BIOMEDICAL CLUSTERS WORLDWIDE: SUCCESS FACTORS AND BEST PRACTICES

MOSCOW INTERNATIONAL MEDICAL CLUSTER

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The report presents the results of a global study of biomedical clusters. Its goal is to identify and analyse the most successful international practices of promoting biomedical clusters, in which the cooperation of universities, firms and clinics, combined with a developed infrastructure and public support measures led to a significant improvement in the quality of healthcare.

The edition summarises the positive effects of biomedical clusters, describes their global landscape and reveals the key success factors, which are then compared with the features of the Moscow International Medical Cluster activities.

The publication is of practical interest to government officials, entrepreneurs, researchers, clinicians, and other professionals involved in the development of biomedical clusters, and to anyone else interested in healthcare and cluster policies.

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FOREWORD

Money cannot buy it, it is above wealth, and it is the greatest gift. Health. The world over, human well-being and life expectancy are the major indicators of a country's socioeconomic development, and their increase is seen as a public policy priority.

Today, medicine and healthcare are facing a number of global challenges such as a growing and ageing population, the proliferation of stress-induced pathologies ("big city diseases"), illnesses caused by inadequate hygiene, metabolic disorders, and brain maladies. Meanwhile, major trends in the aforementioned areas include the transition to personalised and preventive medicine as well as steadily growing demand for a new quality of life, including the ability to compensate for lost body functions [Gokhberg (Ed.), 2016].

Parrying global challenges and meeting emerging needs is not an easy task. Accomplishing this requires joining the efforts of various actors operating at the junction of research, production, clinical practice, and healthcare policymaking, and also by involving patients in improving treatments. Numerous countries focus on clusters as a way to step up cooperation to foster the development of medicine [Alberti et al., 2014; Bathelt, Zhao, 2016; Braunerhjelm et al., 2000; Cooke, 2002; Fornahl, Tran, 2010; Koo, Choi, 2013; Mishra et al., 2004; Prevezer, 2008; Vasmant, 2009; Wolff, 2003]. The Russian Federation is one of them [HSE, 2018a].

According to the Cluster Map of Russia, there are more than 20 clusters throughout the country, which bring together members specialising in medicine, pharmaceuticals, biotechnology, and related industries [HSE, 2018b]. One of the recent and most large-scale cluster initiatives in Russia is the Moscow International Medical Cluster (MIMC) currently being set up in the Skolkovo innovation centre. Its mission is to support the transfer and application of best global medical practices in the national healthcare system.

The MIMC will comprise clinics specialising in treating socially significant diseases, a technology park, various R&D infrastructural facilities, an international university, and producers of pharmaceuticals and medical equipment. A special legal regime already applies in the cluster, which allows foreign clinics from OECD member states use protocols and medical techniques, equipment and drug preparations officially approved in their countries without extra licencing in Russia, and to employ professionals from abroad without obtaining quotas and work permits. This will help Russian and foreign doctors improve the healthcare sector together.

The MIMC has been conceived as a global project from the very start. Therefore the goal of this study is to identify and analyse the most successful international practices of promoting biomedical clusters and examine the Moscow International Medical Cluster through the prism of the accumulated experience.

Despite the wide variety of definitions for such terms as “cluster” and “biomedicine”, we still decided to suggest our own – synthetic – interpretation of a “biomedical cluster”, based upon the study’s focus and the attributes of its subjects (which could hardly be challenged). Therefore we propose viewing a biomedical cluster as a geographic concentration of clinics,

relevant R&D and educational organisations, and biotechnology and pharmaceutical companies linked by a functional dependency and implementing joint projects in order to develop medical technologies and improve the quality of healthcare.

The global study of biomedical clusters included several stages, each described in a specific chapter in this report.

We began with the review of academic literature to identify and structure the positive effects that clusters have upon patients, research, businesses, and the overall healthcare system. For example, biomedical clusters promote the emergence of new services at the junction of the medical, hospitality, and insurance industries and help maintain the continuity of treatment due to the territorial proximity of clinics and specialised infrastructure. Cluster members conduct intensive biomedical research by recruiting R&D personnel worldwide, having shared access to advanced facilities and equipment, and attracting investments for projects jointly implemented by companies, clinics, and universities. Such alliances lead to the emergence of medical start-ups and the accelerated application of innovations in clinical practice. Finally, biomedical clusters contribute to the development of the patient care system by bringing in new medical competences and creating advanced medical solutions.

From the positive effects we moved on to their sources: the global biomedical cluster landscape was analysed at the next stage of the study. To this end, we selected 40 clusters from 22 countries, which were the leaders in medical tourism or in terms of the overall level of healthcare. The cluster selection criteria were international visibility, involvement in developing national medical treatment systems, and the presence of clinics among their members. Having assessed the whole sample using binary indicators to measure the cluster home countries' positions on the global medical services market, their members' activities, and management systems, we conducted a cluster analysis which produced the following grouping:

global high-technology medicine clusters, which bring together a large number of members representing various industries and technology areas, and whose products and services are widely in demand abroad;

world-class biomedical research clusters, which are primarily focused on implementing scientific discoveries in treatment practice on the basis of advanced university clinics and knowledge centres;

international medical tourism clusters, which blend the healthcare and hospitality industries to provide innovative integrated services to patients by merging treatment and recreation.

Target models were also identified for each group, describing the key points of members' cooperation and the prerequisites of clusters' creation.

The resulting diverse global biomedical cluster landscape was then studied in detail, namely by identifying success factors. Representatives of each cluster group were interviewed about the clusters' emergence, members, and their contribution to the development of medicine and healthcare, the government support they received, and the role of the cluster management team. That is, we asked them about all the factors that had made those particular clusters sources of best practices. Each cluster prospered in its own unique way, yet many of the activities turned out to be similar. We grouped them into seven success factors subsequently described in detail in 30 case studies with quotes from the interviews. In summary, it can be argued that biomedical clusters' success in various countries depends upon the following factors:

- **a full communication agenda**, implemented via active networking (online and offline), joint projects, formal and informal contacts, the dissemination of information about the cluster and its members;

- **interdisciplinary cooperation**, which implies bringing together the research, technological, and social competences of various cluster members to develop and apply relevant medical solutions at the junction of different activities (such as patient treatment services, the production of medical equipment, pharmaceuticals and nutrition, construction, etc.) and technologies (nano-, bio-, information, etc.);

- **partnership-based management**, to balance the interests of key members representing different areas (healthcare, medical and pharmaceutical industries, research, education, public administration) and professionally administer cluster development;

- **support from the regional authorities**, which implies clusters can receive both public funding and non-monetary benefits (such as assistance in dealing with the national government, involvement in the drafting and adjustment of industry-specific regulations and programmes, preferential access to infrastructure, and so on);

- **national-level recognition of clusters**, which means that the government requires their expertise in healthcare-related issues and participation in state projects and programmes;

- **involving patients and doctors** in the development and testing of healthcare innovations, which is an area where end users' needs frequently inspire producers to create new goods and services or improve them;

- **a comprehensive approach to supporting innovation**, which implies building up basic and specialised infrastructures, nurturing start-ups, and using the intellectual base of universities and other knowledge centres.

At the final stage of the study, a comparative analysis of the identified success factors and key aspects of the Moscow International Medical Cluster activities was conducted. Is the MIMC going its own unique way or does it fit into the mainstream of biomedical clusters in other countries? To answer this question, we polled experts from the Russian medical community: what role, in their opinions, could the MIMC play in the development of Moscow's and the larger Russian healthcare system. We discovered that the Moscow International Medical Cluster did follow the major global trends but also could offer certain unique solutions to its peers from abroad.

The special legal regime granted to the MIMC at the national level, the managerial and investment contribution of the regional authorities to the cluster development, diverse international membership, and advanced infrastructure create unique career and educational opportunities for Russian doctors and biomedical researchers, while patients get access to the world-class healthcare in their own country.

We hope the members of existing biomedical clusters will find the results of this study useful and that it will inspire those just launching a cluster initiative.

ABBREVIATIONS

AG	Aktien Gesellschaft (Joint Stock Company)
AIDS	Acquired Immune Deficiency Syndrome
BB	Brandenburg
BE	Berlin
BMA	Business Support Centre for Biomedical Research Activities
CEO	Chief Executive Officer
CfPIE	Centre for Professional Innovation and Education
CHU	Collège Centres Hospitaliers Universitaires (University Clinics College)
CIC-IT	Lille Clinical Investigation Centre for Innovative Technology
COBIS	Copenhagen Bio Science Park
CRO	Contract Research Organisation
DBA	Doctor of Business Administration
DGMIF	Daegu Gyeongbuk Medical Innovation Foundation
EFS	L'Etablissement Français du Sang (The French Institute of Blood)
eHIS	electronic Hospital Information System
ERDF	EU Regional Development Fund

ESCA	European Secretariat for Cluster Analysis
ESS	European Spallation Source
EU	European Union
EvB Klinikum	Klinikum Ernst von Bergmann
FUI	Fonds Unique Interministériel (French Unified Interagency Investment Fund)
GDPR	General Data Protection Regulation
GIE	Groupement d'Intérêt Économique (Group of Economic Interests)
GmbH	Gesellschaft mit beschränkter Haftung (Limited Liability Company)
GMP	Good Manufacturing Practice
HAN	Hogeschool van Arnhem en Nijmegen (HAN University of Applied Sciences)
HIV	Human Immunodeficiency Virus
HSE	Higher School of Economics
HZB	Helmholtz-Zentrum Berlin für Materialien und Energie (Berlin Helmholtz Centre for Materials and Energy)
ICT	Information and Communication Technology
IFC	Inter-firm Cooperation
IHRC	International Human Rights Commission
IRBs	Institutional Review Boards

ISMED	Institute for SMEs Development
ISO	International Organisation for Standardisation
IT	Information Technology
LSN	Life Science Nord
MBA	Master of Business Administration
MD	Doctor of Medicine
MDC	Max-Delbrück-Centrum für Molekulare Medizin in der Helmholtz-Gemeinschaf (Max Delbrück Centre for Molecular Medicine in Helmholtz Association)
MIMC	Moscow International Medical Cluster
MMO	Master of Management and Organisation
MPA	Master of Public Administration
MSc	Master of Science
NBIC	Nanotechnology, Biotechnology, Information Technology and Cognitive Science
NL	Netherlands
OECD	Organisation for Economic Co-operation and Development
PPP	Public-private partnership
PwC	PricewaterhouseCoopers
R&D	Research and Development

RAS	Russian Academy of Science
S&T	Science and Technology
Scion DTU	Technical University of Denmark Science Park
SMEs	Small and medium-sized enterprises
STEMO	STroke Emergency MObile
TAT	Tourism Authority of Thailand
TCI Network	The Competitiveness Institute-Asociación Competitividad
TFHC	Task Force Health Care cluster
UK	United Kingdom
US	United States
WHO	The World Health Organisation

1 POSITIVE EFFECTS OF BIOMEDICAL CLUSTERS

Why do we need clusters?

Any initiative to join the efforts of government agencies, businesses, research and educational organisations to step up the development of a particular field starts with this simple, logical question. In our case the field is healthcare. Will treatments become more effective and affordable if hospitals are members of a cluster? Could the establishment of a cluster lead to breakthroughs in biomedical science? Will the quality of the medical personnel's training improve? Will research results be applied more rapidly by manufacturers and doctors? These questions have inspired our study. To answer them, we have reviewed academic literature and scrutinised best practices of biomedical clusters around the world. The analysis revealed that clusters affect several areas of economic and social activities. We grouped the identified positive effects into four categories. This chapter suggests a closer look at each of them.

BIOMEDICAL CLUSTERS: POSITIVE EFFECTS

FOR PATIENTS

/ Emergence of new integrated services, due to cooperation between the healthcare sector, hospitality, and insurance businesses

/ Ensuring treatment continuity due to joint medical infrastructure

FOR SCIENCE

/ Development of biomedical research and commercialisation of its results by recruiting R&D personnel worldwide

/ Extension of R&D potential by concentrating advanced equipment and facilities in clusters, and providing collective access to them

/ Increased investments in cluster members' joint R&D projects

FOR HEALTHCARE SYSTEM

/ Optimisation of medical processes
/ Improved training of medical personnel

FOR BUSINESSES

/ Increased number of healthcare start-ups

/ Accelerated application of innovations in medical practice

POSITIVE EFFECTS FOR PATIENTS

Emergence of New Integrated Services, due to Cooperation between the Healthcare Sector, Hospitality, and Insurance Businesses

Many biomedical clusters select medical tourism as their main activity profile. In recent years, treatment, rehabilitation, and wellness have become the fastest-growing segments in the tourism industry [Alberti et al., 2014; De Vera et al., 2008; Horowitz, Rosensweig, 2007]. Certain Asian countries such as Thailand, Singapore, and the Republic of Korea receive more than a million foreign patients a year [Kandasamy, Rassiah, 2010], while global medical tourism turnover amounts to several billion US dollars.

BRINGING THE HEALTHCARE SECTOR AND HOSPITALITY INDUSTRY TOGETHER INTO A CLUSTER ALLOWS ONE TO OFFER PATIENTS NEW INTEGRATED SERVICES, NOT SOLELY MEDICAL ASSISTANCE, BUT ALSO VARIOUS RELATED FACILITIES.

Further, this industry's share in developing economies is steadily growing [Castillo and Conchada, 2010]. For example, **Thailand Medical Tourism Cluster** offers its clients translation, banking, insurance, and legal advice [Harryono et al., 2006] (fig. 1.1).

The integration of healthcare and hospitality service providers into **Lithuanian Medical Tourism Cluster (LitCare)** allowed the members to create a unique system where everything was specifically planned to meet all possible needs of patients in the best way. Among other things, the cluster offers a full spectrum of information and arrangement services such as visa support, accommodation, making appointments with doctors, booking tickets, translation, babysitting, and so on. In addition to medical assistance, patients are offered various recreational opportunities: in the city or in the countryside, there are entertainment, museums, sports, amusements for children, excursions, and much more (fig. 1.2).

One of the barriers hindering biomedical clusters' development is insurance companies' reluctance to cover healthcare treatment costs incurred abroad. Any medical insurance is a high-risk activity, but if the patient decides to receive curing in another country, the uncertainty becomes much greater [Harryono et al., 2006]. Therefore, setting up insurance programmes specifically oriented towards medical tourism is a necessary condition for the industry's successful development in a particular region.

STRENGTHENING THE LINKS BETWEEN A MEDICAL TOURISM CLUSTER AND INSURANCE COMPANIES (THROUGH TO INTEGRATING THEM AS FULL-FLEDGED MEMBERS) COULD CREATE MULTIPLE POSITIVE EFFECTS FOR VARIOUS PARTIES.

Clinics within the cluster get an opportunity to attract more customers: people who are not ready to pay for medical tourism out of their own pocket, but whose insurance companies cover treatment costs incurred in other countries can be potential clients. For patients, acquiring healthcare services abroad becomes much more affordable. Insurance companies as members of the cluster can cooperate with hospitals more closely and better assess the quality and costs of medical services.

The effect from such cooperation may increase further if an insurance organisation already has experience with the relevant international programmes. Today a number of firms in different countries offer medical tourism services as part of their basic coverage package. For example, Ingosstrakh Insurance Company (Russia) has the international insurance programme, which covers medical treatment costs the world over, with a wider range of services than the standard voluntary medical insurance policy provides[1]. AlfaStrakhovanie Group (Russia) offers protection against oncology-related risks within the AlfaSynopsis programme that covers treatment costs in Israeli, Spanish, and South Korean clinics, airfare, and accommodation (at hotels of up to 4-star rating), for the insured and one companion[2]. Blue Cross Blue Shield of South Carolina already offers access to overseas procedures through a subsidiary, Companion Global Healthcare, Inc., which has medical tourism contracts with hospitals in Singapore, Thailand, Ireland, Turkey, and Costa Rica[3] .

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1 Ingosstrakh Insurance Company [official website]. URL: https://www.ingos.ru/health_life/intl_dms/ (last accessed on September 21, 2018).

2 AlfaStrakhovanie Group [official website]. URL: https://www.alfastrah.ru/individuals/life/antionko/calc/ (last accessed on September 21, 2018).

3 Medical Tourism Magazine [official website]. URL: https://www.medicaltourismmag.com/news/2014/07/health-insurers-look-medical-tourism-transparent-strategy-face-obamacare/ (last accessed on December 10, 2018).

Fig. 1.1. Members and Partners of Thailand Medical Tourism Cluster

Source: compiled by the authors based on [Harryono et al., 2006].

LITHUANIAN MEDICAL TOURISM CLUSTER SERVICES

WAY OF A MEDICAL TOURIST

1
Information support
Trip planning

2
Preliminary medical consultations

3
Visa support
Ticket reservation
Organisation of transfers

4
Accommodation
Rest

5
Medical consultations
Preparation for procedures

6
MEDICAL SERVICES
Diagnostics and treatment
Complex examination
Gastroenterology
Ophthalmology
Gynecology
Urology
Reproductive medicine
Traumatology
Orthopedics
Cardiology
Vascular surgery
Plastic and aesthetic surgery

7
DENTISTRY
Implantation
Prosthetics
Surgery
Orthodontics
Periodontics
Endodontics
Laser dentistry
Aesthetic dentistry
Sedation dentistry
Pediatric dentistry

8
REHABILITATION
Neurology
Traumatology
Orthopedics
Arthrology
Cardiology (for adults)
Pulmonology (for children)
Ophthalmology (for children)
Gastroenterology (for children)

Observation
Consultations
Recommendations

9
SPA PROCEDURES
Spa treatment
Mud bath
Vertical baths
Classical massage
Underwater massage

10
Salon treatments

11
TOURISM AND RECREATIONAL SERVICES
Rest in the city or in nature
Organisation of business meetings
Entertainment events
Visiting museums and galleries
Sea tour
Sport
Excursions
Shopping
Driver services
Babysitting service
The services of a personal guide

12
Ticket reservation
Organisation of transfers

13
Patient-doctor relationship

CLUSTER MEMBERS

Logistics
Tour operators
Organisers of treatment

Treatment
Medical organisations
Dental clinics
Rehabilitation centres

Wellness
Spas
Hotels

Fig. 1.2. The Chain of Services Offered by LitCare

Source: compiled by the authors based on the Lithuanian Medical Tourism Cluster data.

Ensuring Treatment Continuity due to Joint Medical Infrastructure

One of the healthcare problems that patients frequently encounter is a lack of treatment continuity, or in broader terms, fragmented medical assistance [Sheiman, Shevski, 2014]. It arises when there is no coordination between clinics, which leads to the duplication of services and failing to meet patients' real needs [Montenegro et al., 2011].

Integrated medical assistance models designed to address the fragmentation issue are based upon novel approaches to organising the work of hospital staff (e.g. setting up multifunctional teams) and the application of integrated electronic systems to improve interactions between various healthcare service providers [Burns, Pauly, 2002; Fulop et al., 2005; Goodwin, 2016; Lê G. et al., 2016; Lewis et al., 2010].

Clinics that are members of a cluster have much better opportunities to set up integrated medical assistance systems due to several factors. These include territorial proximity, healthcare organisations' ability to concentrate on treatment (while other cluster members step in to provide supplementary services the patient might need) and the centralisation and coordination of support and logistics activities such as purchases, laundry, the supply of medicines, etc. [Schmidt et al., 2007].

HealthCapital Berlin-Brandenburg (Germany) is a good example of setting up an integrated medical assistance system. The cluster comprises the EvB Klinikum health park (29 specialised hospitals with the total capacity in excess of 1,000 beds); the Vivantes concern (10 clinics, 5,000 beds); a pension; nursing homes; rehabilitation centres; the Carl-Theim Klinikum (24 departments); and one of the largest in Europe, the Charité University Hospital. The clear, well-defined procedures for the interaction of medical staff and the efficient exchange of information between them help to ensure treatment continuity [Goodwin, 2016].

