UNIVERSITÀ DEGLI STUDI

DI MODENA E REGGIO EMILIA

Dottorato di ricerca in

Lavoro, Sviluppo e Innovazione

Ciclo XXXII

Innovazione e sviluppo economico territoriale attraverso la creazione di un polo tecnologico (hub), un modello integrato di incubazione, ricerca, servizi alle imprese e formazione: il caso del Parco Scientifico e Tecnologico del Mirandolese ed i suoi sviluppi futuri

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Sommario

SINTESI E STRUTTURA DELLA TESI (inglese)

Innovation and territorial economic development through the creation of a technological hub, an integrated incubation, research, business services and training model: the case of the Science and Technology Park of Mirandolese and its future developments

The aim is the creation of a technological hub, integrating incubation, research, training and business services model which can bring innovation and territorial economic development. The objective is identifying the most suitable management / organizational models and funding sources for a technological center for the Mirandolese biomedical district; Mirandola district is characterized by high specialization and by the coexistence of heterogeneous companies (dimensions and competences). Moreover will be important to understand the impact that this kind of hub on the growth of a territorial ecosystem.

INTRODUCTION

Thesis started from a concrete case of study, the development of the Advanced Materials and Applied Research and Science Park (Mirandola PST), Mirandola's TPM, in the meantime entitled to "Mario Veronesi", founder of the biomedical district di Mirandola (one of the most important in Europe for the specific specialization).The objective of the research was to identify and apply an integrated model (hub) capable of favoring (economic and social) territorial development in the biomedical field; this model may guarantee the necessary flexibility to respond rapidly to technological and socio-economic changes.

The TPM "Mario Veronesi" aims to achieve also international visibility, transforming itself into a model capable of becoming the reference point not only at a national level, but also at a European level.

The main point treated are:

- State of the art and best practices analysis: study of scientific parks
- Identification of the key elements needed for the development of a science park and incubation infrastructures
- Analysis of Mirandola history and ecosystem
- Understanding of the synergies that can exist and must be emphasized among companies, start-ups and the network of possible stakeholders, which services need to be provided
- Definition of the target and objective to be reached in function of the territorial development
- Definition of a model to be implemented in Mirandola scientific and technological park

The work will be structured in 3 articles:

1. **Mirandola, history and innovation process**
2. **Science and technological parks (STP): lessons to be learned**
3. **Mirandola biomedical village**

The first takes into consideration the history and characteristics of the Mirandola biomedical district, with the aim of analyzing the development and transformation processes (in particular with regard to innovation processes); it will be a paper with a historical cut that aims to analyze the innovation models of the districts and what were the "trigger" events that favored the change and evolution of the "Mirandola model" intended as a case study within this historical perspective;

The second one analyzes in a more specific way the scientific and technological parks presented in the literature, with a specific focus on those specialized on "life sciences" to identify similarities or differences with the Mirandola ecosystem and to highlight elements of interest for the district; it will be a meta-review of the parks aimed at identifying the common characteristics and of interest;

The third, combining the elements analyzed in the first two works, represents the conclusion of the research work with the identification and application process of the model considered most suitable for the specific context. Also some of the results reach in the period 2015 – 2018 were presented.

SINTESI E STRUTTURA DELLA TESI (italiano)

Innovazione e sviluppo economico territoriale attraverso la creazione di un hub tecnologico, un modello integrato di incubazione, ricerca, servizi di business e formazione: il caso del parco scientifico e tecnologico del Mirandolese e i suoi sviluppi futuri.

L'obiettivo è la creazione di un hub tecnologico, integrando incubazione, ricerca , formazione e servizi che possa portare sul territorio innovazione e sviluppo economico. L'obiettivo è identificare i modelli organizzativi e di gestione e le risorse finanziare per la realizzazione e lo sviluppo di un centro tecnologico all'interno del distretto Mirandolese; il distretto di Mirandola è caratterizzato da un'altissima specializzazione e dalla coesistenza di imprese eterogenee (per dimensioni e competenze). Inoltre, sarà importante capire l'impatto che questo genere di hub può avere per la crescita di un ecosistema territoriale.

INTRODUZIONE

La tesi prende avvio da un caso concreto di studio, lo sviluppo del parco scientifico e tecnologico sui materiali avanzati e ricerca applicata (PST di Mirandola), TPM, intitolato a "Mario Veronesi", fondatore del distretto biomedicale di Mirandola (uno dei più importanti a livello Europeo per quanto riguarda la specifica specializzazione). L'obiettivo della ricerca è stata l'identificazione e, successivamente, l'applicazione di un modello integrato (hub) capace di favorire lo sviluppo teritoriale (sia economico che sociale) nel settore biomedicale; questo modello potrà garantire la necessaria flessibilità per rispondere rapidamente ai cambiamenti tecnologici e socio-economici.

Il TPM "Mario Veronesi" ha l'obiettivo anche di raggiungere una visibilità internazionale, trasformandosi in un modello capace di diventare il punto di riferimento non solo a livello nazionale, ma anche Europeo.

I principali temi trattati sono:

- Stato dell'arte ed analisi delle best practices: studio dei parchi scientifici e tecnologici
- Identificazione degli elementi chiave necessari per lo sviluppo di un parco scientifico e di infrastrutture per l'incubazione
- Analisi della storia di Mirandola e dell'ecosistema
- Comprensione delle sinergie che si sono instaurate e che dovrebbero essere messe in evidenza tra le imprese, le start up ed il network di possibili stakholders e comprensione dei servizi che devono essere erogati
- Definizione dei target e degli obiettivi che devono essere raggiunti per lo sviluppo territoriale
- Definizione di un modello da implementare all'interno del parco scientifico e tecnologico

Il lavoro è strutturato in 3 articoli:

1. **Mirandola, history and innovation process**
2. **Science and technological parks (STP): lessons to be learned**
3. **Mirandola biomedical village**

Il primo articolo prende in considerazione la storia e le caratteristiche del distretto biomedicale di Mirandoola, con lo scopo di analizzare i processi di sviluppo e trasformazione (in particolare per quanto riguarda i processi di innovazione); sarà un paper con un taglio storico che ha lo scopo di analizzare i modelli di innovazione e quali eventi hanno favorito il cambiamento e l'evoluzione del modello "mirandola" che è il caso studio.

Il secondo analizza in modo più specifico i parchi scientifici e tecnologici descritti in letteratura, con un focus specifico sulle "scienze della vita" per identificare similitudini o differenze con l'ecosistema di Mirandola e per evidenziare gli elementi di interesse del distretto; sarà una meta-review dei parchi, finalizzata ad identificare le caratteristiche di interesse.

Il terzo, integrando gli elementi analizzati nei primi due lavori, rappresenta le conclusion della ricerca con l'identificazione e l'applicazione dei modelli considerati i più adatti per lo specifico contesto. Saranno presentati anche alcuni risultati del periodo 2015 – 2018.

PRIMO PAPER

Mirandola, history and innovation process

INTRODUCTION

The aim of the present work is to fill the gap existing in the analysis of the evolution of industrial districts. For our purposes we adopt the following definition "*the districts are geographically defined productive systems, characterized by a large number of firms that are involved at various ways, in the production of a homogenous product. A significant feature is that a very high proportion of these firms are small or very small*" (Brusco, 1990). Several of these districts can be found in the North of Italy. Districts are characterized by a very strict relation between all the social and economic entities located in the area and by the existence of a strong cooperation and collaboration by the enterprises. Industrial districts has been deeply analyzed because of their importance and spread in Italy; in particular, their evolution during time (Hervas-Oliver et al., 2015) and the impact that they could have on enterprises performance (Albahari et al., 2016, Bonacina et al., 2018, Siegel et al., 2003) have been analyzed. Indeed, literature treats aspects such as: mechanisms of knowledge transfer within districts (imitation, relationship between different entities located in the district, or human resources mobility) (Albahari et al., 2016; Albino et al., 1998) or knowledge creation; the relationship between the district and the external entities (Albahari et al., 2016); how the industrial spin off are generated (Camuffo and Grandinetti, 2006) or the factors influencing the district life cycle (Belussi et al., 2009). However, analysis on how degree of openness of innovation mechanisms change within the districts and how they have an impact on the relationships between the entities located in the district, is not so diffused. With innovation mechanisms we consider how companies carried out innovation. Indeed, these kind of papers don't take into account open innovation or innovation processes occurring in the enterprises.

In the open innovation literature, innovation processes are mainly analyzed taking into account the single enterprise (Laursen at al., 2006, Mortara et al., 2011) or according different types of companies, such as SMEs (Dufour et al., 2015, Lee et al., 2010), while fewer attention has been given on open innovation approaches within industrial clusters.

Our aim is to fill the gap existing in the analysis of how innovation approaches change for enterprises located in a district due to trigger events or other disrupting changes external to district (due i.e. for economic crisis or technological revolution). The objective is to analyze district evolution considering how firms' open innovation strategies could affect its transformation during time, offering a contribution towards new models for the analysis of district performance and evolution.

To perform this analysis we defined a theoretical framework, taking into account how open innovation is implemented and how it affects companies performance. Hence, we adopt the model proposed by Huizing (Huizing et al., 2011) for the classification of innovation processes and innovation outcomes and we applied this model to a district context.

As field analysis we focus on a specific innovation ecosystem in Mirandola biomedical area and how its innovation processes are evolving. Mirandola biomedical district is one of the most important at European level for the medical technology (medtech) sector. Modena Chamber of Commerce (Camera di commercio di Modena RAPPORTO ECONOMICO SULLA PROVINCIA DI MODENA anno 2016) reports that in Modena province more than 90 enterprises involved in biomedical sector operate. Concerning the evolution of the district, a study (R&I, Osservatorio sul settore biomedicale nel distretto mirandolese, prima e terza rilevazione, 2004), reports some historical data about biomedical district growth: companies in 1997 are 74, in 2000 are 70, 78 in 2003 and 74 in 2004. Mirandola district is specialized on dialysis, extracorporeal circulation, nutrition, apheresis, gynecology products and relative components. However, several other application areas can be found, such as pharmaceutical, lab services, advanced therapies, etc., representing an evolution of the traditional "Mirandola" production. Disposable (single-use medical devices - MD) and equipment are realized by different kind of enterprises, large companies with foreign capital, local independent companies (both small and medium), subcontractors or services providers which are established in the territory. Hence Mirandola is a compound of different entities and expertise specialized on a specific sector.

The evolution in Mirandola biomedical district innovation processes can be analyzed by adopting the lens of a Schumpeterian model in which the action of single entrepreneurs can be considered as the force driving innovation and development – *"entrepreneurs as individuals who exploit market opportunity through technical and/or organizational innovation"* (Schumpeter J.A., 2017). Indeed, Mirandola district born in 1963 thanks to a single entrepreneur, Mario Veronesi, a pharmacist, who found the first company (Miraset). Mario Veronesi in his frequent visits in hospitals found that there was an unresolved technological problem: the transfusion tubes were made in latex and this could expose the patients to risk of contaminations. Transfusion therapies were very risky for patients. Veronesi developed and introduced disposable tubes, which can be subjected to sterilization. In 1965, Veronesi founded its second enterprise, Dasco, with the purpose of realizing the first artificial kidney. Dasco was acquired by a multinational in 1973 and in the same year Veronesi created Bellco, specialized on hemodialysis equipment production. Bellco was acquired by another multinational. In the meanwhile other companies were created by other entrepreneurs and then acquired by multinational. This process of creation of new companies and acquisition of established biomed companies by multinationals was replicated several times on the territory. Within a few years the territory passed from a typical agricultural economy to a highly industrialized and specialized area. This process was also strongly enhanced by the development in the region of the mechanical and plastics industries, which supported the creation of medical devices. Indeed, this contamination from other sectors allows to promote and accelerate the industrialization processes in medical device sector.

Shifting from the literature analysis to the specific theme of the paper, Mirandola differs for its characteristics from other biomedical districts concerning the characteristics (dimension, evolution, geographical characteristics, etc); we performed an analysis to identify the common elements and the differences between Mirandola and other two international biomedical districts (Ireland Medtech and Minneapolis St. Paul districts). These districts have in common their specialization, focused on medical devices (both disposable and equipment). The main differences concern the geographical dimensions, the public support and the enterprises characteristics (see table 5 and 6 of Annex 1). This analysis is useful to identify some elements to be deeply studied for a better

understanding of very specialized biomedical district and to identify the specific characteristics of Mirandola in respect of international territory.

Mirandola district analysis represents an interesting field of analysis because it is characterized by specific features:

- while Italian industrial districts are traditionally characterized by the presence of small and medium enterprises which traditionally opt for closure and autonomy (Biggiero et al., 2003) when organizing innovation processes, in Mirandola a process of transformation towards "open innovation approaches" started since its foundation and it is still ongoing. Thus, by adopting an historical perspective of analysis, it is interesting to analyze how open innovation approaches evolved over time;
- it is possible to interpret its evolution in the last 60 years by considering the influence of some recognizable external factors (such as the recent earthquake in 2012), which acted as triggering event for innovation processes;
- the presence and the evolution in Mirandola of a hyper-network (described by Biggiero – Biggiero et al., 2003 – Biggiero, 1999), characterized by well rooted and consolidated relations between the actors present in the district (public and private entities). Hyper-network is characterized by different relations, collaboration and exchange established by public and private entities, or research centers and companies, etc. These structured relationships patterns could have consequences on companies performances and on district characteristics, thus influencing innovation processes.

In our paper, we create a theoretical framework to analyze the evolution of a specific district and, we will analyze the different phases characterizing Mirandola biomedical district transformation. In this way we contribute to the literature by developing a model to study district evolution and innovation processes occurring in companies and how this process is influenced by external events (trigger events).

THEORETICAL FRAMEWORK

As anticipated, the purpose of the work is to fill the gap existing in the analysis of industrial district concerning the evolution of innovation process in the district companies. To fill this gap we need to adopt theoretical models to analyze how the Mirandola ecosystem evolved from its foundation to the present days and how the innovation processes changed. Indeed, Mirandola district transformed its characteristics, and we will analyze how in districts innovation can be generated starting from the single small enterprise (in which the distance from the founder and the workers are reduced) or from the relations that enterprises establish (i.e. between the companies and suppliers) (Brusco et al., 1989). We will analyze also the methods in which innovation and information are exchanged, i.e. thanks to human resources transfer from one enterprise to another (Camuffo and Grandinetti, 2006).

In particular, our focus is on the innovation-related relationship established between different entities present in the district (intra-district innovative collaboration) and how the innovation

processes are carried out. Our aim is to identify how enterprises decide to carry out innovation, if they establish collaboration with research centers or other entities, and in which modalities.

For our purposes, following the approach used by McCormack (McCormack et al., 2015), we can adopt this definition of open innovation *"The use of single purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation respectively"* (Chesbrough et al., 2006.) which includes the participation of different actors in the creation of innovation. These actors can be companies (SMEs or big enterprises), universities, local entities, customers, suppliers, end users, etc. Hence, open innovation is an approach requiring the collaboration to generate innovation; collaboration could have different characteristics and it can be structured in different ways.

Concerning innovation, we applied the definition introduced by Gopalakrshnan (Gopalakrshnan et al., 1997), trying to adapt them for the application in a district analysis (table 1). Due to the specialization of Mirandola district we adopt definition that could be easily used for the enterprises of medtech sector. Product and process are the output of the innovation, whereas radical and incremental traits represent the way of "making" innovation.

	Literature definition	**In our work**
product innovation	outputs or services that are introduced for the benefit of customers or clients	Outputs or services that are introduced for the benefit of the healthcare system / patient or for the value chain improvement
process innovation	all that mediate between inputs and outputs and are new to an industry, organization or subunit	All that concern a new method in the "production" of a product or service in the medtech sector
radical innovation	produces fundamental changes in the activities of an organization or an industry and represent clear departure from existing practices	Something producing fundamental changes in the way diseases are treated or in the way medical devices are produced
incremental innovation	marginal departure evolution from existing practices	No evident innovation in respect of the existing products / services / treatments (optimization or adjustments)

Table 1: Authors' review of Gopalakrshnan table

We don't take into account technical vs administrative innovation because in our case study, administrative innovation are not relevant; we will analyze only innovation related with technological aspects.

