



THE TURKISH LIFE SCIENCE AND HEALTH SECTOR

Identifying opportunities to exchange knowledge and products
between the Netherlands and Turkey.



(Source: VUMC, PET-MRI Scanner)

Eline Bakker, Bsc
Trainee Netherlands Network for Innovation, Technology & Science, Ankara

drs. Rory Nuijens
Advisor for Innovation, Technology & Science, Ankara

Derya Kaplan, LL.M.
Economic and Commercial Officer, Sector Lead LSH

THE TURKISH LIFE SCIENCE AND HEALTH SECTOR

Identifying opportunities to exchange knowledge and products between the Netherlands and Turkey

Eline Bakker

Ankara

March 24, 2015

Advisor for Innovation, Technology & Science of the Embassy of the Kingdom of the Netherlands,
Ankara

Economic Department of the Embassy of the Kingdom of the Netherlands, Ankara

Management Summary

This report shows the Life Sciences and Health opportunities for Dutch knowledge institutions and companies in Turkey. It discusses the challenges in the Turkish LSH sector and the collaboration potential with Turkish knowledge institutions and companies. Innovation and Research & Development (R&D) are important for emerging countries. Turkey aims to strengthen its R&D and innovation capacities in order to upgrade their industries and expand their export. One of the actions the Turkish government took to overcome the middle income trap was the investment in the R&D and innovation.

The Life Sciences and Health sector is for both Turkey and the Netherlands a topsector. Turkey showed by the implementation of the Health Transformation Program their commitment to the healthcare reforms. This program showed a significant improvement in the healthcare system in Turkey. This improvement is partly a result of the investments in R&D and innovations in the healthcare.

The translation of research into the industry is mostly integrated in Teknoparks or Technology Development Zones. For (foreign) companies, these areas show great advantages since they are exempt from several taxes. Companies and universities show an active research mentality and Turkey participates in several EU programmes such as Horizon 2020. There are several sub-sectors in the LSH sector discussed in this report. Every sub-sector has a specific collaboration potential and therefore, has a unique recommendation. This report shows five different sub-sectors and one sub-sector cluster. Research within these sub-sectors is performed in universities and companies.

The sub-sectors medical devices, pharmaceutical industry and E-health show more R&D conducted by the industry. The other sub-sectors are more focused on the R&D within research institutions. Sub-sectors in the field of LSH show different trends of research development. As a result, the recommendation of cooperating with these sub-sectors in Turkey is as follow:

1. The sub-sector medical devices show large potentials especially due to the increase and variation in health care needs. As a result, fast advantages in technology and the development of high-technology medical devices are necessary. Medical devices are very well-developed in the Netherlands. Currently, Turkish companies are more focused on low value added products. The high demand for medical devices, the market access in Turkey and the fact that Turkey is the hub to the Middle East and Asia makes Turkey a very attractive country for investments. It is recommended that Dutch companies and knowledge institutions collaborate with Turkey in the field of medical devices. EU programs and workshops would be very helpful for the Turkish industry. The Dutch industry would be able to show the Turkish government to support this market since this sub-sector is very promising for the high value added export products. Due to the complicated reimbursement system there is a market distorting. As a recommendation, the Netherlands should consider what the Turkish focus is regarding medical devices in knowledge institutions and anticipate on this focus.
2. Second, E-health shows large opportunities for Dutch companies and knowledge institutions. Turkey stimulates R&D in the sub-sector E-health by funding a large amount of research projects. The sector is facing challenges which can be changed into opportunities. Opportunities are visible in the development of software for E-health, mobile health applications, software security and healthcare information technology policies and ethics.
3. The pharmaceutical industry shows overlap with the medical devices industry. Both sub-sectors have the same reimbursement policies and share a department in the Turkish Ministry of Health. Due to their reimbursement policies, the pharmaceutical industry is mainly focusing on generics instead of original pharmaceuticals. This results in high amount of imported drugs and a low amount of exported high value added drugs. There are several

challenges visible in this sub-sector. Knowledge institutions focusing on pharmaceuticals perform high quality research. Unfortunately, The Turkish government shows not enough interest in bringing this knowledge into companies to produce high added value products. This sector shows potential for Dutch institutions which are outsourcing their activities. The Turkish pharmaceutical industry predicts that the policies in the pharmaceutical market will change and makes the pharmaceutical industry more attractive for foreign companies and knowledge institutions to cooperate.

4. The Turkish sub-sector cluster genomics, oncology and stem cell biology is developing rapidly. Currently there are several Dutch knowledge institutions collaborating with Turkish universities. The quality of the student programs and knowledge within some universities is very high. Besides the challenges in this sub-sector, the opportunities to collaborate with Turkey look promising. Both countries would gain from collaboration such as student/ staff exchange, bilateral research projects and shared EU research projects.
5. The fifth sub-sector is biomaterials and biomedical engineering. Turkey shows interest in the R&D within this relatively new sub-sector. Currently the sub-sector deals with several challenges, for example the valorisation and industrialising process. These challenges could be changed into possibilities with the help of external factors. Fortunately, it is an interesting sub-sector for Turkey to conduct high added value products. It would be recommended for Turkey to improve their research capabilities and share projects.
6. The last sub-sector is preventive healthcare. Dutch knowledge institutions have a lot of knowledge in this field due to the shift from communicable diseases into non-communicable diseases. The Netherlands would be a logical collaboration partner for Turkish research institutions since they have a large Dutch-Turkish population with a Turkish lifestyle and there are several Dutch studies in the field of preventive healthcare focusing on this Dutch-Turkish society. The shift to non-communicable diseases is currently on-going in Turkey. To prevent a high prevalence of chronic diseases in the future the Ministry of Health should focus more on preventive healthcare.

The different sub-sectors are all interdisciplinary connected. Besides, innovation within the LSH sector in Turkey shows a variety of factors which affect the opportunities. Altogether, it indicates that the findings within this report are calculated on the circumstances of the cooperation agreement.

Knowledge institutions and companies specialised in R&D and innovation within the LSH sector are mostly located in Ankara, Istanbul and Izmir. For Dutch companies the cities Izmir and Istanbul would be the most convenient to collaborate with. These cities have a direct flight to the Netherlands and both cities have teknoparks and Technology Development Zones. For knowledge institutions, all three cities have knowledge institutions performing high quality research. Ankara is more research focused but has problems with the valorisation of the research in the industry.

For questions about the content of this report, please contact the Innovation Advisor Rory Nuijens on +90 530 844 2810 or send an e-mail to ankara@ianetwerk.nl.

Index

Colophon.....	2
Management Summary.....	3
Index.....	4
Introduction.....	5
1. R&D in Turkey.....	6
2. Turkey: Sub-sectors in the field of LSH.....	7
2.1. Medical Devices.....	7
2.2. E-health.....	9
2.3. Pharmaceutical Industry.....	12
2.4. Genomics, Oncology and Stem Cell Research.....	15
2.5. Biomaterials and Biomedical Engineering.....	20
2.6. Preventive Healthcare.....	22
3. Discussion.....	24
4. Conclusion.....	27
5. References.....	28

Introduction

The Turkish economy shows an impressive growth in the past decade. It is among world's most developed countries and currently, Turkey has the world's 18th largest nominal GDP¹. Although the positive growth and the impressive future perspectives, Turkey shows some structural problems. The country is at risk to fall into the middle income trap and due to the low demand of export products there is a trade deficit². As a result, the Turkish government took the appropriate measures³. The Prime Minister of Turkey composed a list of goals in a document called "vision 2023". These goals will boost R&D and innovation in Turkey. In this document, the Prime Minister has set a goal for Turkey to become a global leader in the health services over the next decade³. The sector Life Science and Health is in Turkey and in the Netherlands a topsector⁴. In 2003, Turkey implemented the Health Transformation Program (HTP). This program showed great benefits in the healthcare and the national health system. On account of the success of the HTP, the Ministry of Health and the Ministry of Science and Technology decided to invest in R&D within Life Science and Health sector. As a result of this investment, knowledge institutions are trying to increase their Research & Development by collaborating with other countries.

In 2014, the Dutch embassy conducted a report which explored the Turkish Life Sciences and Health sector. This report was meant for relevant Dutch actors and the Netherlands Economic Network to show a global overview of the sub-sectors for possible collaboration in the field of Life Sciences and Health.

It represents the sub-sectors: Medical devices, E-health, the pharmaceutical industry, biomaterials and biomedical engineering, genomics, oncology, stem cell research and preventive healthcare. These sub-sectors are chosen due to the report from 2014 conducted by Dennis Linn, the focus of the Dutch Trade Board (DTB) on Turkey, the topsector policy and the decision made by the topsector LSH to focus on Turkey⁵. Current report will not include other subjects in the field of Life Sciences and Health³. Please notice that the topic health tourism is also not included in this report.

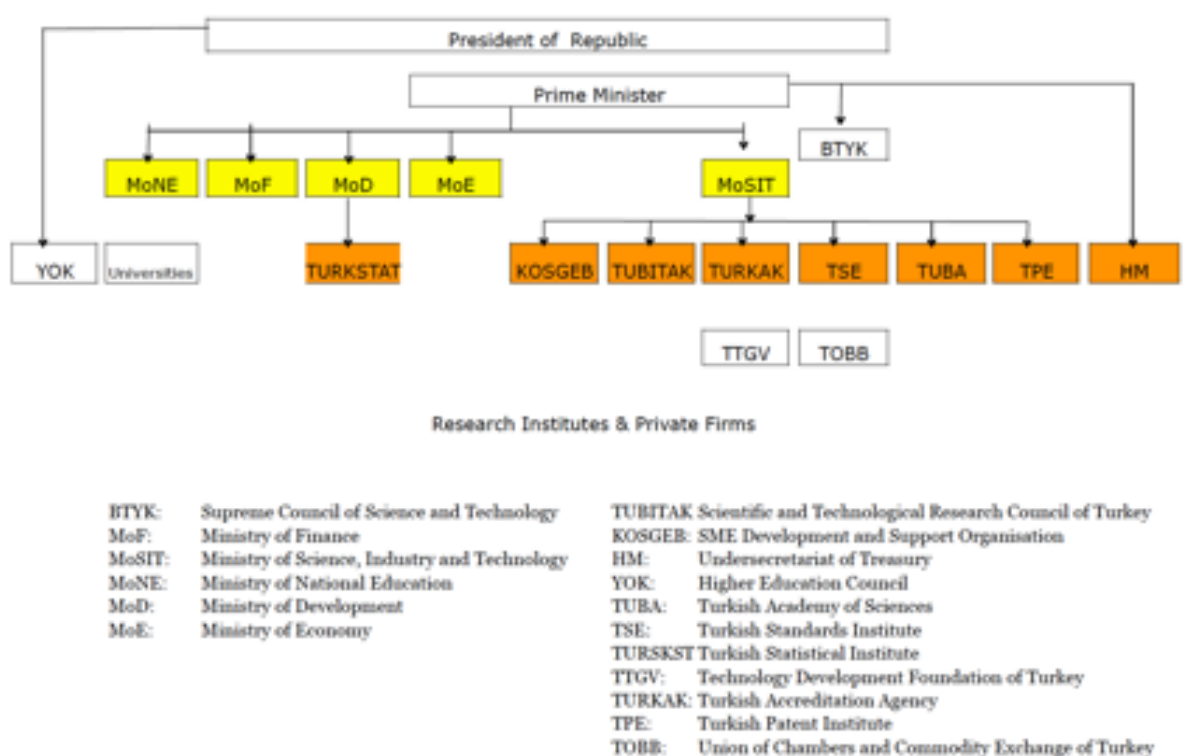
At the moment, Life Science and Health is one of the nine topsectors in the Netherlands. The demand for Life Sciences and Health products is increasing. R&D supports the innovations that will lead to an upgrade in efficiency and lower the costs of the healthcare⁶. For further collaboration it is important to point out the specific opportunities in the Turkish LSH sector.