Biomedical clusters frequently implement initiatives to improve the coordination of medical activities by setting up unified clinical information databases. For example, **Health Valley Netherlands** participates in developing and testing the digital MeXtra system[4] designed to allow doctors, patients, and nursing personnel to share information, draft and subsequently adjust treatment plans, and so on.

Clusters ensure patient care continuity, due to sustainable interactions among various medical organisations and the creation of a unified information infrastructure that facilitates the exchange of clinical data among all participants in the treatment process. In addition, the coordinated activities by all biomedical cluster members lead to the emergence of new integrated services for patients with their provision at all stages being arranged and supervised by a single supplier.

[4] ZorgInnovatie [official website]. URL: https://www.zorginnovatie.nl/innovaties/mextra (last accessed on September 23, 2018).

POSITIVE EFFECTS FOR SCIENCE

Development of Biomedical Research and Commercialisation of Its Results by Recruiting R&D Personnel Worldwide

A "high-skill ecosystem," this is how an association of gifted researchers capable of achieving breakthrough results in life sciences can be described [Finegold et al., 2004]. It is not a simple task, which requires the involvement of professionals specialising in various S&T areas (medicine, biology, engineering, ICT, etc.). A cluster accumulates a critical mass of participants with mutually complementary skills. The research community emerging therein looks attractive to scientists in other countries, who can contribute to its activities [Rauch, Wappler, 2011]. For example, a case study of Boston biotechnology cluster revealed that higher-quality information (i.e. novel and critically important) is more often created and disseminated not within local communities but as part of strategic international partnerships [Owen-Smith, Powell, 2004].

The establishment of biomedical clusters in Singapore and China was followed by the implementation of programmes aimed at attracting scientists from abroad. This, in turn, led not only to the improved quality of studies but increased entrepreneurial activity [Finegold et al., 2004; Prevezer, 2008]. In 2002–2005, the Singapore National University Hospital together with the Biopolis Technology Park launched integrated housing programmes for the invited researchers [Wong, 2007]. To smooth their integration into clusters, the government adjusted national bioethics practices to match international requirements. For example, in 2001 the Bioethics Advisory Committee was established, and "Research

Involving Human Subjects: Guidelines for IRBs" was published in 2004. Incubators designed to help foreign scientists launch start-ups for commercialising R&D results were set up in the Singaporean clusters likewise, e.g. **BioEnterprise Asia.**

A major programme to repatriate researchers from abroad was implemented in China in 1996–2003. About 700,000 young people left for other countries to do academic work in 1978–1996, 30% of them specialising in biomedicine and technology [Qi, 2003]. Less than 25% returned to China upon completing their studies. The Encourage Overseas Scholars to Serve their Country in Different Ways programme was aimed at creating favourable conditions and providing initial funding for scientists returning from abroad to start their own companies. Examples of successful biotech firms established by repatriated researchers in Shenzhen, Beijing, and Shanghai clusters are Proexact Biotech, Beijing Huada Genomics Institute, and United Gene [Prevezer, 2008].

Extension of R&D Potential by Concentrating Advanced Equipment and Facilities in Clusters, and Providing Collective Access to Them

Medical innovation would not be possible without high-technology equipment [Collins, 2008]. At the same time, many companies in the industry are small or medium and have limited opportunities for procuring expensive devices. For example, in the Republic of Korea, only 8.7% of medical equipment producers have their own research facilities [Sohn et al., 2015].

IN BIOMEDICAL CLUSTERS, MEMBER COMPANIES' R&D DEPARTMENTS FREQUENTLY SHARE EQUIPMENT AND PREMISES WITH HOSPITALS; THIS COOPERATION IS MUTUALLY BENEFICIAL FOR CLINICAL TRIALS.

Certain features specific to the biomedical industry create a number of additional barriers related to the high level of regulation and strict requirements for in vivo testing [Brennenraedts et al., 2006]. To help small and medium producers of medical equipment and developers of drugs enter the relevant markets, many clusters provide shared access to advanced research infrastructure [Collins, 2008; Sohn et al., 2015].

The Business Support Centre for Biomedical Research Activities – BMA, a facility at **KOBE Biomedical Innovation Cluster** (Japan), allows members use its laboratories to study radioactive isotopes. Also, the BMA provides them with the opportunity to share the costs of animal testing conducted by specialised firms [Collins, 2008]. Similarly, members of the French biomedical cluster **Lyonbiopôle** can use the cluster's resources for their own research. The Lyonbiopôle laboratories are equipped in line with the ISO and GMP standards; all facilities are operated and serviced by private companies[5].

[5] Lyonbiopôle Auvergne-Rhône-Alpes [official website]. URL: https://lyonbiopole.com/en/facilities/our-labs-offer (last accessed on September 9, 2018).

Increased Investments in Cluster Members' Joint R&D Projects

Clusters' contribution to encouraging investments in biomedical research was noted in many countries [Guimon, 2013]. For example, in Singapore, measures to support the biomedical cluster were aimed, among other things, at improving the intellectual property protection system, which resulted in increased R&D expenditures by member companies [Finegold et al., 2004; Graham, Woo, 2009].

A study of Scottish, Swedish, and Danish experiences [Rosiello, 2005] revealed that the amount of private and public funding in clusters largely depends upon how the R&D and production system is organised and how members cooperate. Accordingly, in many countries cluster policy is focused on improving communication as an investment attraction factor.

For example, in France, the amount of public financing provided for biomedical clusters' R&D directly depends upon the coordinated activities of their members. A cooperation agreement based on a shared vision of the future cluster development is a necessary condition to receive support. Also, cluster members must present a detailed description of a joint project including technical, R&D, and financial specifications. For example, in 2008—2011 the French **Eurobiomed** cluster received 423 million euros in public funding for 121 R&D projects implemented by research organisations and companies together, in the scope of the Poles of Competitiveness (Les Pôles de Compétitivité) programme[6].

[6] Pôle de compétitivité: Eurobiomed [official website] URL: http://competitivite.gouv.fr/documents/commun/Les_Poles_en_mouvement/fiches_synthetiques/Fiche-Eurobiomed-fr.pdf (last accessed on September 9, 2018).

Some biomedical clusters take specific steps to encourage members to step up their R&D expenditures and simplify their dealings with investors. The French **Medicen Paris Region** cluster hosts special events five times a year, where companies and research organisations are given ten minutes to present their projects to an investors' committee[7].

Clusters positively affect the dynamics of interdisciplinary R&D at the junction of medicine, biology, computer science, chemistry, and physics, involving the leading local and foreign researchers. Joint cluster projects implemented by universities and enterprises largely become subject to private and public investments, while the collective access of cluster members to advanced infrastructure, equipment, and facilities ensures the flow of such projects.

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[7] Medicen Paris Region. Innovation for Health [official website]. URL: http://www.medicen.org/services/financement/ (last accessed on September 2, 2018).

POSITIVE EFFECTS FOR THE HEALTHCARE SYSTEM

Optimisation of Medical Processes

The members of biomedical clusters such as R&D organisations, firms, universities, and hospitals frequently become the first to find innovative medical assistance solutions. These may include not only improved therapy and diagnostic techniques but also new ways to optimise treatment, procurement, regulation, and data management processes [Rosiello, Orsenigo, 2008]. The latter is still a problem for many medical organisations. According to the WHO report, some national databases do not track patients in and out of hospitals, between hospitals or even within the same hospital, because they do not use unique patient identifiers [World Health Organisation, 2013]. Developed countries and leading clinics are constantly improving their databases and electronic appointments facilities, while hospital admissions or ambulance calls are registered in a unified information system. This makes the provision of medical services significantly more efficient [Amarasingham et al., 2009].

In many cases, such practices emerge and are replicated due to the activities of clusters comprising networks of clinics and developers of relevant IT products. For example, the members of **Health Valley Netherlands** actively participate in designing healthcare information systems. The cluster has a partnership with the Zorginnovatie platform where companies can present new solutions for optimising medical processes and receive financial support. For example, Cortex is a toolset for healthcare institutions and pharmaceutical manufacturers to build mobile ecosystems for certain patient groups. So-called

Clinicards make it possible to create a personalised app to capture specific data for the diagnostic plan (among others with sensors) and to support digital interventions for evidence-based behavioural influencing[8]. In line with the national e-health strategy, the **Connected Health** cluster members together with the Estonian Health Insurance Fund and the Ministry of Social Affairs are developing telemedicine services.
In particular, they are working together to come up with a solution for seamlessly integrating remote treatment into processes and including them in the fund's pricelist[9].

Such systems and applications allow one to more actively involve patients in the medical assistance process, reduce the time they need to spend with doctors (planned visits) and quickly react to changes in their state of health.

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[8] ZorgInnovatie [official website]. URL: https://www.zorginnovatie.nl/innovaties/cortex (last accessed on September 23, 2018).

[9] Connected Health [official website]. URL: http://connectedhealth.ee/success-stories/connected-health-cluster-promotes-entrepreneurship-helps-make-world-better-place/ (last accessed on September 22, 2018).

Improved Training of Medical Personnel

Apart from usual professional duties, the medical staff of cluster member organisations have other responsibilities: they participate in the development and implementation of joint projects, organise events, consult businesses on involving patients in the assessment of innovative products and services, etc. All this creates the need for the ongoing upgrading of their communication skills, and abilities to work with diverse groups [Kósa et al., 2013].

Many biomedical cluster organisations arrange coaching sessions for their members' clinicians in order to help them acquire the relevant supplementary competencies (e.g. in project management, advanced ICT, communication, and research). Most clusters comprise medical universities or organisations that specialise in staff training and retraining. For example, the US **BioOhio** cluster offers various programmes at the Center for Professional Innovation and Education – CfPIE. Cluster member companies that pay for training their professionals specialising in pharmaceuticals or medical technologies at the CfPIE get a 10% discount[10].

Another American cluster, **BIOCOM**, offers medical education programmes together with San Diego University, Miramar College, and the non-profit organisation San Diego Workforce Partnership. While the University of San Diego and Miramar College are implementing a master programme, the BIOCOM cluster runs courses in biotechnology (both intramural and online). For example, the Life Science Immersion programme helps students gain insights into the work of biomedical companies and the overall business environment of California. Further, it also provides tips for running projects and building communication networks with industry experts. Thus, the cluster, on the one hand, organises

[10] BioOhio [official website]. URL: https://www.bioohio.com/membership/talent/ (last accessed on September 22, 2018).

personnel upgrading in the areas demanded by the member companies, while on the other, it spreads job offers among potential workers, helping reduce unemployment in the region [Global Connect, 2010].

Some clusters provide educational services not just to their members' employees but to other organisations' staff as well. The Mayo Clinic (member of the US **Medical Alley** cluster) established several training centres: the Mayo Clinic College of Medicine, the Mayo School for Graduate Medical Education, the Mayo Graduate School, the Mayo School for Health Sciences, the Mayo Medical School, the Mayo School for Continuous Professional Development, and the Mayo Clinic School of Medicine[11]. Such impressive educational base allows the Mayo Clinic to make a sizeable contribution to upgrading medical personnel in the cluster's home region.

[11] Mayo Clinic [official website]. URL: https://www.mayo.edu/mayo-clinic-school-of-medicine (last accessed on September 22, 2018).

Clusters stimulate positive changes in the healthcare system by bringing together the most active representatives of the professional community, knowledge centres, and innovative companies from the medical and related industries. They jointly develop and test information systems, software products, and applications that allow patients to be more actively involved in the treatment process, and enable doctors to respond faster to changes in their health, reduce the administrative burden on hospital staff, and ensure the efficient use of medical record systems. In addition, the interaction between different cluster members contributes to the development of a whole training chain (university studies – internships at clinics and companies – professional qualification upgrade during a career – the transition of clinicians into R&D and academic work) as well as to an increase the professional standards in healthcare.

POSITIVE EFFECTS FOR BUSINESSES

Increased Number of Healthcare Start-Ups

Many biomedical clusters support existing start-ups and promote the creation of new ones. This is an effective way to attract funding, promote growth in the industry, strengthen clinics, and increase their market competitiveness [Bagchi-Sen, 2007]. For example, many US biomedical clusters became leaders in emerging therapy and diagnostics due to strong, well-established cooperation between academia and business, which begins already at the university research stage. Alliances of biotech companies and R&D centres within clusters frequently lead to the creation of start-ups.

The situation in Europe is similar [Serwatka, 2018]. For example, according to a Dutch law passed in 2015, young entrepreneurs from non-EU countries can get temporary residence permits for up to one year to launch an innovative business. A condition to obtain this privilege is to have a mentor at a state-approved organisation.

Health Valley Netherlands is one of such mentors. The cluster signs an agreement with the prospective entrepreneur, according to which the support in areas such as organisation, management, market research, securing funding sources, and assessing the business idea has to be provided. Apart from acting as a foreign start-up facilitator, Health Valley Netherlands also helps its own members, who are early-stage innovation entrepreneurs. For example, the cluster is a partner of the Rockstart Digital Health Accelerator programme which provides assistance to start-ups who develop innovative solutions in areas such as self-help, smart premises, and doctor-patient communication platforms. The programme provides funding for the best start-ups (up to 20,000 euros), mentor services, organises meetings with venture capitalists, grants preferential access to infrastructure, helps with team building and management, and with international promotion via partnership networks. Ten cluster members have been supported in the scope of the programme so far[12].

MORE THAN 100 START-UPS SPECIALISING IN BIOMEDICINE AND LIFE SCIENCES HAVE BEEN ESTABLISHED IN THE CAPITAL REGION BERLIN-BRANDENBURG IN THE LAST FIVE YEARS.

[12] Health Valley Netherlands [official website]. URL: https://www.healthvalley.nl/services/start-up-ondersteuning (last accessed on September 22, 2018).

Such an impressive number of new companies having emerged in quite a short amount of time is due to favourable conditions for supporting young innovative entrepreneurs, which were created by **HealthCapital Berlin-Brandenburg**. The cluster organisation's professionals hand-pick the most appropriate funding tools for start-up projects, refer the beginner businessmen and businesswomen to targeted investors, and help them integrate into the regional innovation ecosystem.

Berlin is a part of Start Alliance – an association of ten cities that are global start-up industry hubs, which help new companies adapting their business models to meet international needs and speed up the innovation process. The cluster members' interests in the programme are represented by the cluster organisation's co-head in Berlin – Berlin Partner for Business and Technology[13].

A SPECIAL KIND OF SUPPORT TO GAIN ENTRY ONTO FOREIGN MARKETS IS PROVIDED IN THE SCOPE OF THE START ALLIANCE PROGRAMME.

[13] HealthCapital Berlin-Brandenburg [official website]. URL: https://www.healthcapital.de/en/services/startups/ (last accessed on September 22, 2018).

Accelerated Application of Innovations in Medical Practice

Regular exchanges of information and ideas within clusters not only promote research and development but also extend businesses' opportunities to transfer their scientific results into production [De la Lama, 2006]. The role of biomedical clusters is speeding up the application of innovations by hospitals.

The Translational Medicine Research Collaboration initiative of the Scottish **BioDundee** cluster aims at fostering the transition of new drugs, treatment, and diagnostic techniques from the laboratory to the clinic. In particular, the initiative is intended to use the existing infrastructure of cluster members (e.g. the University of Dundee), as well as the construction of a new Clinical Research Centre. It is partially funded by the Wyeth pharmaceutical company. The rapid practical application of R&D results is not just a positive effect of cooperation between universities and hospitals; it is actively promoted by various initiatives of cluster organisations. Depending on regional and other features, such initiatives may be focused on technology transfer mechanisms or on fostering entrepreneurial skills among researchers [Europe Innova, 2008].

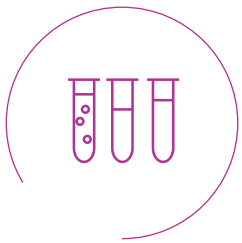
The Value Chain Coaching programme implemented by the Swedish **Biotech-valley** cluster is dedicated to supporting member SMEs in the practical application of their products.

The cluster acts as an agent and consultant for companies. It provides expert evaluation and "second opinion" services, access to laboratories, and helps with organising clinical trials.

The French cluster **Lyonbiopôle** has been implementing the Clinical Innovation programme since 2013[14]. Its objective is to help to introduce innovative products designed by cluster member SMEs into medical practice in the Auvergne-Rhône-Alpes region.

The main directions of Clinical Innovation Programme

Identify hospitals' needs and potential barriers to minimise the risks of projects' failure



Conduct clinical trials

Present innovative products to doctors and patients

Interact with public agencies and help SMEs receive the ethical committee's approval

[14] Lyonbiopôle Auvergne-Rhône-Alpes [official website]. URL: https://lyonbiopole.com/en/research-and-innovation/clinical-innovation (last accessed on September 22, 2018).

The primary role of clusters in entrepreneurship development is to create conditions for growing new businesses and introduce the R&D results of their members into the healthcare system. Management teams of biomedical clusters facilitate the access of research organisations and companies to the specialised infrastructure, support programmes, investors and partners, as well as interactions with the regulatory authorities, doctors, and patients who are the final consumers of innovative products and services.

2 GLOBAL LANDSCAPE OF BIOMEDICAL CLUSTERS

What is a modern biomedical cluster?

Healthcare development has always involved the transfer of S&T advances in the medical, pharmaceutical, and related industries, as well as clinical practices. ICT now plays a major role in all these areas, transforming not just treatment techniques and the production of medicines and equipment, but also management models applied by hospitals and national systems of patient care more generally. Clusters as a format for bringing actors from medicine, science, business, and public administration together and coordinating their efforts often become drivers of positive changes in the whole healthcare sector.

OUR WORK AIMS AT PERFORMING A COMPREHENSIVE STUDY OF THE CORE ACTIVITIES, BEST PRACTICES, AND SUCCESS FACTORS OF BIOMEDICAL CLUSTERS IN WHICH THE COLLABORATION OF UNIVERSITIES, COMPANIES, AND CLINICS COMBINED WITH ADVANCED INFRASTRUCTURE AND PUBLIC SUPPORT RESULTED IN APPRECIABLY IMPROVED QUALITY OF PATIENT CARE.

This chapter describes the sampling for analysis, the employed assessment system, and the resulting groups and target models of biomedical clusters, which, in our opinion, make up their global landscape.

RESEARCH SAMPLE

At the first stage of the study, we drafted a longlist of biomedical clusters, which served as our sample. The main information sources comprised specialised databases such as European Cluster Collaboration Platform[1], TCI Network[2], and European Cluster Observatory[3].

Clusters included in the sample had to meet at least one of the following criteria:

Presence of medical organisations or university clinics among their members

Involvement in the development of the national healthcare system

Membership in countrywide and international medical associations or partnerships

Location in a country with a high-quality healthcare system

Leading positions of the cluster's home country in rankings maintained by medical tourism websites

Forty clusters from twenty-two countries were included on the longlist based upon the analysis of the databases (fig. 2.1). Biopharmaceutical and biotechnology clusters with no clinics among their members were not considered.

