARKET IS STILL IN "BLUE SEA"

The direct-to-consumer (DTC) genetic testing industry is characterized by its fragmented structure and a plethora of business models. This is quite typical of an emerging industry, and it remains to be seen which companies will succeed in the long run.

The industry is benefitting from the trend toward consumers who are looking for greater control over their healthcare. A key-driving factor for future growth in this industry is the increasing use of the Internet on the part of consumers for medical information.

Factors that may moderate growth in this industry include the availability of adequate test interpretation informatics; consumer concerns for the privacy of their own genetic data; and uncertainty about the future regulation of DTC tests.

Current DTC testing industry consists of two market segments: routine clinical laboratory tests, and advanced genetic tests. Routine tests include metabolic panels, CBC with differential, lipid panel, prothrombin time, and TSH. Both LabCorp (through Walk-In Lab) and Quest (through Blueprint for Wellness Direct Pay) provide these services. Tests can be ordered by going through a physician.

WGS SERVICE TOWARDS NEWBORN: MAXIMUM CUSTOMER VALUE CREATION

The thesis will address a specific topic that is not only to apply WGS service in 2C market but to target directly to newborn babies in order to gain maximum customer value.

Customer value has two definitions. For a customer, the customer value is the difference between what a customer gets from a product, and what he/she has to give to get it (Anderson & Narus, 1998). On the other hand, from the business's perspective, customer value is a value that customer is worth to the business over his lifetime of engagement. WGS service is a special service that will give customer's genomic information upon demand. As the service will focus on the customer's own information, the customer value will change totally between different customer segments. For example, a healthy adult cares much less the health information interpreted from his/her genome than a patient susceptible to genetic diseases does.

23andMe's success in marketing strategy will be one of topics in the thesis. From a perspective of customer value, it targeted young adventurers who consider their own genetic information as "fancy toy" coming from current innovating technologies. The customer value was even co-created with and between the young customers.

Here, this thesis tried to find a customer segment with maximum customer value for WGS service. As genomic information would be expected to benefit customers in the future ere of precision medicine, the main customer value from WGS service would be proportional to customer's remaining lifetime. For example, a young child would beneficial from his genomic information database for his/her whole life; old people would be beneficial from new technology but surely the customer value would be less. Moreover, at beginning of life spin, especially in the newborn phase, a deep insight into one's genomic information would help reveal sever or genetic disease risk and make early prevention.

However, this market is different to any other D2C market. WGS service gives confidential information about the subjects, the newborns, while buying decision must be taken by parents (in most cases). Beside ethic and consent issues that have been largely discussed in other reviews, the market itself is completely unknown.

EFFECTIVE MARKETING COMMUNICATION FOR NEW PRODUCTS

Companies must communicate their value proposition to customers to build a stable and profitable relationship. For a company with a new value proposition, it's even more important to build up a marketing communication strategy to get their first customers. This is the exact case for a future marketer of WGS D2C service. As a new service using innovative technologies, WGS D2C service is supposed to be a complete brand new product for almost all the consumers.

The whole marketing communication involves identifying the target audience, building a promotional program to transfer the marketing message to the target audience and get the responses from the target audience. Instead of using five major promotion tools, advertising, personal selling, public relations, and direct digital marketing, marketers developed effective mass-media communication techniques and digital techniques to support integrated marketing communications (IMC) in the past decades. This communication mode is a surge in customer engagement through digital media and has been proved a huge success.

To develop such a marketing communication, company needs identify the target audience, determine the communication objective according to the buyer-readiness stages, design the message, pass the message by a chosen channel and collect feedback from the audience.

For a completely new market, WGS D2C service will be proposed to all the consumers in the future. But to initiate the first communication, companies should find an appropriate target audience to build the first customer relationship. Ideally, to start a new business, companies should find an audience that has the highest customer value to the new service.

Once the target audience identified, one should determine a clear communication object. The target audience could be in any of six buyer-readiness stages:

1. Awareness
2. Knowledge
3. Linking
4. Preference

5. Conviction

6. Purchase

Depending on where the target audience is situated in the six stages, marketers should design specific communication message to move consumers to move towards the final purchase.

For a new product especially a new business, the market needs to be studied to find the main audience and their buyer-readiness stage before designing the following communication programs in IMC.

CUSTOMERS' BUYING BEHAVIOR TOWARDS NEW PRODUCT

For a service that involved newborn and the personal health information, the consumer's behaviors in the face of such new service need to be studied.

Consumer's buying behaviors are affected by both consumer's characteristics and environmental factors, which can be classified into four groups:

- Cultural factors

  Including culture, social class, etc.

- Social factors

  Groups and social networks, family, etc.

- Personal factors

  Age and life-cycle stage, occupation, economic situation, lifestyle, personality and self-concept, etc.

- Psychological factors

  Motivation, perception, learning, beliefs and attitudes.

D2C WGS service to newborns will target specifically newborns' parents, which is still a large and heterogeneous consumer group. To understand which factors are key to affect consumer's buying behaviors will be critical for making a successful marketing strategy. Moreover, for most consumers, WGS service is still a too new product in current consistence. How the psychological factors, especially perception and attitudes towards the new service to newborns, would influence future consumer's buying behaviors to need to be elucidated.

On another hand, the buying center plays key roles in the buying process. This buying center is composed of:

- Initiator(s)
- Influencer(s)

- Decider(s)
- Purchaser(s)
- And user(s).

As mentioned above, the buying center of D2C WGS service will focus on parents of newborns. The parents will be always the buying decider and purchaser in the buying center while the users will be surely the newborn children. However, many more persons or organization will be involved in the buying center as professionals charged with newborns' health management, such as doctors and insurance. They would be critical in the buying decision playing roles of initiator or influencer.

PERCEIVED CUSTOMER VALUE OF WGS SERVICE

WILLINGNESSS-TO-PAY

Willingness to pay (WTP) is the maximum price at or below which a consumer will definitely buy one unit of a product. WTP reflect the customer value of a product. Accurately gauging consumers' willingness to pay for a product or service is critical for formulating competitive strategies, conducting value audits, and developing new products (Anderson & Narus, 1998).