This report will show the content of the Life Science and Health sector both in the Netherlands and Turkey. Besides the economic opportunities for the Netherlands, this report will also show the opportunities for companies and knowledge institutions in Turkey. To create this cooperation, the report will focus on companies and knowledge institutions from both countries. The aim of this report is to investigate the opportunities product and knowledge exchange between Turkey and the Netherlands in the field of Life Science and Health. Opportunities will be defined as knowledge holes, required expertise and the potential to work within EU framework programmes or the ability to generate products together.

1. R&D in Turkey

Turkish research is led by the Supreme Council of Science and Technology (BTYK). This is a legally formalised body chaired by the prime minister that directs and coordinates research and innovation policies. The BTYK is composed of relevant ministers, heads of public and private bodies, universities and non-governmental organisations.

Other important actors in the design and implementation of science, technology and innovation policies are the Ministry of Science, Industry and Technology (MoSIT) and the Ministry of Development (MoD). These two actors collaborate with the Scientific and Technological Research Council of Turkey (TUBITAK). The educational policies within the research policies are designed by the Ministry of National Education (MoNE) and the Council of Higher Education (YOK). Last, the Turkish Academy of Science (TUBA) determines and recommends scientific priority areas and proposes laws to the government on issues related to scientists and researchers.



Source: Erawatch Turkey⁷

For researchers, the most important actor in this system is TUBITAK, which designs and implements programmes to increase R&D activities to the public and private sectors, and universities. Other main bodies implementing industrial R&D support measures are the Small and Medium Enterprises Development Organisation (KOSGEB) and the Technology Development Foundation of Turkey (TTGV). Turkey has its own industrial and intellectual property rights organ called the Turkish Patent Institute (TPE) and an accreditation agency (TURKAK) which manages the accreditation of organisations and laboratories⁷.

TUBITAK has its own research centre which is the primary research performer in the public sector. This Marmara Research Centre of TUBITAK provides contractual research, testing, training, consultancy, analysis and certification services and operates a technopark. TUBITAK funds on account of the aim to become a global leader in the Life Sciences and Health sector 75% of fundamental approved research in Turkey⁸.

In general, public funding for research and innovation is provided by the MoSIT, TUBITAK, the MoD, the Ministry of Economy (MoE), KOSGEB and the Technology Development Foundation of Turkey. TUBITAK is the largest provider of recourses. There is other funding available provided by the government to the universities for their scientific research project. Universities fund research projects from their yearly budgets.

There are three types of special investment zones in Turkey. One of these types are the Technology Development Zones (TDZs), these are special areas focused on R&D activities and attract investments in high technology fields. There are 59 approved TDZs in the country. TDZs have several advantages⁹:

- Revenues derived from software development and R&D activities are exempt from income and corporate taxes until December 31, 2023
- Sales of application software produced exclusivity in TDZs are exempt from VAT (Value-Added Tax) until December 31, 2023. Examples include software for systems management, data management, business applications, different business sectors, the internet, mobile phones and military command control
- Salaries of R&D and support personnel covered by the exemption shall not exceed 10 percent of the number of the R&D personnel.
- Enterprises may make the investment, required for the production of the technological product obtained as a result of the R&D projects conducted in the zone, in the TDZ, if deemed suitable by the operator company and allowed by the Ministry
- 50 percent of the employer's share of the social security premium will be paid by the government for 5 years until December 31, 2024

Turkey is a key partner of the European Union and is currently applying for EU membership. Due to this application, the European Union decided to allow Turkey to join cross border cooperation programmes to improve EU relation and to enhance cooperation through joint projects. One of these projects is the joint programming. The aim of this project is to pool national research efforts in order to make better use of Europe's precious public R&D resources and to tackle common European challenges more effectively¹⁰. On international level, Turkey is member of five Joint Programme Initiatives (JPI's) and observer to two JPI's. These are the following JPI's:

Observer:

1. Urban Europe
2. JPI Climate; Connecting Climate Knowledge for Europe

Member:

1. Agriculture, Food, Security and Climate Change
2. EU Joint Programme – Neurodegenerative Disease Research
3. JPI A healthy diet for a healthy life
4. Joint Programming Initiative on Antimicrobial Resistance
5. Water Challenges for a Changing World

2. Turkey Sub-sectors in the field of LSH

Turkey is an interesting country for the Netherlands due to the country's increasing income and the plans to expand its economy. In 2003, Turkey introduced the Health Transformation Program. This program reformed the Turkish health system. Due to the introduction of this program, the Turkish healthcare system improved enormously. As a result of these improvements the Turkish government began to support R&D in the Life Sciences and Health sector. Therefore, bilateral cooperation in the field of LSH seems like a wise step for both countries.

Although the differences in policies between the Netherlands and Turkey could be a challenge for this cooperation, the marked opportunities in the Turkish LSH sector could be beneficial for both Turkey as well as the Netherlands. As mentioned in the previous chapter the following sub-sectors will be discussed: Medical devices, E-health, Pharmaceutical industry, Genetics, Oncology, Stem Cell Biology, Biomaterials and Biomedical Engineering and Preventive Healthcare

2.1 Medical devices

2.1.1 General Information

The field of medical devices is a very interesting field within the Life Science and Health sector in Turkey. With an increasing demand of medical supplies and medical technology, the Turkish market becomes more and more interesting for other markets to invest. Without the small and medium enterprises focussing on R&D in Turkey, the focus is mostly on low value added products³. To increase the quantity and quality of the healthcare, Turkey needs to invest in high value added products. There has not been a lot of R&D in this field in Turkey. The medical device market was valued at \$1.9 billion in 2008 and is expected to grow at a Compound Annual Growth Rate (CAGR) of 4.7% in 2020. Due to an increasing elderly population, universal health coverage and government initiatives this market expects a positive growth trend¹¹. The report of Dennis Linn showed the challenges in the field of the medical devices. The reimbursement system in Turkey is retrospective. The government is trying to cut back on the medical devices expenses by choosing the most inexpensive device to reimburse. This results in a high stimulation of low value added inexpensive products. The Social Security Institution, who organizes and controls the reimbursement, is therefore a powerful organization during the import of medical devices. Because of the high stimulation of low value added products, and the low production costs in Turkey, the import in the field of medical devices is low. This results in a low incentive to invest in R&D and makes the valorisation process difficult. The focus of this chapter will be R&D opportunities between Turkey and the Netherlands in the field of medical devices³.

The Turkish ministry of Health has its own department focussing on medical devices and pharmaceuticals, the Turkish Medicines and Medical Devices Agency. It is founded in order to establish the rules and standards related to licensing, manufacturing, placing on the market, sale, import, export, supply, distribution, servicing, withdrawal and storage of medical devices and to carry out laboratory analysis and to authorize, licence, supervise public and private persons concerned and to apply sanctions if necessary¹². Turkish National Medical Device Database (TITUBB) is a part of the Turkish Medicines and Medical Devices Agency to strengthen health services financial management and restructuring the healthcare in Turkey. It contains an electronic catalogue system to comprehend end-to-end healthcare supply chain together with public surveillance and vigilance capabilities. Approval of TITUBB is the first step for reimbursement and the information provided via TITUBB is being used by other national authorities. TITUBB provides some statistical data related with local manufacturers, dealers, public procurement prices and reimbursement data¹².

2.1.2 Challenges in the field of medical devices

Together with the pharmaceutical sector, the medical devices sector is one of the major elements of the Turkish health sector. The biggest health care cluster in Turkey is located in Samsun. The Samsun Health Care Cluster has 44 manufacturers among Turkey's 183 medical equipment manufacturing companies and provides the international market of medical equipment. This Health Care Cluster in Samsun is globally known as the third centre for medical equipment clusters following Germany and Pakistan. The Netherlands are among the export destinations of the medical devices developed in Samsun. Unfortunately, due to low added value products developed in this cluster, cooperation with Samsun is not interesting for The Netherlands¹³. This is an example of the challenges visible in this sector. Another challenge is the reimbursement supporting the production of low value added medical devices. The Turkish government reimburses only the medical devices registered in TITUBB, the Turkish National Drug and Medical Device Databank. TITUBB is not an independent authority and therefore, the reimbursement of medical devices is a challenge for foreign companies¹².

2.1.3 Opportunities in the field of medical devices

Firstly, R&D collaboration possibilities could be supported through Horizon 2020 projects. Collaboration should be focused on the knowledge exchange instead of product exchange. Dutch knowledge institutions have the technical knowledge to innovate in medical devices and could transfer this knowledge to Turkish knowledge institutions. As result, it would be recommended to look to cross-sectional connections and find out what Turkish Universities are currently developing.

The healthcare expenditures have increased tremendously in the last 10 years. The increasing economy and increasing healthcare expenditures result in more investments in the medical devices sector. The Turkish government has been taking steps to privatise the healthcare market. For example, a new government plan allows private industry to build and operate new hospitals which will be leased by the government. Turkey recognizes CE (Conformité Européenne) for medical devices. This is fortunate for companies in the EU who wants to collaborate with Turkey. A Turkish company with products that have a CE mark are able to register their devices with the Turkish Ministry of Health and appoint a local Authorized Representative to deal with the regulatory issues¹⁴. Taken the reimbursement policy into account, currently, the higher demand for medical devices is an opportunity for the Netherlands. Especially since the Netherlands has high added value products and private companies have their expertise in the Netherlands. These private companies could expand their business to Turkey, a country with better opportunities for competitively priced products and due to the location these companies can also benefit from European, Asian and African consumers.

