POLITECNICO DI TORINO

Master's Degree in Engineering and Management

Production path

Project Management to support innovation and development of a new Business Model

IRIS case study

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INTRODUCTION

In this case study it is illustrated how has been developed and achieved the implementation of a methodology for the development of a business unit, and how it has been developed a business unit strategy proposal by using innovation strategy and project management principles.

The object ofthe study is IRIS srl, which is a SME located in the industrial area of Turin, it is mainly an R&D company and has a high technological know how on different techological domains. However, as it is frequent in SMEs companies, the project management structure (as it is intended by Project Management standards e.g. IPMA, PMBOK) needs to follow a continuous improvement process, to guarantee the proper structure to follow the development process of R&D projects, innovative products and a new business models. The company has deepened its knowledge on superficial plasma treatments over the years and needs to better understand the market to which is proposing the superficial plasma technologies and the Green Plasma machine, whose technology is based on an IRIS's patent. The firm wants to further develop this new business line of products and services based on plasma technologies, but has to to understand the best strategy to implement it beforehand, and how to do it with the support of a well defined methodology.

The aim of this work is to develop a business model proposal for the plasma business unit of the company, in order to strengthen the surface plasma treatment technologies and the Green Plasma waste-to-energy product, with the ultimate aim to ensure stability to this business unit based on plasma technologies.

Project management and innovation management principles have been used to develop a methodology in order to give structure to this strategic decisional process.

The aim is reached through the performance of a strategic analysis. But before that, given the peculiarity of the subject and the scarcityof informations, a market analysis of the markets in which the company wants to propose its products is conducted in the first place. After that, the methodology has been defined. It has been created an account and monitoring tool represented by a tailored programmed Excel file with a double use. Firstlly, as a *Project Management tool* with the aim to give structure and support the monitoring phase of the relationship advancement with possible clients, and to keep track of the tasks to perform and their deadlines. Secondly, as a *Market Analysis tool* with the aim to extrapolate informations such as KPIs values, which will be fundamental for the development of the business model proposal by using the Business Model Canvas tool. It represents the starting point to perform the strategic analysis and to develop a business model proposal for a stable business unit.

1. Project Management framework

1.1. Project Management first applications

The discipline of modern Project Management was born in the early 50s of the last century, when it was implemented within corporate projects, initially only in the military field and later extended to the construction sector. Only years later, Project Management was expanded to include projects with different areas from those mentioned above. In 1951-1953 in the United States of America, the Project Manager (PM) figure was first introduced in the 'Transmountain Oil Pipeline' project by Bechtel. This figure did not reflect the modern Project Manager, as a person who held a position of great responsibility and who worked with an autonomous and independent team was hired. In fact, this resource was not well accepted within the existing working group, as the teams were used to having different figures as project managers according to the work phases. In the same years in Australia, Civil & Civic (C&C), a construction company that expanded its business, became a leader in project management. In fact, in the years 1954-1955, C&C started a project in which the subdivision that the same company was developing was promoted.

However, it was noted that the introduction of the new breakdown of the proposed organization made it possible to achieve a cost reduction of 40%. From the results obtained, the company decided to expand its market by taking the management of external projects under its responsibility, becoming the first leading company in the world of Project Management. With the advent of the Project Management discipline, new methodologies for project management were developed. The Critical Path Method, CPM, was developed and implemented in projects in 1956 by the chemical giant Du Pont. While, the technique of the Project Evaluation Review Technique, PERT, was born in 1958 within the POLARIS project, for the construction of a submarine missile. The introduction of the figure of the Project Manager has made it possible to obtain a greater final profit within the projects. In fact the inclusion of a project manager increases the initial costs of resources, but brings a greater profit at closure. This is possible because the actions carried out by the PM allow to optimize the use of resources and development time, minimizing total costs.

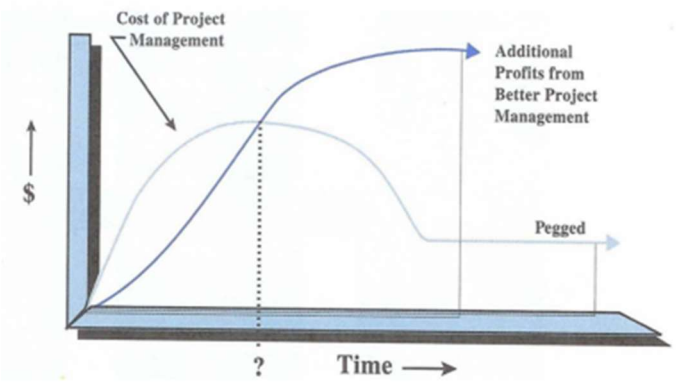


Figura 1: Cost and benefit of the introduction of Project Manager figure

1.2. Project Management Today

That being said, nowadays Project Management can be defines as the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. Project management is accomplished through the appropriate application and integration of the 47 logically grouped project management processes, which are categorized into five Process Groups. These five Process Groups are:

- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing

Managing a project typically includes, but is not limited to:

- Identifying requirements
- Addressing the various needs, concerns, and expectations of the stakeholders in planning and executing the project
- Setting up, maintaining, and carrying out communications among stakeholders that are active, effective, and collaborative in nature
- Managing stakeholders towards meeting project requirements and creating project deliverables
- Balancing the competing project constraints, which include, but are not limited to: Scope, Quality, Schedule, Budget, Resources, and Risks.

The specific project characteristics and circumstances can influence the constraints on which the project management team needs to focus. The relationship among these factors is such that if any one factor changes, at least one other factor is likely to be affected. For example, if the schedule is shortened, often the budget needs to be increased to add additional resources to complete the same amount of work in less time. If a budget increase is not possible, the scope or targeted quality may be reduced to deliver the project's end result in less time within the same budget amount. Project stakeholders may have differing ideas as to which factors are the most important, creating an even greater challenge. Changing the project requirements or objectives may create additional risks. The project team needs to be able to assess the situation, balance the demands, and maintain proactive communication with stakeholders in order to deliver a successful project. Due to the potential for change, the development of the project management plan is an iterative activity and is progressively elaborated throughout the project's life cycle. Progressive elaboration involves continuously improving and detailing a plan as more detailed and specific information and more accurate estimates become available. Progressive elaboration allows a project management team to define work and manage it to a greater level of detail as the project evolves. [1]

[1] (Project Management Institute, PMBOK Guide, 2013)

1.3. Projects and Strategic Planning

Projects are often utilized as a means of directly or indirectly achieving objectives within an organization's strategic plan. Projects are typically authorized as a result of one or more of the following strategic considerations:

- Market demand (e.g. a car company authorizing a project to build more fuel-efficient cars in response to gasoline shortages)
- Strategic opportunity/business need (e.g. a training company authorizing a project to create a new course to increase its revenues)
- Social need (e.g. a nongovernmental organization in a developing country authorizing a project to provide potable water systems, latrines, and sanitation education to communities suffering from high rates of infectious diseases)
- Environmental consideration (e.g., a public company authorizing a project to create a new service for electric car sharing to reduce pollution)
- Customer request (e.g. an electric utility authorizing a project to build a new substation to serve a new industrial park)
- Technological advance (e.g. an electronics firm authorizing a new project to develop a faster, cheaper, and smaller laptop based on advances in computer memory and electronics technology)
- Legal requirement (e.g. a chemical manufacturer authorizing a project to establish guidelines for proper handling of a new toxic material)[2]

1.4. Processes and Procedures

Initiating and Planning: Guidelines and criteria for tailoring the organization's set of standard processes and procedures to satisfy the specific needs of the project. Specific organizational standards such as policies, product and project life cycles, and quality policies and procedures, and Templates

Executing, Monitoring and Controlling: Change control procedures, including the steps by which performing organization standards, policies, plans, and procedures or any project documents will be modified, and how any changes will be approved and validated. Financial controls procedures. Issue and defect management procedures defining issue and defect controls, issue and defect identification and resolution, and action item tracking.