As a new and promising technology, WGS can be used as a powerful diagnostic tool but may generate anxiety, unnecessary testing, and overtreatment. In a survey study published in 2017 which included 410 adults in the United States, Marshall et al. reported 3% of interviewees would pay more than $1000 for WGS service while 7% would pay more than $400. Interestingly, the majority (55%) would not pay for that if no medical treatment concerned (Marshall et al., 2016).

In another report, Marshall et al. compared 203 adult patients and 980 college seniors. More parameters are compared and associated in this study. Their results demonstrated that the patients with primary care (mean age of 55) have even lower percentage (31%) of being willing to use WGS service than young college seniors with less than29 years old (59%). In the college group, sex, annual family household income and knowing someone who had genetic testing or having had genetic testing done personally was associated with significantly higher WTP. Higher annual household incoming (> US$ 100 000) was tightly associated with higher WTP ($p < 0.001$) (Chakradhar, 2015). This finding explained, at least to a certain extent, the success of the marketing strategy of 23andMe, which focused on the young and passionate consumers.

Summarizing from the existing reports, perceived customer value varied heavily to consumer segments. However, these studies were focusing on the WTP for private genomic sequencing service in the US, which was not relevant to other markets. Moreover, it should be noted that consumer willingness to pay is a context-sensitive construct, and a consumer's WTP for a product depends on the concrete decision

context. A dedicated study to D2C WGS service for newborns is needed to understand the real WTP in the specific market.

PROBLEM STATEMENT

Given the current huge market evolution and obscurity of emerging markets, I would like to answer the following questions:

- **What can be the key factors to achieve effective D2C marketing for WGS service targeting the newborn market?**
- **What will be the consumer's perception towards the future D2C WGS service and how would the perception impact their buying behaviors?**
- **What would be the trends of the new industry according to the future stakeholders in the industry?**

To approach these questions, I split them into the following sub-questions:

1. Validate the choice of newborn market?

The original hypothesis was that people more likely invest in genome sequencing-related service for their descendants especially newborns (than themselves). Due to the characteristic of NGS service, genomic information could benefit the whole life of new babies because they will be the beneficiary from the precision medicine in the future. However, this hypothesis needs to be validated.

2. What is the perception (concerns and benefits) for consumers towards the future D2C WGS service in current cultural and economic environment?

The technical and ethical concerns about the marketing of WGS service for newborns are extensively discussed in the current literature. But the perception in potential consumers is still unknown.

3. What could be the key factors that affect the consumer's buying behaviors in D2C NSG service for newborns?

4. What are the opinions from the future stakeholders in the industry?

CONTRIBUTION

The study will analyze the emerging industry of D2C WGS service combining the undergoing changes social factors and technology revolution and analyze the potential consumer's perception about new technology and eventual new D2C WGS service towards use in new-borns. The results are expected to:

1. give an insight of future trends in the industry;
2. find and validate the most adapted consumers to start D2C WGS service;
3. idnetify the important and special key factors in marketing WGS service to consumers;
4. provide a brief guidance in optimizing the product development and life-cycle management of future WGS D2C service.

The recent study help to understand both the upcoming trends in the new industry and potential market of D2C WGS service and the new findings in the study was expected to give a guideline in building a successful D2C marketing strategy for the future WGS service.

CHAPTER 3: RESEARCH DESIGN

SECONDARY RESEARCH:

The study will started with a secondary research by analyzing one the most successful D2C genetic testing providing company 23anMe. Based on the annual report of company, available research report and documents, we will focus on its marketing strategies and business model.

By the secondary research on one of the few successful pioneer companies, I hoped to find relevant references for building another successful D2C marketing strategy.

PRIMARY RESEARCH:

The main body of study will be realized in form of surveys to different stakeholders. Given little knowledge about the potential consumers, the primary research will focus especially to future consumers. But we will also include the key stakeholder in the service provider professionals into the review to understand the future trends in the industry and their concerns from a professional's view.

Given the different types of the interviewees, the study will be divided into two parts:

SURVEY PART 1: CONSUMER'S RESPONSES

The survey part 1 will focus only the potential consumers (See Appendix – Survey PART 1).

The survey will be in the form of face-to-face interview survey (focus group survey). Interviewees will be anonymous and selected randomly from the focus group – parents who wish to have babies recently. The interviewees were identified in gynecology/obstetrics service in a hospital with convenience sampling. About 10 respondents were expected.

The details about the survey are in the Appendix. Briefly, the survey will be started with an introduction to the study and open questions about the knowledge about the current genetic testing and new technologies. The same questions will be asked after an explanatory description of precision medicine and future trends of genetic testing. The second part of the

survey will be the multiple-choice question about how willing they will pay the new WGS service for themselves or for the newborn babies.

The goals of survey would be:

- to understand what's their perceived value towards precision medicine and genomic information management;
- to evaluate their willingness-to-pay for the new WGS service for themselves and for newborn babies;
- to reveal the concerns from the consumer side.

The survey was designed to understand the current perception of consumers about the new WGS service but also to capture the perception changes after putting the interviewees into a specific context with mention of future precision medicine.

The survey was also designed to compare the WTP for adult consumers and that for the newborn babies in the context that had been mentioned. The interviewees were expected to express explicitly their willingness and a value range that represented an acceptable price for them to pay the service with their own money, for themselves or their babies.

SURVEY PART 2: PROFESSIONAL INSIGHT

The survey part 2 focused on the important stakeholders in the service providing side.

The survey was an expert survey in the form of face-to-face interviews or telephone surveys according to the availability of each interviewee. The interviewee group was designed to have various professionals involved in the business, which were composed of doctors, biologist /technique experts, and directors of research center/hospital.

The survey will be made up by open questions about their opinions from their own professional angle. The goals are to:

- get deep survey in macro/microenvironment of business/industry;
- identify new trends in industry;
- get feedback for the feasibility or reasoning of business model;
- know the concerns from different professional angles.

CHAPTER 4: RESULTS

CASE ANALYSIS: 23ANDME'S D2C STRATEGIES AND BUSINESS MODEL

23andMe is a privately held personal genomics and biotechnology company based in Mountain View, California. The company is named for the 23 pairs of chromosomes in a normal human cell.