RoboGait

One of the few examples of high value added products created and developed by Turkish companies is the Robogait, developed by BAMA Teknoloji. The Robogait is a Robot Assisted Walking Therapy Device to regain and develop walking ability in situations of loss of walking ability caused by traumatic brain and spine injuries, strokes, neurological or orthopaedic causes¹⁵. This product is recently introduced in the Dutch market in cooperation with Biomedicer Medical Products¹⁶. The R&D of this product is mainly done at the Middle East Technical University Technopolis and manufactured at OSTIM, an industrial park for small and medium enterprises in Ankara¹⁷.

2.1.4 Conclusion

Due to the low investments in R&D for medical devices, Turkey creates low value added products. However, in several instances, R&D within universities and companies focuses on higher value added devices such as RoboGait. These higher added value products are often conducted to increase the export. As mentioned above, the number one challenge in the field of medical devices is the Turkish reimbursement policy. The opportunities in Turkey in this field are the fact that the government would like to expand and increase their export and therefore supports the R&D. The low fabrication prices show an opportunity for Dutch companies to outsource their production and development process. Another positive factor to collaborate with Turkey, is the fact that Turkey is the hub to the Middle East and Asia. The advice for Dutch companies which conduct medical devices is to collaborate with Turkish Technoparks and knowledge institutions which have experience with the translation of research in the industry and outsource their production and exchange knowledge. It is not always clear on what account the TITUBB approves the medical devices. This results in uncertainty at the Turkish companies. Therefore, Turkish SME's are not willing to and are not capable to develop high value added medical devices. The Netherlands are experienced in the development of these high value added medical devices. This can be an opportunity for the Netherlands to help Turkish companies and knowledge institutions with their knowledge holes. It is recommended to find out which Turkish universities are capable of developing medical devices and focus on these universities. The final conclusion is that there are knowledge holes we can help Turkey with, but the uncertainty in the reimbursement system makes it difficult for foreigners to invest and collaborate in this sector.

2.2 E-health

2.2.1 General information

E-health is the transfer of health resources and healthcare by electronic means. First, it includes the delivery of health information for health professionals and health consumers through the internet and telecommunications. Secondly, it includes using the power of IT and e-commerce to improve public health services, e.g. through the education and training of health workers. Lastly, it includes the use of e-commerce and e-business practices in health system management (WHO 2015)¹⁸. There are many benefits of using e-healthcare services. For example, healthcare institutions expenses will be lowered. This will result in an improvement of their efficiency of serving healthcare services and distribution of sources and the communication among the healthcare staff. Another benefit is the usefulness for patients living in rural areas or patients that are not able to travel to the hospital due to their health conditions¹⁹⁻²¹.

E-health is an important sub-sector in Turkey. Achieving an e-health system in Turkey has been a component of The Health Transformation Program, published in 2003. The goals of this e-health system were to ensure standardization of data used in healthcare, to create an Electronic Health Record for citizens, for data analysis in the healthcare to support managers, to speed up the flow of information among stakeholders and to save resources and increase the efficiency in the healthcare system. There are five major healthcare information technology systems²²:

- Sağlık-net (Health Net)
- The Centralized Hospital Appointment System
- The Basic Health Statistics Module
- The Core Resources Management System
- The e-prescription system of the Social Security Institution

Sağlık-net is the most important system and each of the five major healthcare information technology systems above are considered as the various applications of Sağlık-net.

Mobile health (mHealth) is a component of e-health. The Global Observatory for e-health (GOe) defined mHealth or mobile health as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs) and

other wireless devices. It involves the use and capitalization on a mobile phone's core utility of voice and short message service (SMS), as well as more complex functionalities and applications including general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), global positioning system (GPS) and Bluetooth technology²³. Mobile technologies have great potential to provide customized healthcare applications due to the increasing demand of personalized healthcare. Aging and population expansion by double aging is one of the major issues for healthcare providers. Healthcare providers try to develop healthcare strategies that help to reduce the amount of people in the hospitals. In this context, mHealth provides opportunities to improve healthcare in both the developing and the developed world²⁴.

E-health services are considered as one of the fastest developing areas in the health industry²⁵. As a result, Turkey developed an information system to improve the efficiency and quality of the healthcare system. This system collects healthcare data from healthcare institutions from all over the country. Turkey did put a lot of effort in conducting this system, but they also know its weaknesses (see below challenges in the field of E-health).

2.2.2 Challenges in the field of E-health

There are several challenges visible in this system. One major issue of this e-health system is the security to insure the privacy for the patients. The data will only be used by the Ministry of Health. As a result, the risk of privacy violation will be reduced. Another major issue is the security of patient information. Due to the transfer of health resources and healthcare by electronic means there is a higher risk to integrity violation.

There are more challenges visible in the Sağlık-net system. Also, there are several E-health related issues Turkey could benefit from when they would collaborate with other countries²⁵:

- Quality of the health data
- Implementation of the Electronic Medical Records
- Integration of different systems of healthcare providers
- Changing the attitude of the management to go digital
- Reduce the amount of medical malpractice
- Increase the productivity within the health sector

The Turkish healthcare is complex. It has a centralized structure and a variety of healthcare providers. The government is the biggest provider in Turkey. Therefore the privacy, quality and security are the biggest issues in the Sağlık-net. The other challenges are difficult due to the implementation of different forms of electronic health records. The last challenges are administrative and thus can be explained by the conservative orientation of Turkish managers and their desire to avoid uncertainty.

2.2.3 Opportunities in the field of E-health

To shift from paper files to digital files is a big step for the government of a country. Turkey has a big focus on e-health and tries to invest in innovative systems to improve the Sağlık-net. On this account, the government is open to high-tech and innovative e-health information system. These information systems could be integrated in a data collecting application such as big data.

The health industry is a fast growing industry in Turkey and due to the international investors, the health industry has become a powerful element of Turkey's national competitiveness within its region. Due to the growing industry, there are important developments visible within the Turkish health market. Besides the increased amount of international investors, the increased amount of travellers to Turkey for the purpose of obtaining medical treatment, as well as increasing consciousness and expenditures of consumers on health related issues require adaptation to the

new marketing strategies and applications²⁶. Turkey is a country which has challenges providing health services to rural and underdeveloped regions. These rural and underdeveloped regions can benefit from mobile technologies, like mobile health applications, to close the gap between developed and underdeveloped. This results in opportunities for foreign companies. They can help to provide these mobile technologies in the rural areas of Turkey.

The next important level in E-health is the clouding of healthcare communication, predicted by IDC health insights²⁷. The Sağlık-net system is an example of an information system where data produced by healthcare providers is saved in a cloud³. This is a first step in the clouding healthcare communication. Health data taken from consumers are sent to the cloud to be analysed and made actionable and presented back to health consumers on computing devices like smartphones and tablets. It will empower consumers to better understand their health and to take responsibility of their health²⁴.

As mentioned above, the E-health sector is an important upcoming sector in Turkey. Due to the high interest from Turkey and the high knowledge from the Netherlands in policy making, law and ethics in the field of digital information systems there is an opportunity for collaboration. The Turkish government is interested in advice and help with the policy making, law and ethics for new E-health applications since these applications become more advanced²⁶. This knowledge transfer would be possible through a Technology Matchmaking or one to one business matchmaking. The Turkish government is not interested in the import of products. They are highly interested in knowledge and business collaboration. For that reason, Turkey is looking for Dutch partners for several projects in the field of E-health²⁸.

Alz-e-Med

An example of a mHealth application developed in Turkey is Alz-e-Med, developed by BYSGroup in collaboration with Gazi University under the E-Medical Patient Care Project. This application is an e-medical patient care system, which is developed with mobile technology infrastructure, web based software architecture, and user friendly interfaces for Alzheimer patients' caregivers with up to date data. It provides first step health-care service at patients' home for maintaining the good physical-physiological conditions of the patients. It improves the quality of life of both, the patients and caregivers. It strengthens the doctor-patient-caregiver relationship and helps patients to live independently at their own homes by facilitating the hardship of daily life. Alz-e-Med is designed as a patient care software for caregivers and relatives to inform them about the disease and its stages, and to slow down the progress of the disease through games. It is an application for tablets and consists of three modules; the health module, rehabilitation module and education/caregiver module. At the moment this application is complete, the first pilot has ended and the application is on the market for potential investors²⁹. This is also a good example of the translation of research into the industry.

Another opportunity for Dutch companies and knowledge institutions is the collaboration between high-tech ICT companies that develop software for applications. The willingness of gaining knowledge instead of importing products also applies for these products. Turkish R&D in the field of E-health is mostly performed at universities and not in companies. A collaboration of R&D and E-health services between the Netherlands and Turkey would be a good opportunity for both countries. Therefore, such collaboration could be funded through EU funding such as Horizon 2020³⁰.

Lastly, the Turkish government has a high focus on the privacy and security of E-health systems. The Netherlands has not yet introduced the electronic patient files but do have companies which

are specialized in software security. Due to the interest in the LSH sector and the opportunities mentioned above, it is very interesting to collaborate in this sector.

2.2.4 Conclusion

E-health is a very attractive sector with lots of opportunities for Dutch companies and knowledge institutions. Turkey implemented several good working E-health systems and is still innovating. There are several challenges visible in the field of E-health in Turkey. It can be concluded that this is one of the most promising sub-sectors within the LSH sector in Turkey focused on the collaboration opportunities.

2.3 Pharmaceutical industry

2.3.1 General Information

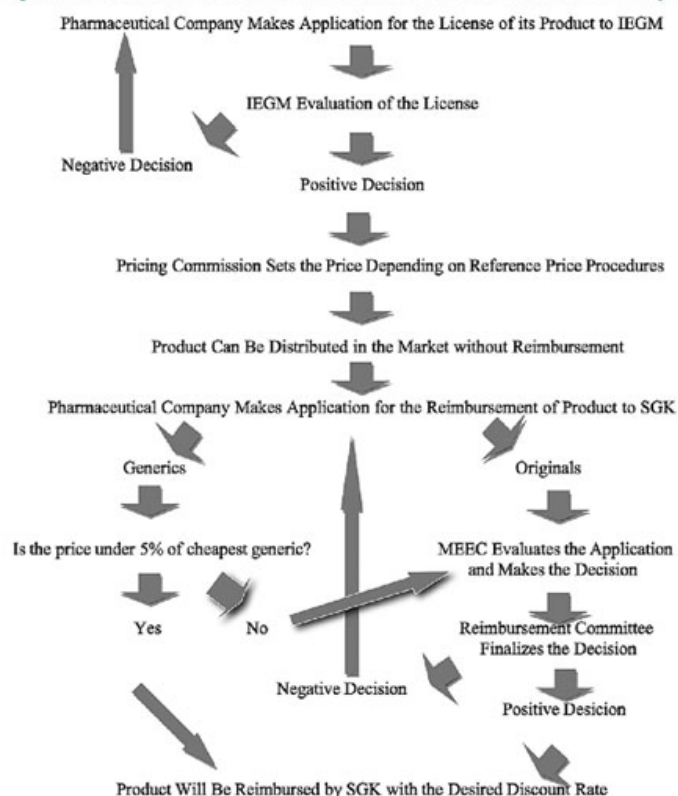
In 2012, the pharmaceutical industry in Turkey was the 6th largest market in Europe in terms of sales. Domestic and international investors are investing in the pharmaceutical sector to take advantage of the attractive market in Turkey³¹. A general overview of the pharmaceutical industry in Turkey shows that the organ responsible for registration, marketing approval/ authorization, pricing of pharmaceuticals, legal classification, advertisement control and inspection of pharmaceutical manufacturers, wholesalers and retail pharmacies is the General Directorate of Pharmaceuticals and Pharmacies (IEGM). This IEGM is a department within the Ministry of Health. Regulations of this department show that registration of medicine can only be granted to a firm in Turkey. As a result, pharmaceutical products imported to Turkey need to be registered in the name of a Turkish company or agency³².