Closing: Project closure guidelines or requirements.

1.5. Project Success

Since projects are temporary in nature, the success of the project should be measured in terms of completing the project within the constraints of scope, time, cost, quality, resources, and risk as approved between the project managers and senior management. To ensure

[2] (Project Management Institute, PMBOK Guide, 2013)

realization of benefits for the undertaken project, a test period (such as soft launch in services) can be part of the total project time before handing it over to the permanent operations. Project success should be referred to the last baselines approved by the authorized stakeholders. The project manager is responsible and accountable for setting realistic and achievable boundaries for the project and to accomplish the project within the approved baselines

1.6. Project Management Techniques

Project Management is a discipline that is not mature yet and for this reason it is constantly evolving and changing, not only as regards the roles played by the Project Manager, but also as regards its representation in the literature. In fact, since the advent of the discipline up to now, many different techniques have developed and established themselves. A first classification can be based on the methodology underlying each of them, dividing them into those belonging to the traditional method and those of the Agile method. The first, also defined as 'Waterfall', has the characteristics of having all the development phases distributed sequentially, reducing the possibility of implementing it in very dynamic and ever-changing areas. On the other hand, the Agile method, developed with the advent of software, presents iterated process developments, which allow you to change the final objectives, without a high cost increase.

1.6.1. Waterfall Method

The first methodology that asserts itself in the world of Project Management is the Waterfall one. In literature, there are many techniques that are part of the traditional method, and all are characterized by a sequential development of the process groups of a project.

Worldwide, even the International Organization for Standardization, ISO, has uniquely defined the discipline and the method applied. The standard in question is the ISO 21500 standard, which examines in detail the figure of the Project Manager and the traditional method, with the related documents for each work phase. According to the aforementioned standard, in the development of a project there are five process groups:

- Initiating, the phase in whichthe project is initiated
- Planning, where activities are planned in order to reach the scope of the project
- Implementing, the execution phase
- Controlling, the monitorig and control phase
- Closing, the phase in which the project il closed.

The start-up phase of the project aims to establish the work team and identify the stakeholders present, a fundamental step for achieving the result. Once this phase has been completed, the next step is the detailed planning of the project. At this stage, the main purpose is to establish the effort necessary to achieve the final goal, defining the resources and activities. After that, there is the mere execution of the project. During this last phase, a control and monitoring process is also carried out, with the aim of observing whether or not the costs and times established in the second phase are respected. An event that may arise during this phase is the presence of changes that require the implementation of changes. After the rectification,

you go back to the execution phase. With the approval of the changes, a revision of the work plan must also be implemented, with a return of the project in the planning phase. There are rare cases in which, after the approval of the change, the initialization phase of the project must also be revised, as the correction made can radically change the final objectives. Only at the end of the activities foreseen by the project planning, it is possible to move on to the final phase, that is the closing phase.[3]

1.6.2. Agile Method

To respond to the constant changes and evolution of the scope of application, the Project Management discipline has undergone improvements in project management techniques. In fact, with the advent of software it was necessary to introduce a much more flexible and streamlined management method. Taking inspiration from the 'Toyota Production System (TPS)' product development technique, many technicians in the sector have developed a methodology capable of responding to the dynamism that the world of software brings. This new methodology developed and implemented in projects is called Agile. The Agile management approach, as the name itself states, is an agile technique characterized by iterative and incremental development processes, which allow the creation of a product and / or service that is very close to the customer's needs. The approval of the technique also at an international level has led to the standardization of the method in the Project Management literature. As can be seen from figure 13, the process groups of a project developed in Agile are interspersed with tests. In fact, the concept of testing the product after each single process is central, so as to reduce the possible problems that may arise. In addition, the entire project is divided into several development phases, called sprints. Each sprint ends with the release of the incomplete product and / or service to the customer, who tests it and gives its feedback, allowing developers to increase it by making it as faithful as possible to the required requirements. With the customer's approval, the development group moves on to the next sprint, continuing until the end of the project.

The Agile approach was born to be mainly applied in the field of software development, but over the years it has been used for projects aimed at product development. This was possible because the 'short release time' paradigm has established itself in the market, through which many physical assets must be released in a very short time, requiring the need for a lean project management technique. Within the Agile approach, various different techniques are distinguished, but the best known are: Extreme Programming (XP) and Scrum[4]

1.6.2.1. Scrum

Another technique that has developed and established itself within the Agile approach is that of Scrum, described in 1995 by Ken Schwaver and Jeff Sutherland. The Scrum project management technique, as well as the others belonging to Agile, divides the project into sequential and iterative sprints. What distinguishes it from the others, on the other hand, are the process groups in the development of the product and / or service and the figures present in the

[3] (PMI-Project Management Institute, 2008)
[4] (PMI-Project Management Institute, 2008)

work team. As for the latter, it has the characteristic of being self-controlled, within which the Product Owner (PO), the Scrum Master (SM) and the actual development team are present. The Scrum Master is a figure within the team, who coordinates and ensures the proper development of the project. His figure can be associated with that of the traditional Project Manager, as he holds the role of leader. The Product Owner, on the other hand, is the liaison figure between the team and the stakeholders of the project, and the responsibility for the financial aspect falls on him. Although it has high responsibilities, it has no authority within the group, but is a support to the development of the project.

Inherent in the project development process with the Scrum methodology, the first step for any project is carried out by the Product Owner. In fact, the latter, in contact with stakeholders and end customers, determines and classifies the Product Blocks. They are defined as the final objectives of the project that must be achieved. Once this sorting has taken place, the project is launched by implementing an initial meeting: the kick off meeting. During this meeting, in which the team with the Scrum Master and the Product Owner are involved, the Sprint Blocks are defined. The latter are the objectives to be achieved within the individual sprints. Each sprint lasts for a maximum of four weeks, in which the team develops and carries out the work to achieve the established objectives. Daily the Scrum Master and the team carry out a meeting, the Daily Meeting or Stand-up Meeting, which highlights the work done, the critical issues that have emerged and what must be completed before the next meeting. At the end of the sprint, the team presents the results obtained to the OP, which evaluates the actual achievement or otherwise of the results, allowing the team to move on to the next sprint, or proposing adjustments to achieve the Sprint Blocks.

1.7. Organizational aspects of Project Management

Project management, as a tool dedicated to the management of orders, must adapt its objectives to these broadening of horizons, keeping the systemic perspective. It is not only necessary to guarantee the efficiency of the processes, but also the complete satisfaction of the customer's needs. In the organizational context, this scenario outlines the need for internal decision-making decentralization. The formation of multidisciplinary groups, over limited periods of time, becomes the solution to specific and non-repeatable problems. Management is required to work more on interdisciplinary objectives rather than on the logic of sectoral efficiency.