To better define the characteristics of openness of the innovation and how it is managed in the district, we will apply the model developed by Huizing (Huizingh et al., 2011), in which we can distinguish between innovation process and innovation outcome and realize a 2X2 matrix for analyze how innovation is "open" (table 2).

		Innovation results	
		Closed	*Open*
Innovation process	*Closed*	Closed innovation Proprietary innovation is developed in house	Public innovation
	Open	Private Open innovation Outcome is closed, but the process is opened up	Open source innovation

Table 2: authors' adaptation of Huizing et al. innovation classification (taking into account results and process of innovation)

Huizing et al. (2011) addressed the questions of what (the content of open innovation), when (the context dependency) and how (the process) open innovation happened. In particular we focus our attention on the classification that the authors reported, distinguishing between process and result of innovation. Closed innovation reflects the situation, where a proprietary innovation is developed inhouse (Chesbrough, 2003a), both the process and the outcome are closed. In private open innovation the outcome is closed (a proprietary innovation) but the process is shared or available. Concerning the results, the outcome of the innovation process is either proprietary (closed) or available to others (open).

In our work, closed innovation represents innovation completely carried out by a single entity (mainly single company) with which have no collaboration with external ecosystem; public innovation is when a result is shared with the ecosystem, whereas the process (in other worlds "how to obtain the result") is always not public in our field; private open innovation allows the sharing of a process among different subjects, but the closure of results are proprietary; open source innovation foresees the complete sharing of information about processes and results.

METHODS

The field of analysis is the industrial district of Mirandola. We can more deepen the definition of "industrial district" reported by Becattini and analyzed by Brusco, 1990, and try to summarize what are the characteristics that we can find in Mirandola (in the past and nowadays) in table 3. In the table we reported the characteristics of industrial district reported by Beccatini and Brusco in the column "industrial district", the characteristics of Mirandola in its first phase in the second column and in the third Mirandola district nowadays. In this way we can have a first idea of the transformation of the district and of the relations between all the entities located in the territory.

Industrial district	**Mirandola district in its first phase**	**Mirandola district nowadays**
Production is flexible to meet the different need of clients	Production was much more flexible than now due to a different regulatory framework	Due to the existence of a strong regulation not all the enterprises could guarantee a flexible production. Indeed, each production phase need to be strictly controlled, each step is regulated by specific procedures, then a single change (i.e. introduction of a new material) requires a complete re-design of the entire process. However for specific stages of the value chains (such as molds realization or materials transformation), regulation has no a relevant impact.
Presence of many small and very small firms	The presence of SMEs was important. The majority of companies located in the district are SMEs; new entrepreneurs founded companies that changed their dimensions only when multinationals decided to locate in Mirandola	The majority of the enterprises are SMEs, with the presence of some multinational firms (such as Medtronic, B.Braun, Fresenius, Livanova, Baxter, Intersurgical)
Some of these small enterprises sell their products directly on the markets, other carry out particular processes or produce component parts	Yes	Yes

Separation between SMEs selling products and sub-suppliers is not rigid	Yes, much more frequent that nowadays	Such as the "flexibility" aspect, this characteristic is true for specific "part" of the value chain where the regulatory aspects are less important
Competition and co-operation co-exist	No, enterprises work mainly with a closed approach	Co-opetition is much more present that in the past
The geographical area of the district is limited	Yes	Yes
Strong interconnection between district as production reality and family, political, social life	No, in a first phase, enterprises don't have a strong connection with the ecosystem because a clear and structurally defined ecosystem doesn't exist	During district development, some initiative started and nowadays the district comprises a complex ecosystem, characterized by the connection between different actors (public authorities, private entities, research structures, etc)

Table 3: Becattini's industrial district definition and Mirandola characteristics at the beginning of its history and nowadays

Hence, Mirandola district offers the possibility of analyzing the specific evolution of an industrial district that is encountering a radical transformation. Indeed, as we can see from the previous table, Mirandola district change from a district with a strong presence of SMEs innovating internally with a closed approach to an international district in which both multinational and SMEs collaborate with each other or with third parties to introduce innovation. Moreover, changes in regulation and procedures, forced companies to acquire much more competencies and to collaborate with external entities to acquire knowledge.

We applied the theoretical framework proposed by Huizing and described in the previous section, identifying 4 main phases (which in part differ from the phases reported by Biggiero, 2002). Indeed, Biggiero identified 3 main phases: trigger, founder and evolution (considering the presence of knowledge deriving from the automotive sector and the subsequent creation of new enterprises as the key point for district evolution): foundation (from '60 to '80), consolidation (from '80 to '90), coordination and internationalization (from '90 to 2012) and post-earthquake (from 2012). In our vision, these phases represent the moments when important changes happening in the innovation processes. These phases were identified analyzing both literature (mainly Biggiero, 2002) and through the direct experiences of the authors that assisted to the district evolution. Indeed, the authors participated actively in some activities carried out in the district concerning mainly R&D. Other information were collected through informal interviews carried out in the district, mainly to companies' founders or researchers.

ANALYSIS

Foundation

As anticipated, the origins of the Mirandola district can be referred to the initiative of its founder (Mario Veronesi) who identified a need and a way to resolve it. He started the first "enterprise" and the other followed (Bellco, Dideco, …) (Mosconi et al, 2017).

Trying to classify the types of innovation involved in the early stage of the district evolution, we can observe that:

(i) the district took its departure from radical innovation, since Veronesi, who founded his companies and started the development and commercialization of new products. This contributed to a significant change in the therapeutic approaches and represents a turning point for the healthcare system. The concept of "disposable" was introduced in the medical device sector for the first time. Another aspect was related to the introduction of new productive processes characterized by standardization and automation derived from the experience that many technical workers developed in the mechanical sector, so well rooted in Emilia-Romagna since 40s;

(ii) in the focalization of these years the focus is on "product innovation", more than on process, since there were new medical devices which were mainly developed at that time. In this period the innovation concerns only the development of new products (the way in which they are produced was not considered as a key point)

Concerning the innovation approach, we can establish that it was mainly "close". The "inventor" established his own company and proceeded with the development of a product with no external collaborations. Moreover, collaboration between enterprises were, in this period, very limited, also due to the low number of biomed-companies. Hence, we can argue that, in its foundation stage, the Mirandola district's companies adopted a "closed innovation" approach (Figure 1).

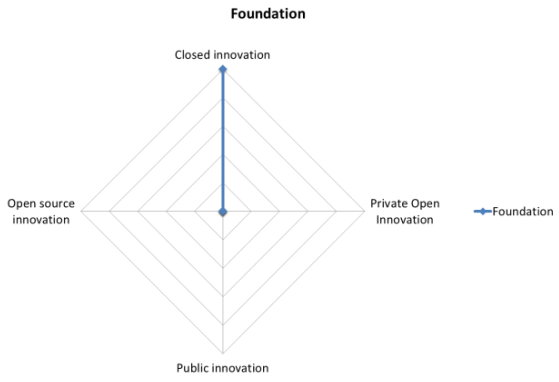

Figure 1: Mirandola foundation: classification of the innovation process

Consolidation

In the 80s the Mirandola district experienced its greatest evolution and growth. The term consolidation is related with the reinforcement of the industrial capacity, while no particular initiative for the "district" development were carried out. Some biomed multinationals invested in the district area. Multinational located in the district through acquisition processes with the aim to acquire specific technologies or knowledge or specific products (i.e. Gambro acquired Hospal or Sorin-FIAT acquired Bellco).

Furthermore, in this phase other significant evolutionary traits emerged that may be underlined as follows:

- Cross-fertilization from other sectors. Biomed district enterprises benefitted from advanced mechanics technologies for the development of new productive processes acquired, in particular from the automotive sector (i.e. mechanical processing). Automation has undergone a major boost, despite skilled labor maintained its relevance for specific processes such as assembly or products' packaging
- Despite the lack of formal collaboration between district enterprises, some informal and indirect inter-organizational practices of innovation diffusion came out. While apparently enterprises seemed to refuse any type of formal and structured collaboration with other firms, in practical terms a lot of SMEs acted as subcontractors for the final enterprise, e.g. it is for companies producing molds. Furthermore, workers in managerial positions or researchers often moved across companies, thus contributing to mobilize knowledge and expertise within the district.
- Collaboration with universities started in these years.

In this stage, the types of innovation introduced by companies were mainly incremental, because the Mirandola biomed specialization was well established and companies invest mainly in the improvement of the processes. Disposable and electromedical (equipment) were the core of the industrial sector and innovation concerned both mainly products (enterprises realized new products to respond to medical needs) and processes, because in these years started a strong industrialization process: the Emilia-Romagna mechanical industry has an important influence on the productive system. Whereas, in the previous period, the new entrepreneur introduced in the market new products that was able to create a sensible innovation in the healthcare system, in this period the acquisition by multinationals and the transformation of the processes focused the attention mainly on innovation aimed that to improve the existing approaches.

Concerning the innovation approach, we observed some pioneering the first examples of adoption of private open innovation strategies, since first attempt to collaborate with enterprises started.

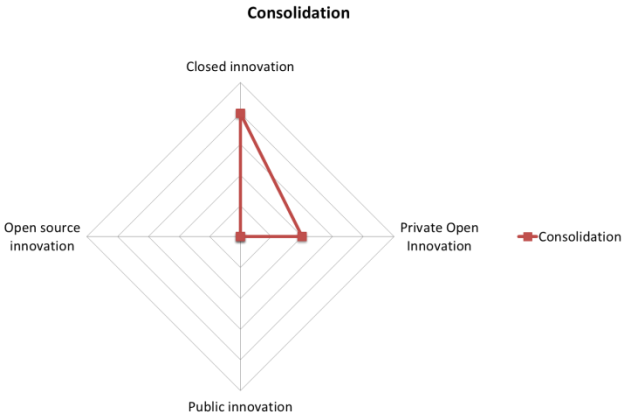

Figure 2: Mirandola consolidation: classification of the innovation process

COORDINATION AND INTERNAZIONALIZATION

In this stage, we observed some specific evolutionary traits:

- a first attempt of district coordination and aggregation at an institutional level;
- the implementation of the international promotion of the district in a coordinated way;
- the passage from a "local value chain" to a "global value chain (De Marchi et al., 2014)" through the partial de-localization of subcontractors.

Examples of these phenomena are the creation of district consortia or aggregations with specific purposes, such as Consobiomed and Quality Center Network.

Consobiomed, a non-profit consortium, born in the '90 with the aim of aggregating and supporting small and medium enterprises in specific biomedical processes such as: product or process certification, purchasing, internationalization. The Consortium invested mainly in the aggregation of activities supporting this last activity SMEs' i(internationalization) was carried out with particular attention by the consortium of: mainly SMEs tried to aggregate to respond to international market, by offering them as. Consobiomed collected SMEs which thanks to the payment of a fee could have access to the list of services. Consobiomed had an internal staff that was dedicated to the different activities. Due to the decreasing of associated SMEs, the Consortium closed in 2014, mainly because the lack of a specific coordination (an entities that can support district cohesion) and because the activity very limited on the territory didn't allow the sustainability of the initiative: the relatively few number of SMEs operating in the territory was no sufficient to sustain all the different actions through a direct contribution (service payments).

Quality center Network (QCN) was born for creating for the Mirandola biomedical district "a permanent system to support the activities of innovation and qualification of human resources

through networks linking health care and research institutions and companies in the biomedical sector" (www.qualitycenternetwork.it/index.php?lang=en). QCN comprises the different actors involved in the process of development, production and commercialization of medical devices: University - Hospital Polyclinic of Modena and the Modena Local Health Unit, University of Modena and Reggio Emilia, Provincial Authority of Modena, Union of Municipalities of the Province of Modena – Northern Area, Fondazione Democenter-Sipe and reference business associations. The aim of the initiative is to favor mainly the collaboration between the enterprises and the end-users (healthcare system); however, QCN worked mainly through technical meeting stable in which the main actors were the institutional actors. Companies were no so much involved and committed.

These new aggregative phenomena notwithstanding, the typologies of innovation observed in this stage are not significantly different from the one registered in the previous years: they we are mainly incremental and related both to processes and products. However, we can register the first signs of a transition from a closed innovation to a much more "private open innovation" approach: collaboration with research partners or external institutions is more frequent than in the previous stages (i.e. we can assist to collaboration between some companies and Universities of Modena and Reggio Emilia).

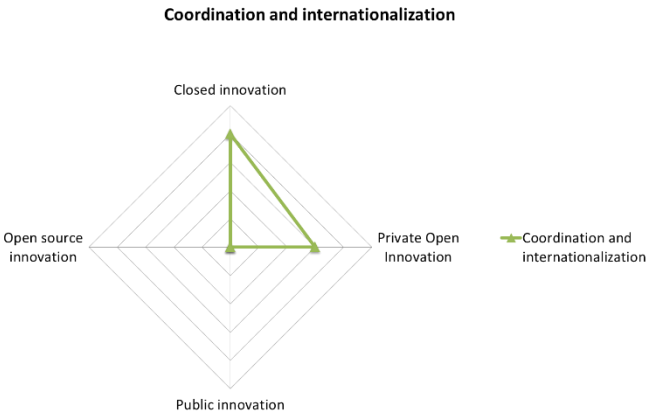

Figure 3: Mirandola coordination and internationalization: classification of the innovation process

The post-earthquake

As anticipated, a slow process of transition from closed to open innovation started since 90s; however, the real change happened after the two shocking external events of 2012 May 25 and 29. Two earthquakes (the second was the one that have the major consequences on Mirandola district), which caused 27 victims and are considered as one of the most clear examples of "economic earthquake". In fact, the major impact in terms of casualties was on the industrial system. The description of the emergency phases, which immediately followed the earthquake and the initiatives, both public and private, undertaken to promote reconstruction, is beyond the purpose of this analysis. Our interest is about the changes which occurred in the district after the shocking event.

The earthquake gave a boost to the aggregation process that started in the previous years. In a recent book (Mosconi, "Dal garage al distretto"), published just after the earthquake, Mirandola district was described as an example of "*resilience*". Earthquake can be considered as a trigger-event that has changed the relationship between the different actors of the district (public, private and institutions).

One of the more important phenomenon which happened after 2012 was the creation of the "Scientific and Technology Park of Medicine" – TPM, specifically designed to favor the further growth of Mirandola biomedical district after the natural disaster. It was inaugurated in January 2015 and it was managed by Fondazione Democenter-Sipe[1] in collaboration with the University of Modena and Reggio Emilia. TPM activities includes: research and development, networking, technology transfer, incubation, fund raising specifically addressed to favor the innovation processes in the companies with a particular focus on SMEs.

TPM establishment was an important turning point in district evolution for several reasons:

- the industrial sector was involved for the TPM design and realization (i.e. equipment acquisition, expertise needed). More than 15 firms, associations and local institutions expressed their interest for the initiative, actively participating in the definition of the competencies and equipment needed to guarantee its functionality. These initiative is a turning point because with respect to other initiatives (such as QCN or Consobiomed), TPM is characterized by the presence of research laboratories located in the district and managed directly by a third entity that can dialogue with companies and public entities. It can be considered as the "intermediary" (Lee et al., 2010) institution able to favor the contamination and exchange among all the actors (university, healthcare system, enterprises).
- TPM was co-funded by Emilia-Romagna region (Fondazione Democenter-Sipe won a public tender) and supported by Mirandola Municipality, and Fondazione Cassa Di Risparmio di Mirandola (a Bank Foundation[2]);

This proactive role in the creation of a proper ecosystem (that we can define as an innovation regional system with the presence of technological enterprises, strong relations between universities and productive system, an history of cooperation, supporting organizations, financial capacity and the presence of capital (Kerry et al., 2016)) for the innovation is proven by the realization of a series of strategical projects involving both research centers and enterprises which in some cases are competitors. Example of these projects (funded by Emilia-Romagna Region - Project POR-FESR 2014-2020) are reported in table 4. It can be considered as We talk about a "proper" ecosystem because in the previous within-the-district cooperation experience there was a clear lack of coordination of actions and only a limited reduced number of activities carried out by public entities or research centers. There wasis not a "third party" able to collect the interests and knowledge needs from theof industrial sector and to transform those requirements in matter of

[1] Democenter-Sipe Foundation (https://www.democentersipe.it/) is a technology transfer center operating in the Modena Province area and that is participated also, among many other subjects, bythe University of Modena and Reggio Emilia. It acts as the link between companies and research center

[2] Bank foundation with the aim of favoring development of the territory

research and innovation in concrete projects. Support was mainly given in aspects such as internationalization or regulation aspects.