Figure 1 shows the overview of licensed product Market access in Turkey³³. The Medical Economic Evaluation Commission (MEEC) and the Reimbursement Committee both consist of IEGM, Social Security Association (SGK) and Ministry of Finance. The difference is that the Reimbursement Committee (RC) is formed of general managers and deputy managers and the MEEC is formed by technical staff from each institution. These institutions are important to most products. Turkey has a Health Insurance Institute (SSI) which has a monopoly position. They try to reduce the drug prices. As a result, the reference pricing system was introduced in Turkey. This way, drugs cannot cost more than prices of that specific drug in the five cheapest EU countries. The reference pricing system forces Turkish pharmaceutical companies to produce generic drugs and to make it almost impossible to invest in R&D within this sub-sector. This approach shows several challenges:

1. It causes drug access problems due to the low reimbursement. International companies are not willing to export their medicines to Turkey. As a result, patients will not get their treatment on time or will not have access to the right treatment.
2. The Health Insurance Institute (SSI) does not reimburse all drug treatments.
3. Importing medicines is more expensive than having your own production and R&D facilities. This is the disadvantage of Turkey's focus on generics.
4. Quality problems with generic drugs. Not all companies are able to produce safe and active treatment³³.

As shown below, the generic products with a price of 5% and below of cheapest generic doesn't have to apply for reimbursement to MEEC and RC. This is also stimulation from the government to companies to produce generic products.

Figure 1: Overview of Licensed Product Market Access in Turkey



Source: <http://www.ispor.org/news/articles/april12/pharmaceutical-policies-market-access-turkey.asp>

A similar biological or 'biosimilar' medicine is a drug that is similar to another biological medicine that has already been authorized for use³⁴. Biological medicines are medicines that are made by or derived from a biological source. They can consist of relatively small molecules. For biosimilar medicines, the company needs to carry out studies to show that the medicine:

- Is similar to the reference medicine;
- Does not have any meaningful differences from the reference medicine in terms of quality, safety or efficacy.

If the information about the reference medicine is already available, the amount of information on safety and efficacy needed to recommend a biosimilar for authorization is usually less than the amount needed to authorize an original biological medicine³⁴. The key advantage for biosimilars is that they cost 20-25% less than the originator product due to these reduced authorization. Biosimilars are the main focus in the field of pharmaceutical R&D. As mentioned above, the authorization of biosimilars is different than the authorization of an original product. It is therefore logical that there are some important points to consider about biosimilars³⁵:

- Biosimilars do not have to be proven for every indication
- Other than looking at the guidelines there are no requirements for development/ trials of biosimilars
- Biosimilars must have comparable quality, safety and efficacy
- Each biosimilar will have gone through the appropriate regulatory pathway
- Every biosimilar product is different and each should be considered as an individual brand in their own right

Due to the low costs, the early market entry and the state funding, the biosimilars market is an attractive opportunity in a developing country like Turkey. There are several advantages of developing biosimilars in countries like Turkey. First, much shorter data exclusivity applies for countries where IP protection is reinforced. In Turkey, the period of data exclusivity is tied to the term of any issued Turkish patent having claims that encompass the active substance of the biological reference product. Data exclusivity is a specific period of time during which governments

do not disclose or rely on the originator's data in generic registrations³⁶. The data exclusivity period for a biological reference product is 6 years from the date of first registration of the product in the European Customs Unions as well as some non-European Union countries. In Turkey, this 6 year data exclusivity period is limited to the term of any issued Turkish patent having claims that encompass the active substance of the biological reference product³⁷. In addition, the low development and manufacturing costs allows up to 50% price reduction versus the original product. Unfortunately, due to lack of regulations, the products are not always of the same quality that would be expected in the EU or USA³⁸.

There are many institutions in Turkey focusing on genomic and pharmaceutical research. One of these universities is Koç University. This university collaborated with other universities in Istanbul and started a project. This project was called ITAM (Basic Drug Research Center). The project had two lines of activity; the first line was experimental work by collaboration universities to find new drug molecules. The universities were: Koç, Sabancı, Boğazıcı, Istanbul, Bezmialem and Kadir Has. The second line of activity was to establish a network between universities and the pharmaceutical industry. Koç University is very interested in collaboration with different countries and therefore, this project could be a good opportunity for collaboration. Turkey has as well as the Netherlands institutions where universities and companies translate research into the industry. Students and companies work together and perform R&D in science parks (Tekno parks).

High ranked universities which conduct pharmaceutical research are³⁹:

Izmir

- Ege University

Istanbul

- Koç University
- Sabancı University
- Boğaziçi University
- Istanbul University
- Bezmialem University
- Kadir Has University
- Yeditepe University

Ankara

- Ankara University
- Hacettepe University

Turkey has one of the largest pharmaceutical industries in the world. As mentioned above, this industry has a main focus on generics and biosimilars. At the moment, innovations are focussing on human genetics as well as the risk analysis of diseases. They do that by shifting the overall treatment of a population to personalized medicine. Personalized medicine shows the more precise, predictable and powerful medicine for each individual. It is often described as "the right patient with the right drug at the right dose at the right time"⁴⁰. Personalized medicine is an effective treatment for patients. It presents challenges and opportunities for the pharmaceutical industry. Many pharmaceutical companies have committed to the personalize medicine vision, especially in oncology and neuroscience⁴¹. The Food and Drugs Authorities say that the era of personalized medicine has clearly arrived⁴².

2.3.2 Challenges in the field of pharmaceuticals

Overall, the pharmaceutical industry in Turkey is not an easy market. There is no clear methodology for the decision making process whether or not the product can enter the market³¹. Turkey does not have an independent pharmaceutical institution which is in charge of

reimbursement of drugs, import of drugs and R&D. The organization in charge of these issues is the (inter-ministerial) reimbursement commission, led by the social security institute. The lack of predictability, sustainability and patenting influences the Turkish pharmaceutical market negatively. Foreign investors would like to see improvement on the "New Molecule Entity" in which Turkey has the lowest price in the world³³. Unfortunately, a report of the Ministry of Health in Turkey showed that the Turkey's pharmaceutical sector is not focused on discovering new molecules to produce new drugs. Instead of concentrating on discovery, which needs large amounts of capital, Turkey is concentrating on generics⁴³. The fact that the government does not have its focus on new molecules does not mean that investors are not interested in the Turkish pharmaceutical market. Investors make it clear that if the policy changes, they are willing to invest a large amount in R&D³³.

2.3.3 Opportunities in the field of pharmaceuticals

Possible collaboration is visible in the high quality pharmaceuticals and the patenting policy. The Turkish pharmaceutical industry is currently focussing on generics due to the low reimbursement. For the future, the Turkish government is trying to increase Turkish export of pharmaceuticals. To increase this export, the companies need to invest in R&D and higher quality products. Especially the low production prices and the knowledge could be attractive to the Dutch industry. The collaboration is only possible when Turkish companies are increasing their R&D and invest in high-quality products. Turkey has the possibility to produce Dutch outsourced pharmaceuticals. Therefore, the collaboration could be possible between two companies, or a Dutch knowledge institution and a Turkish company. The collaboration between Dutch and Turkish knowledge institutions is less attractive for Dutch companies and knowledge institutions due to the valorisation difficulties in this industry.

2.3.4 Conclusion

The pharmaceutical industry shows a diversity of companies and R&D within universities. Unfortunately, due to the current policies in Turkey the focus in the pharmaceutical industry in Turkey is generics. Although these companies are able to produce generics for the Turkish government, the cost price of producing products with a higher added value is below the Dutch cost prices. This is positive for Dutch companies which are producing high added value pharmaceuticals in the Netherlands. These companies are able to outsource their production facility to Turkey with the research department still in the Netherlands. The result of such a bilateral collaboration is beneficial for both sides.

2.4 Genomics, oncology and stem cell research

2.4.1 General Information

Genomics, oncology and stem cell research are three major topics within the biomedical and biotechnology field with a lot of overlap. Therefore these three important sub-sectors will be discussed in one major chapter. The biomedical and biotechnology field is an important sector in Turkey. Currently, universities and other research institutions in Turkey are investing in their research capabilities, which is a key driver of future sustainable growth⁴⁴. TÜBİTAK, the Scientific & Technology Research Council of Turkey is the governmental R&D organization. They have high-level institutes that researches fields such as genomics, oncology and stem cell research. Other actors in this field are the universities in Turkey. The, in this field, only publicly funded research entity of Turkey is the Genetic Engineering and Biotechnology Institute (GEBİ), founded as department of TUBİTAK. GEBİ aims to contribute to the national economic development⁴⁵. Scientists at GEBİ are working on the different aspects of medical research. Examples of the research facilities are a sequencing facility and proteomics facility. There is a bioinformatics team which supports the facilities and the team includes scientists from areas focus actively focussing on computational challenges in next-gen sequencing applications⁴⁵.

2.4.1.1 Genomics

Genomics is defined as the study of genes and their functions, and related techniques⁴⁵. Turkey is a member of the European Molecular Biology Organization (EMBO) and benefits from its economic support and programs. They perform research in the field of molecular biology and genetics and research meets international standards⁴⁵. The genomics industry overlaps the pharmaceutical industry with the shift to personalized medicine. This focus is relatively new due to a transition from manufacture-driven to innovation-driven economy⁴⁵. This transition is driven largely by the achievements in molecular biology and genomics. For governmental support, it is important to work interdisciplinary, international and with an industrial focus. There are many institutions in Turkey focussing on genomics research. The high-ranked universities which conduct genomics research are³⁹:

Izmir

- Izmir Dokuz Eylül; they established the Izmir Biomedicine and Genome Centre

Istanbul

- Boğazıcı University; they conducted the human genome project in Turkey
- Koç University
- Istanbul University; Whole Genome Sequencing Laboratory
- Bilgi University
- Sabancı University
-

Ankara

- Bilkent University
- Hacettepe University; Center for Biobanking and Genomics
- Middle East Technical University; Bio Informatics Program, Genomic Disease Modeling for Personalized Medicine
- Gazi University Hospital

2.4.1.2 Oncology

Oncology research is an important research field for Turkish scientists. The Turkish Association for Cancer Research and Control (TACRC) is a Turkish organization founded in 1947 and promotes the awareness of cancer and therapies. The association works on cancer control, early detection, tobacco control, patient support and supports cancer research and supports educational activities at national and international level⁴⁶. At the moment, Turkey is far behind other developed European countries in oncology research. In 2011, Turkey had an R&D expenditure of 60 million dollar, which was 0, 05% of the total global budget. Especially the exploration of new molecules, identification of the clinical controlled trials and phase studies were far behind. The number of publications per capita is far behind in the oncology field compared to other European countries⁴⁶.