An organizational structure can be defined as a set of methods that regulate the placement of individual functions in the corporate organization chart, the lines of authority that interconnect the functions and the information channels through which information flows in a proceduralized way. In the manufacturing sector and partly in the services sector, it can be divided into three fundamental types: the functional structure, the divisional structure and the lean factory. [5]

1.8. Project management methodologies and adoption benefits

A methodology is the set of guidelines of principles that can be customized and applied to a specific situation. Within projects these guidelines can also consist of a to-do list. a

[5] (Cantamessa M., Cobos E., Rafele C., Il Project Management, 2007)

methodology can be defined as a process that documents a series of steps and procedures to guide the project team from the beginning to the end of the project. There is no methodology suitable for all types of projects; in fact, even within the same organization there may be several methodologies. Each suitable for a particular type of project. Furthermore, depending on the size of the project, its context and its importance for the organization, the methodology will require some form of adaptation, even within the same project category. Sometimes a methodology is designed that is as generic as possible and a certain margin of discretion is left to the project managers in customizing the methodology, according to the needs of the individual project. Other organizations prefer to start with a pilot project, and then with the design of a methodology for that type of project, and subsequently refine the methodology during construction. This can be a good choice, especially for organizations approaching project management methodologies for the first time. Some methodologies go into detail and propose forms, templates and checklists to be used throughout the project life cycle. Obviously a large company will require its designs to be much more documented than a small company's. Developing a project without a minimum of documentation necessary to monitor its progress involves high risks and inefficiencies. a pm methodology does not exist in isolation in a company, it must coexist with other methodologies such as, for example, the production or marketing methodology. Sometimes it is not a question of real methodologies but of simple organizational procedures. Therefore the choice of a methodology, or its ad hoc design, must foresee the evaluation of the processes or technical cycles of the various types of projects that the organization usually undertakes.

The adoption of a methodology can bring benefits. In fact, it can be demonstrated that ultimately all the benefits are attributable to economic benefits. As far as internal projects are concerned, these are often implemented with the aim of improving efficiency and therefore reducing costs. some benefits linked to the execution of projects are the improvement of communication between members of the work team and project stakeholders, also thanks to the use of a common language. Without a project management method the project owner, the project management team and the project team may have different ideas on how to organize the work and on the completion times of the various tasks that the project intends to accomplish. In addition to improving communications, a common methodology provides more predictable results as the activities of each team member can be framed in processes known to all. Moreover, without a method, the success of the projects would be left to the discretion and experience of the individual project managers, who may be more or less good and have a more or less in-depth knowledge of the best project management practices. If accompanied by the creation of a database, all company projects and the lessons learned thanks to their development, the implementation of a methodology brings benefits to future projects of the organization. Project managers will be able to consult this database and benefit from previous experiences, thus generating the much desired process of continuous improvement. Other clear benefits of implementing a good project management methodology are: improved control over projects and change request management, and reduced time-to-market leading to improved performance. The work is carried out in less time at a lower cost, in fact, the implementation of the methodology involves an improvement of the work processes and the qualitative improvement of the products that these processes produce. In general, thanks to the methodology, the probabilities of success of the projects are improved, because the methods and tools of the same defined promote a better understanding of the requirements and of the project results since the initial phases of the process.

Methodology implementation is tightly related with the organization's strategy. In fact the effective implementation of a project management methodology can lead to the creation of a sustainable competitive advantage. However, to achieve this objective it is necessary to plan its implementation in a strategic way. The organization's strategy becomes fundamental in defining the methodology. It is therefore necessary to start from a good understanding of the organization's strategies.[6]

1.9. Innovation strategy

When speaking about innovation strategy, we are taling about creating a plan describing what kind of innovations the firm will pursue in the planning horizon, together with the means for doing so. Given its significant and wide-ranging implications, innovation strategy will be an integral part of strategy at corporate level. Innovation strategy can be defined as the "part of corporate strategy that has to do with the way with which the firm will pursue innovation in its many possible facets". The formulation of corporate strategy can follow a number of approaches and. The choice depends with the specific type of company, its attitude, the environment it operates in and the availability of information that decision-makers can rely on. Therefore, given the close link between corporate strategy and innovation strategy, there will not be a single way for defining the latter. In Miles and Snow's (1978, 1984) classical distinction, companies can act as prospectors, analyzers, defenders and reactors. Prospectors are the ones who proactively pursue opportunities for change and innovation. Defenders are firms that settle in a somewhat stable industry and avoid engaging in diversification or innovation. Analyzers are somewhat in the middle between the previous two, and generally engage in diversification or radical innovation only after extensive reflections. Reactors are the most conservative firms, and accept change only when external pressure to change becomes impossible to resist. There are many approaches to define innovation strategy, such as product portfolio management approach which views the firm as a collection ofbusiness units (BUs) and/or product families, directed to a variety of markets; or such as the theory of competitive advantage which is a well-known approach to strategy formulation, proposed by Michael Porter (1979). Or the competitive advantage approach goes quite deep into analyzing and defining firms' strategic behavior, and the connection with innovation strategy is strong, even though it may not be so obvious.[7]

1.9.1. Innovation strategy as the management of competencies

Corporate strategy is based on two pillars that are: the definition of a desired portfolio of competencies and the planning of their development, and the outlining of a portfolio of product and market development activities. In order to manage and develop the competencies portfolio of a firm, the first issue to be solved has to do with classifying and assessing competencies. Competencies have been defined as the organizational routines that involve resources, Just as in product portfolio management, visual tools such as bubble charts can be quite useful to support the representation of competencies. Management will identify two axes

[6] (Cantamessa M., Cobos E., Rafele C., Il Project Management, 2007)
[7] (Cantamessa M., Montagna F., Innovation Management and Product Development, 2016)

for locating each competence, and the size of the related resources pool will be represented by the diameter of the bubble

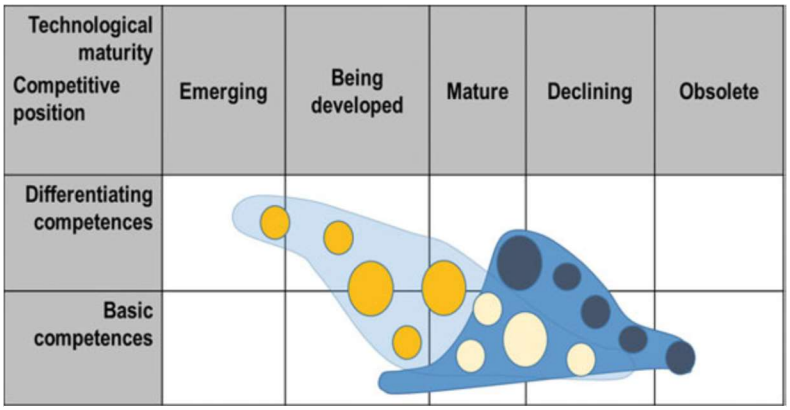


Figure 2: An example bubble chart representing an "As-Is" portfolio of corporate competencies (area to the right) and a "To-Be" one (area stretching top left to bottom right) (Source: Cantamessa, Montagna Management of innnovation and product development 2016)