The company was founded by Linda Avey, Paul Cusenza and Anne Wojcicki in 2006. The company became much better known due to that the founder Wojcicki was married to Google co-founder Sergey Brin at the time and Google has been one of the principal investors in the four rounds of investment in this company. In 2007, 23andMe became the first company to begin offering autosomal DNA testing for ancestry, which all other major companies now use. Its saliva-based direct-to-consumer (DTC) genetic testing business was named "Invention of the Year" by Time magazine in 2008.

The company uses custom-designed high-density SNP arrays manufactured by Illumina. Although 23andMe stayed on conventional genetic testing service, it stayed on the D2C market that is still rare today.

In 2015, the U.S. Food and Drug Administration ordered 23andMe to cease selling and marketing its tests until it could prove their accuracy and ensure that consumers could understand the results without a doctor's involvement. 23andMe's team spends years working closely with regulators to convince them that it's safe to deliver results directly to consumers. In 2018, 23andMe came back and became the first company to get approval to inform women of their breast cancer risk, based on three gene mutations — all without a doctor's intervention.

D2C MARKETING STRATEGY OF 23ANDME

23andMe's marketing strategy cannot be successful without its excellent product-price-promotion marketing program.

23andMe was working closely with its partner Illumina to create a high-plus-value product. They chose mature and stable microarray technology instead of NGS, which was still a

pioneering and expensive technology at that period. The genetic-testing microarray was beautifully designed with its partner Illumina to be performing enough to access genomic information of consumer but also simple enough to make bulk analysis to get lower cost. Instead of painful conventional biopsy sampling methods used in the laboratory, its innovating saliva sampling method helped people obtain personal health data by only mailing in a saliva sample. The well-designed website provided simplified and straightforward results about consumer's genetic information. Contrast to obscure conventional genetic testing which was designed to be understood only by healthcare professionals, every detail in the product of 23andMe had been considered regarding D2C service to give a consumer a unique and delightful experience (Figure 5), and to provide a high-plus-value product for consumers in the end.

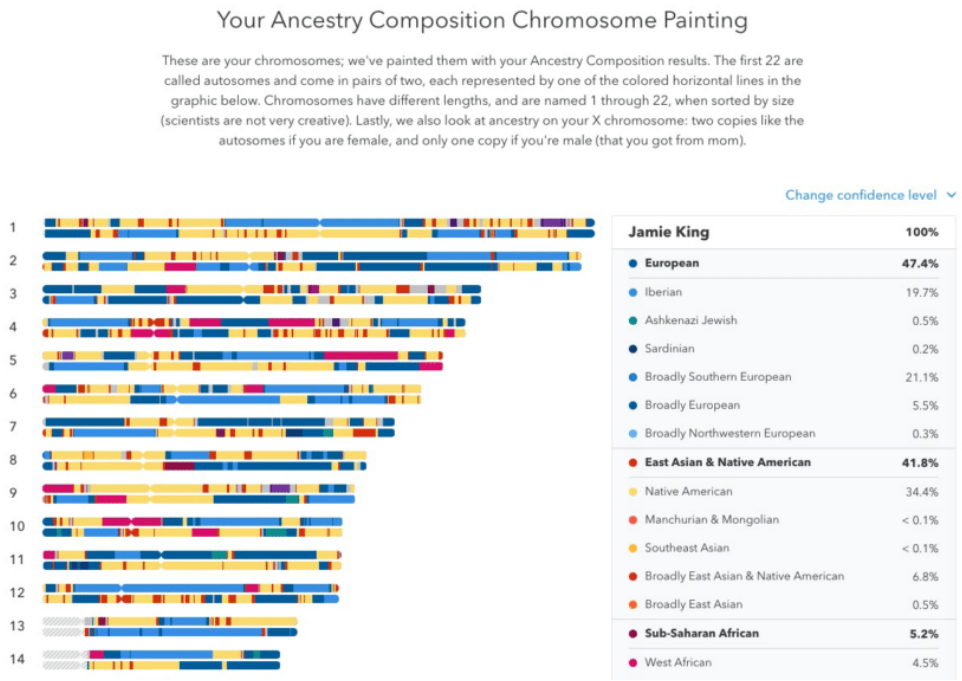

Figure 5: Straightforward and lucid report from genetic testing in 23andMe. (Source: 23andMe Blog https://blog.23andme.com)

Thanks to its ingenious product design, 23andMe kept a low pricing strategy to attract more consumers. Quickly after its 1st marketed product, D2C genetic testing kit lowed its price to US$299 per test. Given the whole genomic sequencing cost was still over US$ 100 000 in 2006, the price was quite accessible for consumers to obtain the most important information

about their genetic background. In November 2012, 23andMe proposed an even lower price, US$ 99 per test, which immediately boosted consumer number (Figure 6).

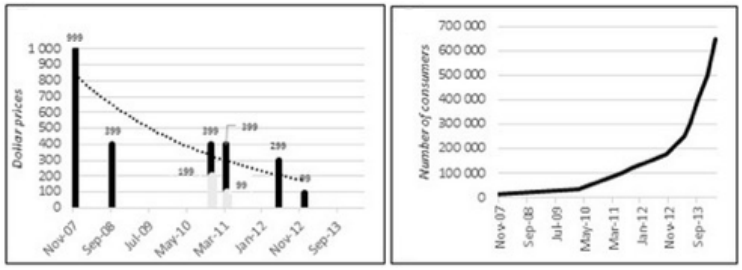

Figure 6: The almost exponential increase in the number of users coincides with the falling price of the kit to $99 in November 2012 and increase in the number of users over time. [Source: (Stoeklé, Mamzer-Bruneel, Vogt, & Hervé, 2016)]

Another key factor in its D2C success was promotion programs that targeted precisely its consumers and engage them to share their experience. As D2C service, 23andMe targeted the general public, especially the young public who are curious. In June 2017, 23andMe created a brand marketing advertisement featuring Gru from the movie Despicable Me. In 2018, the company further marketed its brand in advertisements narrated by Warren Buffett, followed by several waves of marketing programs via the Internet. All these programs were destined to the young public who were amazed to see how innovating technology gave another insight into their life than they knew about themselves. In another side, neatly designed reports motivated consumers to share their experience with others. Even today, when typing 23andMe in search engine we see still its consumers sharing the joy when showing their report and discuss the people who have already their reports. These consumers have eventually formed a community that often gives positive feedback to the product, and thus attracting even more consumers.