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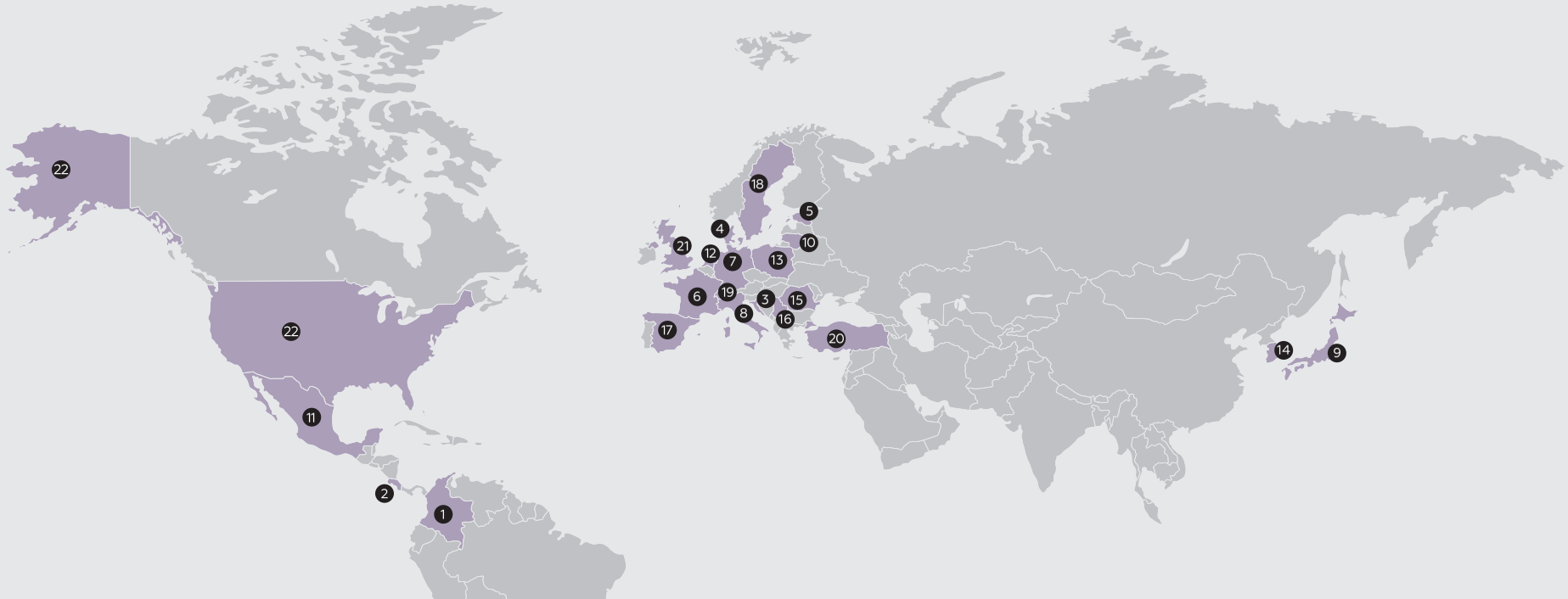
1 https://www.clustercollaboration.eu/

2 http://www.tci-network.org/

3 http://ec.europa.eu/growth/industry/policy/cluster/observatory_en



1 COLOMBIA
- Medellin Health City
- Medical Travel International

2 COSTA RICA
- PROMED

3 CROATIA
- Kvarner Health Tourism Cluster

4 DENMARK
- Copenhagen Healthtech Cluster
- Medicon Valley

5 ESTONIA
- Connected Health

6 FRANCE
- Eurasanté
- Eurobiomed
- Genopole
- i-Care Cluster
- Lyonbiopôle
- Medicen Paris Region
- Nutrition Health Longevity Cluster (NHL Cluster)

7 GERMANY
- BioCon Valley
- BioPark Regensburg
- Gesundheitswirtschaft Hamburg
- HealthCapital Berlin-Brandenburg
- Life Science Nord
- Medical Valley EMN

8 ITALY
- Advanced Life Science in Italy – Italian Technological Cluster (ALISEI)
- Cluster of Health, Innovation and Community (C.H.I.CO.)

9 JAPAN
- KOBE Biomedical Innovation Cluster

10 LITHUANIA
- Lithuanian Medical Tourism Cluster (LitCare)

11 MEXICO
- Monterrey Healthcare City Cluster

12 NETHERLANDS
- Health Valley Netherlands
- Task Force Health Care

13 POLAND
- Polish Innovative Medical Cluster PIKMED

14 REPUBLIC OF KOREA
- Daegu Medical Cluster

15 ROMANIA
- Health Romania

16 SERBIA
- Wellness Serbia

17 SPAIN
- BIOTECYL – Health Cluster of Castilla y León
- Mental Health Cluster of Catalonia

18 SWEDEN
- Medicon Valley

19 SWITZERLAND
- Health Tech Cluster Switzerland

20 TURKEY
- Istanbul Health Industry Cluster (ISEK)

21 UNITED KINGDOM
- Cambridge Medical Campus
- eHealth Cluster

22 UNITED STATES
- BioOhio
- MassBio
- Medical Alley

Fig. 2.1. Biomedical Clusters Included in the Sample

Source: compiled by the authors.

CLUSTER ASSESSMENT SYSTEM

At the next stage of the research, biomedical clusters on the longlist were assessed for their subsequent classification, description of patterns, and identification of success factors. A system of 15 indicators grouped into three categories was developed (fig. 2.2).

HOME COUNTRY

CLUSTER'S HOME COUNTRY ON THE GLOBAL HEALTHCARE MARKET

Annual revenue from medical tourism

Number of foreign patients per year

Position in the Bloomberg Healthcare Efficiency Index

Medical Tourism Index value

Inclusion on the PwC list of leading medical tourism destinations (top 10)

Ranking by medical tourism aggregators

MEMBERS

CLUSTER SIZE

Number of organisations that have officially confirmed their membership in a cluster

DIVERSITY OF CLUSTER MEMBERS

Having members that belong to one or more of the following groups:

- Clinics
- Production companies
- R&D organisations and universities
- Public authorities
- Support organisations

SPECIALISATION

One or more of the following activities:

- Medical services (diagnostics, treatment, rehabilitation, wellness)
- Biomedical R&D
- Production (pharmaceuticals, medical equipment)

INNOVATION ACTIVITY

Two or more innovation infrastructure facilities

Two or more start-ups

MANAGEMENT

PPP-BASED MANAGEMENT

Having public authorities represented within a cluster's governance structure

GOALS

Indicating one or more of the following goals in the cluster's strategy:

- Promoting members
- Contributing to socioeconomic development of its home region
- Contributing to S&T development of its home region

ESCA LABEL

Having ESCA cluster management quality label (bronze, silver, or gold)

INTERNATIONAL VISIBILITY

Availability of information in English on the cluster's website (home page and structure only, or full version)

Fig. 2.2. The System of Biomedical Cluster Assessment Indicators

Source: compiled by the authors.

The first category comprises indicators measuring the position of a cluster's home country on the global healthcare market. We assumed that the level of the national medical system and related industries determined the strengths of particular clusters to some extent. The assessment was based on the amount of annual revenues from medical tourism and the number of foreign patients. Relevant figures were calculated by HSE experts (500 million US dollars, and 200,000 people, respectively, were set as the threshold values for ranking a cluster home country as a major exporter of medical services) [Syomin, Petrova, 2018]. A country's position in the Bloomberg Healthcare Efficiency Index was also taken into account (the top 20). Furthermore, its Medical Tourism Index value (at least 65), inclusion on the PwC list of leading medical tourism destinations, and ranking by aggregators such as Healthtourism.com, Booking Health: Treatment Abroad, and similar websites were considered [Bloomberg, 2014; IHRC, 2017; PwC, 2018].

Indicators in the second category assess cluster members and their core activities. We took into account cluster size measured as the total number of participating organisations (the threshold value for classifying a cluster as large was set at 100). Another criterion was diversity, i.e., having various types of members such as universities, manufacturers, clinics, and public agencies. Cluster specialisations were considered as well, measured as the mix of members' activities (treatment and rehabilitation services; the production of medical equipment and pharmaceuticals; biomedical R&D). The more organisations a cluster had and the wider the range of their activities were the higher was the cluster's overall score for those criteria. Plus, clusters were assessed by the level of innovative infrastructure[4], which the members had access to, and by the presence of start-ups among their participating firms.

[4] For the purposes of this study, the following facilities are classified as innovative infrastructure: business incubators, industrial and technology parks, engineering centres, prototyping centres, certification, standardisation, and testing centres, technology transfer centres, business accelerators, and laboratories.

The third category comprises management-related indicators. These include having public agencies represented in a cluster's governance structure and a cluster's strategy reflecting its home region's socioeconomic and S&T development goals. We also checked whether or not a cluster organisation[5] had an ESCA[6] label (bronze, silver, or gold), and the level of cluster international visibility. The amount of information about the key members, their activities and projects available in English on the official cluster portals was used as an indicator. We distinguished between either the translated home page and structure, or the full English version of the website.

The assessment, based on all three indicator categories, was conducted by using a binary system: one point was assigned if a cluster matched the criterion, and zero if it did not.

[5] Here and below, by a cluster organisation (or a cluster management company) we mean an entity chosen or established by cluster members (or founders) to provide methodological, organisational, expert, analytical, and information support.

[6] The European Secretariat for Cluster Analysis established a system for assessing cluster management and issues relevant certificates. The system was developed within the scope of the European Cluster Excellence Initiative (ECEI) of the EU Competitiveness and Innovation Framework Programme.

GROUPS OF BIOMEDICAL CLUSTERS

The following stage of our research was a cluster analysis of the assessment results for breaking up the sample into uniform or similar (in terms of certain characteristics) categories. After several iterations, the whole biomedical cluster sample was divided into three groups (table 2.1).

GROUPS / CHARACTERISTICS	Global High-Technology Medicine Clusters	World-Class Biomedical Research Clusters	International Medical Tourism Clusters
HOME COUNTRY	Germany, the United States, and the Republic of Korea	European and Asian countries	European and Latin American countries
SPECIALISATION	Biomedical R&D (100% of clusters), medical services: treatment and rehabilitation (over 55%)		Medical services: treatment and rehabilitation (90%), biomedical R&D (30%)
COMPETITIVE ADVANTAGE	High external demand for medical services	Strong university clinics and knowledge centres	Medical treatment at relatively low prices
FOCUS OF ACTIVITY	Interdisciplinary cooperation: medicine and ICT; treatment and tourism	Application of R&D results in clinical practice	Full range of medical tourism services
SIZE	Over 100 organisations		Less than 100 organisations
INNOVATION ACTIVITY	High-level innovation infrastructure (over 60%), supporting start-ups (over 45%)		High-level tourism infrastructure, supporting start-ups in some clusters
ESTABLISHMENT INITIATIVE	Predominantly public	Predominantly private	
PUBLIC AGENCIES' INVOLVEMENT IN MANAGEMENT	Public agencies usually involved in cluster management (70%)	Management usually independent from the state	
ESCA MANAGEMENT QUALITY			

Table 2.1. Groups of Biomedical Clusters and Their Characteristics

Source: compiled by the authors.

GROUP 1.

Global High-Technology Medicine Clusters

The first group comprises ten clusters from Germany, the United States, and the Republic of Korea (fig. 2.3). PwC (2018) ranks these countries among the top 10 with the largest shares of the medical tourism market. Clusters in the first group typically have a large number of various members (up to 650), i.e., clinics, pharmaceutical and ICT companies, producers of medical equipment, and biotechnology firms. The state plays a significant role in their development: 70% of clusters in the first group were established either by the public authorities or through PPP mechanisms. For example, **BioCon Valley** (Germany) emerged as a result of the joint efforts by the Mecklenburg-Vorpommern Government and BioCon Valley® GmbH[7].

Daegu Medical Cluster was set up within the scope of the Daegu–Gyeongbuk Regional Development Plan [DGMIF, 2016].

Global high-technology medicine clusters become gravity centres attracting professionals and patients from abroad; their home countries' annual revenues from medical tourism exceed 1 billion US dollars, and the number of foreign patients served is more than 200,000 people.

[7] BioConValley [official website]. URL: http://www.bioconvalley.org/en/ueber-uns/ (last accessed on October 5, 2018).

UNITED STATES

BioOhio

MassBio

Medical Alley

GERMANY

BioCon Valley

BioPark Regensburg

Gesundheitswirtschaft Hamburg

HealthCapital Berlin-Brandenburg

Life Science Nord

Medicine Valley EMN

REPUBLIC OF KOREA

Daegu Medical Cluster

Fig. 2.3. Global High-Technology Medicine Clusters

Source: compiled by the authors.

GROUP 2.

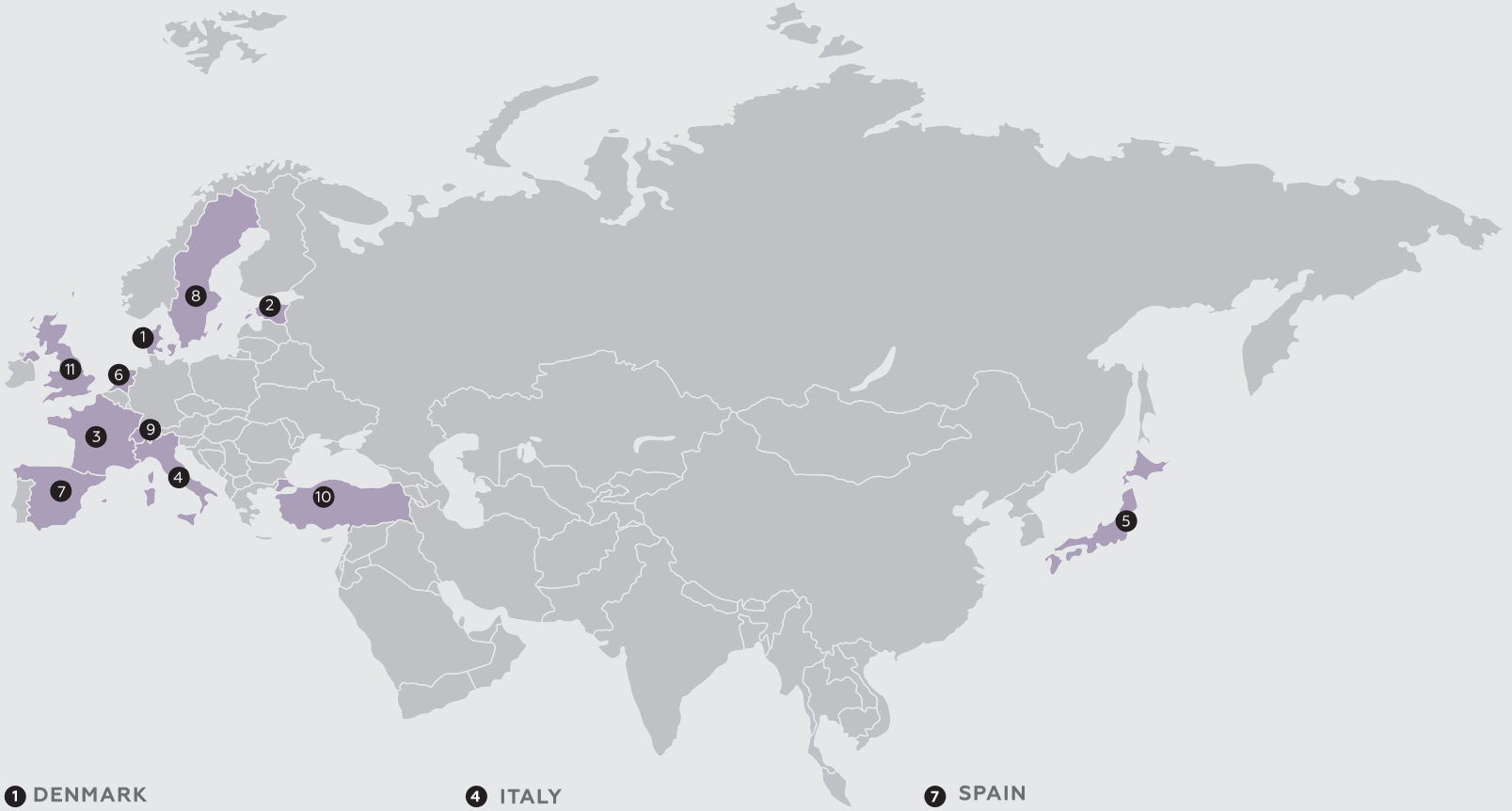
World-Class Biomedical Research Clusters

The second group in our typology is made by 20 clusters in European and Asian countries (fig. 2.4). Notably, more than two-thirds of them are based in the states with advanced high-ranking healthcare systems [Bloomberg, 2014], but with small shares of the global medical tourism market (in annual revenue terms). The development of biomedical science is a priority for clusters included in the second group. Academia played a major role in setting up most of them. For example, **Medicon Valley** was established at the initiative of the Lund (Sweden) and Copenhagen (Denmark) universities. The University of Lille was one of the founding organisations of the **Eurasanté** cluster. The Radboud University of Nijmegen, the University of Twente, and the HAN University of Applied Sciences are represented on the Board of Directors of **Health Valley Netherlands**.

A common feature of clusters in the first and second groups is that they see medical R&D as a major area that also receives considerable amounts of public support. For example, over 80% of R&D in the French **Nutrition Health Longevity Cluster** (group 2) was funded by the French Unified Interagency Investment Fund (Fonds Unique Interministériel – FUI)[8]. A group 1 cluster, **MassBio** (the United States), participates in the international CARB-X programme, which supports R&D in creating next-generation antibiotics to combat drug-resistant bacteria that cause serious infectious and chronic diseases[9].

[8] NHL Cluster [official website]. URL: https://www.nhl-cluster.com/nhl-cluster-2/key-figures/ (last accessed on October 5, 2018).

[9] CARB-X [official website]. URL: https://carb-x.org/about/overview/ (last accessed on October 5, 2018).



1 DENMARK
Copenhagen Healthtech Cluster
Medicon Valley

2 ESTONIA
Connected Health

3 FRANCE
Eurasanté
Eurobiomed
Genopole
i-Care Cluster
Lyonbiopôle
Medicen Paris Region
Nutrition Health
Longevity Cluster
(NHL Cluster)

4 ITALY
Advanced Life Science in Italy – Italian Technological Cluster (ALISEI)

Cluster of Health, Innovation and Community (C.H.I.CO.)

5 JAPAN
KOBE Biomedical Innovation Cluster

6 NETHERLANDS
Health Valley Netherlands
Task Force Health Care

7 SPAIN
BIOTECYL – Health Cluster of Castilla y León

8 SWEDEN
Medicon Valley

9 SWITZERLAND
Health Tech Cluster Switzerland

10 TURKEY
Istanbul Health Industry Cluster (ISEK)

11 UNITED KINGDOM
Cambridge Biomedical Campus
eHealth Cluster

Fig. 2.4. World-Class Biomedical Research Clusters

Source: compiled by the authors.

GROUP 3.

International Medical Tourism Clusters

Finally, the third group formed on the basis of our analysis comprises 11 clusters located in Europe and Latin America (fig. 2.5). Their key characteristics include predominantly private initiatives for cluster establishment; management structures independent from the state; and the provision of medical treatment at relatively low prices.
In particular, countries like Mexico and Costa Rica export healthcare services at a level comparable with that of the United States, while the number of foreign patients they annually receive is twice as many [Syomin, Petrova, 2018]. These clusters concentrate on providing a full range of services to patients and actively applying ICT for medical purposes.

Clinics like the members of **Monterrey Healthcare City Cluster** (Mexico) offer rehabilitation programmes designed specifically for foreign clients, in the scope of which the cluster bears the board and lodging costs[10].

A developed infrastructure of medical organisations and tourist service centres for patients from abroad as well as the active promotion of the Medellin City brand as a personalised treatment provider allowed **Medellin Health City** (Colombia) to attract more than 12,000 people from other countries and increase the revenues from healthcare services by 75% during the first three years of operations. In 2010-2013, the inflow of foreign patients grew by 66%[11].

Unlike the clusters in the first and second groups, most of which are large networks of organisations specialising in various areas ranging from biomedical R&D to pharmaceutical manufacturing and healthcare services, the third group comprises clusters, which promote cooperation between clinics, travel agencies, and the hospitality industry in order to create an integrated chain of services for patients.