There are several challenges in the field of oncology research. The six most important challenges are listed below:

1. *Lack of effective scientific policies.* The lack of effective scientific policies results in the fact that in reality, no other organization than pharmaceutical companies tends to pay for the clinical trial expenditures. Pharmaceutical companies naturally tend to support trials which are in line with their future perspectives.

2. *The shortage of experienced and trained man-power*. The reason for the shortage of experienced and trained man-power is the fact that clinical trial methodology is not the natural part of training in oncology.
3. *The lack of financial support in performing clinical trials*. The third problem is due to the selectivity and difficulty in reaching the governmental funds as well as the small sizes of those funds that would not help to solve the problems. Without the funding scientists are not capable to do clinical trials.
4. *Difficulties at ethics committee approvals*. Difficulties at the ethics committee for approvals are common in Turkey. Even when the research is funded and there are sponsors, approval of regulatory authority takes too long. Therefore, it is not unusual that a trial recruits the number of patients abroad until ethics committee approval is attained. For researchers it seems like the authority are intentionally not approving their research.
5. *Difficult working conditions, intensity of work*. The fifth challenge is the difficult working conditions and the intensity of the work of oncologists. Turkish healthcare service personnel have longer working hours than their European colleagues. This limits time to be spared for clinical trials.
6. *Insufficient number of medical oncologist in Turkey*. The last challenge is the insufficient number of medical oncologists in Turkey. This results in a lack of time for research⁴⁶.

There are several universities focussing on oncology. Not all of these universities conduct oncology research. The high ranked universities in Turkey which conduct oncology research are³⁹:

Izmir

- Dokuz Eylül University
- Ege University

Istanbul

- Koc University
- Maltepe University
- Istanbul University

Ankara

- Hacettepe University, faculty of oncology
- Ankara University
- Bilkent University

The Turkish government introduced a cancer control program in Turkey. Together with the EU suggestions, they conducted a system that includes breast cancer screening, cervical cancer screening and colorectal cancer screening. In 2002, there were 11 cancer early diagnosis, screening and education centres in Turkey. The goal is to increase this amount of screening centres to 275 centres in 2015. Since it is the beginning of the screening there are problems found in the first phase (pilot phase 2008-2012⁴⁷). There is not enough manpower for cancer screening, especially pathologists and radiologists are rare and it is difficult to access the services due to the crowded population, the large surface area and the hard winters. At last, the Turkish epidemiological data is difficult to work with due to the younger age population and the heterogeneous city populations and cultures⁴⁸. In 2014, there were four national cancer control projects in Turkey:

- Tobacco and Alcohol Control Program
- Healthy Eating and Active Life Program, Diabetes program
- Turkey Excess Salt Consumption Reduction Program
- Health Effects of Electromagnetic Field Monitoring Project

The government conducted three new cancer prevention programs in 2014:

- Strategic Action Plan for Asbestos
- Radon Mapping and Control Program
- Carcinogenic Substances Report

And there are several regional cancer prevention programs in Ergene, Dilovasi Tuzkoy the Eastern Black Sea.

There are several stages of cancer prevention, treatment and control. Cancer screening is the first stage of cancer prevention and control. The final stage of care given to a patient who has a serious or life-threatening disease is palliative care. Before 2010, an organized palliative care system was lacking in Turkey. The cancer control program is trying to increase the quality of palliative care. In Turkey, both physicians and health directors have ignored the palliative care for many years. In 2009, the Turkish Ministry of Health launched a national cancer control program for the next 5 years. Palliative care was one of the topics within the cancer control program. At the moment, there are few palliative care centres across Turkey. Most of these centres are pain units. The consumption of morphine was low and the availability of morphine within the Turkish market was lacking. Currently, a lot of opioids are not available in Turkey. Before 2009, general practitioners and family physicians were not allowed to prescribe morphine. Few specialists had the right to prescribe opioids. Each prescription was closely followed by the local health governors and the narcotic division of the police department. Therefore, these measures led to limitations in morphine prescription. After the launch of the cancer control program, the Turkish Ministry of Health introduced a project focusing on two main topics: Opioids availability and implementation of a community-based palliative care model. The Cancer Control Department searches for international drug companies who may get interested in the import of opioids and the Ministry of Health is in contact with local national drug companies for a national production capacity for opioids. With the new legislation, all family physicians and their related home care teams will have the right to prescribe opioids.

The community-based palliative care model (Pallia-Turk project) has unique properties:

- A community based-system with family physicians, their nurses and home care teams so that every citizen will have the chance to receive basic palliative care
- Integration of non-governmental organizations (NGOs) and local governors to cover the psychosocial, economic and religious needs of patients.

There are three levels of organization in the model

1. Primary level.
The primary level of organization includes family physicians, home care teams, NGOs and local governors. Patients who cannot be managed at this level are referred to secondary and tertiary level centres.
2. Secondary and tertiary level centres
These are responsible to take care of patients with several symptoms and for patients who are in need of acute-subacute and chronic palliation that cannot be managed by family physicians. These are the centres of excellence. These centres will also plan research activities within time⁴⁹.

2.4.1.3 Stem cell research

Stem cells are cells with the potential to develop into many different cell types in the body during early life and growth. They are unspecialized cells capable of renewing themselves through cell division and under certain physiologic or experimental condition; they can be induced to become tissue- or organ-specific cells with special functions. Before 2006, there were two types of stem cells; the embryonic stem cells and the somatic stem cells. Both types can be derived from animals and humans. The embryonic stem cells are pluripotent stem cells derived from the inner cell mass of the blastocyst. The Somatic stem cells are undifferentiated cells found in organs and differentiated tissues with a limited capacity for self-renewal in laboratories and differentiation. In 2006, a Japanese study discovered conditions that would allow some specialized adult cells to reprogram genetically to assume a stem cell-like state. These cells are called induced pluripotent stem cells (iPScells).

The Turkish policy for stem cell research is complex. Until 2005, Turkey had legislation prohibiting the use of embryos for research. After 2005, the government decided to develop regulations but these were pretty tenuous. This resulted in a disturbance of and uncertainty and eventually the government blocked the human embryonic stem cell research. The break-through in 2006, by the discovery of the iPSCs resulted in a new, innovative way to do stem cell research. Due to the restrictions on other research there is only one way to do research in Turkey. It also resulted in a delay of research and publications in the field of stem cells by Turkish scientists.

Currently, stem cell research is a new and small field in Turkey. There are 20-30 people clinically based working in the field of stem cell biology. Besides the clinical based research, there are 10 basic scientists, almost all of them located in Istanbul. The high-ranked universities which conduct stem cell research are³⁹:

Izmir

- Ege University; Department of stem cells

Istanbul

- Koc University
- Maltepe University

Ankara

- Ankara University; Institute for Stem Cell Research
- Hacettepe University

The government and universities are very interested in the field of stem cell research. This results in access to government funding and support from universities. Stem cells are not only used for research, they are also used as a treatment to a large scale of diseases and plastic surgery. Specialized stem cell clinics are treating patients and are doing research. A lot of these treatments are not scientifically proven and this can result in health problems. The International Society for Stem Cell Research (ISSCR) is going to publish guidelines for stem cell treatment to prevent the wrong treatments⁵⁰.

2.4.2 Challenges in the field of genomics, oncology and stem cell research

There are several challenges visible in the field of genomics and pharmaceutical research. Turkey and the Netherlands have got potential for a possible collaboration due to their strengths. It is up to the sector whether they operationalize this potential. For example, Turkey has an easy access to interesting patient materials due to their large population and interesting genomic diseases due to cousin marriages. With the help of a country like the Netherlands, they can increase the quality of their research within a short space of time. Now the potential is described, the sector is advised to organize workshops, seminars, missions and matchmakings. Both countries are experienced with international collaboration therefore EU framework programs could help both countries to value their strengths.

2.4.3 Opportunities in the field of genomics, oncology and stem cell research

Turkey has a lot of strengths in the field of genomics. Turkish students are much more competitive than Dutch students and have more theoretical knowledge. Turkey is focussing on biomedical and biotechnology research. Due to the large population, they have an easier access to patient materials and the amounts of patients with genetic disorders are higher than in The Netherlands. The Turkish government is more interested in R&D with the years and as a result of the aim to become a global leader in the Life Sciences and Health Sector the government started a finance program which finances 75% of fundamental approved research⁵¹.

The biomedical and biotechnology sector is aiming to translate their research in the industry. There are examples of these translations. One of these is the company "gentest" which maps the genome of a person to explore their probability or risk to get a certain disease. The advantage of this company is that it compares the risk to the lifestyle of a person⁵².

2.4.4 Conclusion

Conclusively, there are many opportunities for Dutch companies and knowledge institutions to cooperate with Turkey. For example, the EU framework programs, students and staff exchanges, and the exchange of patient materials, bilateral research projects are suitable ways to collaborate. As recommendation, Technical Matchmaking Missions and mission for small and medium enterprises will improve opportunities to collaborate.

2.5 Biomaterials and biomedical engineering

2.5.1 General Information

Biomaterials are *"any substance or combination of substances, other than drugs, synthetic or natural in origin, which can be used for any period of time, which augments or replaces partially or totally any tissue, organ or function of the body, in order to maintain or improve the quality of life of the individual"*⁵³. There is a lot of knowledge in the field of biomaterials and biomedical engineering in Turkey. This sector is closely related to the sectors oncology, genetics, biotechnology and medical devices. Cooperation between knowledge institutions in Turkey and The Netherlands would be interesting since both countries have their own knowledge and equipment for biomaterial and biomedical engineering research⁴.