From an organizational perspective, the development of competencies is a process that requires relatively long time constants. The bubble chart representing a competencies portfolio can be developed by looking only at the firm being analyzed. However, it can also be used for competitive benchmarking, by placing it side by side with a similar chart representing—possibly with some approximation due to lack of information—selected competitors. Managers might also decide to map the competencies of the entire value network the firm is part of. This allows to work on knowledge partitioning within the chain, and to support a broader innovation strategy that may also involve key players operating in its ecosystem. Working at this level will make it possible to identify whether competencies have to be developed internally by the firm ("make"), by using selected suppliers ("buy") or by associating with complementors and customers ("ally"). This decision will depend on the strategic stance that the firm has with respect to each competence. Clear decisions can be taken if the competence is recognized to be core (in-house development will obviously be recommended in this case) or non-core and generic (contracting with generic suppliers will in general make sense, unless cost analysis suggests differently).[8]

1.9.2. Internal research and development

The most traditional apprach is to develop a desired competency internally. Today it still represents a common and powerful approach, but it must be constantly be assessed against other means. When evaluating the appropriateness of using internal R&D projects to build new competencies, a few elements must be considered. The main advantage is definitely the high degree of appropriability of the competencies generated. However in order to achieve this

[8] (Cantamessa M., Montagna F., Innovation Management and Product Development, 2016)

objective some critical aspects should be considered. One aspect is the definition of the amount of R&D to be budgeted, since is not trivial to identify and compute the financial returns coming from R&D investment, which makes it difficult to define an "optimum" amount to be spent. Another critical aspect is the way internal R&D money are spent. More specifically path-dependency can limit the capability of the firm to develop new competencies that are far away from its existing knowledge base, or to do so in a reasonable time. Another aspect to be considered when dealing with R&D projects, is to address the issue of worker productivity and their incentives. In fact when dealing with intellectual work in general, it is difficult to measure productivity. Lastly an aspect to deal with is the strategic decision concerning the organizational positioning of R&D units. Two solutions are traditionally available, with either a centralized R&D unit serving all BUs, or having decentralized R&D units in each BU.[9]

1.9.3. Innovation strategy as Project Portfolio Management

This paragtaph provides a complementary view of innovation strategy to the one that has been developed in paragraph 1.9.1. Still following the resource-based view of the firm, the focus will be shifted to the decisions pertaining to which projects and activities should be performed, given the competencies the firm currently possesses, and the ones that it wishes to develop. Most activities related to innovation are project-based, and it is therefore possible to borrow concepts, methods, and tools from the field of Project Portfolio Management. PPM is one of the areas of the broader discipline of Project Management, and focuses on the selection of the projects that must be initiated, managed, and terminated. Due to its strategic relevance, firms that do not make a correct use of PPM run the risk of being unable of formulating and enacting a sound innovation strategy. In general, lack of discipline in PPM leads firms to start too many R&D projects, without a clear strategic focus and/or without a strong understanding of their compatibility with the type and quantity of available resources. It is always fairly easy to give a go-ahead to a potentially interesting project, but attention should be paid to the strategic reasons that justify it (which, in turn, determine what specific outcomes should be expected from it) and on the resources that are required in order to ensure success with respect to timing and results.

Formulating and executing an innovation strategy therefore requires a robust PPM system, which can be conceived as being based on three pillars. Defining a process for evaluating projects, and using tools for decision making. It is not uncommon for companies to be quite unaware of their R&D portfolio. This inability can bring, for instance, not knowing how many and which R&D projects are active at a given time, being uninformed of the ratio between the overall workload and the available manpower. But also can bring to difficulties to terminate unsuccessful projects when it becomes clear that the desired results are not emerging, and to do so before costs become too high. When dealing with R&D and innovation, not being able to terminate projects is a big problem. It means either that the firm is unable to manage its project portfolio and keeps on running unsuccessful projects or, conversely, that its innovation strategy is so conservative that it concentrates on projects whose probability of success is close to one. Lastly, not having a sufficiently developed PPM system, will bring firm to find it difficul to explicitly relate projects to innovation strategy.

[9] (Cantamessa M., Montagna F., Innovation Management and Product Development, 2016)

When dealing with R&D and innovation activities, the fact that projects are not all the same is the first element to be recognized. In order to avoid comparisons between projects of a different nature, it should be emplyed an appropriate categorization to differentiate these differences. Differences that can be identified along a number of dimensions, such as risk, project size, and project scope. Concerning the latter, projects may be characterized by different degrees of innovative content with respect to the product (or specific subsystems), the process, etc. However, the main difference to be identified is related to distance that the project's results will have from the market. As a first cut, it is certainly possible to set research projects aside from development projects. However, one can develop finer differences, as listed:

- Basic research projects
- Applied research and technology development projects
- Next-generation and/or platform development projects
- Product development projects
- Customization projects

An important aspect to keep an eye on when evaluating project portfolios is definitely the technology roadmapping, in which the idea behind is to create a high-level view of the set of projects of different types that the firm is considering as candidates for its portfolio, together with their mutual relationships and their placement in time. In general, a technology roadmap provides a comprehensive view of the project portfolio in order to ensure its intrinsic coherence, and does not cope with its economic or financial sustainability. A technology roadmap allows having a compact view of the portfolio and of the way with which results from "upstream" activities will feed into "downstream" projects.[10]

[10] (Cantamessa M., Montagna F., Innovation Management and Product Development, 2016)

2. IRIS Cases study

In this chapter is presented the company that is the object of the present case study. In the first place is given an overall presentation of the company, the vision that unites all activities, and then, in the second place, the whole portfolio of solutions developed inside the company is presented. A characterization of each solutions in term of Value Rarity Inimitability and Organization is also performed.

2.1. IRIS srl

IRIS is an innovative SME based on the industrial area of Turin. Over the years it specialized in the development of innovative technologies solutions that find significant applications in:

1- Circular economy framework
2- Small scale industrial environmnet
3- Civil realities.

It was founded in 2012 by 4 friends who decided to bring together their competencies experiencies and ideas in an entrepreneurship project to bring to the market solutions based on laser and plasma technology that will distringuish themselves for efficiency and competitiveness also in small scale applications very often neglected by the market despite the demand from the italian SMEs

The development path in which the company mainly focused are:

1- Process technologies: by developing industrial applications of plasma and laser technologies, with a focus on laser welding processes and additive manufacturing
2- Circular economy: by developing funcional modules for the recovery of resources such as water, energy, primary materials. It is specialized in small-scale treatment solutions siutable for isolated areas such as rural areas, ships, off grid contexts and refuges, or for little comunities that have the need of being autosufficient such as energetic communities, small cities or rban districts.

IRIS is a member of the MESAP, that is, the reference point for the regional innovation center “Smart Products and Manufacturing” and it is active in a wide range of european collaborations gathering the most excellent research institutes dealing with topics such as transition to circular economy and innovative applications of laser and plasma technologies.

The company is characterized by a great operational flexibility that enables to satisfy the most particular and demanding requests.

In fact, what IRIS offers are both:

- Consulting services
- Development and integration of solutions

The first can be adopted to the specific and demanding case that requires experimental validation texts or to the case in which the client needs to facilitate the process of technological and competence transferral.

The latter refers to the development and integration of solutions for many industrial processes.

Thanks to the shared know-how and different competences inside the group, IRIS is capable of building technological demonstrator prototypes and testing new processes and machines in the industrial area. The processes test results can be rapidly directed to production or toward the industrialization by constructing ex-novo the most ideal plant solution.