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[10] Salud Mexico [official website]. URL: http://mexicosalud.com/medical-tourism-clusters-as-a-means-to-promoting-the-industry/ (last accessed on October 5, 2018).

[11] Medellin Health City [official website]. URL: http://www.medellinhealthcity.com/en/About-us (last accessed on October 5, 2018).

1 **COLOMBIA**
Medellin Health City
Medical Travel International

2 **COSTA RICA**
PROMED

3 **CROATIA**
Kvarner Health Tourism Cluster

4 **LITHUANIA**
Lithuanian Medical Tourism Cluster (LitCare)

5 **MEXICO**
Monterrey Healthcare City Cluster

6 **POLAND**
Polish Innovative Medical Cluster PIKMED

7 **ROMANIA**
Health Romania

8 **SERBIA**
Wellness Serbia

9 **SPAIN**
Mental Health Cluster of Catalonia

Fig. 2.5. International Medical Tourism Clusters

Source: compiled by the authors.

TARGET MODELS OF BIOMEDICAL CLUSTERS

In addition to the groups of biomedical clusters, we have identified their target models, which are supposed to be an important element of the global landscape as well. By "target models" we mean the basis of cooperation between clinics, enterprises, knowledge centres, and public administration agencies that reflects the prerequisites for cluster emergence. The target models were distinguished by expertise, using the analogy method, i.e. grouping objects based on the similarity of their features. The analysis was grounded on open data sources (such as cluster strategies, information from their websites and publications in the media). Table 2.2 illustrates the combination of target models and groups of biomedical clusters[12].

GROUPS / TARGET MODELS	Global High-Technology Medicine Clusters	World-Class Biomedical Research Clusters	International Medical Tourism Clusters
COORDINATING THE ACTIVITIES OF REGIONAL HEALTHCARE PLAYERS	BioCon Valley Gesundheitswirtschaft Hamburg HealthCapital Berlin-Brandenburg Life Science Nord	BIOTECYL — Health Cluster of Castilla y León Connected Health i-Care Cluster KOBE Biomedical Innovation Cluster	Kvarner Health Tourism Cluster Medellin Health City Monterrey Healthcare City Cluster
SETTING UP A FRAMEWORK FOR THE COOPERATION OF R&D ORGANISATIONS AND BUSINESSES WITHIN THE TECHNOLOGY TRANSFER		Eurasanté Health Valley Netherlands Medicon Valley	
ESTABLISHING A GLOBAL NETWORK OF MEDICAL AND PHARMACEUTICAL COMPANIES, R&D ORGANISATIONS, AND UNIVERSITIES	BioOhio HealthCapital Berlin-Brandenburg Life Science Nord Massbio Medical Alley	Health Tech Cluster Switzerland Lyonbiopôle Medicen Paris Region Task Force Health Care	
PROMOTING COOPERATION BETWEEN MEDICAL ORGANISATIONS, TRAVEL AGENCIES, AND INSURANCE FIRMS TO PROVIDE A BROADER RANGE OF SERVICES FOR PATIENTS			Kvarner Health Tourism Cluster Lithuanian Medical Tourism Cluster (LitCare)

Table 2.2. Combination of Target Models and Groups of Biomedical Clusters

Source: compiled by the authors.

[12] The table contains examples of the clusters we have addressed to in the text.

TARGET MODEL 1.

Coordinating the Activities of Regional Healthcare Players

Within the first target model a cluster organisation is typically established on the basis of a regional development institute with the following responsibilities:

Providing an integrated communication platform for R&D organisations, medicine centres, private companies, universities, and regional authorities to facilitate the creation of a joined regional production network

Selecting regional platforms to carry out R&D

Helping attract funding for cluster members' projects that bring together R&D organisations and businesses particularly important for the region

Assisting cluster members make the best use of available public support initiatives

Typically, in the scope of the first target model biomedical clusters are focused on strengthening their home region's competitiveness and increasing its investment appeal by concentrating public and private resources in the healthcare sector. This model may be applied by clusters from all three groups: global high-technology medicine clusters, world-class biomedical research clusters, and international medical tourism clusters.

For example, the goal of establishing the German cluster **Gesundheitswirtshaft Hamburg** (Free and Hanseatic Town of Hamburg) (group 1) was to promote the federal state's sustainable image as an advanced healthcare centre on the global market. The objectives included improving the regional medical service system, ensuring continuity throughout all stages of treatment, and optimising patient assistance procedures[13].

[13] Gesundheitswirtshaft Hamburg [official website]. URL: https://www.gwhh.de/gesundheitswirtschaft-hamburg/ziele-und-leitbild/ (last accessed on October 5, 2018).

Note that like many other German clusters, Gesundheitswirtshaft Hamburg was established at the initiative of the state authorities and its management company is a subsidiary of a regional development agency. Typically, such a structure does not feature formal membership, all players in the regional healthcare sector can use the basic services provided by the cluster organisation.

A key area of the French **i-Care Cluster** (the Auvergne-Rhône-Alpes region) (group 2) is helping members find partners to implement joint innovation projects in medicine. The management team focuses primarily on organising communication events and exhibitions with the participation of clinics, R&D organisations and SMEs and on designing regional programmes to support healthcare start-ups[14].

The Croatian **Kvarner Health Tourism Cluster** (the Primorje-Gorski Kotar county) (group 3) brings together key players in the medicine and hospitality areas, the University of Rijeka, the regional administration, and the Croatian Ministry of Health in order to improve the quality of treatment and promote the Kvarner coast as a world-renowned health resort. Cluster members receive marketing and consulting services, and assistance with attracting public and private funding[15].

[14] Cluster I-Care [official website]. URL: http://i-carecluster.org/historique/presentation/ (last accessed on October 5, 2018).

[15] Kvarner Health [official website]. URL: http://www.kvarnerhealth.com/about-us (last accessed on October 5, 2018).

TARGET MODEL 2.

Setting up a Framework for the Cooperation of R&D Organisations and Businesses within the Technology Transfer

If clusters based on the first model focus on helping their home regions accomplish the strategic socioeconomic and S&T development goals, clusters based on the second model usually concentrate on promoting the application of R&D results in clinical practices or by pharmaceutical and biotechnology companies.

In our "system of coordinates", the world-class biomedical research clusters (group 2) mostly fit this model. For example, **Health Valley Netherlands** was established in 2004 to improve direct communications between universities, private companies, and medical organisations in the Nijmegen region.

The Danish-Swedish cluster **Medicon Valley** was created at the initiative of two collaborating universities and has now grown into a large network comprising 11 R&D and educational organisations, more than 30 medical institutions, and 350 companies, a significant proportion of which are university start-ups.

The French cluster **Eurasanté** was set up in 1994 at the influence of Lille University, which even then had a lot of impressive R&D results in need of commercialisation. The cluster organisation from the very start helped members with evaluating ideas, preparing business plans, attracting funding, and hiring or training staff. As one of our experts noted, a typical problem frequently faced by the healthcare sector was that talented doctors or researchers were unable to implement their commercial projects due to the lack of business skills and managerial competencies.

TARGET MODEL 3.

Establishing a Global Network of Medical and Pharmaceutical Companies, R&D Organisations, and Universities

In the scope of this model, clusters operate as international associations comprising domestic companies and overseas members alike. The goal is to facilitate knowledge exchanges between them. The cluster acts as a communication platform providing access to information about the participants' R&D results and cutting-edge S&T advances.

We discovered that this target model was predominantly applied by global high-technology medicine clusters and world-class biomedical research clusters (the first and second groups in our sample, respectively). A good example is the US life science network **MassBio** (group 1). MassBio annually hosts more than a hundred events such as international conferences and subject-specific meetings with investors and sponsors. The goal is to help members find interested partners for implementing joint projects, both to conduct R&D and commercialise their results.

The MassBio's MassCONNECT programme dives deep into the life sciences: it involves a two-month mentorship where industry experts guide entrepreneurs as they seek to develop business plans, launch companies, and raise capital[16].

Another example is the Dutch biomedical cluster **Task Force Health Care** (group 2), which actively promotes partnerships with healthcare organisations all over the world. The cluster has established six communication platforms: TFHC Asia, TFHC Europe, TFHC Africa, TFHC Latin America, TFHC Middle East, and TFHC North America. Their objectives are helping members to find partners and share their experience with leading life sciences companies in relevant regions. This structure allows one to take into account different approaches toward organising a healthcare system in various countries and regions[17].

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[16] Massachusetts Biotechnology Council [official website]. URL: https://www.massbio.org/discover/massconnect (last accessed on October 5, 2018).

[17] Task Force Health Care [official website]. URL: https://www.tfhc.nl/ (last accessed on October 5, 2018).

TARGET MODEL 4.

Promoting Cooperation between Medical Organisations, Travel Agencies, and Insurance Firms to Provide a Broader Range of Services for Patients

Clusters of the fourth target model aim at facilitating the collaboration of primarily private companies into a single chain in order to minimise the costs of services integrated. Universities rarely become members of such clusters and usually act as their external partners. The fourth target model was adopted by international medical tourism clusters. A very good example is **LitCare** (Lithuania). The cluster comprises exclusively private clinics, spas, sanatoriums, and hotels. Its competitive advantage is based upon a wide range of high-technology medical services offered at lower prices than in Western Europe and the United States[18].

EVEN IN CLUSTERS BELONGING TO A SINGLE GROUP, THE TARGET MODELS ARE FEATURED DIFFERENTLY, WHICH DEMONSTRATES THE MULTITUDE OF THEIR PRACTICES. IN THE NEXT CHAPTER, WE WILL SHIFT THE FOCUS OF ANALYSIS FROM THE GLOBAL LANDSCAPE TO SPECIFIC CASE STUDIES AND TRY TO IDENTIFY THE SUCCESS FACTORS OF BIOMEDICAL CLUSTERS.

[18] LitCare [official website]. URL: https://www.litcare.com/homeru (last accessed on October 5, 2018).

3 SUCCESS FACTORS OF BIOMEDICAL CLUSTERS

What is the secret of a cluster's success?

To answer this question, we must clearly define the successfulness criteria. According to our initial hypothesis, each of the three identified cluster groups could have different measures of achievements. For example, the performance of global high-technology medicine clusters could be evaluated in terms of their revenues from exporting healthcare services. The growth of R&D expenditures could serve as an indication of world-class biomedical research clusters' effectiveness. Further, high positions in medical tourism rankings could give one grounds to conclude that the relevant international medical tourism clusters were successful.

The testing of this hypothesis began with open-source data analysis such as websites, programmes, and presentation materials prepared by the clusters from our sample. The preliminary results were subsequently adjusted following the interviews with representatives of cluster management companies from each group. On the basis of those interviews, we came to the conclusion that totally different clusters became prosperous due to the adoption of similar practices, the exact mix of which in each case varied. We tried to interpret the resulting case studies in terms of success factors.

SUCCESS FACTOR 1.

COMMUNICATION AS THE ULTIMATE VALUE

Personal meetings with members, designing a single cluster brand and promoting it globally, organising events, producing information materials, developing common databases and online platforms, interacting with clinics and patients – these are just a few of the answers we received from our experts to the question "What is the value of a cluster?" A full communication agenda is a common feature of all biomedical clusters and a key responsibility of their management companies. Without such ties, it would be impossible to arrange a flow of joint projects carried out by R&D organisations and enterprises, systematically promote research results, apply innovations in clinical practice, and develop international collaboration. Cluster managers we have interviewed used different approaches to establishing cooperation: some believed in "digital" and offered members all sorts of platform solutions to promote networking, while others were convinced nothing was more important than personal contacts. However, all of them agreed that communication was the most important aspect of clusters' operations.

DENMARK – SWEDEN

«In Cluster Networks»

Case of Medicon Valley

PETTER HARTMAN

MSc in Political Science, CEO
Medicon Valley Alliance

The key value that Medicon Valley Alliance brings to cluster members is developing a network of communications on both sides – Swedish and Danish. We construct the collaboration platform for regional authorities, hospitals, academia and industry players; provide facilitating services to develop and run their projects. So we use networks. You constantly need them (especially when working across national borders) to build an identity among various organisations and institutions – being a part of one single cluster from two different countries. And this is the foundation of our cluster management. We arrange about 25-30 events every year. When our members begin to network and find out how to collaborate, we then help them to develop these collaborations: getting an investor or a partner from business or research community.

Medicon Valley Alliance helps cluster companies step up cooperation and implement joint projects by involving them in various networks:

- **Medicon Valley Alliance Executive Club**: an exclusive network for top managers of the cluster member companies; they meet twice a year at gala dinner;
- **Medicon Valley Alliance Oncology Network**: an association of the cluster firms and universities specialising in the treatment of oncological diseases. The alliance's objective is to maintain an expert discussion between business and academic community, transfer research results into production, inform R&D organisations about industrial problems, and jointly look for solutions. Members meet several times a year, taking turns to arrange the meetings;
- **Medicon Valley Medtech Network**: an association of companies and innovation infrastructure organisations engaged in the production of advanced medical equipment (e.g. Alteco Medical and SAXOCON, Ideon Science Park, etc.). Members meet quarterly, in Denmark and Sweden in turn.

Establishing such networks in the cluster is an ongoing process prompted by the members' current needs. For example, in 2018 the cluster organisation together with the Technical University of Denmark, Lund University, and Novo Nordisk company launched a new network – **Medicon Valley Alliance Microbiome Network**. This initiative emerged in response to the growing interest in microbiome research, which became evident during Microbiome Summit 2017, recenty hosted by the cluster. The new network brings together Danish and Swedish researchers and entrepreneurs focused on designing drugs, food additives, and probiotics.

THE NETHERLANDS

«Communication Ecosystem»

Case of Health Valley Netherlands

CHRIS DOOMERNIK

MSc MMO, Managing Director
Health Valley Netherlands

Businesses want to join our cluster because they see that we have created a very dynamic environment. The key benefit is that we would build an ecosystem of different parties that cooperate in innovations in healthcare. The number of our members grew from 110 to 270 over the last five years. A lot of parties joined us from other areas of the Netherlands. We provide connecting and communication services; we can guide our members to the right partners (investors or other parties of knowledge), to bring their products to the market. We also spread information in our newsletter and via social media.

Most of the services provided by Health Valley Netherlands are designed to help with professional communication management, networking, and project team building. The cluster members include law firms, consulting companies, living labs[1], marketing and estate agencies, employment offices, innovation infrastructure organisations, and venture foundations. In response to their requests, the cluster organisation finds the most suitable providers of services to conduct research, give legal advice, prepare business plans or applications for funding, recruit staff, find premises, facilities, and equipment. Health Valley Netherlands helps set up consortia comprising entrepreneurs, researchers, and medical organisations to implement joint projects, pick the right subsidy programme or a private investor, test innovative products in a real-life environment, etc.

At the moment, the cluster members participate in five EU-funded projects (table 3.1).

The cluster management company hosts about 30 members' meetings annually; regular appointments with representatives of healthcare organisations to learn about the problems and requests they might have for developers and researchers; it organises "contact exchanges" for SMEs; innovative ideas competitions for start-ups; workshops for doctors and patients, etc. Several staff members of the cluster organisation are responsible for the production and dissemination of information materials about the cluster's and its members' activities and for maintaining their visibility in media and social networks. Health Valley Netherlands launched a special platform – Stay-connected! – to support communication among members.

PROJECT TITLE	Total budget (million euros)	Subsidy volume (million euros)
CIALE	0.43	0.32
VR4REHAB	4.01	2.41
Smart Systems	2.76	1.39
Zorg Verbindt	4.64	2.79
MIND	5.74	3.54

Table 3.1. EU-Funded Projects with Cluster Members' Participation

Source: compiled by the authors based on the Health Valley Netherlands data.

[1] Living lab is a project or infrastructural facility which implies the systemic involvement of users in real-life innovation processes [Kokareva A., Kutsenko E., Islankina E., 2018].

GERMANY

«From Words to Projects»

Case of HealthCapital Berlin-Brandenburg

DR KAI UWE BINDSEIL

Cluster Manager
HealthCapital Berlin-Brandenburg

The main goal of every cluster is to bring all the relevant parts of the industry and science together to share ideas and make them work. The majority of my team are engaged in project management. Projects are typically based on medical needs or technical problems and possible technological solutions. Communication is the key: it is very important that people can talk to each other, share their own experiences, and discuss possibilities. If you are connected with projects as a cluster organisation, you must host events, bring people together. We are typically becoming active if there is more than a single individual interested, but if we see that three, four, or five companies are collaborating in a new area. We are facilitators trying to find financing for different projects, to combine them with a systemic solution. Concrete projects are discussed by the cluster board. We are not making the decisions about whether a project is funded or not. We only decide if it is worth spending time on it and supporting financial engineering. Right now in my database, I have about 400 projects and initiatives.

The Berlin-Brandenburg region hosts a large number of research organisations and predominantly small and medium-sized enterprises operating in the biomedical sector.

Supporting the transfer of R&D results into production is a key success factor for their joint innovation projects development.

The key areas to start joint cluster projects are: biotechnology and pharmaceutics, medical technologies, patient care and rehabilitation, and medical tourism and preventive medicine. Activities in each area are planned taking into account five cross-cutting topics: skilled professionals, ageing society, inward investment, internationalisation, and e-health (table 3.2).

HealthCapital Berlin-Brandenburg promotes cooperation between cluster members using various tools, including the following:

- **identifying** and promoting the development of scientific ideas with high market potential;
- **facilitating** interdisciplinary networking in key research areas;
- **initiating** and coordinating joint R&D projects;
- **helping** with the practical application of research results;
- **providing** support and securing funding for innovation projects in the scope of regional and national programmes and from the EU foundations (table 3.2).

Project Indicators	2017	2011 - 2017
Number of projects	50	118
Project volume (million euros) Involved parties in Berlin (BE)-Brandenburg (BB) (million euros)	**95.32** 58.60	**220.53** 162.97
of which funding for participants in BE and BB is provided by (million euros): federal states authorities	8.12	35.74
national authority	37.52	111.03
European (EU) authority	1.25	1.81
other authorities	2.54	2.64

Table 3.2. Projects Implemented with the Participation of HealthCapital Berlin-Brandenburg

Source: compiled by the authors based on the HealthCapital Berlin-Brandenburg data.

GERMANY

«Welcome to the Group!»

Case of Life Science Nord

DR HINRICH HABECK

Managing Director
Life Science Nord Management GmbH

Communication is the cluster's core. We have to get in contact with one another quite often. Last year we started a digital collaboration platform (called LSN XCHANGE), which operates as a social network: cluster members have their own profiles, talk to each other, join working groups, exchange experience and documents, etc. Their topics and inputs determine the platform content. We have established working groups that offer a place for members and external experts to engage with important issues. These are not just bringing people together, but helping them find investors for projects, jointly solve emerging problems. Besides, we do a lot of advising; one of the groups on LSN XCHANGE is dedicated to regulatory issues. At the moment, the most urgent concern is to adapt for changes in European regulation of medical devices manufacturers. Cluster companies have many questions about this, therefore we help them to correctly understand and implement the new rules. We discuss issues remotely, but we can also arrange to meet offline.

Some of the services the cluster organisation offers its members are integrated into the LSN XCHANGE communication platform. The website is structured by thematic areas (e.g. healthcare regulation, staff development, project implementation, organising events, etc.), so the cluster members choose which they would like to join. Registered users apply for membership, and when it is approved, they get involved in the collective activities. The website also features a database of cluster members' representatives one can contact regarding specific issues, or invite to team up. For example, the project implementation working group encourages interested members to share their ideas, experience, competencies, and abilities in specific areas, which can lead to the emergence of joint projects. One of the active projects currently being implemented via the platform is Northopedics. It focuses on designing solutions for bone fracture associated problems. Members of the staff development working group share best human resources management practices. They also have access to a database of jobseekers in the biomedicine and pharmaceuticals companies.