SUCCESS AND FAIL IN MARKETING COMMUNICATION

Like all other innovative products that focus on consumers, how to communicate the product value is key in designing a customer value-driven marketing strategy.

23andMe launched several waves of marketing campaigns that focus on educating consumers. The campaign focuses on educating consumers about how understanding their DNA can help them make more informed and proactive health decisions. The campaign will also build brand

awareness for 23andMe. The campaign features people discussing their real 23andMe results, visualized as graphics to help illustrate what they learned about their health by exploring their DNA. This marketing communication program successfully evoked the enthusiasm of the public and laid a solid foundation for the following promotion programs.

Figure 7: 23andMe's TV campaign which aimed to educate consumers. (source: 23andMe.com)

However, 23andMe's marketing communication was not perfect. In 2013, the FDA asked the company to stop marketing the $99 test kit because of the concerns about inaccuracy and unintended use of results from the kits (Tyler, 2013). 23andMe's CEO, Wojcicki told Fortune that her company fell behind schedule and failed to communicate proactively with the FDA and the public (Michal, 2013). In the following two years, 23andMe worked closed to FDA to get approve its products. On October 21, 2015, 23andMe announced that it would begin marketing carrier tests in the US again after the FDA sent clarification about the regulation of the test to 23andMe.

UNIQUE BUSINESS MODEL

Beside its marketing strategies, 23andMe created a unique 2-sided business model, which connected the need for genetic information from consumers and that for a large number of genetic backgrounds from private or public research laboratories.

Besides the need of consumers for their own genetic information, research laboratory need urgently enough number of genetic background in their work. Scientists want to learn more about the genetic roots of various conditions and diseases in the hope that this information will lead to better treatments or even cures. Both nonprofit academic institutions and drug companies are doing this kind of work. The key burden in these works is to obtain a sufficient number of genetic samples.

By that way, the average customer who chooses to let 23andMe share their data for research contributes to more than 230 studies on topics including asthma, lupus, and Parkinson's disease. Comparing to D2C service, 23andMe's 2B business will have a much longer life cycle and will bring long-term benefit (Figure 8).

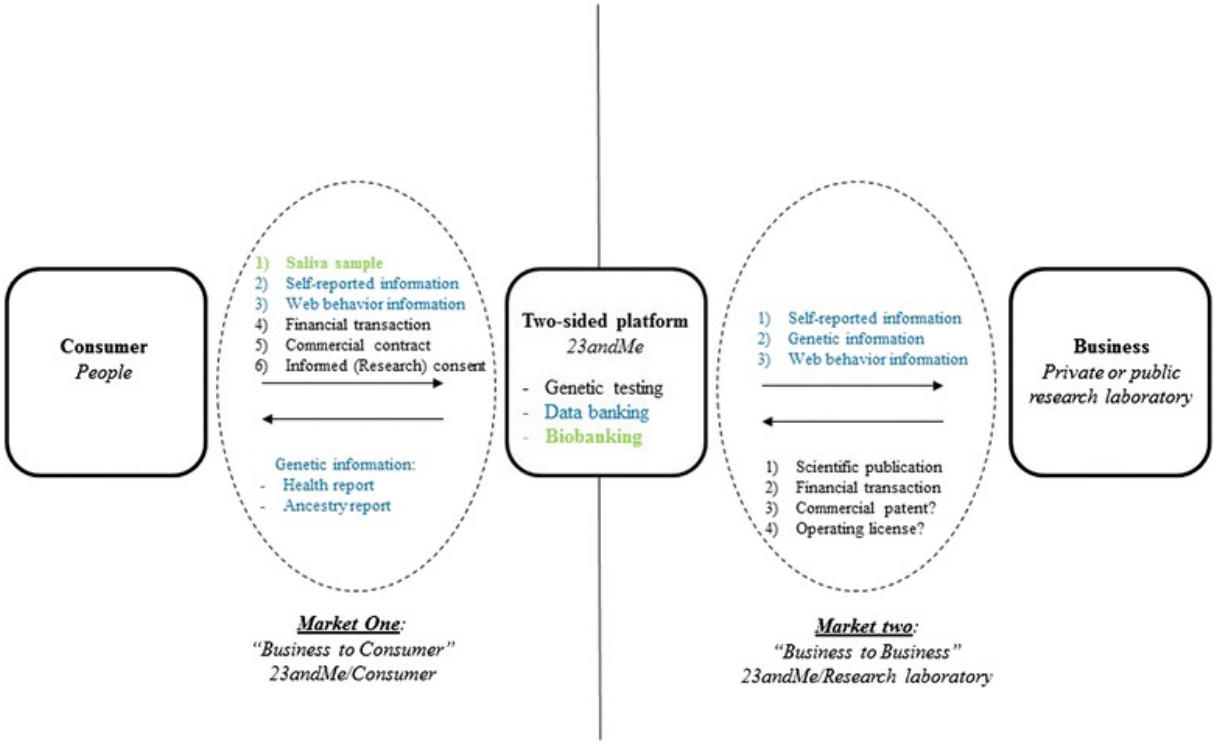

Figure 8: Illustration of double-sided business model in 23andMe. Source: (Stoeklé et al., 2016)

SURVEY 1 RESULTS

23andMe is the most successful D2C genetic testing service provider. However, its D2C marketing success was based on a delicate design of the product with mature microarray technology, and the price advantage brought by the more stable technology. For more innovating technology such WGS and especially to a specific to-newborn service, a secondary study would not enough. We need dedicated studies to insight into more specific features of the market and their responses in the specific circumstance.

The primary research was composed of two parts. Part 1 survey was designed to specifically focus on the direct consumers whereas Part 2 survey was destined to the stakeholder in the service-provider side.

The first part of the survey was performed totally in the Gynecology and Obstetrics Department of CHR de Citadelle (Citadelle Regional Hospital Center) in Liege, Belgium. Through the period from the 12th October 2018 to the 28th February 2019, 14 patients attending medical visit in the Gynecology and Obstetrics Department and expecting baby birth within nine months have been randomly selected and inquired. The survey was carried on in the form of face-to-face interview described in the Appendix.

CUSTOMER VALUE

In this study, we estimated the customer value of future WGS service by direct inquiring WPT from the newborns' parents, which is more relevant to our specific question.