In the sustainable environmental field IRIS collaborates with Walden, a technological start-up, born in 2019, active in the field of sustainable management and usage of natural resources, but also in the field of supply of forest products, offering of renewable energy services and Ambornetti, that is, an entity created in order to launch the restore of an abandoned village through the creation of an eco-sustainable resort that will use inside it the innovative technologies patented by IRIS

MISSION

To reduce the environmental impact of industrial processes. Protect the environment by recovering raw materials and energy.

VISION

Create a greener future through technological innovation.

This approach guide every action of IRIS team, and is the driving force of the projects that expand year by year, both in the industrial sector and the environmental one.

What IRIS promotes is an approach to technology at the service of the environment and society, capable of gather and interpret our contemporary challenges, especially regarding the topic of circular economy transition.

Moreover IRIS promotes partecipative collaboration and encourages the creation of a constant and constructive dialogue in the Academic world, with a perspective of mutual exchange and results sharing with the aim to reduce the gap between scientific research and the market.

Speaking about some figures, the revenue related to the year 2021 has been 1.6 Million euros and, as of today, it counts 15 employees. It should be pointed out that since its foundation in 2012, the workforce has doubled up every year until today. The firm is growing, and at the present moment, it is facing a threshold, a crucial point, in which the projects, the workforce and also the workload is increasing significantly. Therefore the need to implement a more structured organization is higher as well, both for tasks implementation and for communication and information flow.

IRIS knowledge is incorporated in people who make up its team. Due to their specialization into different technological domain, IRIS’employees are organized in different

teams focused among four main technological domains, which will be further described in the following paragraph:

- Laser welding and additive manufacturing technologies
- Nano PEF technologies
- Architectural solutions (i.e. Chestnut Cabin product and Ambornetti Project)
- Plasma technologies (i.e. superficial plasma treatments and Green Plasma machine)

As can be seen, since it is an interdisciplinary company which deals with different topics for its R&D projects it can be stated that IRIS operates in different industrial sectors as well.

For the laser welding and additive manufacturing technologies the company is currently operating in the manufacturing industry, more specifically in the metallurgical sector, automotive sector, electronics sector and aviation sector.

For the Nano PEF technologies for water recovery, the technology that has been developed competes in the Nano Pulsed Electric Field (PEF) sector, however when the final product will be launched has the potential to operate in different sectors such as the food and beverage sector, the packaging sector, the water treatment sector and the dairy sector.

Regarding the architectural solutions developed by IRIS: the Chestnut Cabin abitative module operates in the modular construction market whereas the Ambornetti project is a more wide-ranging project that involves the put into practice of IRIS's technology that can be applied in the circular economy field, that is, the Water Plasma and the Green Plasma machines, and will incorporate the use of Chestnut Cabin as well when the construction of the settlement will be concluded.

Speaking of the thermal Plasma technologies IRIS has recently refined and improved the Green Plasma machine which has the potentiality to compete in every sector and situation that implies a production of waste that needs to be converted into energy. Whereas regarding the superficial plasma treatment technologies, their knowledge has been deepened as well and the company needs to understand in which specific sector among the manufacturing industry can begin to propose the new technology which is an innovative solution with respect to many traditional manufacturing processes.

For each solution it is performed a VRIO analysis of the underlying competences behind. VRIO is an acronym for a four-question framework focusing on value, rarity, inimitability, and organization, the criteria used to evaluate an organization's resources and capabilities.

The questions to answer for each solution are:

- Value = Does the company the company offer a resource that adds value for customers? Are you able to exploit an opportunity or neutralize competition with an internal capability?
- Rarity = Does the company control scarce resources or capabilities? Do you own something that's hard to find yet in demand?
- Inimitability = is it expensive to duplicate the organization's resource or capability? Is it difficult to find an equivalent substitute to compete with its offerings?
- Organization = Does the company have organized management systems, processes, structures, and culture to capitalize on resources and capabilities?

2.2. Laser welding and additive manufacturing

2.2.1. Laser Welding

The company develops intelligent autoadaptive soltions for the efficient use of laser processes: welding, direct deposition of materials.

It focuses on the process setting, the characterization and validation with respect to the performance target and ecological labeling.

The laser welding technology exploits anthropomorphic arms and it can be a good substitute to TIG (tungsten inert gas) MAG (metal active gas) and MIG (metal inert gas)

TIG MAG and MIG

TIG, MIG, and MAG all involve welding using a short arc. Short-arc welding refers to the short arc between the welding wire and the material to be welded. The welding equipment creates such high voltage that an arc is formed between the wire and the material. The electrons of the arc are transferred to the material via the welding wire and heat it to a temperature at which it starts to melt. In MIG and MAG welding, the wire becomes so hot that it melts into the material. TIG welding, however, uses a tungsten electrode which does not melt.

Although both MIG and MAG use the same equipment as TIG welding, the gases used often have completely different purposes – metal inert gas (MIG) and metal active gas (MAG), i.e. a protective (non-reactive) gas and a gas that actively affects the material being welded. In all three welding methods, the power source of the welding unit is connected to the material to be welded. Voltage is generated by passing electricity out of the cabling/nozzle and holding it close to the material. An arc is then formed between the nozzle and the material.

LASER WELDING

What are the advantages of laser welding compared with TIG, MIG, and MAG?

In most cases, laser welding can replace traditional welding, offering greater safety, precision, and speed, and usually at a fraction of the energy consumption required in TIG, MIG, or MAG. The speed of laser welding benefits productivity, and in practice this means that a single laser station can produce as much as several TIG, MIG, or MAG stations.

The costs of gas and wire disappear with laser welding, and much less energy needs to be transferred to the base material than in traditional welding. This in turn results in much less shrinkage at the joint, and thus less risk of deformation. In addition, fewer gases are released as laser welding heats less of the material.

Furthermore, laser welding is significantly safer for workshop staff than traditional welding methods are. TIG, MIG, or MAG welding pose a high risk of burns and heat radiation

to operators due to their proximity to the welding process (which requires a constant temperature of at least 1,500 degrees Celsius).

Figure 3: IRIS's Laser Welding machine

V	R	I	O
High	High	Low	High

Tabella 1: VRIO Analysis for Laser Welding technology

2.2.2. Additive manufacturing

IRIS has contributed to the development of an innovative 3D printing procces belonging to the methodology “Direct Energy Deposition” (DED).

According to the ASTM/ISO standard for AM terminology (ISO/ASTM 52900-15):

“DED is an additive manufacturing process in which focused thermal energy is used to fuse materials as they are being deposited.”

Meaning that the process uses the laser to melt the metal powder suspended in air during their descendent trajectory toward the surface, in this process metal components from powder feedstock are built. In the additive manufacturing field, IRIS has gained a relevant specialization developing a particular attention toward technological integration, but also toward the use of primary materials and reduction of production time, and a high flexibility in terms of volumes management, and regarding the topic of increasing energetic efficiency. Laser-based AM technology was invented in the 1980s and the two most commonly known methods available for commercial use today are powder bed fusion (PBF) and powder fed directed energy deposition (DED) systems. Directed Energy Deposition (DED) is a valid alternative to Powder Bed Fusion (PBF).

DED and PBF comparison

Directed energy deposition (DED) is similar to Power Bed Fusion PBF because it uses a laser (or electron) beam to melt powder. However, the way in which powder feedstock is deposited and melted enables DED to scale more easily and cost-effectively to larger AM parts.