Research in the biomaterials and biomedical engineering in Turkey has become competitive with the international labs in this field. Over the last decades, biomaterials represent a challenging field which shows opportunities for companies to invest large amounts of money in the development of new products⁵⁴. In 2010, Turkey established their Centre of Excellence in Biomaterials and Tissue Engineering, BIOMATEN, with a grant support of the Ministry of Development. BIOMATEN established in the same year their Biomaterials and Tissue Engineering Application and Research Centre after the approval of METU Senate and the Higher Education Council of Turkey and publication in the Official Gazette. BIOMATEN is located in Ankara on the Middle-East Technical University. It has both members from knowledge institutions as well as the industry, and is experienced with the translation of research into industry. It is a collaboration between the Department of Biological Sciences, Chemistry, Mechanical Engineering, Metallurgical and Material Engineering, Engineering Sciences, and Biotechnology of METU University, and has the advisory committees from OSTIM (Ortadoğu Sanayi ve Ticaret Merkezi), SEIS (Health Industry Employers Association of Turkey), and two Non-governmental organizations from the medical sector and GATA (Gulhane Military Medical Academy). It has an international collaboration with professors all over the world and the Biomaterials and Tissue Engineering Society of Turkey, established in 2008, is one of the non-governmental organizations that support the centres.

The Biomaterials and Biomedical Engineering industry is becoming a large industry in Turkey. Companies are investing in research and collaborate with Turkish universities. They produce biomaterials and industrialize these products for hospitals. These companies are located in OSTIM, an industrial zone in Ankara. They industrialize and patented together with BIOMATEN a wound dressing material called Neoderm.

Yeditepe University

In relation to other Turkish academic and research institutions, the department of Genetics and Bioengineering of Yeditepe University shows good valorization processes. Research within knowledge institutions in Turkey requires prior approval by the Ministry of Agriculture for the Environmental Standards. Research projects of Yeditepe University are funded by TÜBİTAK and the Ministry of Science Industry and Technology. The head of the Department of Genetics and Bioengineering of Yeditepe University is stimulating the researchers to commercialize their products. The antibacterial wound dressing materials and medical textile researchers searched for the leading company in Turkey in this field and asked whether they were interested in these products. The company they are currently working with is Nurel Medikal, which exports their products to several foreign countries including the Netherlands. International patents are very expensive. Therefore, the university pays the patenting process and return on the investment. Patenting would not have been possible without the help of Yeditepe University. The advantage of Yeditepe University compared to other universities in Turkey is that Yeditepe University is a private university. To conclude, their competitive advantage is the private money that enables Yeditepe University to do more investments in the valorization process⁵⁵.

Research of biomaterials mainly consists of high-tech and innovative end-products and this result in a positive mentality for future research plans. The policy of the Ministry of Development is pushing them for research. The program science for science does not have sufficient resources so the Ministry is using this budget for suitable companies. This way they encourage universities to collaborate with companies and other knowledge institutions.

There are several high-ranked universities which conduct research in the field of biomaterials³⁹:

Istanbul

- Yeditepe University
- Istanbul Technical University
- Kocaeli University
- Acibadem University

Ankara

- Middle East Technical University
- Hacettepe University

2.5.2 Challenges in the field of Biomaterials and Biomedical Engineering

There are challenges visible in every sector in Turkey. The field of biomaterials and biomedical engineering have similar problems as the genomics, oncology and stem cell field. There are also sector specific challenges. Biomaterials and Biomedical engineering is globally and economically expanding. The field is filled with international companies. As a result, Turkish companies are experiencing difficulties with entering the market.

Another challenge in the field of biomaterials and biomedical engineering is the research process. For biomaterials you need facilities for animal and clinical testing. These are not common in Turkey and necessary for the research of biomaterials.

The third challenge is the fact that scientists are not used to go through the industrialization of their products. Scientists have another focus for their research topics. Their vision is different and therefore, they invest in different needs. The access to funding is not difficult but the Good

Manufacturing Practices (GMP) certificated facilities in Turkey are located at universities where they conduct research in the field of biomaterials and biomedical engineering.

Besides these challenges, the development is positive at the moment. All the actors in the field need positive trust. Professors at BIOMATEN are struggling with the industry. The industry complains about the support BIOMATEN receives from the university. The professors at other universities are complaining and saying "*the Centre of Excellence is robbing us from our work*". Professors at BIOMATEN are defending this by the fact that they receive little governmental funding. BIOMATEN is certain they will expand their capabilities in the future, but currently, they say that the state is funding mostly in the wrong directions⁵⁶. It will be a challenge to change the mentalities of the industry and the other professors, but BIOMATEN is convinced their work is will add value to the community. Therefore, they say that they are sure the industry and the other professors will change their minds on short term when the Centre of Excellence is showing results.

As mentioned in the chapter of genomics, oncology and stem cells, the organizations system is a problem. The driving forces of research in Turkey are the consumers. Indirectly, the consumer is the state. In other western countries, the driving force is the industry since the consumers are directly in contact with the industry. This results in a limited research capability because the state mainly funds the research which leads to cost reduction.

Lastly, a lot of companies and researchers in this field are switching to other easier sectors. Companies do not have commitment because they do not have a voice in the policy of the state. It is not a comfortable region at the moment, but universities are certain that the market will increase as soon as the region is more stable⁵⁶.

2.5.3 Opportunities in the field of biomaterials and biomedical engineering

Besides the visible challenges in the field of Biomaterials and Bioengineering, this field shows opportunities as well. Students are well trained in Turkey and have more knowledge of Biomaterials than the Netherlands. The high-ranked universities in Turkey are very competitive. Their graduate students are very successful in the States and Europe. Their success will eventually positively reflect back on Turkey.

Due to the policies and the sector receives government funding this sub-sector is attractive for international companies. As mentioned above, Turkey does not want to import products from international companies. They would like to increase their research capability and as results they would like to increase their export. Turkey is focussing on the translation of tissue engineering and biomaterials research into the industry. Dutch research institutions are more focused on other topics within the LSH sector, such as the sub-sectors E-health and preventive healthcare⁵⁷. There is one science park focused on high-performance materials, biomedical materials and bio-based chemicals and materials. This science park is located in the southern part of the Netherlands and called *Brightlands*. Within brightlands there is a lot of knowledge in the valorisation process and their slogan is "knowledge is crossing borders". Therefore, there could be collaboration between Turkey and The Netherlands in the field of Biomaterials, although the Turkish knowledge institutions have more knowledge and the Dutch companies are more developed.

2.5.4 Conclusion

The sector biomaterials and biomedical engineering is currently increasing in Turkey. There is a lot of knowledge and the government is encouraging universities to execute research. Besides all the governmental input there are several challenges detectable in this sub-sector. These are all relative small struggles and easy to change into opportunities. The opportunities in the field of biomaterials and biomedical engineering and the research mentality in this sub-sector show great potential for a possible collaboration. Again, in this field the valorisation is the most important struggle. Turkish knowledge institutions find it difficult to industrialize their innovations. Dutch knowledge

institutions are capable of conducting this valorisation. It would be recommended to collaborate with Turkish in this field and to focus on their valorisation. Besides, Turkish knowledge institutions are very capable in conducting high-quality research. As a result, Turkey and the Netherlands could join projects and share their knowledge in bilateral collaboration programmes.

2.6 Preventive healthcare

2.6.1 General Information

Preventive healthcare consist of the measures takes to prevent diseases instead of disease treatment. There are two types of diseases: Communicable diseases and Non-Communicable diseases. Communicable diseases are infectious diseases; they spread from one person to another or from an animal to a person. Non-Communicable diseases are chronic diseases and are not passed from person to person or animal to person. Last century faced health struggle against the communicable diseases in global scale. This century we try new approaches to increase the healthcare among Non-communicable diseases. Diseases and disability are affected by environmental factors, genetic predisposition, disease agents and lifestyle choices. These factors vary from country to country and on that account, health prevention is most of the time country specific⁵⁸.

There are several health prevention projects in Turkey. Currently, prevention is the main target of the Ministry of Health and every regulatory effect is taken to promote healthy lifestyle habits. Local municipalities are trying to implement health promotion project and the health insurance covers rehabilitation with a small reimbursement⁵⁹.

There are a few universities doing research in the public health field of healthcare prevention and focusing on risk factors. The high-ranked universities which conduct research in the field of preventive healthcare³⁹:

Izmir

- Dokuz Eylül University

Ankara

- Hacettepe University
- Baskent University

2.6.2 Challenges in the field of preventive healthcare

Turkey is among the countries with high Cardio Vascular mortalities in Europe. Especially Turkish women suffer from circulatory diseases. Before the smoking ban, CV diseases were mostly caused by the amount of people who smoked. After this ban, obesity and diabetes became the most prominent risk factors⁶⁰. The importance of health prevention is not only to reduce the disease, but also reduce the risk factors. Counteracting against the risk factors causing chronic diseases can be successful, but only with the support of the national policies and long-term strategies. The most important lifestyle changes to reduce the risks causing non-communicable diseases are: Healthy nutrition, increasing physical activity and reducing tobacco consumption⁶¹.

Research capacity building in the public health is very important due to the recent demographic transition. Despite the need, there is no previous research in the public health area in Turkey. The conducted research in Turkey is focused on the diseases and not on disease prevention. Currently, there is a lack of coordination between governmental institutions and researchers. The evaluation systems and research monitoring are not sufficient and health information systems are inadequate.

Specialization is not common in public health and there is no funding for research⁶². Collaboration with the Netherlands could be a challenge since the Netherlands are experienced in research in the field of preventive healthcare and Turkey is not yet experienced. Also, the Netherlands has a different target group due to another life style and population than Turkey. Fortunately, the Netherlands has a large Turkish population which has Turkish habits and there are special health prevention programs conducted for this target group.

Turkish institutions are focusing on the diseases instead of the risk factors. Therefore, Turkey researches diseases like COPD, Diabetes Mellitus and obesity and tries to find a drug to reduce the incidence. Turkish institutions are not focusing enough on the risk factors which goes hand in hand with these diseases. As a result, there is not enough research in the public and preventive health sector and it is difficult to receive funding for this sector. Besides preventive healthcare research for chronic diseases health prevention for diseases such as breast, colorectal and cervical cancer is also an important factor. This shows that preventive healthcare is related other sub-sectors and very important for future policies since it eventually will reduce the healthcare expenses.

2.6.3 Opportunities in the field of preventive healthcare

Currently, the focus of the Turkish government is reducing the healthcare expenses and increases the quality of their healthcare. Dutch universities are specialized in public and preventive healthcare research. Turkey joined the European Public Health Program in 2015. As a result, Turkish universities are willing to collaborate with Dutch universities to increase the awareness in Turkey of the importance of preventive healthcare and how the screening led to early diagnosis. The public health department of the Dokuz Eylül University in Izmir pointed out their interest in collaboration with Dutch institutes like the RIVM, VU Amsterdam and Maastricht University. They are interested in the Erasmus Plus program and collaboration between universities with a health science track in the Netherlands.