Short name	Title	Research center involved	Enterprises involved	Partners for disseminatio n activities
TECNO_EN-P (2016 – 2018)	smart materials applied to biomedical device to remove cells and substances in biological fluids	TPM "Mario Veronesi" CIRI SdV – Centro Interdipartimentale di Ricerca Industriale Scienze della Vita e Tecnologie per la Salute – Università degli studi di Bologna CIRI MAM – Centro Interdipartimentale Per La Ricerca Industriale Meccanica Avanzata E Materiali - Università degli studi di Bologna	Fresenius HemoCare Italia S.r.l. B. Braun Avitum Italy S.p.A. Eurosets srl	Democenter-Sipe Foundation
NANOSENS4LIFE (2016 – 2018)	Nanobiosensors on functionalised polymer matrix: smart devices for in-line monitoring of extracorporeal treatments, assisted respiration and oxygen therapy	TPM "Mario Veronesi" MIST E-R – LABORATORIO DI MICRO E SUBMICRO TECNOLOGIE ABILITANTI DELL'EMILIAROMAGNA – MIST E-R S.C.R.L Dipartimento Rizzoli RIT – Research, Innovation&Tecnology	Intersurgical S.p.A. B. Braun Avitum Italy S.p.A. Eurosets srl Medica spa	Democenter-Sipe Foundation
NANOCOATINGS (2016 – 2018)	New nanostructured antibacterial films for applications in the biomedical sector	TPM "Mario Veronesi" Dipartimento Rizzoli RIT – Research, Innovation&Tecnology ISTEC – ISTITUTO SCIENZA E TECNOLOGIA DEI MATERIALI CERAMICI	TECH S.r.l. B. Braun Avitum Italy S.p.A. Organic Spintronics S.r.l.	Democenter-Sipe Foundation

Table 4: description of some strategic projects representing an example of private open innovation

In these projects, the involved research centers developed a compound of knowledge and expertise needed for the creation to develop innovative products. Involved enterprises share their expertise in

the sector to develop this new platform. The platform allows to realize different prodocuts. Enterprises obtained the "right" to have an exclusive license for one specific product realized with the platform. In the case of NANOSENS4LIFE, the project allowed to develop the technology needed to create sensors usable in extracorporeal circulation for the detection of particular parameters. All the involved enterprises collaborated to the development of the technologies, both with personnel and access to equipment. Moreover each of the company had the right of exploiting a specific application (i.e. monitoring of pH in the blood in hemodialysis or pCO2 again in hemodialysis), whereas the patent were filled by TPM. In this case, the public funding allowed to develop a technological platform and to favor the introduction of new products (enterprises are carrying out all the industrialization phases needed to access the market).

Furthermore, a new consortium was created (very similar to Consobiomed), Consobionet, with the mission of "*creating synergies, partnerships, exchange of expertise between its partners, to realize a network of contacts in Italy and abroad, in a highly competitive market* (www.consobionet.it/en/consortium/)." This initiative could be considered similar to Consobiomed Consortium, but differently from the first consortium, Consobionet is strictly focalized on internationalization and no other activities (such as support for products registration) are not carried out.

In conclusion, the post-earth quake period was characterized by the same typology of innovation that have historically crafted the Mirandola district's innovation processes, namely incremental innovation referred both to product and process. However, the approach to innovation, in this stage, has shown substantial differences compared to the previous evolutionary stages. Indeed, a major number of enterprises decided to collaborate with non-district external form the district entities for R&D activities. The strategical projects cited in table 4 represent an example of a mix of Private Open innovation and public innovation (TECNO-EN-P or NANOSENS4LIFE).

Other example of the openness of the companies can be detected in the innovation carried out in the territory, several with the support of public funds which favored the collaboration with research centers.

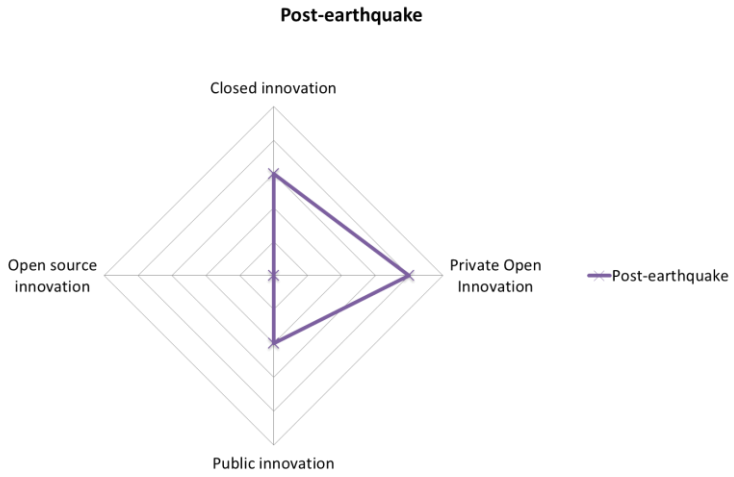

Figure 4: post-earthquake: classification of the innovation process

DISCUSSION

Several analyses were performed about industrial district evolution and transformation, starting from the industrial district definition of Becattini to the very focalized analysis on Mirandola district (Biggiero et al., 2003). However, studies lack of a concrete focus of how open innovation could affect the transformation of an industrial district and how industrial district react to external triggering events.

Starting from these considerations and assuming that Mirandola biomedical districts needs to innovate (both introducing incremental or radical innovation) to maintain its primacy and it needs to adapt its innovation model to be competitive (Brusco et al., 1989), we perform an historical analysis of how the innovation processes in Mirandola district have evolved over time. We studied changes in types of innovation (incremental or radical) and approaches to innovation (close or open) across four stages of evolution.

We can assume that if in a first phase the model used to study and analyze the district was the Schumpeterian one, in recent years enterprises started to collaborate with other enterprises and research centers (both university and private centers); the passage was from a very closed innovation to a much more collaborative process. In particular we can assist to a first phase characterized by the presence of very innovative solutions with companies' closure in respect of collaboration. Then, gradually, although the innovation has become incremental, the opening has been greater, also favored by an external event such as the earthquake. This passage has been favored by distinct events, such as the cited earthquake, but also by the presence of a third party (TPM) which acting as an intermediary actor favored the collaboration between private and public entities.

Hence, Mirandola biomedical district represents a complex system in which relations and processes have been adapted and modified in different ways during the years due to technological (in terms of products and productive processes) and socio-economics (ecosystems characteristics, ageing of populations, etc.) changes. If at the beginning of the district, the companies were born and developed independently, during the years enterprises have started to collaborate, both in informal and formal ways. Moreover, intermediaries associations grew up with the aim of supporting the ecosystems both in internationalization and research activities (such as TPM or Consobionet).

In figure 5 it is reported the results of the analysis of the different kinds of innovations present in Mirandola.

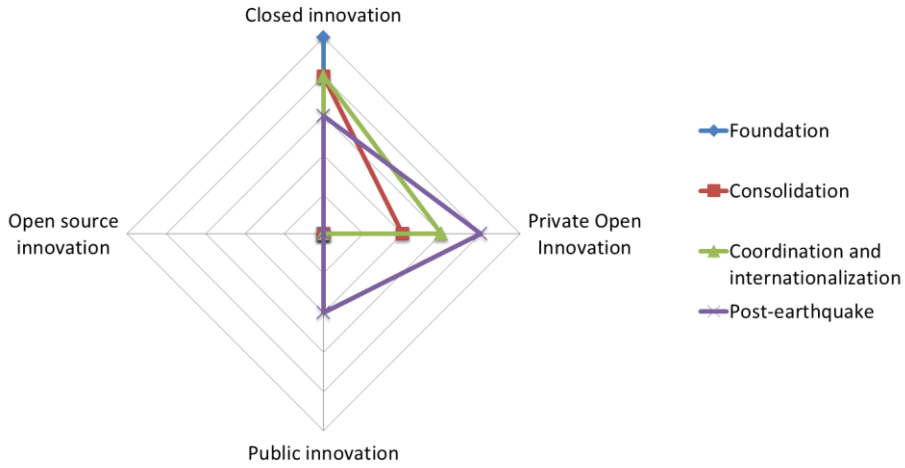

Figure 5: innovation process evolution during Mirandola district transformation

We can assist to a clear shift from a closed to a much more open innovation approaches. This process was at the same time stopped (in a first phase) and then revived after the 2012 earthquake. In our vision, "open source innovation" is a kind of innovation approach that does not fit with the needs of the specific sector (biomedical). Indeed, as described, biomedical sector (such as the pharmaceutical one) requires huge investments and very long times, so it may be difficult that a company decides to make the results (processes and/or products) of its investments available to competitors. Regulatory aspect is i.e. one of the key-problem for the companies: beside the investment needed for R&D, respond to the certification requirements is time and money-consuming. Public innovation represents the right compromise, in which some companies collaborate for the development of a common technological platform, which is then exploited exclusively by a single company for some specific applications.

This lead out to ask if the "classical" definition of industrial district could be adopted also when open innovation approaches are applied or only in specific case (i.e. when we assist to private open innovation approaches).

Understanding these kinds of events, that can favor industrial district evolution and changes, can help to transfer the same model to other industrial districts and favor the growth of these kind of ecosystems.

CONCLUSION

The dynamics currently present within the district can be summarized in the following image in which the different kind of relations established during a new product or services development are reported in figure 6.

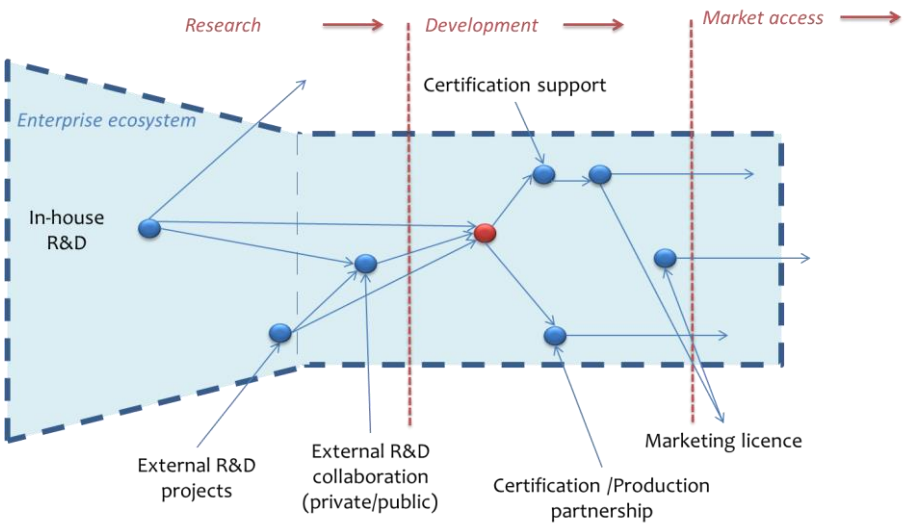

Figure 6: elaboration of innovation processes present in Mirandola district

Process is indicatively subdivided in 3 main phases (research, development and market access) which represent the main activities required for new products realization. As indicated "certification support" is one of the main step needed in medical device sector, which for our purposes is reported in the development phase, after the prototype validation (red point). Ideally, the entire process could be carried out by a single enterprises, however what happens it's a complex flow of contamination between inside and outside, in all the phases of realization of a new device. These processes can all be found within the Mirandola district. Then, we can assume that enterprises located in Mirandola adopt an "open innovation" model, despite this model is not codified or evident; open innovation model is adopted mainly by the multinational (that are more involved in collaborative projects) and by few SMEs that decided to collaborate with research centers for small development projects. The model is not codified or evident because these kinds of collaboration are starting after the trigger event (earthquake) and they have not still led to a well established approach. Indeed, in the district, firms adopt non-pecuniary open innovation activities (such as non-R&D workers knowledge, customers interviews, etc) (Şimşek et al., 2016), and they acquire knowledge from the outside (i.e. collaborating with external R&D centers). Approaches of open innovation are sporadic initiative, proposed by third entity (TPM) that through public contribution, favored the collaboration between the companies.

In summary, our model identified four main points:

- the relation between the players involved in the innovation process, as R&D manager or enterprises' owners are required; their propensity to adopt innovation process or "open innovation" approaches influences the acquisition of external competencies (Labory, 2011), acquisition of external competencies favored also the collaboration with other companies
- the occurrence of a trigger event (earthquake) can cause a radical change in the relation between all the socio-economic actors present in the district and the external partners. Trigger event accelerated in a concrete way some processes and favored the collaboration mainly between public and private entities
- the creation of a dedicated research center, Tecnopolo "Mario Veronesi" managed by Democenter-Sipe Foundation in collaboration with the University of Modena and Reggio Emilia and realized with the contribution of different entities such as Mirandola Municipality or Fondazione Cassa di Risparmio di Mirandola, a bank Foundation, can act as the intermediation subject that can positively influence the moderator required for favoring SMEs growth.
- the specialization area, medtech (defined as "*products, services or solutions that prevent, diagnose, monitor, treat and care for human beings*."- Medtech Europe) is characterized by a high technological content and stringent regulation which have important consequences on the innovation process and on the generation of new products. Medtech sector is characterized by an intensive R&D activity and this make indispensable for enterprises an opening towards external specialized stakeholders to maintain their competitiveness. Enterprises need to find outside skills and competencies required for their growth (Laursen et al., 2006) and to ideate, prototype and realize medical devices. Indeed all these activities require different competencies and skills (spanning from engineering to chemicals and biology or mechanics, electronics, IT, biochemistry and material sciences – Labory et al., 2014). Often small and medium enterprises need to have technological and high specialized partners. Moreover, some general considerations need to be underlined when innovation in "medtech sector" is treated and when this particular district is analyzed, since cross-sectoral investments and competencies are needed: a) medtech requires much more integration and collaboration between different actors than other sectors (eng., biologists, chemicals, expert of regulations, etc); b), new business model will be developed to face societies' transformation (i.e. linked with the ageing of population, the increasing of chronic diseases and the reduction of public health expenditure); c) "commoditization" process occurs: since some of the products realized in the district (such as "the disposable") are "commodities", the risk is the transfer of their production from Mirandola to low-cost countries; d) regenerative medicine and its passage from the lab to the bed could be both a threat and an opportunity (a threat because new treatments could replace technologies realized in Mirandola, an opportunity 'cause the competencies and the products realized in Mirandola should be the exploited for the transition of the therapies to clinical application).

However, one of the key element of the district is that companies performing research tend to maintain internally the core-R&D activities, we don't assist to "substitution" phenomenon (Dahlander et al., 2010). This could be due to the complexity of the specific sector and to the necessity of maintaining internally the competencies needed to evaluate the proper partner to perform R&D activities (Cohen et al., 1989). Indeed, companies collaborate with external entities

only for very specific activities: i.e. for the identification of a single component or material of a product or for analyzing the performance of a process or product. Enterprises exploit external technologies or competencies when they can complete or improve their knowledge about a specific theme.

Points that we learned are:

- different growing phases which can be identified to describe districts' evolution, these phases differ for the innovation process adopted by the actors in the territory and the relations between all the entities
- higher concentration of enterprises which differ for dimension, specializations, activities can favor contamination and changes. The major percentage of enterprises are SMEs and this allows to analyze as the innovation processes evolve during the last 50 years. It is important to report that being part of a district can favor the patent filing (Labory, 2011) and this could be linked to the ecosystem present in the district made of local and foreign enterprises, healthcare system, associations, institution, etc.

Hence, this analysis underlines that development and growth of a district is a complex and articulated process, in which different actors contribute to creation of new products, processes and services. To reach an international level (on other words to compete with other companies mainly at European and USA level), it is necessary that all the actors have a common interest and common purposes. Trigger events (such as earthquake) can contribute to accelerate some processes (such as the establishment of collaborations) and favor the growth of intermediary organizations. This happened because companies located in the territory started to collaborate to avoid the interruption of the production. Stop the production could have two effects: stopping the supply at European level of biomedical technologies for "life-saving" therapies and favor the delocalization of the multinational. This collaboration, after the emergencies moments survived also in the subsequent periods.