In laser-based, powder-fed DED, the material being fused is deposited by "blowing" metallic powder through small nozzles or orifices into a melt pool created by the laser. Depending on the power and type of laser being used, the laser beam is focused to create a known spot size. The depth and velocity of the resulting melt pool are dictated by the scan speed of the laser and the energy absorption and thermal conductivity of the feedstock that is being deposited. The size of the melt pool, the speed at which the laser moves and the powder feed rate dictate how much powder is captured in the melt pool and ultimately how much material is fused to the part—the layer beneath as well as adjacent material within the layer currently being built.

Once optimized, build rates for DED tend to be a little faster than PBF. The laser spot size for DED is at least 10 times larger compared to what is used in PBF. This creates a larger melt pool target for the powder to hit, melt and fuse together.

Criteria	*Powder Bed Fusion PBF*	*Direct Energy Deposition (DED)*
Build speed [com^3/h]	Up to 170	Up to 2000
Max. build size (X;Y;Z)[mm]	(0.8;0.4;0.5)	(4.0;2.0;2.0)
Accuracy	0.05/25	0.25/25
Min. thickness [mm]	0.2	1.0
Surface Quality [um]	Ra 10	Ra 20
Design Freedom	High	LOw
Applications	Rapid prototying High end parts	Repairing parts Adding features

Table 2: Comparison between PBF and DED (Source: Researchgate)

Also, larger powder particles tend to be used in DED systems (50- to 150-microns in diameter in DED versus 20- to 50-microns for PBF), as they tend to flow better and provide more surface area to speed the melting process. Larger powder particles also enable thicker layers compared to PBF, which means fewer layers to build when using DED. With DED, deposit material is deposited only where needed. The laser simply moves three to four times around the circumference of the nozzle to build a layer and the next layer starts immediately after the laser is repositioned. With PBF, however, the next layer can only begin after a new layer of powder has been spread.

V	R	I	O
High	High	Low	High

Table 3: VRIO Analysis for Additive Manufacturing (DED) technology

2.3. Nano PEF technologies

IRIS has ideated projected and patented a solution for the treatment of liquids, based on Nano PEF technology. Which is an advanced oxidation process in waste to water treatment. It exploits electrical impulse at high voltage, which means with an high energy content, confered in a small portion of second to any kind fluid that is treated.

When applied to water it eliminates bacteria, prevents algae formation and eliminates non biodegradable contaminants.

When applied to edible liquids (e.g. milk) thanks to the low temperatures it enables to treat the liquid mantaining its organolectic properties.

When applied to gas it facilitates many decontamination reactions (i.e. desulfurization) or carbon dioxidec onversion (i.e. CO2 transformation into syngas)

Figure 4: Nano PEF technology machine

V	R	I	O
High	High	Low	High

Table 4: VRIO Analysis for Waterplasma machine

2.4. Architectural solutions

2.4.1. Chestnut cabin

It consists in a self-sufficient living module, made up by wood from Piedmont. Chestnut Cabin has the goal of promote the local forestry chain through the use of chestnut wood from Piedmont. Starting from the peculiarities of such woody species, the project develops a constructive solution of type prefabricated and modular capable of solve the dimensional problems typical of solid wood. The prototype is prefabricated and transportable and can be used in different application cases: isolated contexts, emergency situations, exhibition spaces for events, outbuilding of accommodation facilities. The cabin is made with a load-bearing structure composed of panels prefabricated sandwich type with frame in chestnut wood (section 3 cm for 16 cm, from Valchiusella wood), poplar OSB / 3 stiffening (origin of Piedmont wood) and insulation in wood fiber. The panels are used for making of the walls, the floor and the roof. The project was conceived thanks to the collaboration between IRIS and Antonio De Rossi, architect and professor of the Polytechnic of Turin.

Figure 5: Chestnut Cabin

Chestnut Cabin is suitable for off-grid contexts. The building is equipped with a system for the collection and treatment of rain cover water and gray water deriving from the internal sinks (non-potable use). The accumulated white and gray water is filtered, treated and used for non-drinking purposes inside the building. The total water storage is equal to 110 liters. The building is also equipped with a system for the production and storage of renewable electricity thanks to the 5 monocrystalline photovoltaic panels positioned on the roof (total power 1.8 kW), combined with a lithium battery.

The advantages of the system are:

- Enhancement and promotion of wood building premises for structural applications and not only.
- Use of solid wood portions otherwise discarded.
- Process optimization with modules of standard dimensions that reduce the processing waste.
- Prefabrication and time reduction processing on site.
- Reduction of CO2 emissions
- Reduction of environmental pollution internal.
- Reversibility, modularity and portability.
- Water and energy autonomy

V	R	I	O
High	High	Low	High

Table 5: VRIO for Chestnut Cabin product

2.4.2. Ambornetti

It is an IRIS' project that with the aim to restore a permanent settlement to 1600 meters above sea level by combining the value of scientific research with architectural quality.

Ambornetti will be a new alpine destination, where it will be possible to stay in a resort with a contemporary design and completely immersed in nature.

Figure 6: Representation of View from the Ambornetti SPA when will be built

Ambornetti is located in the Ostana area. Ostana is an Italian town of 88 inhabitants in the province of Cuneo in Piedmont. It is located in the Po Valley and is included in the list of

the most beautiful villages in Italy, where projects to enhance the mountain landscape have been experimented for some time.

Figure 7: Graphic representation of the village after the riqualification

The Ambornetti project was born with a vocation completely linked to sustainability, in all its forms: environmental, social and economic. The project proposes a new form of sustainable closed-cycle economy, which limits waste and aims at the recovery of energy, water, waste and raw materials. It also envisages the recovery of the hamlet where a handful of old stables and barns currently stand. These closed-cycle economy envised by the Ambornetti project will be able to take place using IRIS technologies such as the Waterplasma for milk and water treatments, the Greenplasma to convert waste into energy and Chestnut Cabin solutions. The township has been acquisited, it has been sucessfully approved the variation to the land use plan, and finished the Preliminary Design. At the moment the following phases will consist in searching for financial partners, then proceeding with the restructuring of the hamlet, and finally, opening of the village.

The last domain is the object of the current study, because the team of this business unit has deepened the the know how of the superficial plasma technology and has perfected the Green Plasma machine, therefore there's the need to understand in which market and with which modality these solutions can be proposed.

2.5. Plasma technologies

2.5.1. Surfaceplasma

This is part of the plasma tehnologies new business line, which IRIS wants to further develop. It is a technology based on plasma but in order to understand it, it should be thought in terms of surfaces. In fact, with the knowledge deepended thanks to massive R&D on superficial plasma technology, IRIS has developed solutions for superficial treatments. The applications are focused on micro-cleaning processes, activation and coating that can be applied on a large industrial scale on materials such as plastics, metal, glass, cardboard, textile article and its composited, used in any sector of manufacturing industry.