The recent results showed high variance in WPT, consistent with the previous report (Marshall et al., 2016). Even within a very narrow segment, only pregnant women, the variance is still surprisingly high. Based on the description given during survey (see Appendices for survey details), the range was from absolute no willingness to pay to 1000 euros with the money of their own pocket for the WGS for their baby. The results validated as well the finding that without insurance coverage: almost half of the interviewees (7/14) don't have the willingness to pay WGS service by answering "definitely not" or "possible not" to buy this service for themselves.

However, when asked about buying the same service for their newborn baby, the answers became more positive, with 7 "likely not" answers and 10 positive answers. Moreover, the WPT is almost dominant in the answer "€0–200" (9/14) for WTP for the service for interviewees themselves but increased into 7/14 answers of "€200–500" for their newborn babies. Even one of the interviewees answered she would pay "€500–1000" for WGS service for her newborn baby. This result validated our original hypothesis that the specific segment of the newborn market should have higher WTP.

Due to limited sample number, no significant association of age could be found to WTP for interviewees or newborns. However, one important finding is that, before explanatory description, interviewees who expressed more their understanding about the new technology gave higher WTP they had for both themselves and newborns. The results show the importance of awareness of need in the perceived value of products for consumers, indicating consumer education will need to be highlighted in the marketing strategies toward the current market in order to get a higher perceived value.

KEY FACTORS IN MARKETING D2C GENETIC TESTING BUSINESS (CONSUMER SIDE)

The survey 1 was designed to get the insight of D2C WGS service from only consumers. The main benefits and concerns about the get involved in D2C WGS service for newborns were also inquired directly.

Most interviewees could not mention any benefit of WGS service of their knowledge without the explanatory description. The results showed most interviewees were not very clear about the benefit that could bring to their newborn babies or themselves. This is fairly consistent with the relatively low prerequisite knowledge about the industry. The recent results underlined the necessity of consumer education on both new WGS service and even the whole industry in future marketing strategies.

However, after explaining the new technologies and WGS service to interviewees, the main benefits they mentioned were the "long-term health benefit" and "disease screening. Although the answers must be sensitive to the context of explanatory description, these two benefits seemed to be the most eye-catching values that new service would bring to them.

In term of concerns, interviewees seemed to have more easily concerns about the new business. At the end of the survey they raised three mains concerns:

1. Economy: including price and insurance coverage;
2. Privacy: including babies' information privacy concern about abusive use of health information;
3. Effectiveness: including concerns about the necessity of WGS service, especially without any medical recommendation from doctors.

SURVEY 2 RESULTS

In the second part of the survey, we focus the stakeholders from the current or future WGS provider side. The goal was to get their attitude toward to the new industry, to analyze with them the current macro-environment of business, to reveal potential concerns from the technical and regulatory aspects and to identify new trends in the industry. The survey was performed in the form of direct interview or telephone interview with doctors (gynecologists, obstetrics, geneticists working in hospitals), technique experts (biologists and bio-informaticians) and research/hospital directors.

REGULATION AND TRENDS IN INDUSTRY

To understand the macro-environment of the future industry, I gave a telephone interview with Professor DE VOS John, Director of the Cellular Therapy Department of the University Hospital Centre of Montpellier, France.

As director of the research center and hospital department director, Professor DE VOS John expressed his concerns about providing WGS service directly to consumers. He said the current genetic testing was still restricted to some specific medical applications such as prenatal screening for some severe genetic diseases. The available genetic testing tools were still largely used in hospitals and they had still high performance for the need of these clinical applications. WGS technology was an innovating technology, but how to apply this

technology and to make proper use the tremendous quantity genomic data was still far from being defined.

In term of regulation, he confirmed that, unlike other continents, Europe Medicines Agency (MEA) banned on providing WGS service directly to consumers without the medical recommendation in Europe. The current technology would bring confusing information to consumers and even to doctors with an undefined association of genomic information to disease. Without enough improvement of the scientific base on human genomics and further changes in the regulatory base, WGS service direct to the consumer would not be expected in the future in Europe.

However, with the fast development of WGS technologies, hospitals started providing genetic testing with WGS technologies with some special applications. Due to the difficulties to handle and to analyze the huge amount of patients' genomic data, some companies started providing information management service to hospitals to help manage these data. This genomic information management would become another axillary business related to WGS service and would have a booming market in Europe.

DOCTORS OPEN TO NEW TECHNOLOGIES

In the face-to-face interview with Dr. PATSOURA Areti, gynecologist/obstetrician in CHR de Liege, the doctor expressed her positive attitude towards providing service with new technologies to patients if the testing method was capable of bringing benefits to patients.

Dr. PATSOURA stated obstetricians prescribed routinely genetic testing to patients. These tests helped patients to avoid the suffering from the deformity or mental retardation in babies caused by genetic abnormalities. The technologies evaluated quickly. For example, the non-invasive prenatal test (NIPT) was an excellent method for prenatal genetic testing for Down's symptom. This technology developed quickly in the 5 last years and was just accepted to get covered by health insurance in Belgium. This new method would help uncountable parents in the future with more accurate testing results but also improvement in the patients' comfort.

When being asked whether she would prescribe WGS service to patients in case of necessity, she confirmed the new genetic testing methods were always welcome and she was quite open

to provide to patients a better medical service with all the technologies that would be benefiting them.

However, she underlined that the available methods for genetic testing were quite strictly regulated. The only approved genetic testing methods are authorized to be used in hospitals.

WGS WILL BECOME MORE ACCESSIBLE AND BOOST LIFE SCIENCE

To understand the technological trends in the industry, I made a face-to-face interview with the scientists and technical experts in GIGA institute of Liege University. All of them were working with the NGS technologies and some of them were the experts of the genomics platform of the institute.

When interviewing the scientists and technical experts working directly with WGS in GIGA institute of Liege University, most scientists expressed their optimism towards WGS use in the future.

From the technical aspect, the core technology of WGS, next-generation sequencing, had already been a mature technology. This is reflected by its low cost and high accuracy.

WGS stepped already into the ere of 1000 euro per genome, even the companies like Veritas Genomics provided service for 200 euros per genome sequenced (Megan, n.d.). With this price, WGS would become much more accessible to life science research. The large-scale analysis, like genome-wide association study (GWAS), would be possible for most of the research projects. These analyses would link the current life science or medical knowledge to the new human genomics research. With other new technologies like data science and artificial intelligence that had been already integrated into the fundamental research of today, our knowledge about the genome and its association to the health/disease would be much clear very shortly.