Moreover, we can conclude that the intervention of the public administration is quite relevant for the development and growth of the district (similar to the entrepreneurial state – Mazzuccato, 2015), above all it has been vital after the trigger-event (earthquake), promoting investment in R&D, both financing the realization of a Scientific Park and R&D project carried out by the local companies. Indeed, public administration decided to invest in the territory: all the actions carried out at regional and local level were coordinated; the aim was to favor the growth and consolidation of the ecosystem in a concrete way. Regional administration make available funds through public tenders, local administration infrastructures and local support.

ANNEX 1

	Companies	ref. Year	source	employee	ref. Year	source	Revenue (€)	ref. Year	source	Export revenue (€)	ref. Year	source
Mirandola District	>90	2015	Camera di Commercio di Modena	5000	2015	Camera di Commercio di Modena	> 500 millions	2015	Camera di Commercio di Modena	> 360 millions	2015	Camera di Commercio di Modena
Medtech Ireland District	450		Irish Medtech Association	29000		Irish Medtech Association			Irish Medtech Association	12,6 bilions		Irish Medtech Association
Minneapolis – St. Paul Districy	>130	2016	Employment and economic development	> 21000	2010	US Cluster mapping						

Table 5: data on the 3 analized disctricts

	Mirandola district	Ireland Medtech district	Minneapolis – St. Paul district
History	District foundation is linked to one figure, Mario Veronesi, who founded several companies acquired in a second moment by multinational; this is a typical Schumpeterian model. Starting from these companies, other similar enterprises was founded in the following years. District foundation happened in the sixties.	Founded thanks to strong policies of attraction of the Irish government; Irish government promoted the territory through the promotion of settlement of companies that attracted several multinational. At the same time, a viable medical health sector has made it possible to attract additional foreign companies.	Could be considered similar to the Mirandola district; the ability to respond to a "need" in of the medical and healthcare system allowed the creation of a first company, and then other enterprises were realized (for gemmation or attraction on the territory). The presence of other technological districts dedicated partly to manufacturing and partly to transport, has favored and it is still encouraging industrial

	The development of the district was certanly helped by the parallel development in the region of other industrial districts dedicate to precision mechanics and industrial automation.		development
Specializations	The macro themes, at least in the start-up phase, are very similar within the three districts, all very focused on the classical "medtech", both equipment and disposable. Only the Irish district seems to be shifting in recent years also on different issues such as biotechnology or advanced therapies. Within the Minneapolis area there are still further technological districts. In Mirandola very few companies are changing the specialization		
Geographical dimensions	Located in a very limited area, it includes some municipalities in the province of Modena; all the companies belonging to the district are therefore very close. However, the regional biomedical sector includes other companies located in the regional territory.	The district includes an extensive area, straddling several provinces and it refers to a very dispersed health and research system, although all referable to the Irish territory.	Territory between two cities (twin), smaller than the Irish district, but still larger than the Mirandolese biomedical district
Enterprises characteristics	The multinationals located in the territory thanks to acquisitions of small and medium-sized enterprises. There are few cases of large companies with Italian capital. There is a strong presence of of small and medium-sized companies both able to commercialize their own products or working for large companies (as subcontractors).	Large companies that, attracted by the territorial policies, placed one of their site in the area. Morover, highly specialized small and medium-sized enterprises developed, working in collaboration with large companies	Numerous multinationals are present. However, also the presence of a network of small and medium enterprises is emphasized. Several multinational headquarters are located in the district
Geographical localization	The geographical location is often referred to as one of the bigger problem of the district, which is quite far from the main cities of reference (Modena / Bologna) and therefore from the local universities. Also the ways of connection have always been	The area of reference is extended, some areas are probably much more reachable than others, therefore more accessible and attractive. However, each area is characterized by one or more specific expertise	Elements of poor "attractiveness" for the cluster are reported, due for example to climatic factors. However, historically, this area is recognized as an important crossroads for the exchange of goods and connections.

	indicated as a problem. Something is changing regarding the location of research centers in the district. Indeed from 2015, TPM (research center) is present in Mirandola.		
Employment	The numbers of people employed in the sector, especially between Minnesota and Mirandola, appear to be very different; it would be comparable, perhaps, if % of employment in the specific medtech sector were used within the geographical area. For Minneapolis this specialization exists; for other areas it is missing. The automation of some industrial processes could erode employment in the coming years; however shift toward new technologies such as biotech or medicine regenerative could favor a transformation of the three districts.		
Education	In all three areas, the need is to have a highly qualified workforce available. This qualified workforce may be a further reason for other companies to locate in the area; for this reason, numerous initiatives have been launched aimed at adequately training the personnel. While in foreign districts much attention is given to "specialist" and university training, within the Mirandolese district, attention is also focused on the training of technical personnel.		
Political initiatives	The regional support policies have intensified especially in the last period also through targeted interventions on different levels (companies, training, research)	There are numerous actions supporting the district creation, such as the investment fund that have attracted and are continuing to attract businesses over the years.	Both the NIH and the state of Minnesota invested in the promotion and growth of the cluster; also in this case numerous associations are mentioned; their purpose is to favor the creation of a fertile ecosystem for businesses
Markets and local ecosystem	The public domestic market is governed mainly by public tenders and the delays in payments put SME's in difficulty. The private market is present. The multinationals are most facilitated because are less affected by late payments	The bibliography cites a certain "vitality" of the internal market, or more generally, of the health facilities located in Ireland, to the acquire products developed within the district.	Strong demand for MD also coming from the local healthcare system, active collaborations with hospitals are recorded. Probably the existence of a strong private healthcare system in America facilitates the products' positioning on the market
Future and trends	All the districts are willing to build a fertile ecosystem for the establishment of businesses, with a special focus on everything related to the creation of new businesses. The relationship with the world of research and health is encouraged at all levels		

Table 6: districts features

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SECONDO PAPER

Science and technological parks (STP): lessons to be learned

INTRODUCTION

The aim of the present work is to define a benchmark for the creation, development and sustainability of Science and technological park (STP), which can be adopted in different ecosystems to promote the growth of a territory. Indeed, growth and development of an innovation regional ecosystem require the presence of technological enterprises (international industries), strong relations between universities and productive system, an history of cooperation, supporting organizations, financial capacity and the presence of capital (Kerry et al., 2016), all these elements can be found in STP and it is clear that the creation and the sustainability of this kind of structures (cluster or scientific and technological parks) requires the interaction of all the actors involved in the innovation process, the adoption of a proper model, and the financial tools at disposition (Colombelli et al., 2016). Moreover, if we consider a specific sector (life science) the ecosystem is much more articulated, other actors must be added (hospitals, end users, no-profit and patients associations). The scope of the present work is to analyze the already existing and well established Science park to identify the best models and elements that can be adopted when new STPs are established or need to be promoted; in particular the first attempt to apply the model in "Science and Technological Park for Medicine of Mirandola", locate in Modena, Italy. First of all it is essential to establish what is a Science Park. The International Association of Science Parks and Areas of Innovation (IASP) reports that:

"A Science Park is an organisation managed by specialised professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. To enable these goals to be met, a Science Park: stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities." (JRC Technical reports, 2014).

Whereas the Organization for Economic Cooperation and Development (OECD) reports that Science Parks:

"(…) they concentrate high-tech industries and specialized service centers (…) they have at least one university department or institute of technology with which hosted companies can communicate with each other (…) they include an important component of research and development (…)" (Guadix et al., 2016).

These two definitions don't differ in the main features, they consider a Science Park as an ecosystem in which business and research enter in contact and also favor the growth of new enterprises (in form of start up or spin off). Science park may act as intermediary between technology developer and technology diffuser and transfer research from universities (research labs) to the market (Simsek et al., 2016). To better understand what a technology park is we can report the characteristics described by Roldan (Roldan at al., 2018), who described a park as a structure able to provide support services, physical infrastructures, relationship network with other companies or universities, innovation (in product, process, marketing, organizational) and improve performance.

For our purposes, we will use the term "scientific and technology park (STP)" for the analysis.

One of the main issue to be clarified is if it is demonstrated that this kind of structure help the growth of business and what are the parameters to be evaluated. Moreover, it is not clear what kind of structure or characteristics the park may have. What kind of services or support the STP should administered? Who are the entities to be involved in its management? What are the infrastructures indispensable to be present in the STP? Another open question is about the evaluation of the STP performance; how we can evaluate the efficacy or the impact that a STP has on an ecosystem?

This kind of analysis will be performed to obtain the knowledge and information necessary to create a model applicable to a specific industrial ecosystem, that is the Science and Technological Park for Medicine (TPM of Mirandola). Established in 2015, TPM is an integrated model that comprises research activities, technology transfer model, incubation (TPM – Cube), education and it is strong focalized on medtech sector.

TPM was established with the aim of creating a structure which can dialogue with enterprises, public institutions, research centers and university, creating the triple helix needed for ecosystem development. In particular, in its first phase of development TPM acted as a facilitator for the connection with university of Modena and Reggio Emilia, as required for an innovation hub (Youtie et al., 2008). Establishment of the TPM is also coherent with European Polices which favor the creation of regional cluster focalized on the smart specialization strategies (S3) (Thomas A. Christensen et al., 2012) and with other European guidelines which clearly established that these "clusters" may favor not only the creation of new products or services but also the development of new business models or organizational models to be transferred to the enterprises (European Commission, The Smart Guide to Service Innovation).

To obtain our aim, we perform a first analysis of the characteristics of life-science sector in respect of other sectors and trends. Indeed, life science in respect of other sectors has different features and characteristics (such as the time required for products or services development, the strong regulation, etc) and it is important obtain a model of STP responding to this kind of requirements. Analysis of the trends are useful to understand what are the key elements to be taken into account in the design of the model. On a second phase, we analyze literature to identify if and how STP have impact on enterprises performances and how these performances are evaluated. To better identify model, above all concerning management systems and infrastructures features, we perform an analysis of best practices at international level, performing also some visits in specific international STP. The collection of all these information, allow to define a model of STP applicable life science ecosystem.

SPECIFICITY OF LIFE-SCIENCE SECTOR AND TRENDS

Life science and medtech sector characteristics

Life science and medtech are quite different from the other productive sectors cause their application area: products and services have direct consequences on people health or physical and mental status. For this reason the sector is strongly regulated and these have consequences on R&D activities. STP may adapts their structure and services to respond to sectors' needs. The main characteristics of medtech (Ramlogan et al., 2007; Rosenberg (1994); Coffano, 2016) are:

- Products development requires a combination of different expertise and specializations (such as biological, chemicals, eng) which may be integrated both in R&D and industrialization phases
- Healthcare system have an important role, both in R&D and market access. The relation with healthcare system is strictly regulated. In Europe public healthcare system acquire product through tendering procedure. This has a strong impact on marketing actions or market characteristics; on the market is not on "new products" but lowering prices is the only objectives
- Regulation, standards and certification are a key element for the development of medical devices, they have a strong impact both on timing and investments needed for new products or services realization and industrialization. Indeed, production must be carried out in special developed environment such as clean room
- Market is well consolidated and very big players are market leaders in specific sector or in specific application

Concerning the medtech trends both from economic and scientific point of view, some information are reported. This analysis of trends was reported to underline the impact that the sector could have on an industrial ecosystem and the challenges that PST may face from a technological point of view and the different expertise need to support the innovation process. Without this kind of information, understanding why is so difficult the establishment of a PST can be difficult.

Today on the market are present more than 500.000 medical technologies, which have the aim of improve, transform or prolong life. Medical devices are grouped in 4 classes (I, IIa, IIb, III) concerning the risk associated with their usage. The sector is characterized by a good rate of innovation (12.000 EPO patents' application in 2016). In Europe the employees are more than 675.000, 27.000 are the companies (Medtech Europe, 2018).

Talking about economic trend, it is foreseen that the global sales will growth at a rate of 5,1% per year, reaching 521,9 billions of dollars in 2022 (as reported in figure 2). R&D investments are forseen to growth at a rate of 3,7% CAGR, from 27 billions of dollars of 2017 to 33.5 in 2022 (Deloitte, 2018).

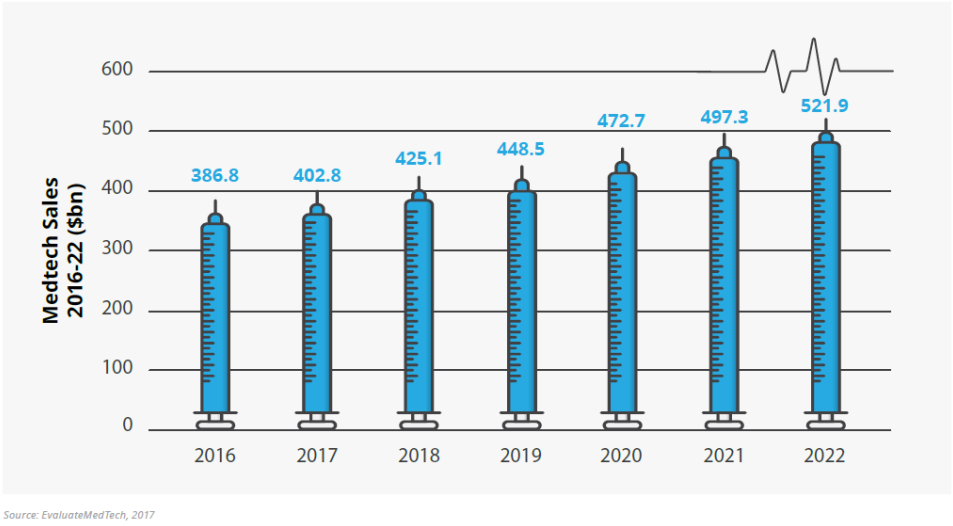

Figure 2: Global medtech sales (US$B) 2016 - 2022

Today, the pro-capite expense in medical device in EU is on average 243 €.

The trends is to assist to a global increases in heath expenditure (see figure 3). This growth is due to the aging and global increase of the population, to the expansion of developing countries' markets, to technological progress (eg higher quality services will be provided innovative therapeutic tests or approaches for chronic and non-chronic diseases) and to the increase in labor costs. However, it should be stressed that health expenditure varies widely from country to country and does not always correspond to a better health system.

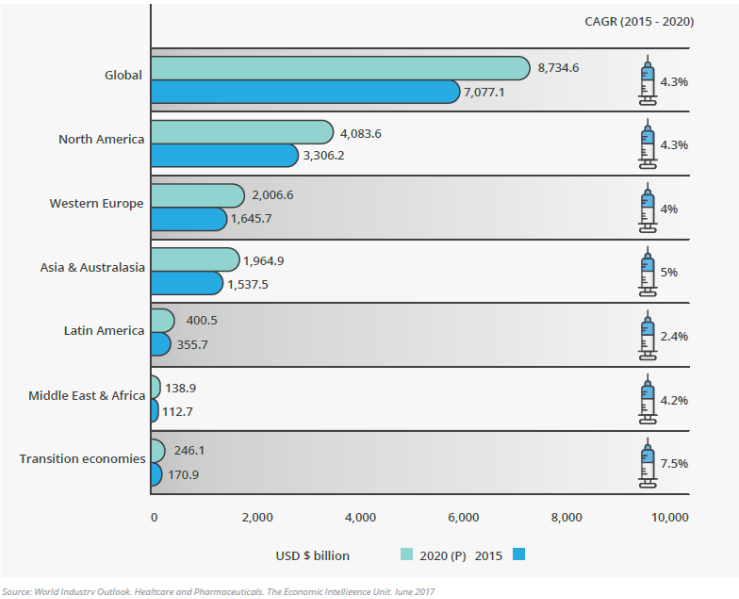

Figure 3: Health expenditure (2015 – 2020)

Globally, with reference to the 4P medicine (prevention, prediction, personalization and participation), a constantly aging population and the fourth industrial revolution, the following trends are identified:

- digitalization: data will be devices' core, algorithms will allow to create increasingly customized therapeutic solutions, within a dynamic ecosystem. In the healthcare system of the future, patients themselves will take a proactive role and digital technologies that can facilitate this approach will become key to managing care and life (E&Y, 2018)
- transformation of traditional business models with the aim of placing the patient at the center and adapting to the changing needs of individuals (E&Y, 2018)
- entry into the healthcare market of new players, these are realities able to offer new technologies for "health" capable of placing the individual at the center; solutions related to fitness are moving towards the medical device for their ease of use and the ability to accompany the individual at all times. For example. the global market for wearable devices is expected to reach $ 612 billion in 2022 (Deloitte, The Future Awakeness)
- development and strengthening of key enabling technologies for new technological solutions; es. addictive manufacturing (3-D printing) and augmented reality (E&Y, 2017)
- introduction of the new MD regulation which will come into force from 2020/2022 and which will force companies to rethink their models (E&Y, 2017)
- establishing partnerships between pharmaceutical companies and technological companies required for technological development (Deloitte, 2018)

METHODOLOGY

In this work we have two main question, one related to the evaluation of STP and another concerning the characteristics of the STP that can be adopted.