Also in this case, IRIS provides:

- Consulting services
- Machine sales
- Assistance services

This services can be supplied to firm working in a huge range of industries from the automobile to transport and packaging to consumer good, biosciences, textile and renewabe energies. Thanks to a deiversified supplied of applications for plalsma technologies in IRIS is able to develop everyday innovative and efficient process solutions tailored on clients necessities. Following are listed some of the possible treatments that can be performed with surfaceplasma technologies:

- Roughness [nm]
- Coating CVD (vs PVD physical vapor deposition)

PVD processes are used to plasma coat surfaces in order to improve wear and oxidation resistance of the material. Its other purposes include improving hardness and lifespan. Plasma treatments are effective and efficient options to change the properties of a material. Unlike CVD where the deposited material is originally in its gaseous form, the deposited material is in the solid state for PVD. PVD occurs under vacuum conditions and includes four different steps:

1) The material to be deposited is excited with plasma, to form a vapor
2) A reactive gaseous species is introduced
3) The reactive gas forms a compound with the vapor formed
4) The compound is deposited onto the substrate

Plasma-enhanced chemical vapor deposition processes (PECVD) is a chemical vapor deposition (CVD) process that uses cold plasma, and it uses very low deposition temperatures compared to the temperatures used in CVD reactors. PECVD has a wide range of applications; one example is anti-scratch layers in optics. Some advantages of PECVD are its low power source and uniformity of deposited layers. Furthermore, the layers created by PECVD may be of a better quality when compared to CVD so the likelihood of cracking the deposited layer is much smaller. It is also relatively easy to clean the chamber after the PECVD process. This is important because the thick films that form on the chamber walls can contaminate the substrate surface (if the chamber is not cleaned properly).

- Cleaning (vs chemical treatments)

Plasma cleaning removes organic contaminants and prepares surfaces for subsequent processing through the introduction of chemical functional groups. Pasma cleaners are able to tune surface chemistry quickly and easily, without hazardous wet chemicals. Surfaces can be plasma cleaned without affecting the bulk properties of the material. As such, plasma treatment can be applied to a wide variety of materials as well as complex surface geometries. Plasma cleaning removes organic contaminants by chemical reaction (O2 or air plasma) or physical ablation (Ar plasma). It represents a economical way to clean specimens uniformly and securely. Removal of contaminants from the studied substrates without affecting the overall properties of the material is one of the benefits of plasma surface cleaning method. Plasma sample cleaning has significant advantages over other surface cleaning methods:

1) Applicable to a wide range of materials (metals, plastics, glass, ceramics, etc.)

2) Eco friendly. This method eliminates the need for hazardous chemical solvents, which saves considerable costs because it does not need to eliminate environmental hazards like other cleaning methods
3) The solvents leave behind the cleaning process while the plasma cleaner is able to perform the cleaning process without any residual effect. This process destroys antioxidants, carbon residues, oils and various types of organic compounds.
4) Plasma surface cleaning is the best solution for microbial contamination. Many medical and manufacturing equipment depends on plasma because it is more effective than aggressive agents and organic solvents.

- Functional group creations

Plasma cleaning also introduces different chemical functional groups (hydroxyl, carbonyl, carboxyl, amine) on material surfaces, dependent on the process gas

Plasma renders most surfaces hydrophilic, which can be observed as a decrease in water contact angle and increased wettability. A clean and hydrophilic surface is often critical to promote adhesion and to enhance bonding with other surfaces.

V	R	I	O
High	High	Low	High

Table 6: VRIO Analysis of Superficial plasma treatment technologies

2.5.2. Greenplasma

IRIS has conceived, projected and patented this technology.

Thanks to years of research and development has arrived at a safe, efficient and compact solution that transforms waste into a resource.

It uses the plasma technology with a treatment that conists in transforming any organic composite into gas and separating it from any matrice. The system has a great potential for circular economy applications, as it enables to recover primary materials and energy without producing any toxic emissions and waste. The product developed is called “GreenPlasma” and is a plasma conversion reactor which derives from the exploitation of an IRIS patent. Its scope is the production of electricity and recovery of material (e.g. carbon fiber from composites). The technology consists of a thermochemical conversion for the small-scale treatment of non-differentiable or special waste. For this reason it can be classified as a pyrolyzer operating in a waste to energy system

At the high temperatures reached inside the reaction chamber (1000 ° C), thanks to an innovative induction or plasma system, the organic waste fraction turns into syngas (reach of Hydrogen > 40%) which, after being filtered and purified from any harmful molecules, can be used as a source of electricity and heat. Since the process happens in absence of oxigen, the system doesn’t produce ashes, harmful emissions and the inerts are 100% recyclable. The plant can process 50kg/h of material and it can be scaled for lower or higher needs.

The ideal places to place the machine are:

- On ships, boats and ports.
- Hardly accessible areas areas, isolated and off-grid contexts (i.e. shelters, rural areas, mountain villages).
- In cities, with the aim to support peak of energy demand (during summer or winter seasons and events such as concerts and festivals).
- Near hospitals for treating special waste like gloves, masks, etc.
- Areas affected by extreme events such as earthquakes and hurricanes.
- In companies for production waste treatment

Figure 8: Green Plasma machine and waste to be pyrolyzed for energy sypply

V	R	I	O
High	High	High	High

Table 7: VRIO Analysis of Green Plasma machine

3. Plasma Technology

In this chapter the plasma technology is further analyzed, in order to better comprehend the physic principles at the basis of the superficial plasma treatment technologies offered and the Green Plasma machine developed by IRIS. Subsequently the current state of the art of plasma technology and the respective industries are analyzed, in order to have also an insight of the environment in which IRIS' plasmabased products are competing.

3.1. What is Plasma?

Plasma was first discovered by Irving Langmuir in 1928. It is not rare, actually, more than 99% of the visible matter in the universe is in the plasma state. It can be seen in its natural form on earth as lightning or as polar light in the Arctic and Antarctic, for example. During a solar eclipse, plasma can be observed as a bright circle of light (corona) around the sun. A plasma consists of positive ions, negative electrons, neutral molecules, UV light and excited molecules, which can possess a massive amount of internal energy. In a plasma treatment process, any or all of these ingredients may interact with a surface. By selecting the gas mixture, amount of energy, atmospheric pressure and other factors, the effects of plasma can be adjusted ad desired.

With increasing energy input, the state of matter changes from solid to liquid to gaseous. If additional energy is then fed into a gas by means of electrical discharge, the gas will turn into plasma.

There is a lot of potential in it.

The term plasma designates matter with a high, unstable energy level. When plasma comes into contact with solid materials like plastics and metals, its energy acts on the surfaces and changes important properties, such as the surface energy.

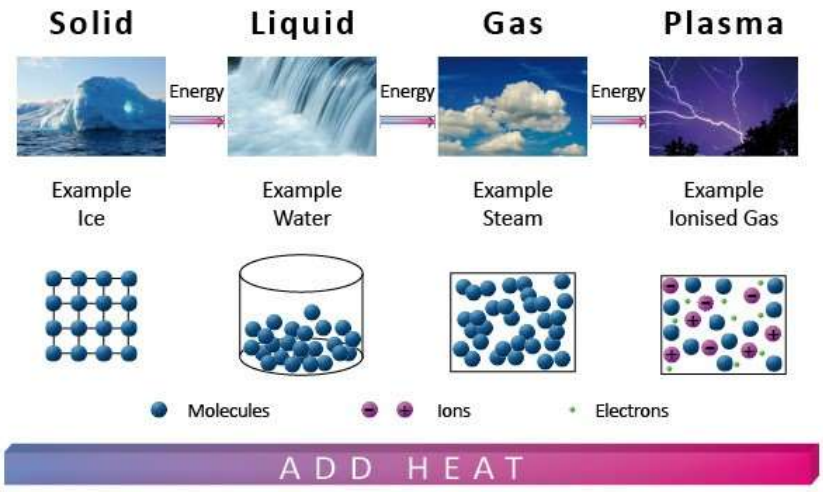


Figura 9: The four states of the matter (source: Ias Gyan)

In the manufacturing industry, this principle is used for selective modification of material characteristics. Treatment with Plasma energy causes a targeted and exactly adjustable increase in the adhesiveness and wettability of surfaces. This makes it possible to use completely new (even non-polar) materials and environmentally-friendly, solvent-free (VOC-free) paints and adhesives industrially. Today, many chemical surface treatment processes can be replaced with surface plasma treatment.