In another hand, the liability of NGS technology was getting much improved. NGS had been in a struggling period where the new technology suffering from the low quality of generated data. However, with the 3rd-generation / 4thgeneration sequencing technology, the liability of NSG data could even get approved for diagnostic use.

CHAPTER 5: DISCUSSION

As we mentioned, the study was based on the assumption that undergoing evolution in science and technologies will reform industry macro-environment. In the current regulatory environment, WGS service is still heavily restricted to the medical applications in most countries, which mean the D2C market is still close. Both ethical concerns and technical issues are still present related to D2C marketing WGS service, which were not topic of this study but have been discussed in other reviews (Beth A Tarini, 2012; Johnston et al., 2018; Marshall, Gonzalez, MacDonald, & Johnson, 2017; Regier, Weymann, Buchanan, Marshall, & Wordsworth, 2018).

The recent study tried to analyze the successful marketing strategy of 23andMe and to insight the potential consumer's behaviors by analyzing their responses to future WGS service.

WHAT WE LEARNED FORM 23ANDME'S MARKETING STRATEGY

The D2C genetic testing service dated from 2007 where the companies like 23andMe use available technologies to provide an insight of genomic information directly to consumers. The new D2C service changed completely the industry that was dominant by professional service upon doctor's recommendation. Some successful companies, like 23andMe, built very consumer-focused marketing strategies to confer a higher consumer value to their service. In the case study of 23andMe, I found their consumer-centered strategies was composed by

1. delicate product design: which could give a unique experience to consumers but also lower cost;
2. competitive pricing: a much lower price allowed 23andMe to attract more consumers and the scale effect decreased even more the price;
3. specific promotion strategies: this was composed of specific targeting young and curious young consumers and encourage them to share their positive experience via social network and to form a consumer community.

The "3P" marketing strategies enabled 23andMe to pass successfully their value to consumers and make use of consumer's feedbacks to enchain other marketing programs.

Another success of 23andMe was building a two-sided business model. Like all other two-sided platforms, 23andMe connected the need from two sides, consumers and researchers. The difference from other ordinary two-sided platforms was that 23andMe was indeed only service provider. If we consider the genomic information they generated for individual consumers was the outcome of their service, both individual consumers and healthcare researchers need this outcome but would use and interpret in different ways. The success in this business model was completely upon the huge need from both sides.

However, 23andMe was founded more than 10 years ago. Today when we talk about genetic testing D2C service, we are talking about future WGS service which will much more powerful but much more controversial in D2C market.

With even more innovative technology and stronger power in data generation and data mining, how to make successful marketing communication to both consumers and regulatory authority will be critical. Given the 23andMe issue with FDA in 2013, the new business with WGS D2C service will face even bigger challenges.

The WGS D2C service is not completely open till now, due to both regulatory restriction and ethic concerns. But as I mentioned in the previous parts in this thesis, the revolution introduced by the data science and artificial intelligence will boost out knowledge about our own genome. This will make legal base for using our own genome information in a more secure manner. The revolution is ongoing and the change is happening right now.

KEY FACTORS IN MARKETING STRATEGIES FOR WGS D2C SERVICE

The recent study focused on the responses to the new D2C genetic test service from both consumer and service provider sides. The results help us to understand the consumer and professional perception toward the new business and will facilitate build successful marketing strategies. The results made emerged several key factors in building future marketing strategies.

EFFECTIVE MARKETING COMMUNICATION TO CONSUMERS

As we mentioned in the previous paragraph, effective marketing communication will be critical for successful early marketing.

The results of the survey 1 showed the future consumers had already strong awareness about their need in genetic testing for their newborn babies. But without explaining to them the future precision medicine, they could hardly imagine the need for genome information in the future for their newborn babies. The reason could be that the consumers were aware of their need in the current context but it was hard for them to put themselves in a future context. This hypothesis could be proved by the fact that interviewees answered positively their understanding of the benefits of new WGS service after the explanatory description. Effective marketing communication to consumers must be accompanied by a situational introduction to the future precision medicine context.

But after inquiring what they really need from the new WGS technologies, they could not tell more than what the description gave to them, indicating they had little knowledge about the new service.

The results showed that in the six buyer-readiness stages, the marketing communication strategies must be designed to build awareness and knowledge about the new product.

EFFECTIVE MARKETING COMMUNICATION TO PROFESSOINALS AND AUTHORITIES

Given the lesson for 23andMe, marketers would put marketing communication to professionals and authorities in a high priority.

Here I would like to distinct marketing communication to authorities from regulatory compliance. Regulatory compliance is another important work in which future companies must conforming to rules, such as a specification, policy, standard or law, which is not a topic of this thesis.

Marketing communication to professionals and authorities must communicate the product value to the potential participants of the business. In the results from survey 2, I focused on the feedbacks from the professional stakeholder in the future D2C business. The interview with them demonstrated different emphases in a future marketing communication to them.

Although doctors are not direct D2C marketing targets, our results showed that they would be key influencers in consumer's buying decision. The results from survey 1 demonstrated that most interviewees relied heavily on doctor's recommendation in face new WGS service even

when we underlined that the service was a consumer product and be purchased without medical recommendation, indicating a consumer's buying decision could be promoted by a positive recommendation about the new products from doctors. It should be noted that Dr. PATSOURA was insisting on the benefits brought by the new product to patients. Although her attitude towards new WGS service should not be generalized to cover all medical professionals, it revealed that at least some of them were prone to supply patients with new innovative technologies and services. On the other hand, her attitude showed that the advantages of WGS service and comparing to existing genetic testing methods should be key features to communicate to doctors.

The higher healthcare facility directors seemed to be more prudent to the new service. They care more about the compliance with the existing law and potential ethic issues introduced by new technologies. As they are often outside the direct-to-consumers marketing program, the healthcare facility directors seemed to be not determinant in the D2C marketing program. However, it should be noted that they are often involved in constructing regulation bases, thus successful communicating the new product value to them could be a critical step to get recognized by regulatory authorities.