SWITZERLAND

«Individual Approach»

Case of Health Tech Cluster Switzerland

DR PATRICK DÜMMLER

Cluster Manager
Health Tech Cluster Switzerland

The main focus of the cluster is to provide a neutral networking platform for different parts of the value chain. This means that when they come together, it is not a very formal thing. After the presentation, we usually offer small things to eat and something to drink, so cluster members get into the discussion after the refreshments and start to develop a relationship with each other. Sometimes this results in new ideas, new ways of collaborating, sometimes it is just a promising contact for the future – who knows what it may bring. And the second thing is – apart from the worth of the networking platform – the content that we provide. For example, we have a regular event, which focuses on data security in healthcare, and this comes with speakers from abroad. They provide insight into how hospitals deal with the issue. This is really for our members to learn and compare it with their own approach. After the presentation they can exchange views on the topic – this is networking.

Health Tech Cluster Switzerland's services are built around networking – events and bilateral meetings. One of the top managers of the cluster organisation regularly and personally meets representatives of the 250 member companies to discuss their objectives, needs, and problems. Companies often want to find partners with relevant competencies, capital, or even require information on access to infrastructure or equipment for a specific project. The manager's objective is to find such partners and bring them together with the cluster members, so their cooperation, in the end, leads to new products or technologies.

Another kind of service offered by the cluster organisation is information (monthly news digests, sent to cluster members strictly upon request), thematic discussions and workshops, participation in exhibitions and fairs. Importantly, some of the events hosted by Health Tech Cluster Switzerland are free for non-members as well. According to the managers, it helps to attract new companies and institutions.

LITHUANIA

«One Cluster, One Brand»

Case of Lithuanian Medical Tourism Cluster

GRAŽVYDAS MORKUS

Managing Director
Lithuanian Medical Tourism Cluster

In medical tourism, reputation builds up for a long time, you need to work for at least five years to start getting feedback. In our case, it is the country's reputation. We try to participate everywhere, to present both the cluster and Lithuania as a world-class healthcare resort.

A European Union grant played an important role in establishing LitCare and provided funding for various communication and marketing activities such as domestic and international market research, brand development, the production and dissemination of presentation materials, website design, a publicity campaign, participation in numerous fairs and exhibitions, and so on. This allowed it to organise the work professionally from the very start, both inside the cluster (the differentiation between and segmentation of the members' services), and outside it (clearly defining the niche and target audience and properly positioning itself on the market). Like any other cluster, LitCare comprises companies that not only complement one another, but also compete with each other. Accordingly, a common marketing strategy was developed for the cluster, taking into account each member's unique advantages. They were structured into a chain reflecting the typical path of medical tourists.

Marketing accounts for a major share of services the cluster organisation provides. LitCare is represented on international and national cluster platforms (such as TCI Network, European Cluster Collaboration Platform, KlasterLT, Lithuanian Clusters Association). The cluster actively promotes its members on medical tourism aggregators and social networks; presents its activities at specialised international fora in Moscow, St. Petersburg, Oslo, Dubai, Baku, and other locations; and arranges publicity tours for partner travel agencies.

An important factor affecting the development of the cluster's brand was (and remains) mutual trust between its members and medical tourists. Regular communication (board meetings, working group sessions and joint workshops, participation in fairs and exhibitions, personal contacts, etc.) allowed Lithuanian Medical Tourism Cluster to build a reputation as a reliable partner and service provider.

SUCCESS FACTOR 2.

INTERDISCIPLINARY COOPERATION

Healthcare is an area around which the structural transformation of the economy is taking place. The success of many biomedical clusters is due to the fact that they bring together different members – patients, doctors, researchers, and manufacturers – to develop marketable interdisciplinary high-technology solutions. At the junction of healthcare, pharmaceuticals, the production of medical equipment, construction, ICT, and other areas, new, rapidly growing and research-intensive activities are emerging that integrate cluster members' various industrial and technological competencies in a novel way (e.g., healthy longevity). Biomedical clusters are also able to foster NBIC-convergence through intensive interdisciplinary research in areas such as nanotechnology, biotechnology, information technology, and cognitive science.

GERMANY

«Healthcare under the Cluster's Umbrella»

Case of HealthCapital Berlin-Brandenburg

DR KAI UWE BINDSEIL

Cluster Manager
HealthCapital Berlin-Brandenburg

New products in the healthcare sector should bring additional benefits to patients, doctors, academia, and business. At their interface in HealthCapital Berlin-Brandenburg, we drive networking and the technology transfer. We are coming from small fields to big projects. Healthcare is at the heart of a comprehensive structural transformation. Our cluster brings together hundreds of companies in pharma, bio- and medtech, major research facilities, and universities. Together, they are working on regenerative and telemedicine; digital health and hospital IT; big data for drug development, ambient assisted living, and smart sensor technology. Everybody who is active in these fields is automatically a part of the cluster. We are not a membership organisation and the cluster is free for everybody to participate.
I think the picture of an umbrella is the right illustration of our structure.

The Berlin-Brandenburg cluster comprises more than 20,000 participants (including more than 500 major biomedical, pharmaceutical, and medical equipment firms; 25 universities; 18 R&D organisations; and eight specialised industrial parks). Among other members, there are 130 hospitals (including one of the oldest and biggest university hospitals in Europe, the Charité). The diversity of HealthCapital Berlin-Brandenburg member organisations, combined with an active communications agenda and advanced conditions for interdisciplinary research and development at the junction of science, production, and medical practices helped the cluster to become a leader in the healthcare sector and related industries.

Here are just a few examples of strategic partnerships and joint initiatives the HealthCapital Berlin-Brandenburg members are engaged in:

/ **the Charité and the Sanofi pharmaceutical company have been cooperating since 2010.** One of their common projects is the joint laboratory for testing post-stroke medications. The laboratory is located on the clinic's campus next to the Berlin Centre for Stroke Research;

/ the Charité (a leading German medical organisation specialising in cardiovascular diseases) together with the Brandenburg cluster members MEYTEC, Thermo Fisher Scientific, and the Berlin Fire Department, established the Berlin Mobile Stroke Unit – **STEMO. It is an emergency assistance service for patients in particularly bad condition**, supplied with a portable tomographic scanner, biomarkers, equipment for electronically documenting the treatment and directly communicating with the hospital;

/ **in 2011, the Charité and the Vivantes concern joined their experience and knowledge in the scope of Labor Berlin – one of the leading laboratories in Europe.** Labor Berlin conducts research in nine areas: laboratory medicine, microbiology and hygiene, virology, human genetics, allergy diagnostics, autoimmune diagnostics, endocrinology and metabolism, haematology and oncology, and immunology;

/ in 2013, based on the combined research competencies of the Max Delbrück Centre for Molecular Medicine in Helmholtz Association (Max-Delbrück-Centrum für Molekulare Medizin in der Helmholtz-Gemeinschaft – MDC) and the Charité's practical experience, the **Berlin Institute of Health – BIH was established**;

/ jointly with the Berlin Helmholtz Centre for Materials and Energy (Helmholtz-Zentrum Berlin für Materialien und Energie – HZB), the Charité is **working on designing treatments for ophthalmologic diseases and tumours based on proton therapy techniques, under the BerlinProtonen brand.** Combined efforts by medical physicists, ophthalmologists, and oncologists resulted in the development of a high-precision treatment technique. One of its components, eye applicators, are also made by a cluster member, Eckert & Ziegler.

LITHUANIA

«One Window»

Case of Lithuanian Medical Tourism Cluster

GRAŽVYDAS MORKUS

Managing Director
Lithuanian Medical Tourism Cluster

The principle of our cluster is one window. This means that the medical tourist, in contact with any point of the cluster (no matter which clinic or sanatorium he or she has arrived in), from everywhere should receive a full package of services. Such an approach creates additional value for the customer. Packaged services became our unique competitive advantage and turned out to be of interest to patients. Today, we receive medical tourists from Russia and many countries in Europe. We do not say that we are the best or the cheapest, but we offer the smart ratio of price and quality.

In 2013, leading Lithuanian private healthcare organisations, dental clinics, spas, hotels, sanatoriums, and hospitality industry companies joined forces to create a cluster of medical tourism – LitCare. Their objective was to provide a full range of high-quality treatment and make the best possible offers to patients. Medical tourists can receive numerous basic and additional services along the way. This approach allows the cluster to take care of the clients' varied needs and control the quality and costs. Specifically for these purposes, a company was established to handle administrative aspects such as meeting patients, managing their logistics, board and lodging, planning treatment, rehabilitation, etc.

SWITZERLAND

«Tied into a Chain»

Case of Health Tech Cluster Switzerland

DR PATRICK DÜMMLER

Cluster Manager
Health Tech Cluster Switzerland

What is quite special about our cluster is that we really hit a market niche. We are not only focusing on medical technology or pharmaceutics alone, but we are embracing the whole health tech value chain, bringing together companies from different parts of it. This makes them better understand the needs of each other, jointly discuss ideas for new solutions to finally improve the overall quality of healthcare services.

Currently, the cluster brings together more than 250 organisations. They comprise clinics, sanatoriums, diagnostic centres and laboratories, manufacturers of medical equipment and pharmaceutics, insurance and consulting firms, engineering and IT companies

Furthermore, 13 cluster members (mainly medical equipment manufacturers) operate abroad: in Germany (seven organisations), Italy (two), Austria (two), Poland and Belgium (each one). Every month three to four new members join the cluster.

Health Tech Cluster Switzerland has partnerships with other clusters, universities, and professional associations – 50 organisations in total. They are based not only in Switzerland but in other countries as well. The partnership agreements Health Tech Cluster Switzerland signs with them imply no financial obligations – simply information exchanges, participation in joint events, etc.

ESTONIA

«Everyone Will Be Heard»

Case of Connected Health

PIRET HIRV

Cluster Manager
Connected Health

One of the cluster's success factors is its diverse membership and a high level of communication among all parties. We really have to have personal contacts with all stakeholders of the ecosystem. Cooperation among firms is important, but not enough to improve the quality of healthcare. Here, one party is not always the buyer and the other the supplier; often combinations of multiple players emerge. Establishing and maintaining relations with the public sector and providers of medical services has a vital role in this sphere. They participate in our cluster to be in the centre of activities, get the new information, and we are the primary source of it.

The Connected Health cluster comprises more than 80 members; some of them are start-up companies, IT firms, biomedical technology developers, and pharmaceuticals producers. The cluster actively cooperates with universities (including Tallinn University, Tartu University and the Tallinn University of Technology), and infrastructural organisations (e.g. Tallinn Science Park Tehnopol acts as the cluster organisation). Two national ministries (the Ministry of Economy and the Ministry of Social Affairs) are the main public partners of Connected Health. A major part of the cluster is medical organisations (hospitals, polyclinics, rehabilitation centres, and retirement homes), doctors, and patients' organisations. Cooperation with them allows one to receive a sufficiently clear understanding of medical services users' current needs and involve them in finding the best solutions for the industry's problems.

SUCCESS FACTOR 3.

PARTNERSHIP-BASED MANAGEMENT

A feature of many biomedical clusters is that they bring together companies and organisations whose activities go beyond a single industry or research area. This requires setting up a management system, which would allow one to balance the interests of key members from various socioeconomic spheres. Most of the clusters we have surveyed establish a multilevel management system.

Strategic management functions are a responsibility of the cluster board comprising representatives of clinics, production enterprises, universities, public authorities, and development institutes. The board makes major decisions regarding cluster development. It frequently has an expert committee, which is comprised of highly qualified professionals. The committee conducts an integrated evaluation of S&T and innovation projects suggested by cluster members seeking additional funding.

A cluster organisation is set up to handle the day-to-day management issues. It is responsible for methodological, organisational, expert, analytical, and information support of cluster companies. Many cluster organisations are focused on project management. Their teams typically comprise project groups formed with consideration of the cluster members' research and industry specialisations and opportunities to implement interdisciplinary joint projects.

THE NETHERLANDS

«Collaborate Like Never Before»

Case of Health Valley Netherlands

CHRIS DOOMERNIK

MSc MMO, Managing Director
Health Valley Netherlands

The cluster was established in 2004 at the initiative of universities, the municipal authorities of the city where we are located, regional governments and a few big companies. The main goal was organisational: to bring knowledge to the society, they had to cooperate more than they had done before. Today, we have a board with representatives from R&D and education, the industry, healthcare sector, and a team bureau with eight employees.

Health Valley Netherlands is the largest innovative healthcare and life sciences cluster in the country. The cluster board is responsible for strategic management. It comprises members representing leading universities (Radboud University of Nijmegen, University of Twente, HAN University of Applied Sciences, University of Applied Sciences Saxion), healthcare organisations (Radboud University Medical Centre, the Jeroen Bosch Hospital, the Siza Care for people with disabilities, the Ikone patients' organisation), three private companies, and the Regional Development Agency East Netherlands Oost NL.

The ongoing management (organising events, producing and disseminating information materials, helping cluster members to find partners, attract funding, etc.) is the responsibility of the Team Bureau Health Valley with the staff of eight employees. Four of them are innovation managers with professional knowledge in areas such as digital healthcare, pharmaceuticals, and medical equipment. The other half of the team is responsible for communication and management.

GERMANY

«Balanced Interests»

Case of HealthCapital Berlin-Brandenburg

DR KAI UWE BINDSEIL

Cluster Manager
HealthCapital Berlin-Brandenburg

"The cluster initiative was a political decision shared with the big industry players. One of the key success factors in cluster management is a balance between full-time professionals and honorary experts both from academia and business."

HealthCapital Berlin-Brandenburg is an interregional cluster: it comprises members from two German states, Berlin and Brandenburg. Two top managers, who are representatives of the regional organisations: Berlin Partner for Business and Technology (Berlin Partner für Wirtschaft und Technologie) and Economic Development Brandenburg (Wirtschaftsförderung Brandenburg) co-manage the cluster on a parity basis, in line with the partnership agreement[2].

[2] HealthCapital Berlin-Brandenburg is one of five cluster initiatives implemented in the scope of Berlin and Brandenburg's joint innovation strategy InnoBB (2007). Along with medicine, the document sets four other priority development areas: energy, ICT and new media, optics, and transport systems. Relevant clusters have been established in these areas too. Berlin Partner for Business and Technology and Economic Development Brandenburg coordinate the implementation of the joint strategy together. Both organisations appointed managers to supervise each priority development area, and, accordingly, the relevant cluster.

At the top of the cluster's management structure is the board comprising 25 members and the chairman. The members include representatives of Berlin and Brandenburg authorities, senior company and medical organisation executives (proposed by the chairman), and experts from both regions' academic and business communities who head the committees supervising key areas of the cluster's activities.

One of the board's responsibilities is setting priorities for the cluster in line with the Master Plan for Healthcare Development in the Berlin-Brandenburg region. It is implemented via the selection of projects for which the cluster team should provide prime support. Typically, these are the initiatives having the highest share of funding from businesses or R&D organisations. Such a requirement minimises the risks of projects' remaining uncompleted and strengthens the cluster members' responsibility for results due to their investments. At the same time, the cluster budget does not include any membership fees; 70–75% of it comes from regional authorities, plus there is a contribution made by the EU. This ensures a balance of cluster members' interests and their equal access to the cluster managers' services.

GERMANY

«PPP-Based Management»

Case of Life Science Nord

DR HINRICH HABECK

Managing Director
Life Science Nord Management GmbH

A cluster is a political instrument that can regulate the economy and science. In Life Science Nord, companies, universities, research institutes and government bodies have combined forces to strengthen the development and economic power of biomedicine and related industries in Hamburg and Schleswig-Holstein.

Life Science Nord is based on a public-private partnership model. The combined share of the German states Schleswig-Holstein and the Free and Hanseatic City of Hamburg (the cluster's home locations) in the authorised capital of the cluster organisation (Life Science Nord Management GmbH) is 80%, and the remaining 20% is provided by Association Life Science Nord e.V. (a voluntary consortium of cluster members).

Life Science Nord Management GmbH serves as the gravity centre of the medical community – representatives of related R&D organisations, businesses, and public authorities. The team comprises 15 people; there are three departments: (1) Innovation and Transformation, (2) Marketing, Public Relations and International Cooperation, and (3) Human Resources. The cluster management company is responsible for organising events, maintaining internal and external communications, providing information and consulting support to members of the two regions' healthcare innovation ecosystem, which comprises more than 500 companies and several large universities (including those of Lübeck and Hamburg).

FRANCE

«Three in One»

Case of Eurasanté

CAROLINE SIMOES-AUBERGER

Communication and Strategy Manager
GIE Eurasanté

**Eurasanté is simultaneously a tech transfer, an incubator, and a cluster manager in the life sciences sector located in the North of France.
For more than 20 years, we have been working to promote the growth of nutrition and healthcare industries in our region by helping researchers, start-ups and companies develop their projects.**

Eurasanté is organised as a "group of economic interests" (Groupement d'Intérêt Economique – GIE), which implies various members' joining forces to accomplish common objectives while remaining legally independent. The Eurasanté Administrative Council comprises five colleges, bringing together 12 key representatives of the regional healthcare sector.

Each college supervises a specific area of activities. For example, Collège Association Eurasanté comprises five representatives of local universities; University Clinics College (Collège Centres Hospitaliers Universitaires – CHU); colleges of the Nutrition Health Longevity Cluster and Clubster Santé; and the Distinguished Experts College. There is also another management body – Eurasanté Directorate headed by president and director general (the latter is also the director of Nutrition Health Longevity Cluster).

Eurasanté animates the Bio-business Park, located at the heart of the leading hospital-university campus in Europe (a 300-hectare site of excellence, dedicated to state-of-the-art activities in the health and nutrition sectors), plus two specialised clusters:

- **Nutrition Health Longevity Cluster** — national competitiveness cluster with more than 200 members, the only cluster in France specialising in research and commercial development at the junction of healthcare, biotechnology, and food industry;

- **Clubster Santé** — regional cluster operating in close contact with hospitals to help companies develop solutions adapted to meet doctors' and patients' specific requirements.

ESTONIA

«The Management of Support»

Connected Health

PIRET HIRV

Cluster Manager
Connected Health

I am the manager of the cluster and also of the health technology division in Tallinn Science Park Tehnopol. At the beginning, the park drafted applications for EU funding, which helped not only complete the cluster establishment, but also launch the first joint projects of our members.

The Connected Health cluster organisation reports to the national business development agency Enterprise Estonia, which administered the EU grant allocated to fund the cluster's creation. The money was used to pay for marketing services and support joint projects (on the 50/50 co-funding basis). Nine projects were implemented altogether, each comprising at least three cluster members. The total amount of funding was 395,000 euros. The objective was to teach companies within a cluster jointly create ICT solutions for the healthcare sector. In particular, the following products were developed:

- **TempID** — a smart thermometer integrated with a smartphone;
- **Wizelife** — a healthy lifestyle digital platform, which designs personal recommendations for participants based on the results of various tests;
- **Diagnostic Match** — a software application for therapists, allowing them to identify people in the HIV risk group;
- **DocuMental** — a digital platform comprising internationally recognised tools for diagnosing, and making treatment recommendations for patients with mental diseases.

The three-strong Tallinn Science Park Tehnopol team is responsible for organising all events, promoting cluster members on domestic and international markets, issuing information materials, and supporting joint projects.

SUCCESS FACTOR 4.

SUPPORT FROM THE REGIONAL AUTHORITIES

Most of the biomedical clusters bring together the whole regional community of companies and organisations active in the healthcare sector and related industries (such as the production of medical equipment and pharmaceuticals, ICT, the food industry, etc.). The region serves as a cluster's institutional basis; it provides specialised infrastructure, access to which is vitally important for cluster members. Regional budget is frequently the main source of initial funding for the cluster organisation. Even if no public financing is provided, information and organisational support of regional authorities is politically important (e.g. while dealing with the national government and development institutes, engagement in the drafting and adjustment of healthcare regulations and programmes).