2.6.4 Conclusion

The sub-sector preventive healthcare becomes more and more important in emerging countries such as Turkey. Overall well-being and health standards increase and there is a shift from communicable diseases to non-communicable diseases. It is a relatively new shift what results in an increasing population with these diseases and a start phase of prevention. Diseases are mostly treated by their symptoms and lifestyle changes are not yet integrated in the general treatment. Another challenge is the research capacity which is very important. This is more an overall conclusion since research is not yet integrated in every sub-sector. Overall, Turkey is at the beginning of the preventive healthcare implementation but the fast development helps the awareness among their citizens.

3. Discussion

Turkey shows impressive future perspectives. It is among world's most developed countries but they are at risk to fall into the middle income trap. Therefore, they must increase their export. Investments in high added value products will increase the R&D and eventually increase the export. Both Turkey and the Netherlands marked the Life Sciences and Health sector as a topsector. Due to their focus and the global interest in high value added LSH innovations this sector shows great potential for collaboration between both countries.

Research in Turkey is mostly led and funded by governmental institutions. For researchers and companies, TUBITAK is the most important actor in this system. They have their own research institute which is the primary research performer in the public sector, and provides public funding for research and innovation. R&D in the industry is mostly performed in the Technology Development Zones (TDZs). These areas attract investments in high technology fields.

This report shows many different results. First, due to the six different sub-sectors there cannot be one advice of conclusion. R&D within the sub-sector 'medical devices' is mostly organized and funded by the industry and the sub-sectors 'genomics, oncology and stem cell research' are focused on the R&D within research institutions. This shows that the results are not comparable with other sub-sectors and therefore, the findings will be discussed one by one.

The first sub-sector 'medical devices' showed that Turkish companies are more focused on low value added products. Even though they are not focusing on high value added medical devices, their health care cluster in Samsun is the third biggest medical equipment cluster worldwide. Although it is currently not innovative yet, the cluster results in a market access which is already available. So even though their R&D is not promising yet, the higher demand for medical devices, the market access in Turkey and the fact that Turkey is the hub to the Middle East and Asia is very attractive for other countries. Besides the discussion about the value added products, Turkey also shows a complicated reimbursement system concerning the field of medical devices. It is not always clear on what account the TITUBB approves the medical devices. The knowledge holes in the field of medical devices can be decreased with the help of Dutch knowledge institutions and companies, but the uncertainty in the reimbursement system makes it difficult for foreigners to invest and collaborate in this sector.

The sub-sector 'E-health' showed a diversity of different opportunities for innovative products and systems. First of all, E-health is a term which should be taken in a broad sense. In Turkey, E-health systems are implemented in the healthcare system are considered as one of the fastest developing areas in the health industry. The E-health sub-sector shows opportunities in the healthcare information technology system of Turkey, the mobile health applications, projects in the field of E-health and software security.

The third sub-sector is the pharmaceutical industry. The Turkish pharmaceutical is due to their policies mainly focusing on generics. This results in the import of high added value and original pharmaceuticals. This is positive for Dutch companies which are producing high added value pharmaceuticals in the Netherlands. These companies are able to outsource their production facility to Turkey with a research department in the Netherlands.

Genomics, oncology and stem cell research is the fourth sub-sector cluster. This sector shows great opportunities for Dutch companies and knowledge institutions. This sub-sector is focused on current research and therefore, there are several Turkish universities which already collaborate with the Netherlands. Turkey has a large population which shows a diversity of different genetic disorders. This results in easier access to patient materials which could be of benefit for Dutch knowledge institutions and companies.

Biomaterials and biomedical engineering are increasing and offers long term opportunities for companies and knowledge institutions. Currently, this sub-sector deals with several challenges. Fortunately these challenges are easy to change and make them opportunities instead. Therefore, it is an interesting sub-sector for Turkey full of opportunities to conduct high added value products. Collaboration with Turkey could result in high export values for Turkey and knowledge and low cost prices for the Netherlands.

The last sub-sector preventive healthcare is still in early stage in Turkey. The Netherlands has a large Turkish population which has the same lifestyle as the people in Turkey. Therefore, their prevention programs could be interesting for Turkey. Preventive healthcare is important for the future. The Netherlands has a lot of knowledge in this field. With the support of the Turkish government the Netherlands could be a great value to Turkey.

3.1 Overall challenges in research infrastructure

As an emerging country⁶³, Turkey tries to increase the research to raise their standards to the amount of other western countries. The government is trying to increase the quality of R&D in Turkey. As a result of this effort, most universities and professors are trying to increase their research. Unfortunately, in some universities professors are still not performing any research. Since Turkey has a hierarchic and bureaucratic structure within these universities, other employees within the university are looking up to these professors⁵⁰. This results in lack of innovation and a blockage to further grow in these knowledge institutions. It will be a challenge to show these universities the benefits of renewal to change their policies.

Another challenge of the hierarchic and bureaucratic structure for R&D in universities is the time waste. A Dutch professor at Bilgi University in Istanbul explained the difference between research in The Netherlands and research in Turkey. *"Research in Turkey is completely different than research in The Netherlands in terms of time and organization. When you order products for your lab in Turkey, first you have to ask for permission at the dean and then you have to go to the acquisition department and if you are lucky you receive the product one month later. Researchers have to wait at least six months before they can start their research. As a result, their research is delayed and this is the reason why Turkey is currently not at the same level as The Netherlands. "*

Lastly, Turkey is a large country. Good knowledge institutions are mainly located in the developed areas of the country, such as Istanbul, Izmir and Ankara. As a result, treatments in these areas are better and professors possess more knowledge than in other parts of the country. Patients with rare diseases who are living in the eastern part of the country need to travel far west to receive their treatments. This results in intense treatments and high thresholds at the beginning of the treatment. A lot of people in these areas are not willing to travel and stay behind with an unknown or unthreatened disease.

3.2 Overall opportunities in the R&D in Turkey

Collaboration between universities and companies in Turkey show great potential for international cooperation. This translation of research into the industry is often integrated in Teknoparks at the universities or in the Technology Development Zones. Both areas show great advantages for example exemption from several taxes and governmental support. Turkey also shows great interest in knowledge and business collaboration. Companies and universities show an active research mentality which results in collaboration in several research projects. In 2014 Turkey became a partner to Horizon 2020 projects. Turkey has been an associate country to EU framework programmes since 2002⁶⁴. They participate in Horizon 2020 and have close relations with the EU members. Besides Horizon 2020 they participate in other EU programmes which are mostly specified to a certain sub-sector.

Other opportunities for Dutch companies are to outsource their production. Due to the low production prices and the location Turkey has lots of advantages. There is an easy access to export countries and the production of high added value products in Turkey may result in an increased added value within Turkish companies.

Within the years, the Turkish government became more interested in R&D. They aim to become a global leader in the Life Sciences and Health sector. To accomplish this aim, the government started a finance program which finances 75% of fundamental approved research⁵¹. This program is open for all technological areas. The only precondition to apply for this programme for companies is to take part in international R&D projects⁶⁵.

An example of the opportunities and the pro-active behaviour of the Turkish government are the new projects to develop 'smart hospitals', which will use the same energy source for heating,

cooling and lighting systems⁶⁶. Currently, they are focussing on energy within hospitals, but this first step shows opportunities for 'smart' medical devices and other added value products.

Lastly, the example of a national health technology development and accelerator project called BioIzmir, founded in Turkey by the Dokuz Eylul University and partners, shows international research collaboration potential. BioIzmir plans to build high facility standards to perform state of the art research and provides soft landing services to foreign companies as well as knowledge institutes. Next to soft landing services they also plan to provide R&D support, pilot product facilities through cGMP laboratories, support for intellectual property, commercialisation of research and certification. The project started on March 3rd 2015 and contains a budget of 9 million 240 thousand TL for a period of 24 months⁶⁷.

3.3 Recommendations

Overall, the LSH sector shows great collaboration potential. Still, there are some recommendations for both countries to increase the possibility for collaboration. It would be recommended for Turkey to improve their R&D in the LSH industry if they want to increase their export. If they change their R&D policies and increase their government support, the companies will be able to generate high added value products. This will increase the Turkish export and this makes Turkey a more attractive partner for other companies to work with.

Another recommendation is to start a follow-up focussing on the two sectors 'E-health', 'genomics' and 'the pharmaceutical industry'. It is recommended to choose the topic 'E-health' or 'genomics and the pharmaceutical industry' for follow-up since these topics share a small common ground.

Lastly, it would be beneficial for both countries to share their innovations and employees with each other. Firms and knowledge institutions should be able to use external ideas and external paths to the market to increase their technology⁶⁷. They can innovate with international partners by sharing risk and sharing reward. This open innovation could improve both companies/ knowledge institutions and supports the collaboration between both countries.

4. Conclusion

In conclusion, the opportunities to collaborate with Turkey in the field of Life Sciences and Health are visible in the sub-sectors 'E-health', 'genomics' and 'preventive healthcare'. Both countries are able to conduct high quality fundamental research. Turkish knowledge holes are described in the sub-sectors 'medical devices' and 'pharmaceutical industry', 'E-health' and 'preventive healthcare'. Companies in the sub-sectors 'medical devices' and 'pharmaceutical industry' are very little investing in R&D. The reimbursement policy from the government does not support this R&D. The pharmaceutical industry shows little R&D conducted by the knowledge institutions. The current government policies are not sustainable for the future. Knowledge institutions expect an increase in R&D and a change in these government policies. Although these changes are expected, it is still uncertain whether they will be properly complied. The other two sub-sectors; 'genomics' and 'preventive healthcare' are attracting foreign companies and knowledge institutions and therefore, the Netherlands could benefit from these two sub-sectors. Preventive healthcare is also a sector which eventually saves symptom treatment. Therefore, it is attractive for long-term healthcare and the approach of stimulating the development of preventive healthcare should be on governmental level.

There are several possibilities for the Netherlands to collaborate with Turkey in the field of Life Sciences and Health. For most sub-sectors, research collaboration with the support from Horizon 2020 would show great advantages since both countries support this framework programme and the target group is performing R&D. Besides Horizon 2020, other EU programmes are developed. If both countries are part of these programmes, the sub-sectors could easier collaborate and discuss their challenges and increase the opportunities.