INSURANCE COVERAGE AND CONSUMER'S PERCEPTION

In the results of survey 1, it was not difficult to remark the importance of insurance coverage in buying decision of consumers. Although insurance indeed covers some health management services and WGS service is heavily regulated and still restricted to a medical service, the situation will change dramatically for future WGS service as explained in the introduction section.

The fact that most interviewees mentioned insurance concerns demonstrated an inherent association of health management services to medical services in the consumer's mind. It would be a critical concern because this inherent thinking would interfere consumer's understanding of the value of service.

This inherent thinking reflected the current consumer's perception of WGS service. The possible solution within the limit of marketing should start from delicately designing product value proposition and improving D2C communication to avoid confusion. However, to

change consumer's perception in-depth and long-term marketing program need to integrate into marketing strategy, such as customer education program.

NEW BUSINESS OPPORTUNITY IN WGS DATA MANAGEMENT

In the discussion with Pr. DE VOS and technical expert in WGS domain during the second survey, the interviewees revealed the need for WGS data management along with current WGS technologies.

Today in most countries, D2C WGS service is still strictly regulated and D2C application of WGS to newborns without medical recommendation is strictly forbidden in Europe. D2C WGS service would be hard to launch in the current regulatory environment. However, lower cost and higher technical reliability of WGS analysis make it much more accessible to routine medical analysis and diagnostics. The number of WGS analysis in hospital is indeed increasing fast in Europe, US, and Asia.

However, the hospitals that promoted the new technologies started encountering difficulties in WGS data management. The difficulties come from two sides:

1. The huge amount of data: Standard 30x-coverage WGS analysis generates up to 250 GB raw data. This huge volume needs high-performance computing capacity to analyze. Moreover, the huge amount of WGS data need to be stored in high security for the lifetime of patient.

2. Confidentiality of data: As described in the "ethical issue" section, to avoid misuse and misinterpretation of patient's own health data, anyone need get access to health data of any patient must be granted, even patients themselves. This restriction urges a third-part data manager to manage the access to patient's WGS data.

In the discussion with Pr. DE VOS, he told that start-up companies have launched in this domain in 2019. But the blooming demand from hospitals could be seen in recent years and a huge market would be expected in the future.

LIMITATIONS OF THIS STUDY

In this study, I tried to analyze the responses of future D2C market of WGS service by inquiring directly different stakeholders, especially the potential consumers. The results from part I survey gave us a clear view of consumer's responses to designed marketing communication and their WTP for the service on newborns. However, the study had some limits and need to be improved in future study.

1. limited information in understanding market and consumers:

This study focused only on two elements in analyzing the market and marketing environment:

- marketing communication: a virtual service product was designed and communicated to customers. Their understanding and perception were recorded during the survey.
- WTP: potential consumers were directly inquired about the WTP for the virtual service product to validate the hypothesis that parents of newborns should have higher WTP for the service for their newborn babies.

The information obtained in this study is far from enough to completely understand the future market and responses of consumers.

2. limited sample number in survey part I:

Limited by resource, survey part I was only carried on with 15 randomly selected interviewees. The sample number was not sufficient to support quantitative analysis.

3. context limitation:

The context given to interviewees in the survey part I was based on an imagined WGS service product. A descriptive explanation was given to interviewees before answering. This design made the results limited to the given context.

4. consumer's responses to a generic product:

As mention above, this survey was based on a generic product that contains only the main features of current WGS service. In the future study, improved design can be added to the

product and consumer's responses will be more relevant to reflect the real market's responses in the future.

In the part II survey, I interviewed several key stakeholders in the business in order to understand the business trends from the professional's perspective. Each interviewee gave insight into the business from his/her own angle. However, after discussing with them and analyzing the whole study, two important stakeholders were missing in the study:

1. regulation maker:

Although the changes could be foreseen as we argued in introduction section, the activity is still heavily regulated and regulation evolution is key to launch such business. In the second part of survey, interviewees from regulation maker such as European commission should have been included.

2. insurance:

Most of interviewees in the survey part I stated insurance was indeed important for making the buying decision. The possible solutions within the limit of marketing was discussed in the previous section. However, a more open option should be addressing directly to insurance companies.

CHAPTER 6: CONCLUSION

With the fast development of WGS technologies, evolution in genomics science and data science, combined health management with digital health and precision medicine can be foreseen shortly. This thesis focused on the first pace to this future business, which was the WGS service supply with D2C marketing model.

During the realization of the study, we obtained substantial direct feedback from potential consumers towards future service. From these feedbacks, the thesis tried to give several guidelines in future D2C marketing strategy.

1. Importance of effective marketing communication:

Our results revealed that effective marketing communication would be critical in building an early marketing strategy. Effective marketing communication should be addressed both to customers and healthcare professionals, as our results demonstrated that healthcare professionals would be key influencers in making consumer's buying decision even in D2C marketing.

Moreover, recent results demonstrated that consumers had stereotypic perception towards future WGS service that would interfere customer's acceptance of the value proposition of new service. Consequently, a delicately conceived marketing communication will be decisive in a successful D2C marketing strategy.

2. Privileged but risky newborn market:

The recent study targeted newborn market based on the hypothesis that newborn children would have maximal customer value from future WGS service. Our results confirmed the advantage of this market by a higher WTP by their parents. Interestingly, the average WTP to newborns reached the current WGS service cost, indicating this future business is becoming profitable and realizable.

However, the results from the survey part II raised as well ethical and technical concerns from the medical professionals. These concerns should be carefully answered before any advance

in the D2C WGS service. At the same time, the discussion with other stakeholders demonstrated another huge business opportunity in WGS data management in the current regulatory environment.

Combining these results from primary research in recent study and secondary research on the marketing strategy of a pioneering company, this thesis gave essential guidelines to help build a successful marketing strategy of D2C WGS service in the future.

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APPENDICES

SURVEY PART 1:

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SURVEY

Implementation of Whole Genome Sequencing (WGS) in pre-natal genetic testing

Part I: Focus Group

Intention to Master degree in General Management

OpenBordersMBA, Cohort 6
HEC Liège – Université de Liège

BAI Qiang

Directeur de l'étude:
Prof. Dr. Marco Motullo
FH Aachen
University of Applied Sciences
Fachbereich Elektrotechnik und Informationstechnik

2018.11

Initial Intention:

Presentation: identification, reasoning.
Declare privacy and aim of study.
Demand for consent.