To identify the parameters needed for a proper evaluation of STP we perform an analysis of literature to obtain the elements of STP that mainly have influence on their performance; for the aim of our work we don't consider the analysis in which performance was evaluated in function of the enterprises established in the park in term of wages, employment rate, etc (Siegel et al., 2003). Indeed, at the moment, Mirandola STP doesn't comprise enterprises established in the park. The aim is to have located in the park only start up or spin off, or R&D enterprises' laboratories. The analysis was performed identifying key elements such as: aim or research question of the paper, statistical approach adopted, sample characteristics and variable adopted (to understand the available data) and authors' conclusions.

Sources to be used to identify parks are different, spanning from databases (UNESCO database - http://www.unesco.org/new/en/natural-sciences/science-technology/university-industry-partnerships/science-parks-around-the-world/science-parks-in-europe/ - and the "International Association of Science Parks and Areas of Innovation – IASP" (www.iasp.ws/our-members/directory) and personal knowledge.

Then, to perform the analysis of best practices and to establish a benchmark, we analyzed the structure of some existing and well established parks. STPs were selected taking into account parameters such as the similarity with TPM (i.e. starting from the "healthcare sector", parks with a specific focus on biomedical sector was be identified; parks only specialized on biotechnology was discarded), the scientific importance, the already-existing contact with TPM or visiting studies performed by the authors. In a second moment the analysis was enlarged with some specific scientific parks belonging to other technological sector. In this case, the focus was on high technology sectors, such as materials or IT. We decided to consider technological sector with an high content of research activities and requiring different kind of specialization, indeed comparison can be performed only with structures having this kind of characteristics. Comparison with sector not requiring i.e. specific infrastructure for products development will be no interesting for the development of a model to be applied for Mirandola biomedical district. Materials and IT was chosen because they could have some overlapping with the competencies required for medical devices development.

Moreover, we used and adapted the classification identified by Cooke (Cooke et al., 2005) for bioscientific and biotechnological value chain (VC) to medtech sector. Three main knowledge kinds were identified: exploration (fundamental research), examination (a sort of validation or testing of the new therapies) and exploitation (the transformation into commercial products). In table 1 some of the activities for each kind of knowledge are reported.

KNOWDLEGE KINDS	**MEDTECH ASPECTS**
Exploration	R&D on materials, proteomics, advanced therapies, molecular approaches, biological aspects, engineering, Pre-clinical studies, …
Examination	clinical studies, regulatory aspects,
Exploitation	Market access, distribution, manufacturing, patients healthcare systems, staff training

Table 1: knowledge kinds classification and medtech aspects

All these elements have consequences on science and technology parks, both in their structures and management; indeed a STP which may support sector development need to take into account these 3 knowledge kinds. We tried to add this kind of evaluation in the analysis of the parks.

THE ANALYSIS OF VALUE DRIVERS FOR STP'S PERFORMANCE

One of the main question about STPs is if this kind of structure if they can favor enterprises and ecosystem growth and what kind of analysis could be performed to evaluate their performance. In the following table are reported our analysis report:

Article title	Authors	Year	Aim	Statistical approach	Sample characteristics	Variable	Conclusion
Looking for best performers: a pilot study towards the evaluation of science parks	Ferrara, M., F. Lamperti, and Roberto Mavilia	2016	Methodology to build an index aggregating the performances on multiple dimensions of each scientific park to be used to evaluate the parks and addressing the political choices	Choquet integral based Multi attribute value theory (MAVT). They interviewed 30 subjects, 10 academic researchers and 20 students from courses related to innovation	56 Italian parks, selected in 2012 among those that in addition to making research infrastructures available, have programs for companies' creation	Number of research centers hosted Patent activity Number of business connections Number of projects in which the park is involved Growth of affiliated companies (2010 - 2012) Number of jobs created after the settlement Average distance between affiliated companies and those located in the park Specialization of the park	The scientific network is complementary to the patenting activity Positive relationship between specialization and industrial growth The best parks do not reach the maximum score in any of the parameters
Science and technology parks and cooperation for innovation: Empirical evidence from Spain	Vásquez-Urriago, Ángela Rocío, Andrés Barge-Gil, and Aurelia Modrego Rico.	2016	Being within PST positively influence the establishment of collaborations?	Use the answers of a questionnaire derived from a standard of the Community Innovation Survey (CIS) Proibit and Ordinary Least Squares (OLS) ATE (average treatment effect), considering the companies outside	39722 Spanish companies, representative in terms of size, sector and geographical location; 653 of these are located in 22 of the 25 Parks	the dependent variable is a dummy equal to 1 if the company has a collaboration defined as defined by the Oslo Manual company size exports belonging to a group if new company growth / decrease rate Technological level of the company investment in innovation	Being placed in the district positively influences the establishment of collaborations

				the park as not treated, whereas companies in the PST are the treated. Control is given by a variable measuring the probability of being placed in a park.		obstacles to innovation spending obstacles to finding information	
	Vásquez-Urriago, Ángela Rocío, Andrés Barge-Gil, and Aurelia Modrego Rico.	2016	Are the results of the collaboration better if the company is placed in a PST?	Proibit and Ordinary Least Squares (OLS)	Of the companies of the previous analysis, they selected 1820, those that declared to have active collaborations with universities, research centers, and public or private providers of services with a high content of knowledge. The questions were on the relation to the partner most used	Companies were asked questions about the impact of the collaboration by splitting between tangible results (8 categories) and intangibles (7 categories) on a Likert scale. To these elements, the authors added the "diversity" variables in the type of activity requested and the "duration".	Being placed in a PST has positive effects on the intangible results of cooperation with research centers, but there are no positive economic effects for this collaboration
The influence of Science and Technology Park Characteristics	Albahari, Alberto	2016	What are the characteristics of the PSTs that influence the performance of	OLS	Data from two surveys, one from the 2009 Community Innovation Survey	age of the park dimension location park management	The age of the park has an upside down U-shape about company performance

on Firms' innovation results			the companies located in a PST?		(ICS) and one on the results of science parks, both Spanish 37201 enterprises, 849 located in PST	Y = new products placed on the market	companies in larger parks perform better, similarly parks with larger management teams have better results
Success variables in science and technology parks	Guadix, José	2016	What are the parameters that allow the evaluation of PSTs?	Fuzzy set Qualitative Analysis (fsQCA)	Literature analysis		The study identifies sets of parameters that can effectively explain the behavior and characteristics of PSTs
Knowledge spillovers in science and technology parks: how can firms benefit most?	Díez-Vial, Isabel, and Marta Fernández-Olmos	2015	Evaluating the effect of local innovation due to belonging to a district, but considering the different capacity of companies to absorb innovation	Tobit, longitudinal study	PITEC, Spanish database, 2007 - 2011 period only those for which data were present for 3 years, then 10882 companies	Y =% of sales due to new products cooperation with universities or other research centers location in a district R&D expenditure intensity of innovation (% of turnover reinvested in research) size of the company (number of employees) age of the company (squared)	PST companies invest more in R&D and this R&D is done internally
Beyond the linear view of innovation in science park evaluation An analysis of Western	Phillimore, John	1999		Questionnaire sent to companies located in the PST	58 enterprises of which 38 answered		Within the PST, formal and informal collaborations are established. These collaborations are not easy to trace

Australian Technology Park.							and everyone probably follows different paths

Choquet integral: allows to take into consideration and analyze the possible complementarities and redundancies between the attributes that influence the performances. Furthermore, it allows you to compare SP according to the needs of the interested parties (by entering or deleting variables). The weight of preferences is not attributed to the single criterion but to a group that collects multiple criteria.

Likert scale: from 0 to 3, lack of impact, low, medium, high

As we can see from the table, the research questions vary substantially in function of the available data and the STP definition adopted; also the outcome are quite variable. The limits generally acknowledged by the literature are: lack of a clear definition of what a STP is, what are the key characteristics of a STP, specialization are different (and this could influence the performance evaluation), financing models are variable between each STP, management models, data lacking.

However, one of the most important aspect which can learned by literature is that the location in Science and Technology park can favor the creation of informal relation and exchange of knowledge. These exchanges can favor the growth of enterprises through the informal passage of information (i.e. linked with new technologies).

So we can assume that location in STP have positive consequences on companies performance and activities and that STP are useful for the ecosystems.

Moreover, this analysis allowed to identify how to compare different STPs. In particular we identified the following dimensions:

- Specialization: both life science parks and parks with high-technology specialization were studied. Indeed, the scope of this first analysis was to identify the model which can be adopted to Mirandola ecosystem
- Information on institutions involved: characteristics about the institutions or companies established in parks boundaries and having some kind of collaboration each other. This dimension is important to have information about the characteristics of the private and public entities present in PST
- Management structures (if information are available on website or through interview or visit to the park where possible)

We adopted these indicators because with these kinds of information it is possible to identify and construct a proper model, both from the structural side and services administration. Moreover, these elements will allow a matrix construction to better compare the different STPs. Hence in our analysis of the benchmarks, we will study these elements. We added also some comments to the information collected to underline some specific points identified during the analysis

ANALYSIS OF SOME BEST PRACTICES AT INTERNATIONAL LEVEL

Analysis of already-existing STP allowed to identify their characteristics and we identified two different key-elements that can be used for their identification and comparison. One of the key element is related to the presence of different infrastructures: laboratory (owned by the STP), R&D centers, enterprises, universities, hospital or start up / spin off located in the area of the STP; the other element is the services administered that can span from R&D services to support in the organization of events; we indicated also if other services (collateral in respect of services administered for innovation) are present (such as accommodation support, sportive activities, etc). These elements were chosen after a first screening of literature that allowed to identify that these kind of information allow to cover the majority of the structures analyzed. Moreover, these

structures are strictly linked with PST performance. In our analysis we added also information about TPM in its last version. Infrastructures presence is useful to identify how the PST are structured and how they are linked with services administered; collateral services are important to evaluate how start up or companies are attracted to PST.

Concerning the visiting studies, to better identify the characteristics of Scientific Science Parks and incubation structures, also some structures present in Silicon Valley are be deeply analyzed. In particular the structures analyzed were:

- Plug & Play (a structure with the aim of connecting the largest corporations to the world's best startups through industry-focused accelerator programs in Silicon Valley and beyond)
- Fogarty institute for Innovation (an incubator specifically focalized on biomedical science. Its aims is to cultivate innovators, accelerate the development of their ideas and elevate the global medtech ecosystem)
- JLABS (a network of J&J's incubators, specifically focused on life science sector).

Whereas Silicon Valley represents the "gold standard" in relation to incubation approaches, for the purposes of our work is it difficult to identify models that could be transferred directly in European ecosystem. In particular, structures as Plug & Play, which can rely on several success cases (such as PayPal) which favor the sustainability of the business, are too far from the Mirandola district to be taken into account. On the contrary, Fogarty Institute and JLABS have some interesting tips.

Fogarty Institute is interesting because of its specialization (very similar to the one developed in Mirandola) and its link with the hospital environment. They have in interesting track records of incubated enterprises and elements such as: duration of incubation, characteristics of the services offered, step and structure of incubation, etc can be adapted for TPM incubation structure.

JLABS, on the contrary, could be very interesting for all the aspects connected with the direct involvement of big companies in the development of start ups. Indeed, JLABS offer spaces, labs and consultancy to some selected new companies on life science sectors. J&J has no official priority on the acquisition of these companies, periodically events open also to other life sciences big enterprises are organized to present these start up and their products / services. Of course, J&J having the direct contacts with these "new" entrepreneurs has a sort of "preview" of the developed technologies. This kind of structure can not be directly transferred to Mirandola, but could be an example to be shared to involve the big companies present the district in the development of the science park.

			Presence of						Services								
Name	**Nation**	**Sector**	**Laboratory (owned by the park itself)**	**R&D centers**	**Enterprises**	**University**	**Hospital**	**Start up or spin off**	**R&D service**	**Education**	**Technology transfer | start up support**	**Rent of space (lab or office)**	**support (event organization...)**	**Other services (sports, accomodation, ...)**	**Knoweldge kind**	**Comments**
Barcelona Biomedical Research Park	Spain	Life Science		X	X		X					X	X		Exploration, Examination, Exploitation	services provided by institution hosted
Leiden Bio Science Park	Netherlands	Life Science	X	X	X	X	X	X	X	X	X	X	X	X	Exploration, Examination, Exploitation	services provided by institution hosted
Bioindustry park Silvano Fumero	Italy	Life Science		X	X			X	X		X	X	X	X	Exploration, Exploitation	services provided by institution hosted
Ideon Science Park	Sweden	connectivity, ICT, Life science, cleantech, energy, medtech, smart materials and food innovation			X	X		X			X	X		X	Exploitation	
Karolinska Institutet Science Park	Sweden	Life Science			X	X	X	X			X				Exploration, Examination, Exploitation	strictly linked with universities
NETPark North East Technology Park	Ireland	Materials			X	X		X			X	X			Exploitation	
Medicon Village	Sweden	Life Science		X	X	X		X			X	X		X	Exploration, Examination, Exploitation	strictly linked with universities
Plug&Play	USA	general incubator						X			X				Exploitation	visiting case study
Fogarty Institute	USA	Life Science	X	X			X	X	X		X	X			Exploration, Examination, Exploitation	
JLABS	USA	Life Science			X			X	X		X	X			Exploitation	visiting case study enteriprise is the owner of the incubator
Biomedical Village	**Italy**	**Life Science**	**X**		**X**	**X**		**X**	**X**	**X**	**X**	**X**			Exploration, Examination, Exploitation	**in its last version**

Discussion

Science and technological parks are institutions present all over the world and specialized in a large number of sectors (technological, medtech, …). Moving through literature is not easy, due to the definitional confusion (Mian at al., 2016) and due to their different features; indeed, they differ for a lot of features (management approaches, companies characteristics, structures, services administered to enterprises or start-up, …) and their characteristics are very influenced by the ecosystem in which they are located. For our purposes we constructed a panel of elements (infrastructures and services) to better compare the STPs; moreover we focalized the attention on the support administered along the value chain.

It is clear that the much more structured infrastructures are the elder: the consolidation of these kind of structures require times and investment and the major parks are the one that have been established years ago. Another important factor which has important consequences on the development of PST is the localization and the socio-economics background of the area (i.e. industries presence, technological specialization); it is clear that all the factors can't be reproduced when new science and scientific parks are established (Etzkowitz et al., 2012).