DENMARK – SWEDEN

«ReproUnion Project: Two Regions' Common Success»

Case of Medicon Valley

PETTER HARTMAN

MSc in Political Science, CEO
Medicon Valley Alliance

Medicon Valley is a regional cluster. From the public side, we have only regional bodies involved from both countries that support us. Our mission is not simply to talk so much about two different regions of Denmark and Sweden, but about Öresund – one region, the things we have in common, and how we can utilise them. Historically there has always been a strong bond between the two nations. This value stands up in the intercalation competition: we want to create a strong lifestyle cluster because we have so many universities, so many companies in our regions. There is a special EU fund, which supports Swedish-Danish collaboration. We managed to break down the national barrier and make a patient mobility agreement between Sweden and Denmark, which gives people in both countries the opportunity to receive the best possible infertility treatment. In addition to the benefits of many couples who could become parents, the agreement is also an example of how we can win by linking competences on both sides of the Öresund. Fertility is the first medical area in which patient mobility was introduced. I think ReproUnion could act as a model for cross-border projects in other therapeutic areas as well.

The objective of ReproUnion is to establish the multidisciplinary Reproductive Medicine Centre in the Öresund region, the cluster's home location.

One of the project's important results was signing a mobility agreement for infertility patients between the southern parts of Sweden and the capital area of Denmark. Now residents of both countries have mutual access to high-technology medical services in the reproductive health and fertility fields. This means that couples from Sweden and Denmark will be able to receive specialised treatment in the areas where Danish and Swedish clinics have unique competencies and experience (e.g., ovarian transplantation at the Copenhagen Rigshospitalet; a special analysis of biological material at the Skåne University Hospital laboratories in Malmö).

ReproUnion comprises 13 clinics and research centres on both sides of the Öresund strait.

The project was initiated by the cluster's management company – Medicon Valley Alliance, which is responsible for all administrative aspects (such as the development of common standards and procedures, coordination of activities, etc.). In addition to helping hundreds of men and women striving to become parents, the project opens wide opportunities for the cluster members' international cooperation in clinical research, the provision of medical services, and next-generation staff training which builds up competencies and strengthens the competitiveness of the whole transboundary region.

ReproUnion was one of the finalists of the RegioStars Awards competition for best regional development practices.

Fifty per cent of the project funding is provided by the EU Regional Development Fund – ERDF, in the scope of a targeted programme to support research-intensive innovative projects in the Öresund area (Interreg V-A - Sweden-Denmark-Norway, Öresund-Kattegat-Skagerrak). The companies' share in ReproUnion funding is 10%, the rest is provided by the regional authorities and universities.

Other Medicon Valley's projects have been funded in line with this scheme too, such as:

- **KADABRA** — a project on synchronising the databases of medical organisations, insurance companies, and biobanks in the two countries, to reduce administrative barriers and help patients;

- **Medicon Valley Beacons** — a project to support development in priority biomedicine and life sciences areas, where the cluster is among the leaders (including immunology, drug delivery systems, systems biology, and structural biology). In particular, communication platforms will be set up to speed up the transfer of R&D results to production; members planning joint projects will receive help with finding investors;

- **Medicon Valley Ambassador Programme** — a project to strengthen cluster members' international cooperation. The cluster has appointed "ambassadors" in three key geographical areas: Eastern and Western coasts of the United States and South-East Asia. The ambassadors are authorised to represent Medicon Valley members in dealings with international partners, establish new contacts, find investors, prepare analytical materials, arrange meetings, organise business deals, and other activities.

THE NETHERLANDS

«Peaks in the Delta»

Case of Health Valley Netherlands

CHRIS DOOMERNIK

MSc MMO, Managing Director
Health Valley Netherlands

Our main partner is the regional government. At the beginning, their funding was 90% of the whole cluster budget. They still give us a subsidy to pay our personnel.

The cluster was established after the provinces of Gelderland and Overijssel adopted a development concept as a part of the national Peaks in the Delta (Pieken in de Delta) initiative. The idea was to bring together businesses, knowledge centres, and regional institutes around the core made by the universities of Wageningen, Nijmegen and Twente. The concept was supported by the Ministry of Economic Affairs. The next step towards establishing the cluster was the Health Valley initiative by the Regional Development Agency East Netherlands Oost NL (now an advisor of the cluster board). It aimed at identifying and supporting innovative joint projects in the healthcare sector implemented by members of the regional ecosystem (the Health Valley Netherlands Foundation was established specifically for this purpose). The cluster emerged in its present form when the Gelderland authorities, Radboud University of Nijmegen, and a number of key companies from Eastern Netherlands decided they needed a reliable intermediary to facilitate cooperation in transferring R&D results to product development, and then into clinical practice, which would be capable to professionally organise and maintain collaboration between relevant parties.

FRANCE

«Our Mission is to Help All Members of the Regional Ecosystem»

Eurasanté

CAROLINE SIMOES-AUBERGER

Communication and Strategy Manager
GIE Eurasanté

The regional funding is to help create jobs on our territory and develop businesses and research in the healthcare sector. Today there are more than 1,000 companies in the Hauts-de-France region, with more than 30,800 employees (with the growth of 9% last year), and 4,000 researchers from both the public and private sectors.

At the initial stage of the cluster's creation, in 1994, all Eurasanté's costs were met from public sources. Today the balance of public and private funding is approximately 60% and 40%, respectively. Services available to all members of the regional ecosystem include the facilitation of communications between industrial companies and R&D organisations, potentially leading to the emergence of new joint projects, international promotion of local companies, access to innovation infrastructure and commercial real estate; there are also personalised services such as legal consulting or help with finding investors. Eurasanté participates in various European programmes, which cover up to 50—60% of the projects' costs using EU sources.

SWITZERLAND

«Medical Confederation»

Health Tech Cluster Switzerland

DR PATRICK DÜMMLER

Cluster Manager
Health Tech Cluster Switzerland

In the beginning, our cluster was an initiative from the canton of Schwyz, i.e., it was not coming from the business side. The canton thought it would make sense to have a regular exchange with companies focusing on health technology. So they were looking for relevant enterprises, brought them together, which finally emerged into a cluster. Very soon they realised it must be something encompassing the whole of Switzerland instead of just one region. They actually said "We want to expand our network from the central part of the country and make it nationwide".

The cluster was established four years ago by the Schwyz canton's council. Today all cluster members including the canton councils pay membership fees. Regional authorities' contribution amounts to 10% of the cluster's budget; the state provides no other financial support. The remaining 90% comes from private companies' membership fees and earnings from events and trade shows.

SUCCESS FACTOR 5.

NATIONAL-LEVEL RECOGNITION OF THE CLUSTER

Biomedical clusters' impressive results are largely due to the fact that their management companies and members are involved in the national healthcare policy. They take part in expert commissions' meetings; actively interact with the public authorities and the medical community as participants of, or consultants for, various high-level projects and programmes. Healthcare is quite a conservative (as many people believe) socioeconomic sphere regulated usually at the countrywide level of governance. National recognition is critical for biomedical clusters and may open far-reaching opportunities to apply innovations.

DENMARK – SWEDEN

«Rivalry is Losing, Cooperation is Winning»

Case of Medicon Valley

PETTER HARTMAN

MSc in Political Science, CEO
Medicon Valley Alliance

Many things we discuss in our cluster are cross-border and depend on the decisions of two national governments. One of the largest problems we have is that the central authorities of Sweden or Denmark do not always support the idea of Medicon Valley as an integrated cross-border cluster. Sometimes at the regional level, policymakers agree with us that we need to support Danish-Swedish Öresund region, while the politicians up in Copenhagen or Stockholm may say "We should not necessarily have this close connection because it interferes with our national agenda".

Both governments have chosen to focus on the life sciences sector. More often the cluster loses from their competition and benefits from their collaboration. For instance, in the EU countries' campaigns to host the European Medicines Agency (which had had to leave London as a result of Brexit), Sweden chose to compete rather than collaborate with Denmark. And what happened obviously was that both countries lost and the agency would be placed in Amsterdam instead.

An alternative solution based on working together was chosen at the establishment of the European Spallation Source. In this case, Stockholm and Copenhagen joined forces nationally. It was a mutual decision that the facilities should be placed on the Swedish side and the joint Danish-Swedish bid actually won.

So, if I look five years ahead, I would like to see more involvement of national authorities in the cluster support.

In 2016-2017, projects to build two world-class research infrastructure facilities were launched in the Öresund region and specifically in the Medicon Valley cluster: the MAX IV Synchrotron Radiation Laboratory and the European Spallation Source – ESS. The multimillion investments, international recognition of the cluster as a unique biomedical and life sciences research centre, new opportunities for cluster members to implement joint projects and attract international partners – all of this became possible due to collaboration between the Danish and Swedish national authorities.

The ESS is a multi-disciplinary research facility based on the world's most powerful neutron source. Its construction will open new opportunities for scientists specialising in a broad range of areas such as life sciences, biomedicine, and biotechnology. It includes a powerful proton accelerator, various laboratories, supercomputer data centres, and software development centres. All ESS research infrastructure is currently being constructed on the Lund University campus, while the data centres are already operating in the COBIS science park in Copenhagen.
The project budget is 1.7 billion euros. The Swedish contribution is 35% and the Danish one is 12.5%. Neutron testing is expected to begin in 2019 and construction is scheduled to be completed in 2025.

The MAX IV Synchrotron Radiation Laboratory was opened in Lund in 2016. It is the largest Swedish research infrastructure investment project, which will open opportunities to study molecular structures and surfaces with the highest possible level of detail, using top-quality X-ray beams, to university and corporate scientists from various countries.
The MAX IV will allow them to create advanced precision-action drugs with minimum side effects. Investments in the first 14 beam installations amounted to 384 million euros; the total number of beams is expected to reach 28, while the total project budget by 2026 will exceed 570 million euros.

In 2017, the ESS and MAX IV signed a cooperation agreement in the life sciences area, based on the mutual use of beams and neutron.

THE NETHERLANDS

«Moving towards E-Health Together»

Case of Health Valley Netherlands

CHRIS DOOMERNIK

MSc MMO, Managing Director
Health Valley Netherlands

We have good relations with the Dutch government (though we are not a syndicate or lobby). We meet a few times a year to discuss new initiatives and how we can make each other stronger. Two main national ministries we cooperate with are the Ministry of Economic Affairs and the Ministry of Health, Welfare and Sport. Their representatives visit the events organised by Health Valley Netherlands and thus raise their status and visibility. Last year Ministry of Health, Welfare and Sport wanted to increase e-health initiatives in our country by introducing special electronic applications at hospitals. But not all of them could automatically implement it. So the ministry asked us to make it easier for healthcare organisations to adapt these innovations. It was not a subsidy, but a commercial project for us.

In 2017, the Dutch Ministry of Health, Welfare and Sport proposed an initiative to establish a national e-health system. The goal was to improve the quality and accessibility of medical services, involve the patients in preventive medicine, treatment, and care practices, and reduce hospital staff's workload through active application of ICT. For example, that included the wide adoption of remote monitoring and consultation technologies (telemedicine) by creating an online environment where people would be able to have round-the-clock access to providers of healthcare services, conduct certain measurements by themselves under the online supervision by doctors, and the medical staff would be able to integrate certain nursing procedures into their patients' daily schedule. Cluster organisation of Health Valley Netherlands became the ministry's partner in implementing one of the major projects within the national initiative – Pilot Acceleration Brokers (Pilot Versnellingsmakelaars). Three brokers, one of whom was Health Valley Netherlands, worked for five months in the regions selected for testing, namely in the Utrecht province, in the metropolitan Amsterdam agglomeration, and in the Eastern region (the provinces of Gelderland and Overijssel) (fig. 3.1).

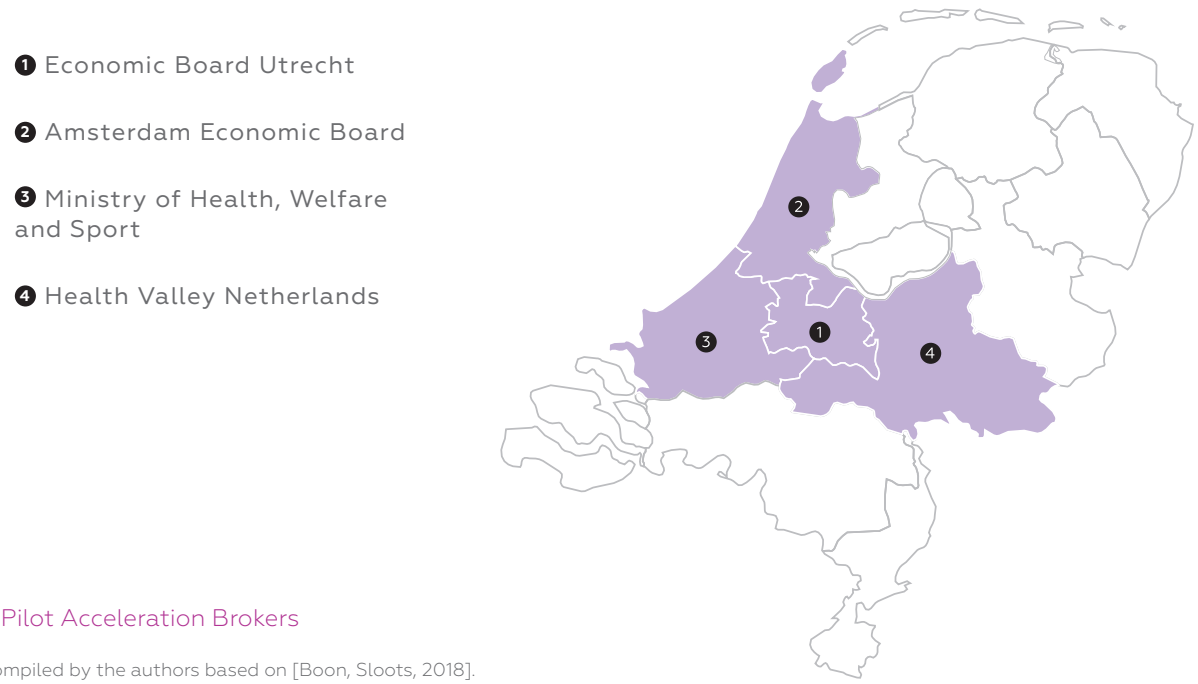

Fig. 3.1. Pilot Acceleration Brokers

Source: compiled by the authors based on [Boon, Sloots, 2018].

Their objective was to identify barriers hindering the application of ICT in medical practices and suggest the best ways to accelerate the transition to an e-health system. The project budget was 50,000 euros per region. As a broker, Health Valley Netherlands organised the networking of regional doctors' and patients' communities with companies developing digital solutions for the healthcare sector. Three kinds of networks were identified: to develop a business model for implementing innovations, to deal with related legal issues, and to test new products in living labs. Helping businesses obtain feedback from medical care recipients to improve their new developments is one of the special services provided by the cluster in partnership with living labs. They test innovations in areas such as first aid, care for the elderly and people with mental or physical disabilities. That experience turned out to be quite valuable for the national initiative too: the technology for interacting with living labs to speed up the application of ICT innovations approved by patients and doctors into medical practices was recognised as successful and recommended for implementation in other Dutch regions.

ESTONIA

«National Partnership for Digital Medicine»

Case of Connected Health

PIRET HIRV

Cluster Manager
Connected Health

Connected Health has partners from different counties of Estonia; we really try to create a special ecosystem for developing medical services nationwide in cooperation with the public institutions. The Ministry of Economic Affairs, the Ministry of Social Affairs, and the Health Insurance Fund are a part of the cluster. The government is very important. It is the only organisation, which creates conditions for the cluster companies to do business.

We help them interact with public authorities. For example, now, all EU member states are facing legal changes regarding private data protection – General Data Protection Regulation – GDPR. Many organisations become confused because they have to amend some procedures, their documentation, which is complicated and expensive, actually. We provide training sessions and invite officials to speak to our members so that they can find out what to do as part of their routines.

The Connected Health companies operating at the junction of ICT and medicine develop software products for the National e-Health System created in Estonia in 2008. All providers of medical services who use the centralised patient database are connected to the system. It comprises more than 20 million records (test results, check-up and vaccination records, clinical histories, etc.). Everybody who has ever applied for healthcare assistance gets a personal account that can be accessed via the integrated portal. By now, 95% of medical organisations' data is digitalised and 99% of prescriptions are issued in electronic format. The government has put in place the infrastructure for the application of new products and services developed by private businesses. Cluster companies – Nortal and Helmes – act as the government's key partners in this major national project.

For example, Nortal was one of the developers of clinical information exchange systems, electronic medical records, and patient portals. As early as in 2003, the company created an integrated information system for the Tartu University hospital. Nortal is an expert in adapting to digital standards. One of such standards the company developed on its own was for user devices communicating with the national medical records system. Now Nortal advises the government and cluster member companies on the application of GDPR. Its services would help developers to take into account the new requirements for products from the very beginning of the design process.

Helmes developed an electronic system that allows doctors and pharmacists to have joint access to the prescriptions database, while patients only need to hand over their electronic card at a drugstore to buy the medicines they require. The second product the company designed in the scope of the national e-health project was the eHIS information system for hospitals. It is a modular platform for clinics, comprising various subsystems such as patient administration, electronic medical records, and X-ray examination data.

TURKEY

«Cluster as a National Initiative»

Case of Istanbul Health Industry Cluster

SEDA ŞENOL

Cluster Manager
Istanbul Health Industry Cluster

As a cluster, we have been funded by the Turkish Ministry of Industry and Technology since 2017. We also received support from our founding members (Teknopark Istanbul, Bosphorus Unıversity, Acıbadem University, Sabancı University, and the Istanbul Chamber of Industry). Cluster membership is now free; besides, private investors are more interested in mature projects or in single companies. So public financing is very important. Close relations with policymakers are a must in our cluster projects. For example, the government is the main purchaser of medicines and medical devices in Turkey.

The cluster emerged on the basis of Inovita – Istanbul Cooperation Platform for Life Sciences and Technologies, which is an online communication network designed to facilitate collaboration between participants of the healthcare sector and foster the application of R&D results. The project was funded for a year by the Istanbul Development Agency. Subsequently, the agency financed another year-long project of the Incubation Centre to promote high-technology biomedical start-ups. Both these projects contributed to launching the institutional basis for the future cluster: a communication network, and a tool to nurse start-ups. The cluster was eventually established thanks to the funding provided by the Turkish Ministry of Industry and Technology. Between 2017 and 2022, public support for Istanbul Health Industry Cluster should amount to about 2.5 million euros.

SUCCESS FACTOR 6.

INVOLVING PATIENTS AND DOCTORS

Innovations that could improve the quality of medical treatment frequently have to go a long and arduous road before they are applied in clinical practice. This is due not only to the high level of regulation in the healthcare sector but also to its inherent conservatism (of doctors and patients alike). Medical discoveries can be transformed into commercial products or services, but they become really successful on the market only if there is sufficient demand for them. Involving patients and doctors in the development and testing of innovations has become a common practice in many biomedical clusters.

FRANCE

«Where Does It Hurt?»

Case of Eurasanté

CAROLINE SIMOES-AUBERGER

Communication and Strategy Manager
GIE Eurasanté

We make the link between hospitals and companies by organising a French national initiative called "Challenge Numérique" every year. The idea is that one medical organisation is invited to indicate a need in e-health, and then there is a competition among regional IT companies to bring the best solution that would meet the hospital's requirements. Finally, one firm wins the challenge, and we then accompany it to implement the innovation at the medical organisation.