Literature

1. IMF World Economic Outlook. October 27, 2014 available from <http://knoema.com/IMFWEO2014Oct/imf-world-economic-outlook-october-2014>
2. Turkish Statistical Institute, geraadpleegd 27 oktober 2014
3. Linn D. De Turkse Life Science and Health sector, een verkenning naar de kansen en uitdagingen voor de Nederlandse innovatiegemeenschap. Ankara: IA Turkije; 2014
4. Saglik Alaninin Öncelikli Alan Olmasi (2013/2016). BTYK'nin 25. Toplantisi. Available from: <http://www.tubitak.gov.tr/en/news/minister-ergun-announced-new-decrees-of-25th-meeting-of-scst-0>
5. Prioriteitslanden Overzicht Topsector Life Sciences and Health. Dutch LSH Alliance 14-8-2013
6. Topsector Life Sciences & Health. Geraadpleegd 23 december 2014. Beschikbaar: <http://topsectoren.nl/life-sciences-health>
7. Erawatch Turkey, Structure of the research System. Consulted on February 21,2015 and available from http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/tr/country?section=Overview&subsection=StrResearchSystem
8. TUBITAK Supports- R&D Project Supports (Industrial) Available from <http://www.investinizmir.com/en/html/1099/TUBITAK+Supports +R>
9. The Republic of Turkey Prime Minister Investment Support And Promotion Agency. Special investment Zones Turkey. Report available from <http://www.invest.gov.tr/en-US/investmentguide/investorguide/Pages/SpecialInvestmentZones.aspx>
10. European Research Area 'What is Joint Programming'? European Commission. Available from http://ec.europa.eu/research/era/what-joint-programming_en.html
11. CountryFocus: Healthcare, Regulatory and Reimbursement Landscape – Turkey. August 2014, Consulted December 23, 2014. Available from <http://www.reportlinker.com/p02274682-summary/CountryFocus-Healthcare-Regulatory-and-Reimbursement-Landscape-Turkey.html>
12. Abdullah Ozdemir, Olgun Sener. Regulation of Medical Devices in Turkey. Available from http://www.who.int/medical_devices/global_forum/K06.pdf
13. Samsun Executive Summary Economic Sectoral Review and Cluster Selection. 18 October 2011 pagina 6. Consulted January 5, 2015. Available from <http://www.smenetworking.gov.tr/userfiles/pdf/ekonomikanalizler/ExecutiveSummaryEconomicSectoralReviewSamsunFinal.pdf>
14. Chris Schorre, Emergo group. Beyond the BRICs: Three Growing Medical Device Markets that should be on your Radar. Medical Device Business August 29, 2013
15. RoboGait Robot Assisted Walking Therapy Device, geraadpleegd 23 december 2014. Beschikbaar via www.bamateknoloji.com

16. Robotgeholpen Looptherapie Apparaat – Biomedicer. Available from <http://www.biomedicer.nl/producten/robotgeholpen-looptherapie-apparaat/>
17. OSTIM – Organized Industrial Region. Available from <http://www.ostim.org.tr/en/default>
18. Trade, foreign policy, diplomacy and health. E-health. Available from <http://www.who.int/trade/glossary/story021/en/>. Consulted 1-28-2015
19. Merve Deniz Pak, Andac Anildi, Meric Yavuz Colak. Usage of E-health Services in Health Institutions and Opinions of Patients. 2014. consulted 24 december 2014. Available from http://www.thinkmind.org/index.php?view=article&articleid=global_health_2014_1_10_70_040
20. F.G. Altin, Application of information Technologies in the healthcare sector; Example Izmir, Süleyman Demirel University Intitute of Social Science of Department of Business Administration, Thesis of Master, Isparta, 2008
21. M. Yilmaz, and A.E. Demirkan, Hospital management and evaluation of the utility of the information system, Journal of Informatics Technology, vol 5 2012, pp 19-28n
22. A. Dogac et all. Healthcare Information Technology Infrastructures in Turkey. IMIA Yearbook of Medical Informatics 2014. May 22, 2014.
23. mHealth New Horizons for Health through mobile technologies. Based on the findings on the second global survey on eHealth. Global Observatory for eHealth series – Volume 3 WHO 2011. ISBN 9789241564250
24. Çiğdem Şahin. Healthier, Happier & Smarter: Digital Health Communication & Digital Publics. Faculty of Communication. 24 April 2014. International Conference on Communication, Media, Technology and Design.
25. Yurt, N. Health in European Union and Turkey: Policies and applications (in Turkish). In M.Z. Sobaci & M. Yildiz (Ed.), EGovernment: Contemporary Development of the Relation Between Public Administration and Technology (in Turkish). Ankara Nobel Publishing
26. Turan, A. H., & Palvia, P. C. (2014). Critical information technology issues in Turkish healthcare. Information & Management, 57-68.
27. Carkoglu, A., Kalaycioğlu, E. (2012). Türkiye'desağlık: Toplumbilimsel bir Değerlendirme. Available from http://research.sabanciuniv.edu/19127/1/Saglik_Raporu.pdf
28. Bakker E. Rapport bezoek Gazi Teknopark BYSGroup; Personal interview January 8 Ankara; 2015 (Unpublished).
29. IDC Reveals Health Insights Predictions for 2015. 20 November 2014 available from <http://www.idc.com/getdoc.jsp?containerId=prUS25262514>
30. Horizon 2020; The EU Framework Programme for Research and Innovation. Available from: <http://ec.europa.eu/programmes/horizon2020/>
31. Assoc. Prof. Yusuf Celik, Dr. Andreas Seiter. Turkey: Pharmaceutical Sector Analysis. Ankara 2008
32. Güvenc Kockaya, Pelin Kilic. Pharmaceutical Policies and Market Access in Turkey, Consulted December 15, 2014. Available from

<http://www.ispor.org/news/articles/april12/pharmaceutical-policies-market-access-turkey.asp>

33. Yased International Investors Association. Determining Requirements For Attracting International Investors' R&D Investments To Turkey. June 2013. Consulted December 22, 2014. Available from <http://www.yased.org.tr/webportal/English/Yayinlar/Documents/rd.report.2013.pdf>
34. European Medicines Agency. Biosimilar medicines. Consulted December 23, 2014. Available from http://www.ema.europa.eu/ema/index.jsp?curl=pages/special_topics/document_listing/document_listing_000318.jsp
35. Biosimilars 2012 – What does the current landscape look like? Available from <http://www.pharmaphorum.com/articles/biosimilars-2012-%E2%80%93-what-does-the-current-landscape-look-like>
36. Pharmaceutical Data Exclusivity in Turkey. Background and Current Status. 13 September 2006
37. IV Mueller. Understanding Biologics and Biosimilars in Turkey. September 2013. Available from <https://bricwallblog.wordpress.com/2013/09/12/understanding-biologics-and-biosimilars-in-turkey/>
38. Combe C, Tredree RL, Schellekens H. Pharmacother. 2005, 25:954–962 Comparability study of biosimilar products manufactured outside the US and Europe revealed that products differed widely in composition, did not always meet self-declared specifications and exhibited batch-to-batch variation.
39. Ranking Turkish Universities. Available from <http://www.webometrics.info/en/asia/turkey>
40. Personalized Medicine. FDA's Unique Role and Responsibilities in Personalized Medicine. Available from <http://www.fda.gov/scienceresearch/specialtopics/personalizedmedicine/default.htm>
41. Personalized Medicine, Future Impact. Available from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2918032/>
42. Paving the Way for Personalized Medicine. FDA's Role in a New Era of Medical Product Development. October 2013
43. Deloitte. The Pharmaceutical Industry in Turkey, Republic of Turkey Prime Ministry Investment Support and Promotion Agency. March 2014
44. Science, Technology and Innovation in Turkey. 2010 TUBITAK. Available from www.tubitak.gov.tr/tubitak_content_files/BTYPD/arsiv/STI_in_Turkey_2010.pdf
45. TÜBİTAK – Genetics Engineering and Biotechnology Institute of Turkey. Available from www.itform.eu/partners/associate-partners/296-tuebitak-genetics-engineering-and-biotechnology-institute-of-turkey-turkey

46. T. Akman et al. A view from Young Oncologists on Clinical Trials in Turkey: Obstacles and Solution Proposals. UHOD number 3 Volume 24 Year 2014
47. A model for using data in cancer control efforts: Turkey. Case study Turkey, International Cancer Control Partnership. Available from <http://www.iccp-portal.org/case-study-turkey>
48. Cancer Control in Turkey 2014. Sağlık Bakanligi, Türkiye Halk Sağlegi Kurumu. Available from <http://kanser.gov.tr/Dosya/Sunular/KanserKontrol2014Eng.pdf>
49. N. Ozgul et al. Turkish community-based palliative care model: a unique design. 2012 Published by Oxford University Press on behalf of the European Society for Medical Oncology.
50. Bakker E. Interview bezoek Koc University stamcel onderzoek Tamer Önder. January 15 2015 Istanbul Turkey (Unpublished).
51. Bakker E. Rapport bezoek Izmir Health Campus; Personal interview Murat Özgoren December 16,2015 (Unpublished)
52. Gentest available from <http://www.gentest.gen.tr/>
53. American National Institute of Health. Biomaterials. Consulted December 24, 2014. Available from <http://www.nibib.nih.gov>
54. P. Zorlutuna, P. Yilgor, F.B. Basmanav, V. Hasirci. Biomaterials and tissue engineering research in Turkey: The METU Biomat Center experience. Biotechnology 2009,4,965-980
55. Bulent Kilic et al. Research capacity and training needs for non-communicable diseases in the public health arena in Turkey. BMC Health Services
56. Bakker E. Rapport bezoek METU BIOMATEN, January 12, 2015 (Unpublished)
57. Bakker E. Personal Interview Thierry Aartsen Taskforce Healthcare, January 27, 2015 (Unpublished)
58. WHO available from www.who.int
59. Country of the month-Turkey. Country report October 2013. Available: www.escardio.org
60. Onat A. Risk factors and cardiovascular disease in Turkey. Atherosclerosis. 2001;156:1-10
61. Republic of Turkey Ministry of health report. Prevention and control program for Cardiovascular Diseases. Strategic plan and Action plan for the Risk Factors 2009
62. Bulent Kilic et al. Research capacity and training needs for non-communicable diseases in the public health arena in Turkey. BMC Health Services
63. Emerging Turkey: Lessons from an Economy in Transition. December 10, 2014. Available from <http://www.worldbank.org/en/news/feature/2014/12/10/emerging-turkey-lessons-from-economy-in-transition>
64. TÜBİTAK The Scientific and Technological Research Council of Turkey. Horizon 2020 National Launch Event is Organized In Istanbul. Available from <http://www.tubitak.gov.tr/en/news/horizon-2020-national-launch-event-is-organized-in-istanbul>

65. Turkey: TÜBİTAK Participating countries & regions Call 2014. Available from <https://www.m-era.net/joint-call-2014/turkey-t%C3%BCbitak>
66. Anadoly Agency. 'Smart hospitals' to create energy savings. Daily Sabah, February 25, 2015 Ankara. Available from <http://www.dailysabah.com/life/2015/02/25/smart-hospitals-to-create-energy-savings>
67. BIOIZMIR project in action. iBG-izmir. Available from <http://www.ibgizmir.deu.edu.tr/index.php/news-from-ibg-izmir/171-bioizmir-project-in-action>
68. Henry Chesbrough. Open Innovation: The New Imperative for Creating And Profiting from Technology. September 30, 2006 Harvard Business School Publishing Corporation. ISBN 1-4221-02383-1