However some elements seem to be essential for a science park creation and consolidation that we found in the STPs analyzed:

- the establishment of collaboration and partnership between all the entities present, that in a district could also favor the development of new enterprises or spin off (McCormack et al., 2015); this kind of relationship can be formal or informal, but they contribute in an active way to create and disseminate innovation; this element is confirmed by the strong importance given by all the PSTs analyzed to the connections between all the entities
- presence of universities or research centers create a favor ecosystem for the growth of start ups and creation of new ideas (products, processes and services); the majority of the PSTs analyzed comprises these kinds of structures
- the integration of education, research and new enterprises creation. Support for new companies could be administered through shared spaces, services, coaching and networking activities (Peter et al., 2004) developed in function of the ecosystem in which the incubator is located (Hackettet et al., 2004 and Wiggings et al., 2003). Education and research carried out need to be tailored to respond to the needs of the ecosystem
- all the actors part of the ecosystem need to be involved in the strategic decision related to park mission and aims. These actors (private or institutional) may have access to a "democratic space" to discuss or make decisions (Şimşek et al., 2016); the majority of the PSTs analyzed comprises these kinds of structures
- trained management is needed to achieve the mission of the park (Allen, 2007)
- it is important to maintain a strict link with universities infrastructures and companies, because in this way can high level research activities are guaranteed and at disposition of industrial system
- creation and maintenance of a "creative environment" which could comprise common spaces, organization of events or workshop, is an important element for exploiting the potential of a PST (Łobejko et al., 2015); all the STPs give importance to workshops and events

- PST success depends both on macro level factors (national and regional context and innovation policy) and micro ones (management, physical spaces, etc) (Machado et al., 2018)

Authors as Machado (Machado et al., 2018), identifies in literature some of the types of interactions occurring in PST which can regards: (i) development of new products, (ii) protection of Property Rights (patents), (iii) enhancement of internationalization and establishment of worldwide connections, (iv) market achievement for new products, (v) promotion of image, (vi) favor companies´ growth and survival rates, (vii) establishment of contracts with stakeholders, (viii) favor the spreading of data, (ix) increasing in intellectual capital and training programs, (x) development of programs to adequate production, (xi) enhancement of networks between companies and other institutions. This is only a qualitative collection of element and for each of them different results are found in terms of impact of the different elements in companies and territory growth.

Parks analyzed are in more or less evident way characterized by the cited interactions, they host companies and/or start up and their aim is to favor their and ecosystem growth. However, their differ for structures and services administered. Indeed, we can identify several groups:

- pure incubators or STPs acting as incubators (Plug and Play, JLabs, Ideon Science park, NETPark North East Technology Park) which support companies in the exploitation of their new products and services, supporting them mainly in market access
- STPs in which services are administered mainly by the companies located in the park, favoring the collaboration and the spreading of knowledge between all the entities (Leiden Bio Science Park, Bioindustry park Silvano Fumero)
- STPs in which universities have a key-role for services administration (Karolinska Institutet Science Park, Medicon Park)
- STPs in which services are administered by lab located and managed by the park (Fogarty Institute, Barcelona Biomedical Research Park).

This classification can support the development of STP in function of the ecosystem present in the targeted territory. Indeed, if an ecosystem is characterized by the presence of a strong universities it could useful to analyzed models such as the Karolinska institute, on the other side, if there is no presence of research centers or other infrastructures, models such as Barcelona Biomedical Research park or Leiden Bio Science Park can be chosen. It is clear, that the last model requires much more investment (to realized infrastructures for research and support) and time.

Other elements that we noticed through best practices analysis and that may be taken into account in STP development are:

- Creation of an “attractive” ecosystem, which is able to attract expertise also from other countries is essential to have at disposition a proper know-how needed to the development of new products or processes or services. Example of well known “attractive” ecosystems are Silicon Valley that is able to catalyze competencies, expertise, human resource and investment or the Karolinska Institute Science Park which is famous for its scientific standing. “Attractive” ecosystems are characterized by a plethora of different elements, spanning from capital availability, industrial presence, scientific standing, etc.
- Some of the best-established science parks have a strict connection with healthcare system. This kind of connection is important for the life science sector, such as the Fogarty Institute, in which the presence of an important hospital, high-specialized, favor the attractiveness of the PST.

Conclusion

Identifying a "common model" of science and technology park is not possible and it is also hard to prepare and having a common way to classify their performance. Operational management (internal administration, such as real estate, organizational services and administrative admission) and strategic management (parks' aims and goals) are influenced by location, specialization, regional, national and international networks (Spolidoro & Audy, 2008). Moreover, Mirandola seems to be an uniqueness considering its structure: indeed in respect of the majority of other STP, in Mirandola the STP was created after the consolidation of an important district with a clear specialization and international positioning (it is a bottom up process in which a well consolidated district requires a public support for its continuous development). No one of the STPs identified has the some characteristics, however we can assert that TPM belongs to the group of STPs in which services are administered mainly by the labs managed by the park itself, though we can assist also to a first attempt of collaboration between the start ups located in the TPM.

However, some important lessons could be learned by the analysis of literature and the park studied:

- Mirandola STP may contribute to the overall growth and economic development of the territory as happened for all the PST studied (such as the Bioindustry park silvano Fumero that contribute to the relaunch of a specific geographical area)
- Cross-fertilization between all the actors involved may be a key element for TPM development (collaboration between different expertise is a plus, as happens in Barcelona park, in which different expertise are present)

However, other elements that may be much more deeply analyzed are:

- involvement of well consolidated enterprises could be a key-elements for the success of the scientific park: they could act both as a scientific and strategic pivot and as financial partners for the most promising start up. We don't observe this kind of information in the parks analyzed; multinational importance is much more analyzed in the literature regarding the industrial districts analysis
- Favor the development of trained workforce, considering also the technical figures could be a plus: in the STPs analyzed the focus is on the training of scientific experts or figures, no information are present about education of much more technical experts

All these aspects need will be taken into account to define the correct structure of a technological and scientific park.

ANNEX 1

Best practices analysis

Barcelona Biomedical Research Park (PRBB)	
Website	http://www.prbb.org/
Specialization	Areas of action: Biomedical informatics and Systems biology, Gene regulation and Epigenetics, Cell and Developmental biology, Pharmacology and Clinical physiopathology Human genetics and Evolutionary biology, Epidemiology and Public health
Information	The six independent research organisations located in the PRBB form an inter-institutional coalition and are connected to one another via the open-plan layout. They focus on investigation into human health and biomedicine in a building that promotes synergies and collaboration. Research centers are: Hospital del Mar Medical Research Institute, Department of Experimental and Health Sciences of the Pompeu Fabra University, Centre for Genomic Regulation, European Molecular Biology Laboratory, Barcelona Institute of Global Health, Institute of Evolutionary Biology. There are 1,468 people physically located in the PRBB building. Taking into account the institutions with various campuses or those which have a direct relationship with the Park, the total number is 1,911. Companies @The_PRBB: - Acellera - IRAB (Barcelona Institute of Applied Radiopharmacy) - ZeClinics
Management	The PRBB Consortium manages and maintains the park and its facilities. It also manages the animal facility as a scientific service. The research centres pay for the rent of space in relation to area and type, as well as for various services in the park. The park receives no structural subsidies.

	The PRBB coordinates together with the centres various working groups and committees (scientific sessions, occupational health, information technology, waste, etc.). It also promotes synergies and inter-institutional collaboration whilst respecting the individual identities and autonomy of the centres. The governing council is the board of rectors which includes representatives from the Government of Catalonia, Barcelona City Council and Pompeu Fabra University and is chaired by the Catalan Minister for Economy and Knowledge. The PRBB Consortium is headed by the General Director, Jordi Cami, and General Administrator, Marga Sala.
Comments	PRBB seems to host few companies and different research centers. It acts as a service provider (i.e. for conferences rooms or events organization). Income (2017) are >15M € (62,8% of which from rent, 11,2% for animal services, 10.4% general services, 15,6% from other sources).

Leiden Bio Science Park	
Website	https://leidenbiosciencepark.nl/discover
Specialization	Life science (mainly focused on drug development)
Information	11 research institutes, 10 educational institutions, 10 healthcare organizations, 12 other organizations, 152 companies. 106 are biomedical (red) biotech companies (25 drug development compagnie, 12 medtech companies, 46 drug development services, 23 business services), 13 other non-scientific areas, 11 scientific areas other than life sciences, 5 ICT, 4 green biotech, 3 provide services to healthcare organizations, 2 healthcare insurers, 2 veterinary biotech, 2 space, 2 water, 1 food, 1 industrial (white) biotech Leiden Bio Science Park's environment of innovative drug developing companies together with an extensive services cluster provides a unique ecosystem. The parks mature service cluster offers drug development services throughout the (bio)pharmaceutical value chain, from target definition to a registered and ready-to-market product, and relevant business services.
Management	At Leiden Bio Science Park, three landowners are active: the municipality of Leiden, Leiden University and the Leiden University Medical Center. These three parties work together in coordination in order to closely correlate management and maintenance tasks.
Comments	Very well-established science park. The structure is similar to the one which could be realized in Mirandola.

Bioindustry Park | Silvano Fumero	
Website	http://www.bioindustrypark.eu/
Specialization	Life Science
Information	Services and infrastructures (acceleration program, accommodation, spaces for events), development services (business development, go to market, support in crowfunding), scientific services through independent research centers Hosting of enterprises and organization (5 corporate companies, 30 SMEs, 4 research centers, 2 associations, 1 Foundation).
Management	BiPCa, the company that manages the Park, is a limited liability corporation with more than €12 million of share capital. The Scientific Committee is the advisory board of the Bioindustry Park Board of Directors. Its main task is to verify the alignment between the projects and the strategic guidelines of the Industrial Plan of the Company. In its propositional and advisory role, the Scientific Committee has the task, whenever required, to evaluate the scientific quality of the projects and support the Park in the selection, approval, planning and evaluation of its scientific projects.
Comments	Bioindustry park is interesting for its structure and its specialization; it differs from TPM for the services provided to companies (TPM has its own laboratories). BioIndustry park has at disposition much more areas and infrastructures.

Ideon Science Park	
Website	https://ideon.se/
Specialization	Ideon and Lund have a long tradition of creating innovations within life science, software/IoT, telecommunications, energy and new materials.
Information	300 000 m2 office space 400 enterprises in the company list (1200 companies since the start) Park offers different services, from location to support for the growth

	Patents registered since 1983 in the park. Events Ideon Science Park not only attracts competent individuals. Companies like Bosch, Sony, Ericsson, Volvo Cars, Huawei, ARM and Schneider Electric have R&D departments or offices here, to benefit from the mix of competences when developing the future. Restaurant are present
Management	Today, Ideon Science Park (Ideon AB) is owned by real estate owners Wihlborgs, Castellum and Vasakronan. The board of directors include Lund University, Lund Municipality, Chamber of commerce and Industry of Southern Sweden, the County Administrative Board Skåne and the owners. The organisation report SUN, a trust created by the original founders, which is a non-profit organisation. The Ideon Science Park brand contains a few supporting brands; Ideon Open, Ideon Innovation, Ideonfonden and Ideon Center, and we work closely together as a team to ensure the mission; helping companies grow and to and increase the employment in the Region. MEMBERS OF THE BOARD • Chairman – Stephan Müchler, CEO, Chamber of Commerce and Industry of Southern Sweden • Anders Jarl, former CEO, Wihlborgs • Ola Orsmark, CEO Castellum, Region Öresund • Anna Stenkil, Regional Manager, Vasakronan • Anders Almgren, Chairman, Lund Municipality • Christer Wallin, Second Vice Chairman, Lund Municipality • Linus Wiebe, CEO, LU Innovation, Lund University • Leif Nyberin, County Administrative Board of Skåne • Maria Ivarsson, Regional Manager, Wihlborgs
Comments	This structure is interesting for its focus on the development of new companies, from the idea to the companies. It is well established and it has very strict connection with big enterprises belonging to different sectors (not only medtech). However it seems to have no specific research infrastructures.

Karolinska Institutet Science Park	
Website	www.kisciencepark.se/en/
Specialization	Life science
Information	Karolinska Institutet Science Park is closely attached to Karolinska Institutet, both geographical and organizational. KI Science Park is located on KI´s two Campus-areas (KI Campus Flemingsberg and KI Campus Solna – a part of Hagastaden). In Solna and Flemingsberg KI Science Park offers superior office and laboratory space with common infrastructure such as conference rooms, reception, internet access, photocopying facilities, security, cleaning, refreshments, etc. At present the total area of the KI Science Park AB premises is around 22 570 square meters at two different sites – four buildings in Solna in the northern part of Stockholm and one building in Flemingsberg, in the southern part of the region. Approximately 60 companies are established on the park premises.
Management	A board of director is present
Comments	KI Science Park can rely on the scientific strength of Karoliska institute. No information about the management structure.

NETPark North East Technology Park	
Website	www.northeasttechnologypark.com/
Specialization	Materials
Information	NETPark encourages collaborative multidisciplinary links, driving innovation, enterprise and economic prosperity. NETPark provides science, technology and engineering companies with a wide choice of world-class laboratory, clean room and office space from the incubation needed in the embryonic stage of growth to the larger spaces needed by companies who are ready to prototype and scale up to manufacture on site. It provides companies with access to a focused and international community where talent flourishes, ideas are generated and businesses have the support and resources to compete with the best in the world. More than 80 enterprises
Management	NETPark is developed, managed and promoted by Business Durham on behalf of Durham County Council. The NETPark Incubator is directly managed by Business Durham

Comments	

Medicon Village	
Website	https://www.mediconvillage.se/en
Specialization	Life science
Information	Medicon Village Science Park offers a unique growth environment for over 140 organizations in life science. Two of our 140 members are big players: Lund University and the regional Healthcare Authority (Region Skåne). The others are mainly SMEs and organisations. At Medicon Village you find areas for chemistry/biochemistry, cell laboratories/cleanroom technology, climate-controlled rooms, pharmaceuticals. They are building a new complex for big and small companies with flexible office space, meeting rooms as well as simple laboratories.
Management	The business operations at Medicon Village is divided by two companies - Medicon Village Fastighets AB and Medicon Village Innovation AB. Both companies are fully owned by Mats Paulsson Foundation for Research, Innovation and Societal Development. The terms of the foundation stipulate that any surplus must be re-invested in research and innovation. The ecosystem for innovation Medicon Village is designed to generate an unbroken chain from idea or concept to finished product, in other words, a complete ecosystem for innovation. The process can be broken down as follows: - There is a desire or need to develop a method, technology or product. It may come from the healthcare sector, the public sector or direct from a specific hospital. - Researchers happen to be already working on this question at university level. - Medicon Village provides a point of contact and a matchmaking service so that the right people from university, the public sector and industry can get together and form some sort of structure (for example, a company) to develop the concept. - A company in the early stages of development can ask to move into SmiLe Incubator, the incubator at Medicon Village, to get support and help it to grow. - Help with development and other services can be provided by one of the 70 or so companies at the Medicon Village business-to-business unit. Through the Village, a small company has all the advantages of the big ones at its disposal. - The company/structure will also have access to rooms, laboratories, lab equipment, etc.
Comments	

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TERZO PAPER

MIRANDOLA BIOMEDICAL VILLAGE

1. INTRODUCTION

The aim of the present work is to define a business model and a structure to be applied to a specific science and technological park (STP) focalized on biomedical sector and strictly connected with an industrial system. One of the main question is related to the relationship that may be established between incubator and research center, education activities to be administered, and how the economic sustainability of the structures can be pursued. In particular, the business model and the structure will be developed to be adopted to Science and Technology park of Mirandola (TPM). Mirandola is one of the main important medtech district at international level; it comprises more than 90 enterprises (spanning from multinational to SMEs) specialized on dialysis, extracorporeal circulation, nutrition, etc. In this context, after the 2012 earthquake, due to the collaboration between enterprises, institutions and foundations Science and Technology park of Mirandola (TPM) was created (an area where research activities, education can facilitate innovation processes).

TPM, inaugurated in January 2015, is meant to be a place where both business and technological expertise can co-work and grow together; TPM helps leverage research and development for a strong biomedical presence in the region in collaboration with a network of acclaimed regional High Technology Centres. TPM is certified quality system ISO 9001 e ISO 13485.

TPM houses three laboratories, all organized and managed in partnership with the University of Modena and Reggio Emilia: TOXICOLOGY AND PROTEOMICS (TOP), APPLIED MICROSCOPY AND CELLULAR BIOLOGY (MAB), MATERIALS, SENSORS AND SYSTEMS (MS2).

Starting from 2015, TPM growth, an incubator (TPM Cube) was created, specialized on biomed, medtech and biotech start up, new labs were added, to respond to the market requirements (usability and chemical – POS). Also services were adapted in function of the companies' requirements.

Moreover, education was reinforced in the area, through the creation of an "Istituto Tecnico Superiore – Nuove Tecnologie della Vita – ITS" (ITS Foundation) which is a course specifically dedicated to medtech.