We also do a lot of work with patient associations. For four years we have organised challenges to come up with new developments for healthy ageing. The competition, named "Silver Surfer", involves old people living at home or in geriatric facilities and their caregivers; together they decide what an innovation should be. To organise the challenge, we formed partnerships with hospitals, associations of disabled seniors, and retirement homes.

The Eurasanté members are convinced that many innovative ideas in medicine emerge from hospital staff's daily practices. Doctors are the ones who create demand for new medical technologies, by highlighting problems, the solving of which may sometimes require unconventional approaches. Doctors may also be able to suggest innovative ways to provide patient treatment or organise the healthcare system. The cluster's objective is to connect ideas generated and problems identified by medical personnel with companies that could develop practical solutions. **Eurasanté has been holding technological competitions and those rewarding innovations pioneered by healthcare professionals to further their development on the market.**

Competitions of the first type are organised for high-technology companies in the scope of the Challenge Numérique national initiative. The objective is to select the best solution for a specific problem identified by a clinic or another medical organisation for subsequent implementation. For example, in 2017 contestants had to propose a methodology for predicting the national demand for labile blood components, following sharp fluctuations of such demand noted by the French Institute of Blood (L'Etablissement Francais du Sang – EFS). The winner was the OpenHealth Company, which suggested a technological solution allowing one to aggregate a large volume of data from the EFS and other sources (including the National Healthcare Institute, regional statistical offices, etc.), and analyse it in real time. The company' project PREVI-PSL received 70,000 euros from Bpifrance (a state investment bank) and the opportunity to complete the work together with OVH, a European leader in cloud computing.

The technological competition format helps the cluster to promote members on international markets and attract foreign partners. For example, in September 2018 in the scope of the EU Interreg France (Channel) England programme to support joint French-British initiatives, Eurasanté together with its UK partner – South East Health Technologies Alliance launched the SMARTHEALTH project (the budget is 494,500 euros). The objective is to help e-health SMEs operating on both sides of the English Channel design innovative solutions requested by clinics and

assist them in other areas such as procurement and entry onto foreign markets. In the scope of the project, French clinics are setting objectives for firms in the United Kingdom, and vice versa.

The second type of competitions, for new ideas, is held for nursing personnel. These are the people who take care of patients on a daily basis, so they know the latter's needs and specific requirements like nobody else, which is something that could trigger the innovative process. The Eurasanté team helps such professionals to transform their ideas into practical results. The six years of holding such competitions show that some of the winners may create a firm, and some choose to remain in medicine and sell the rights to their know-how.

One of such competitions helps the cluster develop services and products for the silver economy sector. They are held in several stages: submitting applications, selecting the five best projects to receive 50,000 euros (to share) for creating a proof-of-concept, and then selecting the final winner(s) by a jury of elderly people and caregivers.

The Silver Surfer-2017 champions were:

Unaide – a device for round-the-clock monitoring of elderly people's health;

Connect'Age – a series of computer games to train memory;

Officina Santé – an app to combat the insomnia;

HEROIC – a platform for interactions between the elderly and their caregivers, which allows one to jointly improve the care;

E-wear Solutions – an experimental series of clothing for the elderly, with sensors to monitor their health (the People's Choice Award).

ESTONIA

«We Want to Design Solutions with You, Not for You!»

Case of Connected Health

PIRET HIRV

Cluster Manager
Connected Health

We have patient organisations as partners of our cluster, which are really important for us. They are the recipients of the healthcare services. So we definitely need to have them as part of our ecosystem, because how else can we know the problems to be solved. One of the concrete forms to work with patients is hackathons. For example, one such activity we had was part of the HIVdigital competition in 2017. We talked to people with the HIV-positive status and their doctors trying to identify the largest issues in treatment. Then we organised hackathons to find what can be solved with digital tools. Some of our hospitals are functioning as living labs. They co-create innovative products together with companies and then test them.

Connected Health holds a competition for digital solutions to improve HIV treatment and prevention. It aims at promoting breakthrough e-health innovations, supporting the transfer of the best ideas into products, and involving the public in dealing with the AIDS proliferation problem. HIV-digital is organised in three stages. The first stage includes the collection of novel ideas and team building. At the second, prototypes of future innovative products are developed on the basis of the best concepts. At the final stage, the solutions are tested and prepared for dissemination. The project participants are engineers, programmers, entrepreneurs, project managers, doctors, social workers, and most importantly, patients and their relatives. Everybody can suggest an idea to help HIV-positive people fight the disease and limit its proliferation.

The winners of HIVdigital-2017 were two solutions designed to meet real-life problems encountered by patients and doctors, with the direct participation of both of these groups. The first invention was the Diagnostic Match application, which allows general medical practitioners in a few seconds' time determine whether the patient needs to be tested for HIV. The second one was the mobile hINF application for people with the HIV-positive status, allowing them to conduct planned check-ups remotely, halving the number of required visits to the doctor.

Connected Health continues to work with patients in the scope of the international ProVaHealth project. Its main objective is testing new products and technologies in real-life conditions. Another objective is exchanging best practices of promoting living labs and encouraging their application by SMEs in the Baltic Sea region. The ProVaHealth project partners are ScanBalt (international bio-economy and healthcare project accelerator), and the European Network of Living Labs.

THE NETHERLANDS

«FieldLabs: Patients- and Technologies-Based Healthcare»

Case of Health Valley Netherlands

CHRIS DOOMERNIK

MSc MMO, Managing Director
Health Valley Netherlands

Our cluster's focus is very broad, but the main topic is healthcare innovation (e.g. in pharmaceuticals, medical devices, or patient treatment). In Health Valley Netherlands, we have hospitals, and also organisations for the disabled, people with mental diseases, and home care associations. Thus, other cluster companies have the unique opportunity to test and evaluate their innovations through the various FieldLabs[3]. Such collaboration allows businesses to bring improved products and services on the market, and consumers get solutions tailored to their needs.

[3] The "FieldLab" term is more commonly used in the Netherlands; its meaning is similar to that of a living lab.

The Health Valley Netherlands cluster helps members launch new projects or join existing initiatives on testing innovations with the participation of patients in a living lab format. For example, the FieldLab Disabled Care project was launched by the cluster member Siza (provider of care for people with physical or mental disorders, autism, or acquired brain injuries). Cluster members developing innovative products and services that could help such patients had a chance to test their solutions and improve them based on direct feedback from users. Successful innovations created in the cluster due to cooperation with patients in the scope of FieldLab Disabled Care include the GoOV cell phone application, which allows people with limited mobility to freely and safely use public transport.

SUCCESS FACTOR 7.

COMPREHENSIVE APPROACH TO SUPPORTING INNOVATION: INFRASTRUCTURE, START-UPS, AND UNIVERSITIES

Clusters are complex phenomena affected by various factors. One of them is the quality of the environment in which members operate, measured via the level of basic and specialised infrastructure development. The biomedical clusters we have analysed are located in the areas with high concentration of world-class research and production facilities. Cluster management companies often have partnership agreements with science parks or business incubators, which, among other things, imply special conditions for start-ups (e.g. no membership fees, or free access to various services). Newly-established innovative businesses are important to biomedical clusters as a source of breakthrough unconventional solutions emerging at the junction of healthcare, high technologies, and patients' needs. In the majority of cases, research-intensive initiatives are based upon the intellectual potential of universities and other knowledge centres. Typically, they are members of clusters, and in some cases have even initiated their establishment.

DENMARK – SWEDEN

«The Öresund Bridge: Two Countries, One Cluster»

Case of Medicon Valley

PETTER HARTMAN

MSc in Political Science, CEO
Medicon Valley Alliance

Back in the days of 1990s, when the cluster initiative was just emerging, there was a decision to build a bridge connecting the southern parts of Sweden and the capital area of Denmark. Everyone was very optimistic because the construction would mean so much for the whole Öresund region. Sweden and Denmark both had really strong life sciences sectors; building the bridge was a good way to start cross-border integration and reinforce the Danish-Swedish Medicon Valley as Scandinavia's leading life sciences cluster. I think, in terms of infrastructure, the most important thing at the beginning was the bridge. There would be no cluster without it.

The Öresund Bridge created basic conditions for much easier contact between participants of the cross-border macro-region's innovation ecosystem. Thanks to the effort of the joint Danish-Swedish team, the cluster initiative emerged along with implementing the newly built infrastructural potential and filling it with tangible content. The competencies of major companies Novo Nordisk, Lundbeck, Ferring Pharmaceuticals, and LEO Pharma located on the Danish side of the Öresund strait were reinforced with the unique innovation infrastructure facilities in the Swedish part of the cluster. Almost 800 people go across the bridge every day from Sweden to Denmark and vice versa to work at cluster member companies. The largest Danish firms with Swedish staff are Novo Nordisk (212 employees), Ferring Pharmaceuticals (121), and Lundbeck (73). Similarly, the Swedish Medicon Village science park employs 40 Danish workers.

This practice allows people to combine high Danish salaries with low living costs in Sweden. In turn, Sweden attracts Danish companies with broader access to venture capital and highly profitable investment opportunities at the stock exchange.

Six large science parks located in the Öresund region make a major contribution to the creation of new biomedical companies in the cluster. On the Swedish side, it is Ideon in Lund (the oldest park in the cluster, built in 1983) and Medeon in Malmö, while on the Danish side these companies are Symbion and Scion DTU. In 2012, two new facilities were launched: COBIS near Copenhagen and Medicon Village in Lund.

GERMANY

«Innovation Infrastructure Hub»

Case of HealthCapital Berlin-Brandenburg

DR KAI UWE BINDSEIL

Cluster Manager
HealthCapital Berlin-Brandenburg

Berlin is a city of start-ups. The lively mix of economic players and scientific institutions, the diverse selection of initiatives, the beneficial location factors and the growing number of IT companies make the German capital region a unique hub for start-ups and digital health solutions.

One of the cluster's success factors is the location at the core of Berlin and Brandenburg's innovation infrastructure, which comprises more than 60 facility units. Many of them are focused on the healthcare sector. For example, Bayer Grants4Apps Accelerator, Pfizer Healthcare Hub Berlin, Flying Health Incubator, helios.hub, Startupbootcamp Digital Health, Heartbeat Labs, and B. Braun Accelerator.

Cluster members have access to the services provided by eight leading parks in the country, such as:

Berlin Adlershof — the largest S&T park in Germany, one of the leading R&D support centres in the biomedicine and pharmaceuticals sphere. Companies have access to laboratories, office space, and production facilities. One of the park's residents, Eckert & Ziegler AG, is a member of the cluster;

Berlinbiotechpark — this technology park was built on the former premises of the Schering Pharmaceuticals; accordingly, all infrastructure is designed to meet the requirements of biotechnology and medical companies. Members

of HealthCapital Berlin-Brandenburg who are residents in this technology park include Bayer AG and Carl Zeiss Meditec AG.

BiotechPark Berlin-Buch is located very close to Berlin's key medical research and service centres. The main partners include the Charité University Hospital, the Max Delbrück Centre for Molecular Medicine in Helmholtz Association, and the Leibniz Institute for Molecular Pharmacology (Leibniz-Forschungsinstitut für Molekulare Pharmakologie). They have established the Experimental and Clinical Research Centre to implement interdisciplinary projects, which allows them to quickly test various innovative designs.

The cluster member companies who are residents in the biopark include B. Braun Melsungen AG, Bayer AG (owns 20% of the park's shares), Glycotope GmbH, and Sanofi-Aventis Deutschland GmbH.

FRANCE

«Eurasanté Bio Incubator: From Start-Ups to Major Companies»

Case of Eurasanté

CAROLINE SIMOES-AUBERGER

Communication and Strategy Manager
GIE Eurasanté

The Eurasanté Bio Incubator helps facilitate projects emerging from the regional healthcare sector to encourage the creation of innovative companies. The incubator was set up in 2000 and is approved by the French Ministry of Higher Education and Research. It supports various innovative biology, health, or nutrition projects resulting from public and private R&D. Since its foundation, the incubator facilitated more than 140 such projects and contributed to the establishment of more than 75 companies and 500 jobs. In 2017, it was ranked among the top 15 best biotech incubators in Europe for the emergence of innovative start-ups (Labiotech.eu) and has the "French Tech Ticket" label, which means that it is able to welcome young foreign entrepreneurs willing to set up a new branch in France.

Located in the Eurasanté Bio-business Park, the Eurasanté Bio Incubator provides companies with a 2,000-square-meter state-of-the-art building, which houses labs, offices, and shared facilities.

Acting as a real driver of innovation, the Bio Incubator team works together with project initiators and entrepreneurs to help them at every stage of their projects.

Global companies grown in the Eurasanté Bio Incubator include:

- **ImaBiotech** — a Contract Research Organisation – CRO, specialising in assessing new drugs. Established in 2010, in four years' time the company grew by 320%. Currently, it has more than 200 clients, European, US, and Japanese pharmaceutical firms, and has conducted 300 trials for them. In 2017 ImaBiotech opened its second US office;

- **Genfit** — a biopharmaceutical company operating at the cutting edge of developing therapeutic and diagnostic solutions for patients suffering from metabolic and inflammatory gastrointestinal diseases. It was established in 1999. Fifteen years later, its capitalisation exceeded 150 million euros. Genfit is a world leader in designing non-alcoholic steatohepatitis treatments;

- **Mdoloris Medical Systems** — a producer of equipment for ongoing non-invasive pain monitoring, including for unconscious patients. The company was established on the basis of 23 years' worth of R&D conducted.

DENMARK – SWEDEN

«The Founding Fathers of the Cluster»

Case of Medicon Valley

PETTER HARTMAN

MSc in Political Science, CEO
Medicon Valley Alliance

The cluster was actually initiated by two universities; they were Lund University on the Swedish side and Copenhagen University on the Danish side at the very beginning. When they applied for EU funding to create a network organisation, Medicon Valley Alliance was called Medicon Valley Academy, which illustrates that it was more about university-driven collaboration at that time. The universities were a sort of the clusters' founding fathers.

Nine universities (five in Denmark and four in Sweden) define the cluster's R&D profile in the life sciences area. For example, Copenhagen University and Lund University conduct world-class studies in neurophysiology and diabetes treatment. The Technical University of Denmark and Malmö University are leading bioengineering centres. Medicon Valley's key research concerns metabolic problems, the use of stem cells, and cancer treatment. The universities' scientific advances are in demand by the cluster companies. For instance, Novo Nordisk and Lundbeck fund diabetes and neurology research. The Regenerative Medicine Centre is being built on the Lund University campus and is sponsored by the Wallenberg Foundation.

TURKEY

«The Cluster's Cradle»

Case of Istanbul Health Industry Cluster

We were born from the Bosphorus University; our story began at the University Centre for Life Sciences and Technologies. Now, the cluster acts as a bridge between academia and private sector under the supervision of Teknopark Istanbul.

SEDA ŞENOL

Cluster Manager
Istanbul Health Industry Cluster

Universities have played an important role in the development of Istanbul Health Industry Cluster since its establishment. The project, which has ultimately led to the implementation of the cluster initiative, is called Inovita. It is a platform for cooperation between businesses and R&D organisations in the biomedical area founded by the Bosphorus University Centre for Life Sciences and Technologies. The cluster currently includes 19 university R&D divisions. Representatives of Bosphorus Unıversity, Acıbadem University, Sabancı University comprise the cluster's Board of Directors responsible for strategic management.

The coordinator of the cluster is Teknopark Istanbul, which is the largest technology park in Turkey. Its main duties are to increase cooperation and interaction between members, organise communication events, promote cluster companies on domestic and international markets, arrange training programmes, strengthen existing academic research and service infrastructures, guide start-ups in securing funding within the scope of existing national programmes and other mechanisms, and provide shared access to research infrastructure.

4 THE MOSCOW INTERNATIONAL MEDICAL CLUSTER:

ITS VALUE FOR THE CAPITAL CITY AND FOR THE NATIONAL HEALTHCARE SYSTEM

A unique path or the mainstream?

Each stage of our research was preceded by specific questions. We tried to find out the answers to the following. Which positive effects do biomedical clusters create? What does their global landscape look like? What exactly makes these clusters successful? The ultimate goal of the study was to summarise worldwide experience and define the Moscow International Medical Cluster's place in the system of discovered coordinates. Do the factors that determined the success of the world's leading biomedical clusters also apply to the MIMC or is it travelling its own path? We have tried to answer this question by analysing the professional views of doctors, biomedical researchers, scholars, governmental officials, and members of the cluster management team regarding the MIMC's certain features and the role it plays in the development of the Moscow and overall national healthcare systems. Expert opinions collected by interviewing the representatives of the Russian professional community and reviewing the MIMC's media coverage revealed that the Moscow International Medical Cluster not only fits the trends of the world's biomedical clusters and their best practices, but can offer a number of original solutions to its peers abroad.

1. THE MIMC

AS A NATIONAL CENTRE FOR DISSEMINATING THE BEST GLOBAL MEDICAL ASSISTANCE AND CLINICAL MANAGEMENT PRACTICES

SERGEY PETRIKOV, DR MED. SCI., Professor of RAS
Director of N.V.Sklifosovsky Emergency Medicine Research Institute

The main output of the MIMC project is technology transfer. Clinics that are members of the cluster will employ international personnel, but most of their staff will be Moscow doctors who will be able to learn and then apply the newly acquired skills at various medical centres in the capital city, public and private ones alike.

Source: [Kommersant special issue, 2018].

The mission of the Moscow International Medical Cluster is to provide and develop world-class patient treatment services in Russia. Therefore, one of the cluster's priority goals is introducing advanced international practices in the Russian healthcare system.

The review of global experiences revealed that the main value clusters create for their participants the world over (which subsequently converts into their success) is communication. It can be local (exclusive "members only" events), subject-specific (between professionals of the same area, e.g., cardiologists, microbiologists, clinic managers, nurses, etc.), interdisciplinary (between patients, doctors, and IT product developers), or international (events at home or abroad with global participation).

MARAT KHUSNULLIN, PhD

Deputy Moscow Mayor for Urban Development and Construction

The MIMC has the potential to not only treat patients but share experiences, teach students, improve the skills of doctors countrywide, and integrate Russian and international healthcare systems.

Source: [Kommersant special issue, 2018].

The best international clinics opening branches in the MIMC on the one hand, and the cluster's openness to doctors from all over Russia on the other, will help create a new platform for international knowledge exchanges.

The MIMC also serves as a platform for consolidating the professional community, where medical industry actors, representing patient care, academia, business, and government, interact between themselves and with the overseas partners.

The communication opportunities the MIMC offers are unique because the cluster gets Russian professionals from all over the country involved in global competence transfer, with the participation of the best healthcare players in relevant groups.

YURY KRESTINSKY

Director of Healthcare Development Centre (Moscow School of Management SKOLKOVO), Chairman of the Board at Bionica Group of Companies

Having branches of leading clinics from various parts of the world located close to each other in the same area can foster the emergence of a new global communication centre in Moscow, promoting exchanges of medical competences.

Source: exclusive interview.

KONSTANTIN TSARANOV, MD, PhD, MPA

Director of Healthcare Development Centre at the Moscow City Government University of Management

The cluster is a laboratory for testing and applying advanced technologies in the Russian healthcare system – not just clinical but management ones too. I'm sure the MIMC can become a major international experience sharing platform.

Source: [Kommersant special issue, 2018].

2. THE MIMC

AS AN ACCESS POINT TO INTERNATIONAL TRAINING OPPORTUNITIES FOR RUSSIAN DOCTORS

Education and training are at the MIMC's core, along with research and the provision of medical services. In this regard, the cluster's efforts are focused on raising a new generation of professionals for the Russian healthcare system on the basis of the OECD-approved curricula and teaching techniques.

The MIMC plans to develop and implement various kinds of training programmes, in particular:

- **healthcare management** (MBA and quality management in medicine), with the participation of professionals from France, the Republic of Korea, the Netherlands, Israel, the US, and other countries;
- **training doctors and nurses** in various specialised fields using advanced evidence-based medicine models, patient-oriented approaches, and 4P medicine principles[1].