Survey questionnaire:

1. What do you know about genetic testing for baby?

2. Have you heard about whole genome sequencing and precision medicine? What do they mean for you?

3. As a new genetic testing and future, are you willing to pay for it for yourself, for your baby? If you give a price you'd like to pay it for yourself / your baby?

For you:

Definitely would have	likely to have	possible to have a try	possible not to try	likely not to have	Definitetely not

€0–200	€200–500	€500–1000	€1000–3000	>€3000

For baby:

Definitely would have	likely to have	possible to have a try	possible not to try	likely not to have	Definitetely not

€0–200	€200–500	€500–1000	€1000–3000	>€3000

4. What are the most interesting/relevant points for you concerning the WGS and precision medicine?

5. What are the main concerns?

EXECUTIVE NOTE:

Interviewee information:

Gender

Age

Ethnic

Num of pregnancy

Interview information:

Date and time

Place

Complete rate

Post-survey information

Sequence number:

Eligibility

RAW RESULTS FROM SURVEY PART 1

(Next page)

order	Question 1	Question 2	Question 3				Question 4	Question 5	Survey information		Interview information	
	1. What do you know about genetic testing for baby?	2. Have you heard about whole genome sequencing and precision medicine? What do they mean for you?	3. As a new genetic testing and future, are you willing to pay for it for yourself, for your baby? If you give a price you'd like to pay it for yourself / your baby?				4. What are the most interestin	5. What are the main co	Gender	Age	Date and time	Place
			WTP (for you?)		WTP (for baby?)							
1	Nothing	Nothing	5.possible not to try	1.€0–200	3.possible to have a try	1.€0–200	-	Usefulness: really need. Require recommend from doctor.	F	32	12/10/18	Pediatrics department, CHR Citadelle, Liege
2	Screeening gene	Whole gene test?	3.likely to have	1.€0–200	2.likely to have	2.€200–500	Screening for genetic diseases	recommend from doctor?	F	-	12/10/18	Pediatrics department, CHR Citadelle, Liege
3	NIPT (non-invasi	Nothing	5.possible not to try	1.€0–200	3.possible to have a try	2.€200–500	Genetic information for future use	Legal	F	26	12/10/18	Pediatrics department, CHR Citadelle, Liege
4	Trisomy	Gene mutation?	2.likely to have	2.€200–500	2.likely to have	2.€200–500	Life-long benefit	Privacy	F	29	11/12/18	Pediatrics department, CHR Citadelle, Liege
5	Gene test?	Nothing	4.possible to have a try	1.€0–200	3.possible to have a try	1.€0–200	Whole genetic diseases screening	Price + inssurance cover	F	-	11/12/18	Pediatrics department, CHR Citadelle, Liege
6	Nothing	Nothing	5.possible not to try	1.€0–200	3.possible to have a try	2.€200–500	-	Privacy	F	25	11/12/18	Pediatrics department, CHR Citadelle, Liege
7	Down syndrom s	Nothing	4.possible to have a try	2.€200–500	4.likely not to have	2.€200–500	-	Privacy + Price + inssurance cover	F	32	15/01/19	Pediatrics department, CHR Citadelle, Liege
8	Nothing	Nothing	3.likely to have	2.€200–500	3.possible to have a try	2.€200–500	Pertinent health information for baby	Relevancy + Price + inssurance cover	F	28	15/01/19	Pediatrics department, CHR Citadelle, Liege
9	Trisomy screenir	Expensive	4.possible to have a try	2.€200–500	4.likely not to have	1.€0–200	-	Price + inssurance cover	F	33	15/01/19	Pediatrics department, CHR Citadelle, Liege
10	Nothing	Never heard	5.possible not to try	1.€0–200	4.likely not to have	1.€0–200	-	Negative Impacts in the future: how use these data?	F	-	15/01/19	Pediatrics department, CHR Citadelle, Liege
11	Nothing	Nothing	5.possible not to try	1.€0–200	3.possible to have a try	2.€200–500	Screening for genetic diseases	Legal	F	30	15/01/19	Pediatrics department, CHR Citadelle, Liege
12	Ultrason?	Nothing	5.possible not to try	1.€0–200	4.likely not to have	1.€0–200	-	Price + inssurance cover	F	24	28/02/19	Pediatrics department, CHR Citadelle, Liege
13	Little	Nothing	4.possible to have a try	2.€200–500	2.likely to have	3.€500–1000	Future medecine	Recommend from doctor	F	29	28/02/19	Pediatrics department, CHR Citadelle, Liege
14	Genetic disease:	Nothing	6. Definitetely not	1.€0–200	3.possible to have a try	1.€0–200	Whole life benefit	Relevancy	F	-	28/02/19	Pediatrics department, CHR Citadelle, Liege

EXECUTIVE SUMMARY

If I look back to the whole thesis preparation, these months of preparation were indeed a repeat cycle of relearning, specifying the questions and going back to book.

I remember when I was asked to give a thesis proposal, the title that I gave was so ambitious: “Research For Opportunities Brought by New Trends In Precision Medicine For New Companies.” I would laugh out if I read this proposal, because the questions asked initially were too vast and impossible to answer. Once the study started, I was indeed struggling to find the right questions for the study from the beginning. The problem came from two sides: understanding of industry (i.e. the precision medicine) and understanding of topic (i.e. the marketing in this thesis).

I don't work directly in the precision medicine industry but my work is related to that, so I thought I should be familiar with the industry. But I realized it would be wrong when I had difficulties to ask correct questions about the industry. More I advanced in the thesis preparation, more I realized that the precision medicine industry was strange to me. That would be reason why the initial questions are so vast.

On the other hand, the knowledge structure was so important that the whole thesis should be build up solidly with logic chains on that. That’s the reason why I had to go back to books again and again looking for theoretic support. Once having a global view on the whole knowledge structure of marketing, I found what I did within the project could only answer so small questions.

Luckily, during this period of confusion, Prof. Dr. Marco Motullo gave a lot pertinent suggestions that helped me out.

The whole preparation of the thesis was so valuable for me because without that, I will continue working with NSG technologies but will probably never have opportunity to think about the industry from the business perspective. The thesis helped me to have an integrated view on the industry to which my work is related.