Whereas research activities of TPM are well established and updated in function of the markets, incubation activities, relationship between all the actors and services to be administered (both tangible and intangible) need to be reinforced and clarified to support the increasing of a region wealth and improving well-being promoting a culture innovation and competitiveness; value may be created both for resident companies and local economy (Ruiz et al., 2016). Indeed, the overall aim of the creation of this kind of structure is to:

- Favor the creation and growth of new companies
- Facilitate the collaboration between enterprises and/or research centers
- Introduce new technologies and favor the development of new products and services
- Favor the cross-fertilization in different sectors
- Favor district internationalization
- Promote education specialized on life sciences technologies

Thanks to this paper we will identify a process to construct a model applicable in a specific ecosystem. The process realized in this work can be replicated in other context or ecosystems. In literature exist several studies on ecosystem, more than 300 articles (Bogers et al., 2019) and we will use the term "ecosystem" which is coherent with the one used by Jackson (2011), who defines innovation ecosystem as "*the complex relationship that are formed between actors or entities whose functional goal is to enable technology development and innovation*". In our view ecosystem is a designed system having a clear purpose and with cross-world link, essential for its local functioning (Deog-Seong Oh et al., 2016).

Our work started with an analysis carried out about the scientific parks and lessons learned, to have information about the characteristics that are necessary to favor industrial growth and to obtain a successful structure. A study of the literature allowed as to state that support for new companies could be administered through shared spaces, services, coaching and networking activities (Peter et al., 2004) developed in function of the ecosystem in which the incubator is located (Hackettet et al., 2004 and Wiggings et al., 2003). Education and research carried out need to be tailored to respond to the needs of the ecosystem. The establishment of collaboration and partnership between all the entities present is essential and in a district could also favor the development of new enterprises or spin off (McCormack et al., 2015). Hence, we perform a more specific analysis of incubators' to identify the existing different structures. We analyzed these two structures because TPM meant to be the a structure where both start up or spin off are hosted and able to administer different services, spanning from research activities to regulation support or market access.

Another important element to be analyzed is the district characteristic and its specific features. These elements allow us to perform a description of the next steps which will be implemented in the area and taking into account these elements, we develop the business model that will be applied in the Mirandola Science Park.

Concerning the contribution to the literature, the present work allows to develop a framework useful to construct a model of technological and scientific park development starting from a specific

knowledge about the ecosystem in which the infrastructure will be established. Indeed, starting from a literature analysis and a deep knowledge of the social and economical ecosystem, we described as a business model can be developed taking into account the different services to be administered, the infrastructures needed, etc. Obviously this process need to be adatapted in different context, but the methodology can be the same. To evaluate our methodology and how the business model implemented work, we reported also some of the results already achieved by Mirandola ecosystem.

2. ECOSYSTEM ANALYSIS

2.1 Science and technology parks: analysis and lesson to be learned

This work has the aim of proposing a process to identify and implement a proper business model for the promotion and growth of an ecosystem comprising both research activities and incubation services, as happened in Scientific and Technological parks (STPs). In a previous work we noticed that a "common model" of STP doesn't exist. STPs exist all over the world, but they differ in term of specialization, organization, management structure, etc and the creation and consolidation of this kind of infrastructures requires time and investment. However, some elements could be identified as essential to the establishment of a successful STP: (i) presence of universities or research centers, promoting the spreading of new technologies, innovation and knowledge, (ii) establishment of collaboration between all the entities located in the STP (spanning from institution to the companies), (iii) integration of all the policies regarding education, development and research, it is vital to have a common vision and a common mission to be pursued.

Hence, all these aspects need to be taken into account developing a model for the Mirandola biomedical district.

In particular, presence of universities or research centers can allow both the creation of an "attractive" ecosystem able to catalyze the presence of both companies and start ups; obviously, presence and establishment of collaboration between all the entities could favor the development of new enterprises (McCormack et al., 2015). All the actors part of the ecosystem need to be involved in the strategic decision related to park mission and aims. These actors (private or institutional) may have access to a "democratic space" to discuss or make decisions (Şimşek et al., 2016). Concerning the integration of education, development and research, support for new companies could be administered through shared spaces, services, coaching and networking activities (Peter et al., 2004) developed in function of the ecosystem in which the structure is located (Hackettet et al., 2004 and Wiggings et al., 2003). These parks are characterized by different revenue models, but all the cited services could generate a revenue for the structures. To be established is the revenues generated are sufficient to sustain all the operations and to cover all the costs without other support (i.e. public funding).

2.2 Incubators

TPM have the objective of hosting new enterprises, so an overview of the existing models and characteristics of incubators are needed. Incubation is and will be one of the activities carried out by the TPM.

New companies or start up/spin off are an essential element to favor the creation and growth of a dynamic ecosystem and a way to favor the generation of new products and services, able to enhance the growth also of well-consolidated enterprises. New companies are also identified as a business generator and they looking for new business model (Blank et al., 2012) that could positively influence a productive area. However, especially in life science sector, new entrepreneurs may be supported along all the value chains to face obstacles (technical, regulatory, etc). To administer support, incubators were created.

The first business incubator was born in the 50s, in America (Adkins, 2002), but the real growth and expansion started in the 80s, when also scientific parks and innovation centers started to spread. Literature identifies 3 generation of incubators (Bruneel et al., 2012), the first characterized by the sharing of spaces (offices), the second one by the administration of services by the enterprises located in the incubators itself and the last one (the third) where the focus is on the technologies and on the network (to reach clients, research or technological partners, business angels, investors, …).

Incubators' mission is to favor and support the origin and growth of new companies (Aernoudt, 2004) and it is essential to foreseen proper enter and exit mechanisms.

Another important aspect to be treated is the difference existing between incubators and accelerators. Accelerators are much more recent, first example are detectable since 2005 in America (Cambridge, Massachusetts) and since 2009 in Europe (Pauwels et al., 2015). Accelerators has the aim of supporting a group of enterprises in defining some aspects of their business with an activities that last on average some months (on the contrary incubation lasts for years, 1 – 5 years). Moreover, in acceleration program frequently consultants are interested in acquiring shares of the new companies (Cohen, 2014).

Whereas accelerators could be an interesting elements to be analyzed, we suppose that for the specific medtech sector the physical incubation could be the best solution for the Mirandola ecosystem.

2.2.1 Companies incubators: models

Taking into account companies incubation, literature reports the existence of 5 organizational models (archetypes) (Zedtwitz et al., 2003; Carayannis et al., 2005):

- Regional business incubators, which serve a local community and their objective is to create jobs and support local commerce and wealth
- University incubators have no particular finance pressure and their aim is to serve scientific community and the university purposes
- Independent private incubators, are profit oriented, and they often focus on a particular technology or industry to achieve this
- Corporate incubators, mainly are focalized on corporate development objectives but could have also political interests
- Virtual incubators, focus on particular needs in the entrepreneurial community rather than a particular industry

The first two archetypes are often associated to no-profit initiatives, whereas the independent and corporate incubators are profit, such as the virtual ones. However it hard to find incubators corresponding to only one category, incubators could be a mix of the different archetypes. For our purpose, virtual incubator will not deeply analyzed, ‘cause they seem to be not appropriate for the Mirandola ecosystem, such as corporate incubators. However, one of the interesting aspect of corporate incubator is their capacity to build relationship and “bridge” between enterprises and start up (Kohler, 2016).

This classification is not the only one reported in literature; another classification relevant for our work is the one proposed by Grimaldi (Grimaldi et al., 2005). Grimaldi considered the aspects and elements which influence the model adopted by an incubator: institutional mission/strategy, industrial sector, location, market, idea origin, intervention phase (maturity of the start up), duration of incubation, revenues, services administered, management team. The identification of a proper model may take into account all these aspects.

In addition to the aspects cited by Grimaldi, another could be added, linked with the output generated by the incubator. These outputs could be classified in the following way (Baraldi et al., 2016):

- funds obtained, intellectual property generated, growth and sustainability for the individual company
- Employment, funds and sustainability for the incubator itself
- Innovation, economic development, employment creation at "institutional" and "political" level.

2.2.2 Incubation: services administered

Carayannis (Carayannis et al., 2005) identifies the categories of offered services:

1. Access to physical structures, which can comprise access to office space, computer network, or other spaces and real estate
2. Administrative/office support, which comprises basic office support such as secretarial or reception services, fax and copying services, etc
3. Access to financial support, which foreseen access to venture capital (private funds, business angels, venture capitalists or local institutions or companies)
4. Business support, which comprises support in the development of skills such as the organizational, management or legal ones
5. Networking activities with the aim of create contacts between start ups and customers or leading-edge programmers or venture capitalists, etc

Lacking of one of these categories could transform the incubator in another kind of structure, i.e. an accelerator could offer points 3 or 4, or an office of technology transfer could offer some of the cited services.

Moreover, all the points could be deepened, describing the typology of services offered; i.e. "access to physical structures" can foresee: offices, common spaces (co-working activities), laboratories and state-of-the-art equipment.

Networking activities could be performed for technology aspects, economical, etc.

3. TPM "Mario Veronesi"

Taking into account the previous analysis and the ecosystem characteristics, the evolution of TPM was designed. In the following chapters we will analyze how the TPM is evolving and the business model identified to favor its growing and consolidation.

3.1 TPM DEVELOPMENT: TOWARDS THE BIOMEDICAL VILLAGE

As described in the introduction, TPM was inaugurated in 2015 and now it comprises laboratories, education institution and a physical incubator. This can be considered the first phase of development of the ecosystem: focus was on research support which can be administered to enterprises' located in the district to favor the creation of new products/process and services and to promote collaboration between all the actors present on the territory. TPM acts as a facilitator for the innovation and in this framework, incubator is only a support offered to few enterprises that

don’t have necessity to have space for their own laboratories, but who can rely on TPM laboratories.

The role of STP is to collect ideas from to the territory and through different intervention lines, and to transform them in new processes, products, services or new companies, taking into account the intellectual property of the input and results (fig. 1). This approach can be applied both for supporting start ups and already-established companies that have new ideas for products, services or processes development.

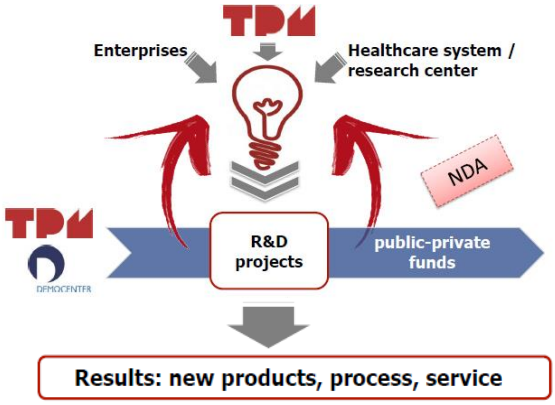

Figure 1: role and activities of TPM “Mario Veronesi”

To pursue this process, TPM was supported by several entities, starting from Democenter-Sipe Foundation (which is managing the research center in collaboration with Modena and Reggio Emilia University), enterprises of the territory which are involved in specific projects, institutions (as Mirandola municipalities), healthcare system (Democenter-Sipe foundation established collaboration with the local healthcare system), regional research networks, “istituto tecnico superiore Nuove tecnologie della vita” – ITS – a formation institute and other research centers. All these entities favor the creation of a proper ecosystem to develop new processes, products, services or new companies, carrying out activities such as R&D, education, services, public and private funding, idea generation, internationalization and networking (as reported in figure 2).

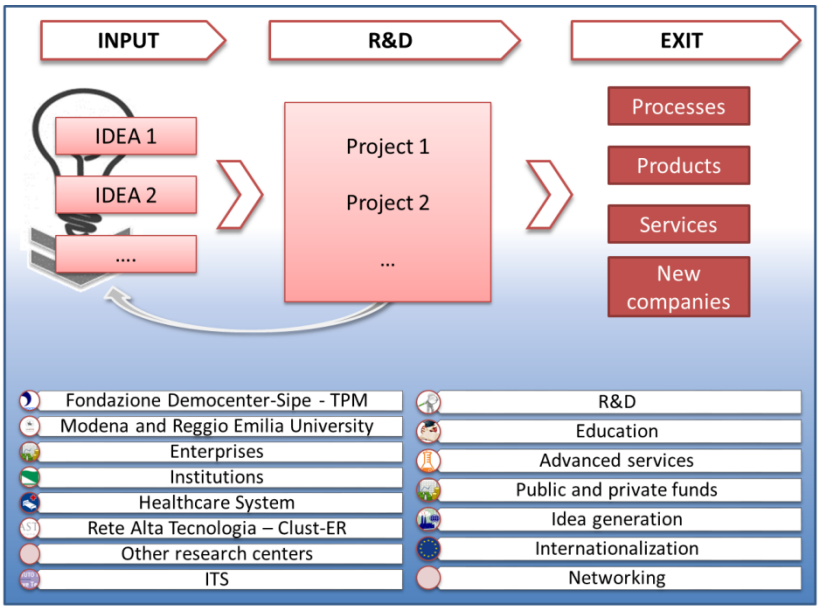

Figure 2: Mirandola innovation ecosystem

TPM role as facilitator of innovation processes is underlined by the several collaborations established with the enterprises for services acquisition (research activities, funding access, etc). Since 2015 TPM collaborates with more than 40 different entities (SMEs, enterprises, multinational companies, research centers, both located in the territory and external). Concerning fund raising, in the same period, TPM helped companies in obtaining funds (over 6 million euros were obtained, for 14 million of investments). Moreover, TPM presence supported the maintenance on the territory of the R & D activities of some large companies that could have relocated after the earthquake or supported their expansion thank to the attraction of funds. The presence of the multinationals has been maintained and strengthened: the district remains highly attractive, an element that guarantees international visibility and positioning.

Support for the generation of ideas, R & D, fund raising and business creation has led to the birth or has attracted around 8 new companies (from 2015 to date) – incubating new ventures – , an element which has favored the renewal of the district. Some of these have contributed to a concrete evolution of the biomedical sector, placing themselves as an interface between classical biomedical and new technologies (eg regenerative medicine or advanced therapies); in this way the district can regenerate itself and continue to be the point of reference for the Life Sciences.

I.e. one of the first start up incubated was Aferetica (www.aferetica.com), a start up created by entrepreneurs with experience on biomedical field. Aferetica mission is to contribute to research for the development, realization and diffusion of complete apheresis therapies dedicated to patients' life and well-being; Aferetica used the expertise and the competencies present in the biomedical district to develop new and advanced products. Aferetica collaborate with TPM for research activities since their born, having its offices in TPM Cube and contacts with TPM researchers. Now Aferetica is an innovative SMEs maintaining one of its office also in TPM, but moving its productive offices in a much more large location.

One of the most recent start up which decide to locate in the TPM is Prometheus (www.prometheus3d.com/en/), a start up of young researchers, coming from another regional university (University of Parma). The importance of Prometheus is linked with its core activities, "Prometheus is a innovative biotech startup that creates and sells human and animal 3d tissue for regenerative medicine and to test new pharmaceutical products. The products of Prometheus are realized and designed thank to an innovative technology, internaly created, the 3d Bio-printer: a printer that use cells and biomaterials like ink to realize biological tissues with an high cells vitality." This start up allow to bring in the Mirandola ecosystem new technologies and new application.

They decided to locate in TPM for two main reasons, one linked to the possibility to have direct and facilitated access to the laboratories and high-specialized competencies present in TPM and the other linked to the location of the incubators. Be in the core of the biomedical district allows to have contact with subcontractors, developers, research partners in a more facilitated way.

Finally, R&D activities carried out by the TPM in collaboration with the territory and supported by the Region, have led to results which could be patented or which could favor the creation of start up or spin-offs anchored to the area hit by the earthquake, and with the support of some of the local companies.

Another element important in the revenue model is linked with the administration of services to both companies (not only located in the territory), but also to public entities (such as other research centers or universities). Services administered are mainly related with specific problem solving that other structures are not able to solve. Indeed, TPM is not focalized on routine activities, but on activities that require specific equipment or expertise.

However, due to the requests coming from the territory and the opportunity offered by the ecosystem, two other growth phases have been started. In figure 3 are reported all the phases related to the development of TPM "Mario Veronesi".

Figure 3: TPM/biomedical village evolution

Phase 1 was the one described until now, in which the creation of a first nucleo of the ecosystem was carried out. TPM (research center) and TPM "Cube" (small incubator whit a general purpose) were created and consolidated, involving mainly companies and institution of the territory.