These will be supplemented by supporting events such as discussion clubs' meetings and roundtable talks. Internships are a particular area of the cluster's education activities.

Not many Russian doctors striving for professional development can afford a long internship abroad. The cluster's medical organisations intend to rotate their staff on a permanent basis, so within about two years' time doctors gain new knowledge and experience and return to their home clinics with a radically different mentality.

The MIMC's own training and simulation centre is already built. There, doctors will be able to upgrade and learn innovative medical techniques applied at leading clinics the world over. The simulation centre has equipment which allows one to recreate real-life conditions while performing laparoscopic, cardiovascular, and other operations, applying anaesthesia, etc.

The MIMC training programmes' competitive advantages will be due to the following:

- participation of international partners in each programme;
- adapting them to the Russian healthcare system;
- accreditation in the continuous medical education system;
- designing the curricula to match trainees' specific requirements.

[1] 4P medicine is a new healthcare model ("medicine of the future"). The name reflects the four basic principles: personalisation, prediction, prevention, and participation.

VLADA SAYFETDINOVA, MD, PhD

Medical Director of the IMC Foundation

We're already organising training events, consultations, conferences with the participation of leading professionals from all over the world. And these are just the first steps. Next, we plan to integrate our international educational programmes into the Russian Ministry of Health's continuous medical education system, launch management training programmes for medical organisations' heads, and advanced programmes for nurses.

Source: [Kommersant FM, 2018].

Together with the Strasbourg University's Medical Education Centre and the I.M. Sechenov First Moscow State Medical University, the MIMC plans to open the first private international medical university in Russia. It will offer internship programmes for young professionals, and learning programmes based on advanced educational and digital visualisation technologies (e.g. virtual and augmented reality, adaptive learning, case studies). Graduates will receive both Russian and international certificates.

YURY KRESTINSKY

Director of Healthcare Development Centre (Moscow School of Management SKOLKOVO), Chairman of the Board at Bionica Group of Companies

“The educational component will play a major role in the MIMC’s development. Establishing an international medical university with clinical departments based at the patient care organisations within the cluster members may be the best solution here. Such an initiative could lead to the emergence of a new competency centre for the Moscow and Russian healthcare systems. A double accreditation, with the university diplomas being recognised in Russia and one or more other partner countries, would make it particularly valuable.”

Source: exclusive interview.

By implementing its own brand-new training programmes for medical personnel with the participation of world-class scientists and clinicians, the MIMC is opening new career development opportunities for future and currently practising doctors, which would help keep top-skilled professionals in the Russian healthcare system.

MIKHAIL YUGAY, MD, PhD

CEO of the IMC Foundation

The scope for our cluster's educational and training activities is huge: we invite speakers from abroad, willing to share their experience and help adapt it to match Russian realities.

We've established a simulation centre, which will allow doctors to practice and sharpen their skills; about 25% of our member clinics' personnel will be foreign doctors, from whom other staff will learn new techniques and innovative treatments. Plus, we plan to have medical English courses, so people will be able to advance their professional development, learn about the latest medical discoveries and communicate with foreign colleagues.

Source: exclusive interview.

Many of the international clusters whose cases we have analysed noted the importance of the educational component of their activities. However, we did not see such a detailed and customised curricula and training plans in any of them, being at the same time integrated into the national continuous medical education system, and going along with a wide network of international partners, including not only traditional higher education institutions but also partner clinics' training centres and corporate universities.

3. THE MIMC

AS A PLATFORM FOR IMPLEMENTING INTERDISCIPLINARY RESEARCH PROJECTS AND TRANSFERRING THEIR RESULTS INTO HEALTHCARE PRACTICES

The MIMC concept comprises three basic elements: the provision of medical services, education and training, and research. Accordingly, one of the cluster's goals is to properly intertwine them, specifically to ensure the transfer of R&D results into clinical practice (e.g., applying genomic research results to advance longevity medicine) and the training of doctors in new specialities (such as IT medics, tissue engineers, telemedicine physicians, molecular dietitians, etc.).

Bundang (one of the MIMC members) is a fully digital clinic providing medical assistance in a wide variety of areas (cardiology, oncology, rehabilitation, traumatology, orthopaedics, etc.), a research organisation specialising in genetics, and a training centre offering further education courses for doctors, nurses, pharmacists, and medical technicians, all at the same time.

VALERY MURYLEV, DR MED. SCI., Professor

Traumatologist-Orthopaedist, Head of S.P. Botkin Moscow Endoprosthetic Replacement of Bones and Joints Centre

The MIMC will help develop theoretical and practical medicine alike. It's important to study not just genetics or stem cells but applied issues as well related to healthcare activities. Unlike basic research, the results of the latter kind of studies could be implemented immediately, not 10 or 15 years later.

Source: [Lenta.Ru, 2018].

The cluster plays a key role in promoting members' joint projects at the junction of various economic activities and technologies, merging medicine with construction, transport, the food industry, and ICT to foster innovation in healthcare. There are more than 11,000 organisations in Moscow providing patient care services, producing drugs, medical instruments, and equipment[2]. Together with the relevant leading universities and R&D centres, they make up the pool of potential MIMC members and partners.

YAROSLAV ASHIKHMIN, MD, PhD
Cardiologist, Advisor to CEO of the IMC Foundation

"We're more than 10 years behind the West in biomedical science. But there is a chance to gain leadership. We need to bring together the best Russian and overseas professionals in various areas – from molecular biology to clinical practice. Further, we must create a comfortable environment for their fruitful work. This is exactly what the MIMC is doing. The cluster's team managed to bring in the best medical organisations as partners. The cluster amounts to more than just business processes, research, and clinical experience. Members trust each other and share a special attitude to their life's work: helping people stay healthy. These are the basic values which determine success in medicine."

Source: exclusive interview.

[2] According to the Russian Federal State Statistics Service's Main Interregional Centre of Processing and Dissemination of Statistical Information (as of January 1, 2018).

SERGEY MOROZOV, MPH, DR MED. SCI., Professor

CEO of Research and Practice Centre of Medical Radiology, Chief External Expert on Radiologic Diagnostics of Moscow City

The MIMC is a potential growth point of the healthcare sector and related industries. Many processes – medical, construction, information, logistical – will be organised in the cluster differently than is typically done in healthcare. Numerous related areas affect medicine and patients, such as ICT, wearable gadgets, insurance and transport, equipment, pharmaceuticals, research, and much more. The cluster can have a significant impact upon them all. For example, IT companies, working together with robot and vehicle manufacturers in the scope of the cluster can offer new products to patients, not registered as medical products in Russia but approved in OECD countries. And this is just one example.

Source: exclusive interview.

Special foods for the elderly, sensors for disabled people's homes, mobile applications to deal with insomnia, computer games for preventing dementia, clothes with health-monitoring sensors – these are just a few of the outcomes of the joint projects implemented by foreign biomedical clusters. Established interdisciplinary contacts and links in research, production, and clinical practice have determined their success, and the MIMC is moving on along the same path.

I believe that areas related to the development of human capital will serve as drivers of the next technological paradigm, specifically medicine and biology. They already account for about 40% of global research. Medicine is a quite conservative field and its advancement is the fastest where it overlaps with other scientific domains and technologies. I think nanotechnology, biomedicine, information technology, and cognitive science will bring progress in the world. Blending them with one another would transform practically all aspects of people's lives.

MIKHAIL YUGAY, MD, PhD

CEO of the IMC Foundation

Source: [Zdrav.FOM, 2018].

The cluster's strategic R&D areas are determined by NBIC convergence, i.e., merging and producing synergies between nanotechnology, biotechnology, information technology and cognitive science, thus promoting the evolution of the medicine of the future.

A business-like and philosophical approach to the MIMC organisation, encouraging interdisciplinary and technological experiments aimed at advancing healthcare development, could not only promote Russian medical science and practices but also open wide opportunities for the emergence of new sectors of the capital's economy, such as a healthy longevity industry.

4. THE MIMC

AS A TERRITORY OF ADVANCED LEGAL REGULATION FOR HEALTHCARE

The cluster's core idea is setting up a flexible legal regulation system on a particular territory. The special International Medical Cluster Law[3] established the main rules for the MIMC operations, including the recognition of the members' diplomas for medical activities issued by the OECD countries, special conditions for hiring foreign professionals, technical regulations, sanitary and epidemiological norms, etc.

The introduction of a special legal regime in a single cluster shows that the government recognises its potential to improve the overall quality of the Russian medical system. On the one hand, it meets international practices of involving clusters in implementing national healthcare programmes, which we included in the number of cluster success factors, while on the other, it is almost unique for our sample. Very few clusters boast an exclusive regulation that applies to their territory alone. One of them is Daegu Medical Cluster.

MIKHAIL YUGAY, MD, PhD
CEO of the IMC Foundation

Methodologies, technologies, and treatment protocols approved in the OECD countries can be applied at the MIMC without extra licencing. Pharmaceutical preparations and equipment registered in the OECD member states also can be used in the

[3] Federal Law "On the International Medical Cluster and Amendments to Certain Legislative Acts of the Russian Federation." Dated June 29, 2015 № 160-FZ.

ALEXEI KHRIPUN, DR MED. SCI., Professor

Moscow City Government Minister, Head of Moscow City Healthcare Department

The MIMC will help make a breakthrough in medicine. In the scope of this project, the best clinics in the world will be coming to Moscow. <...> An appropriate law was passed in the Russian Federation, a territory was made available in Skolkovo, and we already have cluster members. Hadassah and Bundang are just two examples. They bring in their operational rules, standards, resources, and high quality. Any foreign clinic can do the same: come up with an investor and work with its own specialists in line with the regulations and using drugs, consumables, and technologies, which do not even have to be licensed for use in Russia.

Source: [GOVORITMOSKVA.RU, 2018].

MIMC; the federal requirement for compulsory registration does not apply. Foreign doctors may be employed by cluster organisations without any restrictions: their diplomas are recognised and no quotas limiting the number of invitations and work permits apply either. All this opens access to medical assistance of the highest standards to Russian patients.

Source: [Kommersant special issue, 2018].

5. THE MIMC

AS A GRAVITY CENTRE FOR INTEGRATED INFRASTRUCTURE DEVELOPMENT PROJECTS IN MOSCOW

The establishment of an international medical cluster in the Skolkovo innovation centre was supported by the Moscow City Government. The project includes the construction of several major infrastructural facilities, which will significantly contribute to the development of healthcare and medical research in the capital city.

In 2018, the Israeli Hadassah clinic– the first MIMC member – opened a diagnostics centre in the cluster; by 2021, the clinic plans to have the therapy centre construction completed. The Seoul National University together with the Korean Ministry of Health and Welfare is designing a multifunctional building of the Bundang Smart Hospital of the Future (scheduled to open in 2022). In addition, in 2022, the Spanish Roman Fernandez clinic is planning to open the Oncology Centre.

MARAT KHUSNULLIN, PhD

Deputy Moscow Mayor for Urban Development and Construction

The MIMC is a world-class project drawing the interest of both Russian and foreign investors. <…> We'll build a 20-hectare technology park with a medical university, laboratories, technology transfer centres, and pilot production facilities.

Source: [Kommersant special issue, 2018].

In ten years' time between 10 and 15 clinics will be opened on the MIMC territory, specialising in more common socially significant diseases such as oncological, cardiovascular, neurological, locomotor disorders, etc. The construction of several R&D facilities is also planned (first of all for live systems and medical engineering research), along with the international university and pharmaceuticals and clinical equipment production facilities. They will be located on the territory of the 20-hectare technology park.

Support by the regional authorities is an important success factor for most of the international biomedical clusters and the development of cluster infrastructure is often a primary area for public funding (suffice it to mention the pivotal role of the Öresund bridge in the establishment of the Danish-Swedish Medicon Valley cluster). The Moscow City Government also invested in the construction of several MIMC facilities (table 4.1) and set reduced land rental rates for cluster members (at 188 roubles per sq. m. a year).

The MIMC's large-scale development projects will create brand-new infrastructure that will contribute to the advancement of the medicine of the future in Russia.

Facility	Allocated funding (billion roubles)
The first pilot facility: Hadassah Clinical Diagnostics Centre	3.6
The second pilot facility: Hadassah Therapy Centre	3.2
Housing	2.0
Roads, engineering networks	1.0
TOTAL	**9.8**

Table 4.1. Public Funding Provided by the Moscow City Government for the Construction of the MIMC Infrastructure

Source: compiled by the authors based on the IMC Foundation data.

6. THE MIMC

AS A PATIENT LITERACY CENTRE AND A "ONE WINDOW" ACCESS POINT TO WORLD-CLASS MEDICAL ASSISTANCE

The MIMC's target audience is predicted to exceed 300,000 people a year. They will receive assistance from leading Russian and foreign doctors who will be able to apply treatment protocols approved in OECD countries and use advanced safe medicines and equipment. The cluster will become a single contact point for clinicians and patients across the full range of healthcare services from diagnostics to post-treatment recovery and support. The MIMC's unique value for people coming for medical assistance and for everybody who cares about their health is improving patient literacy.

The MIMC members are convinced that the patients themselves play the key role in protecting their health and could become the doctors' partners in choosing optimal treatments for acute illnesses and chronic diseases. Meanwhile, the WHO studies reveal that people insufficiently literate in this field tend to feel worse and have a higher risk of hospitalisation. Increasing patients' interest may help make them feel better and more satisfied and further produce clinical and economic effects as well [WHO, 2008].

VLADA SAYFETDINOVA, MD, PhD

Medical Director of the IMC Foundation

The cluster's professionals are focused on finding the most advanced, cutting-edge solutions the patients might need, which would help people take care of their health, feel comfortable in the medical environment, and receive services of adequate quality.

Source: exclusive interview.

Workshops will be held in the cluster to teach patients to better understand what causes illnesses and which factors affect their health. Leading Russian and international medical professionals will teach people self-diagnostic techniques, the right ways to take medicines, monitor the symptoms and treatment efficiency, how to spot dangerous signs of progressing diseases, and doctors will learn advanced patient interaction techniques. Healthy lifestyle practices will be at the core of the MIMC's educational programmes.

ILDAR KHAIRULLIN, MD, PhD, DBA

First Deputy Director
of the IMC Foundation

Source: [Kommersant special issue, 2018].

Consumer behaviour in the field of medicine is changing. Today, there is a shift away from the paternalistic model, when the state declares "I'm the sole owner of your health", towards a partnership, where each member has specific responsibilities. Health is seen as private capital now: people are increasingly willing to invest in their well-being because they are aware of its value and realise how important it is to take preventive steps, go to check-ups, etc.

Active interaction between patients and doctors is a success factor of many biomedical clusters the world over. The MIMC plans to adopt the widespread "living lab" format to systematically involve Moscow citizens (and with time, residents of other Russian regions as well) in projects on improving innovative healthcare products and medical assistance quality. The Active Citizen project initiated by the capital city mayor may become the cluster's pillar – a platform for the electronic polling of Muscovites on relevant urban planning issues.

Three thousand six hundred online polls were conducted in four years' time, with more than two million participants. One thousand nine hundred decisions were implemented based on the results[4]. By adopting this successful experience of involving citizens in the development of the city, the MIMC will contribute to increasing patient literacy and introducing 4P medicine in Moscow.

[4] Active Citizen [official website]. URL: https://ag.mos.ru/info (last accessed on December 25, 2018).

7. THE MIMC

AS AN EFFECTIVE PARTNERSHIP MODEL FOR PUBLIC AUTHORITIES, INVESTORS, AND CLINICS

The MIMC managed to design a specific organisational model based upon public-private partnership mechanisms, using various formats for bringing together key members with clearly defined roles in the cluster.

The Moscow City Government is the founder of the cluster management company, the IMC Foundation, and co-invests in the construction of clinics, infrastructure, and other facilities. It further is represented on the cluster's supervisory board, which is the highest management authority headed by the capital city's mayor.

Membership in the cluster implies involving investors and operators (i.e., organisations actually providing medical services) from Russia and the OECD member states. Investors provide funds to build and equip facilities (such as clinics, diagnostic centres, etc.) and finance current work.

VLADA SAYFETDINOVA, MD, PhD

Medical Director of the IMC Foundation

"The mayor of Moscow is determined to make the cluster a success and to raise it to the world-class level. The city government allocated about 10 billion roubles to co-invest in the construction of the cluster's pilot facilities and infrastructure as well as support education and training efforts. Our first member, the Hadassah clinic (one of the Israeli healthcare leaders), has opened a branch on the cluster's territory, which is the only one in Russia and is already serving patients. Next in line are South Korean, Spanish, and French clinics. So far about 25 major medical centres in the OECD countries expressed interest in becoming cluster members. We're discussing new projects with them on a co-funding basis."

Source: exclusive interview.

Operators bring in personnel and organise the provision of medical assistance (including treatment protocols and the required drugs). There are other possible partnership models, involving Russian and international members.

Under any of them the IMC Foundation provides land and engineering infrastructure and professional management services (coordinates activities, supports cluster members' cooperation, helps with the promotion of their products and services on the market, the attraction of patients and partners, staff training, and so on). The biomedical clusters from other countries that we have benchmarked apply different public-private partnership models to manage and finance their activities. One of our experts confessed that if he could have gone back in time to the early period of the cluster, he would have tried to involve representatives of the governmental officials in the cluster management and diversify funding sources by attracting more public funds. From this perspective, the logic of engaging members, organising investment schemes and the management system chosen by the Moscow International Medical Cluster seems to be quite sensible.

ZEEV ROTHSTEIN, MD, PhD, Professor

Director General of Hadassah Medical Organization (Israel)

It's a great honour for the Hadassah clinic to become the cluster's first operator. However, it's also a responsibility to represent world-class medicine and share cutting-edge scientific advances. <…> We'll make every effort to live up to the expectations and accomplish our objective, which we see as preventing, identifying, and treating diseases.

Source: [Kommersant special issue, 2018].

A comparative analysis of the key aspects of the Moscow International Medical Cluster's operations and the success factors of biomedical clusters the world over revealed that the MIMC does follow global trends while also possessing its own know-how. The cluster enjoys powerful support from the authorities, which helps it build infrastructure from the ground up, provides strategic management, and ensures an exclusive legal regime. Accordingly, the MIMC has become a gravity centre for leading international medical researchers and practitioners and is now opening unique opportunities for Russian doctors and patients to provide and receive world-class treatment, professionally improve, increase healthcare literacy, and contribute to the medicine of the future at the junction of nanotechnology, biomedicine, ICT, and cognitive science.

IN LIEU OF CONCLUSION

Our study was a continuous search for answers to a multitude of questions, the most important of which could be put as follows: what must biomedical clusters have in order to help improve healthcare?

The experience and practices of the MIMC and other clusters around the globe have been scrutinised, which leads us to conclude that their strength lies in diversity: diverse members and partners, various areas of activity, communication channels, management structures, support mechanisms, and so on. We have learned how very different, but in every case very important, decisions were made, such as building a bridge to bring together research, medical, and business organisations from two regions into a single cluster; giving an area a special legal status so the best clinics would be able to apply treatment techniques unavailable outside of the cluster; digitalising the national healthcare system and bringing medical organisations and IT firms together within the scope of a cluster, so that their cooperation would make medical assistance more efficient, user-friendly, and safe. Each of these decisions was based upon a managerial vision, scientific validity, economic sense, political support, and public involvement. However, the key to success was the strong expertise, enthusiasm, and personal stake of the professionals whose mission was to secure people's health.

As the saying goes, lack of medical personnel's cordiality is far worse for patients than cardiac failure. In the course of the study we have learned about people with kind and caring hearts who have brought their talents and resources together to make other people's lives longer and happier.

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