Phase 2 and 3 will be performed taking into account some gaps existing between the supply and demand for business support within the park (Albahari et al., 2011) and between the park and the entire ecosystem (quadruple or quintuple helix). As Albahari, we used the classification of Autio and Klofsten (1998) to classify the gaps in terms of "configuration orientation" (i.e. insufficient resources and inappropriate infrastructure) and "process orientation" (i.e. negative attitude towards learning or cultural barriers). In particular Autio and Klofsten (1998), described configuration as all the aspects related with budgets, organizational characteristics, geographical location, institutional link, etc; whereas, process are related with the support administered. The authors established that literature tends to analyze process aspects and less process gaps.

We tried to take into account both configuration and process to identify the gaps and weakness present in TPM.

The results are reported in table 1.

Configuration gaps	Process Gaps
Lack of infrastructures for incubation	Cultural barriers to networking activities
Lack of common spaces for co-working or "contamination"	Lack of information about the park administered services at regional, national, international level
Lack of infrastructures for specific R&D activities (such as prototyping)	Lack of support concerning new enterprises creation and consolidation
Lack of expertise in specific areas of interest for Medtech sector	Lack of technical figure in the district

Table 1: Configuration and process gaps identified in TPM/Biomedical village

Phase 2 – European Biomedical Hub (EBH):

This ongoing phase (2019) regards the realization of a new structure for the incubation. In particular, a new infrastructure is going to be realized for hosting 4 laboratories for new companies. The structure is near the existing TPM laboratories to facilitate also the access to the existing structure. The new building will comprise also offices, a new labs for prototyping and a co-working space.

The aim of these expansions is to offer to medtech new companies spaces for developing their products in appropriate laboratories.

This intervention was co-financed by Emilia-Romagna Region, Mirandola Municipality and Democenter-Sipe Foundation received a grant for realizing and equipping the spaces (offices and laboratories).

TPM Cube will be still available and optimized for hosting a major numbers of enterprises.

Phase 3 – Biomedical Village (BV):

This is the last phase of the interventions that in the future will be made in the area and regards the completion of the ecosystem, transforming the EBH in a real biomedical village. This transformation will comprise also an enlargement of the space at disposition for the activities.

Considering the business model that will be described in the following chapters, a first configuration of the available spaces were realized, able to respond to the identified needs. Different areas have been identified:

- Education area: aimed at hosting entities such as ITS or other post-diploma structures
- Start up area: aimed at offering to start up office and spaces to carry out their activities
- Lab. Area: aimed at offering both to start up and enterprises spaces equipped for research activities; some common lab area will be designed to host equipment with general purposes
- Area to host researchers: aimed at offering spaces to universities interested in the activities carried out in BV
- Common areas which comprise all the infrastructures needed for general activities (such as co-working, cafeteria spaces, etc).

3.2 Biomedical Village business model

Literature reports that business model definition is becoming very important for managers and despite there is no shared vision about its efficacy or vantages in the adoption (each researchers adopt its own vision), we decided to use this approach (Zott et al., 2011; Isabel García-Gutiérrez & F. Javier Martínez-Borreguero, 2016). Indeed, we believe that business model could be a useful tool for understanding how to generate value or to communicate with internal and external stakeholders (Cosenz et al., 2018).

To identify the best business model to be implemented in Mirandola, it is essential to clarify some important organizational model, such the one reported by Filioli (Filioli 2013, Ruiz et al., 2017) in table 2. In the table we reported also elements declined for the Mirandola Biomedical village.

Organizational elements	Description	Biomedical Village
Customers	Provision of services to resident companies that develop innovative high technology activities, some specializing in specific sectors and others with activities related to several sectors.	Services can be administered to the companies located in the district (or directly in the incubator) and, due to the specific specialization, also to international enterprises focalized in the medtech sector or in the advanced therapies
Value proposal	Benefits offered by the managerial organization to customers based on lower cost and/or differentiation of services and infrastructure compared with other parks as factors that attract companies to science parks	Biomedical Village is very focalized on the medtech industrial sector. Its management come from the industrial sector. Its location in the district allow to find all the competencies needed to develop and commercialize new products or services. I.e. in the district is possible to find experts on regulation aspects, in processes' realization, subcontractors, experts on market-access or marketing activities.

Key activities	Main activities to meet the requirements of installed companies and attract new ones, ranging from project management to obtaining resources, technical and technological services of interest to customers, incubation, property management and maintaining physical structures	New structure will be able to offer different kind of services, ranging from: project management, public and private fund raising, research and advanced services support, specialized education, incubation, support for internazionalization and market entry, normative support, rent of spaces (lab or area for events), property management support, support for ideas development
Key resources	Resources necessary to the park's activities, classified as (1) physical (land, buildings, social areas, common infrastructure); (2) human (managerial organization team); (3) intellectual property assets of the managerial organization (patents, copyright, customer database)	Key resources are: spaces (comprising laboratories, common spaces, offices, area for events or co-working), humans (comprising both researchers and managerial organization. Moreover, experts in medtech fields are at disposition, i.e. concerning sectorial regulation)
Key partnerships	When no asset is available to offer a certain activity, the managerial organization can seek partnerships for this purpose, most commonly with universities or research institutes, the authorities (at several levels), business associations and funding agencies.	Key partnership are both already established and to be established. Partnership are established with international research centers (such as Krems research center) or other European entities such as Italo-German chamber of commerce (ITKAM) or local authorities (healthcare system)
Financial aspects	Sources of funding for the implementation of capital goods, sources of revenue through operations (own revenues), external sources of revenue and operational costs of the park.	Financial aspects need to be carefully identified and analyzed. Revenue could regard the administration of services (advanced services or R&D), spaces location, management service

Table 2: Organizational elements, description and Biomedical village description

Taking into account this ecosystem and the needs collected by the territory a positioning of Biomedical Village was established. This positioning taken into account ("Plan and manage a science park in the Mediterranean"): government policy priorities, presence of competing technopoles, international regulation. Concerning:

- government policy priorities, BV was realized coherently in respect of the regional framework (i.e. in respect of the S3 specialization strategy). Indeed, also the funding received for the enlargement was granted to the structures proving their respect of regional guidelines
- competing technopoles: Foundation Democenter and TPM are part of ASTER (the Regional Network of High Competencies) – now ART-ER – and of the regional Life Sciences and Wellbeing Clust-ER which promotes the regional development of life science value chain. These elements guarantee to BV to have clear idea of possible regional competing technopoles. At the moment, BV is the only one very characterized on Medtech sector and located in a high-specialized district. We performed also an analysis of the national and international innovative parks, and we are able to identify the specificities of BV in respect of other structures.

- international regulation: due to the peculiarities of the sectors, it is clear that the sector is highly regulated. However, these regulation are a key part of technology development, so BV is well structured to face this aspect and to support companies (above all SMEs) in the transition from the old to the new regulation

One important aspect is to consider the economical sustainability: BV could be considered a mix of public model and a private one. Indeed, if from one side the objective is to favor the growth of the territorial ecosystem (i.e. job creation, industrial development, etc) on the other side, it is necessary to have profits to be reinvested in the facilities and in expertise acquisition.

In table 3 we reported a SWOT analysis of the BV.

Strength	Weakness
• Localization in the district • State-of-the-art equipment • Labs available for start up • Industrial management • Link with local healthcare system • High level expertise • Stakeholders involvement	• Distance from the main regional cities • International positioning of BV • Weak link with national healthcare system
Opportunities	**Threat**
• New MD regulation • New application of medtech in advanced therapies	• Competition of similar structures • HD of multinational are not located in the district • Competition of new emerging countries

Figure 3: SWOT analysis of biomedical village

3.3 THE MODEL TO BE IMPLEMENTED

Different business model can be identified to define as STP create and deliver value to all the stakeholders. Cuentas et al. (2013) (Volkonitskaia, 2015) classified STP as follow: megaparks (established by state authorities), University park, entrepreneurship parks (public-private partnership model, created to support early-stage start up), departmentalized research parks (founded by government and private entities; they support business that require different actors), parks with intensive offer of laboratories and technological support, parks with intensive offer of infrastructure or virtual support and ecommunity parks (promoting human development). This classification could also reflect different business models, indeed all these parks could have different incoming or approaches to the market.

BV could be classified as a park offering laboratories and technological support, but also departmentalized research parks, with the capability of support generation of ideas at different level.

Taken into account SWOT analysis and the characteristics of well established STP, we identified a possible model to be implemented in BV. BV may be an integrated structure supporting the territory development, so able to provide research services, incubation and education. The R&D activities are focalized on life science sector, medtech, pharmaceutical, cosmetic, and some specific services that could be administered to agrifood. R&D Services could span from structured project to problem solving or regulation support.

Incubation is provided to start up, spin off or SMEs which can support the territory development. Spaces will be structured to host different kinds of laboratories.

Another aspect to be taken into account concern the relationships that will be established between all the actors involved in the BV. It is quite clear that BV is characterized by the presence of a Quadruple Helix Model which comprise the following interaction reported by Machado et al. (2018): generation of jobs in the neighborhood, increase in local suppliers, generation of jobs in the park, network with local companies, contracts with local companies. On the other hands, existence of the quintuple helix is much more harder to establish. Improvement in life quality and stimuli to eco-innovation are part of the BV, but are not a focus.

Positioning: BV aims at consolidating its position as reference point for the medtech sector, intercepting also sector which could benefit of the competencies and expertise of the Mirandola district, such as regenerative medicine or pharmaceutical.

To better identify the business model of BV, we identified different kind of activities, such as: (i) external services, considering all the services that could be administered to third parties and that generate revenue for the park. External services comprise R&D services, incubation, fund raising, education and other activities; (ii) internal activities, comprising all the activities which may carried out to guarantee the operational capacity of BV and the international visibility of the structure; (iii) no-profit external activities which comprise all the activities that may carried out due to the institutional “mission” of the BV.

EXTERNAL SERVICES (€)	
R&D services	Accelerated R&D services • Design and implementation of cell models for biocompatibility and efficacy studies. • Surface characterization studies • Distribution of blood and / or biofilm cells in a material. • In vivo models of human pathologies to test the therapeutic efficacy of drugs based on cell therapies. • Evaluation of the performance of materials • Design and validation of measurement systems • Production and characterization of materials • Design and mechanical prototyping • ICT and biomedical business Intelligent life services • Usability Engineering in the innovation framework of medical devices • Support for CE certification and registration of EU • Clinical Evaluation Report (CER)Medical Device Safety Assessment
Incubation	Fund raising Strategic advice Contact with multinational Space rental
Fund Raising	Regional, National, European Public & Private
Education	In-house courses Workshop
Other	IPR assistance Market access Technology transfer Strategic advice

INTERNAL ACTIVITIES	
Marketing / communication	Marketing materials Partecipation to events
Fund Raising	Regional, National, European Public & Private
Management	Involvement of industrial and university competencies
New companies creation	Exploitation of research results
Partnership	Definition of strategical partnership at local and international level

EXTERNAL SERVICES (no-profit)	
Internationalization	District promotion
Knowledge diffusion	Workshop Technical event

Table 3: description of BV activities

Definition of these kind of activities and services, allowed to define also a business model in which also revenue and costs are defined through Business Model Canvas (Osterwalder et al., 2010) (figure 4) .

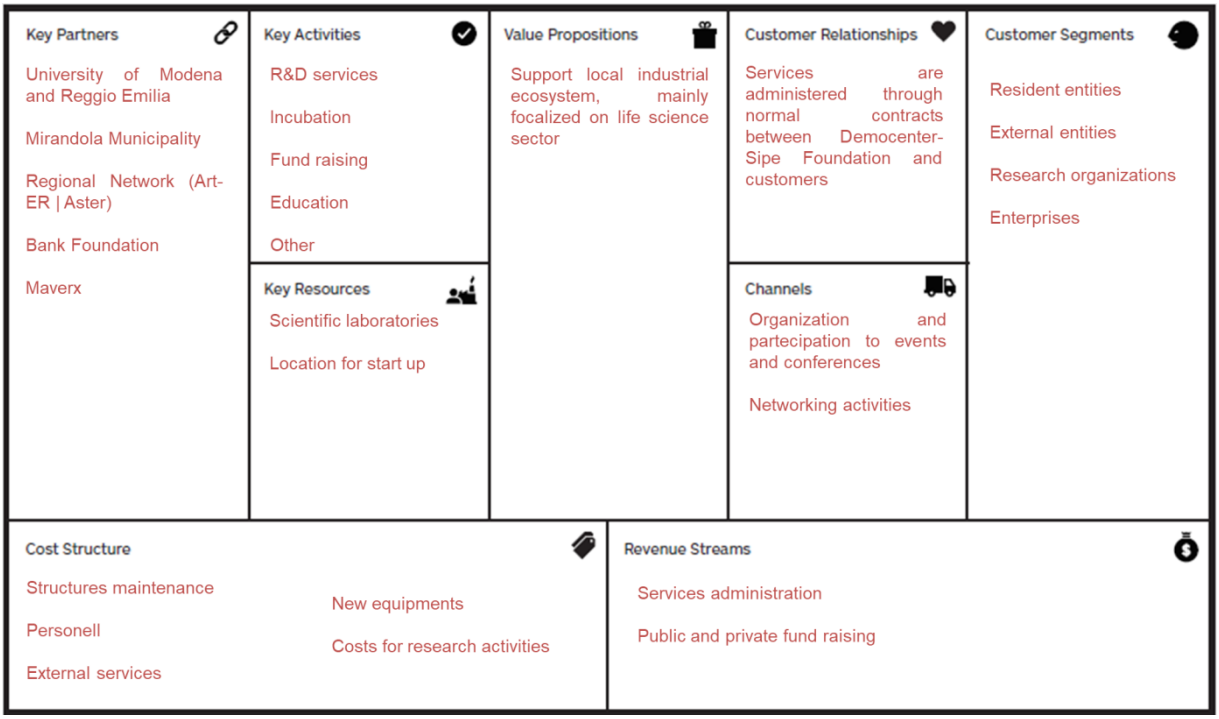

Figure 4: Business model Canvas

During the first period of activities, some of these services will be implemented, and the first attempt to position the BV allowed to reach some important results reported in the Annex I.

Another important consideration concerns the possibility of translating some of the results and consideration obtained also to other STEM areas/scientific and technology parks, except for the aspects concerning the development of medical devices such as costs, timing, regulation etc. The considerations about the activities (external services, internal and external activities) could be easily applied to other context.

Hence, present work could be useful to different actors present in the biomedical district ecosystem. In particular:

- industrial manager could obtain information concerning the impact that scientific and technological park could have on economic and industrial system and how to establish profitable relation with these kind of structures; identifying the different services administered and the structure (and its revenue model) of scientific parks can support the industrial growth of a specific company. Industrial manager can have also an active role in the parks creation and development, hence reading the present work could help to identify the best ways to obtain the result
- institutional players are the figures that may benefit the most from this work; indeed, the present work illustrates how may be structured a scientific and technology park to guarantee both economic sustainability and economic ecosystem growth. Of course the specific model described may be adapted to a the specific socio-economic framework.

ANNEX I

SOME of the RESULTS

TPM started its activities in 2015 and in this periods, some of the cited activities were carried out. In particular, some of the results were listed below:

Year	activities (n.)	Events number	Participants	Publication
2015	32	-	-	1
2016	84	36	506	4
2017	131	34	673	5
2018	115	33	706	3

Projects	Typology	Activities period	Partners
NANOSENS4LIFE	Research	2016-2018	Research centers and enterprises
TECNO_EN-P	Research	2016-2018	Research centers and enterprises
NANOCOATINGS	Research	2016-2018	Research centers and enterprises
Helix-rec	Research	2018 - TBD	Research centers and enterprises
CUBIBOX	Research	2019 - 2021	Research centers and enterprises
DINAMICA	Research	2019 - 2021	Research centers and enterprises
CLEAR	Research	2019 - 2021	Research centers and enterprises
Healthcare made in Emilia-Romagna	Internazionalization	2019	TPM

Name of public grant	Number of SMEs project funded public grants	Number of big companies funded by public grants
Bando ricerca 2015	4	5
Bando start up 2015	1	
servizi innovativi 2016	5	
Legge 14		1
servizi innovativi 2017	2	
CCIAA di Modena	9	4
Innolabs	1	
Start up 2018	2	

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