3.1.1. How plasma discovery can bring to innovation

Invention is the typical outcome of the activity called technology which has the aim of ideating and validating artifacts. Whereas innovation can be defined as the economical exploitation of an invention, which means that society moves from invention to innovation when an invention is marketed and bought. Meaning that a producer is able to produce an artifact tha will give customer utility that is greater that the cost of production and to offer it at a given price and in such a way that customer will be able to recognize its value. The profitability of an innovation to the innovator depends on the value created by the innovation and the share of that value that the innovator is able to capture. Different innovations result in very different distributions of value (between customers, suppliers, innovator and followers).

That beign said, the economic exploitation of the physical concepts of plasma into a new invention that can become an innovation can be performed in many ways. The main machines performing plasma treatments today often have a vacuum chamber at high or low pressure. After air is pumped out of the chamber, a gas flows in and an electrical field is applied to yield a plasma. Plasma treatment is typically carried out at relatively low temperatures, allowing for the treatment of heat-sensitive materials. Plasma treatment is also conducted with what are known as atmospheric 'jet' plasmas. These plasmas function at ambient atmospheric pressure and are ideal to the localised application in an in-line production process, possibly through the use of automation.

Some of the main possible applications of Plasma treatment in industrial sectors to economically exploit it are the following:

- Cleaning
  The micro-cleaning (plasma cleaning) allows to free the surfaces from release agents and additives in a delicate and safe way and to sterilize them
- Plasma cleaning is capable of eliminating oils and grease down to the nanoscale. It can also reduce various risks of contamination much more efficiently than conventional cleaning processes. Plasma cleaning generates a spotless surface, suitable for bonding or additional processing, without producing damaging waste material. Ultraviolet light produced in the plasma is very efficient at the breaking the organic bonds of common surface contaminants, including those in oils and greases. Energetic oxygen species in the plasma also perform cleaning actions, reacting with contaminants to create primarily water and carbon dioxide. A plasma cleaning process for easily-oxidised materials like silver will use inert gases like argon or helium. In this cleaning process, the plasma-

activated ions blast away organic contaminants, breaking them down so they can be vaporized and removed from the chamber.

- Surface activation
  Many polymers are inert and do not bond readily to other materials, like paints and glues. By attaching polar molecular groups to it, plasma surface activation can increase the adherence of a polymer material surface. Plasma surface activation can make polymers much more receptive to coatings and bonding agents. Oxygen is commonly used in this process; however, many plasma activations can be conducted with ambient air. Once activated, materials remain in the altered state for anywhere from a handful of minutes to many months, based on the type of material.
- Coating
  A plasma coating process creates a nanoscale polymer layer over the surface of an object. The process requires only a few minutes to produce a coating less than 1/100th the width of a human hair. Attached at the atomic scale, these coatings are typically clear, odourless and otherwise undetectable. Plasma coatings are currently a hot topic in many scientific fields because they have massive potential in a broad range of applications

The range of applications of these treatments can theoretically find a place in almost every industry sector, which means that possibilities of applications of plasma technology for an economical exploitation are almost inesaurible. However, in some realities plasma treatments at low and atmosferic pressure are diffusing, whereas in many other sectors such as life science and alternative energies but also in aerospace field new applicative solutions are being studied which means technology is still in incubation phase. The radical innovation is often at the base of new sectors that inevitably go through an incubation phase. In many cases firms working in the sector in incubation phase have high profits, but often high profits attract new entrants and the pioneer can be shaked-out from the market. During incubation phase the demand is low, mainly powered by users who focus on the search for the new. Innovation is stillnot widely known and prices are higher. It is likely that awareness of the new technology will be quite widespread, and that the promises associated to it may be expressed in exaggerated terms. Practitioners often say that new technology easily suffers from hyperinflated expectations, or simply hype. A well-known representation of this phenomenon is routinely proposed by the Gartner consultancy for technology related to ICT, in the form of hype cycles as shown in Fig. 10.

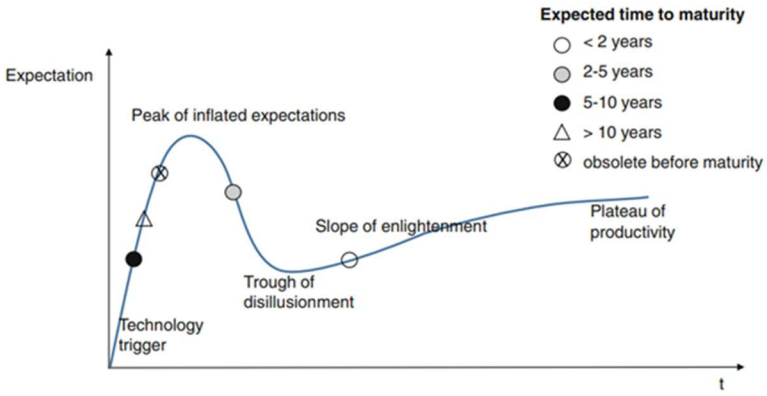


Figure 10: A simplified representation of a hype cycle (source: M. Cantamessa, F. Montagna, Innovation management and product development 2016)

According to this representation, soon after a technology appears (technology trigger), markets will tend to "fall in love" with it, and expectations will grow until they become unrealistic (peak of inflated expectations). When these expectations eventually fail to materialize, the market will quickly lose interest in the technology and dismiss it as a failure (trough of disillusionment). At this point, the technology will slowly mature and realistic applications will emerge (slope of enlightment), until the technology will finally affirm itself (plateau of productivity). The incubation phase is therefore very important for technological progress, since it allows companies to improve technology in absolute terms, to find applications that are reasonable from a technical perspective and might lead to a profitable market exploitation, to steer technology toward these "real" applications and to raise awareness and confidence in customers.

Speaking of potential future uses, many are predicting that plasma will be used in new ways in the not-too-distant future. One potential use is the destruction of toxic waste. Capable of containing enough energy to change the atomic structures of substances, plasma could possibly be used to completely eradiate very harmful toxic substances. Plasma is already being used as a very precise scalpel for medical operations. Hot plasma could also be used in medicine to cauterize wounds, drill cavities and sanitize. Ground-breaking particle scientists are already working with plasmas to unravel the secrets of the universe. These researches could unlock the secrets of existence, but it could also lead to more practical plasma applications.

3.2. Classifications of Plasma-based technologies

3.2.1. Thermal Plasma

The current status of waste treatment using thermal plasma technology, including the treatment of a variety of hazardous wastes, such as residues from municipal solid waste incineration, slag and dust from steel production, asbestos-containing wastes, health care wastes and organic liquid wastes. The principles of thermal plasma generation and the technologies available are outlined, together with potential applications for plasma vitrified products. There have been continued advances in the application of plasma technology for waste treatment, and this is now a viable alternative to other potential treatment/disposal options. Regulatory,

economic and socio-political drivers are promoting adoption of advanced thermal conversion techniques such as thermal plasma technology and these are expected to become increasingly commercially viable in the future

3.2.1.1. Superficial Treatments

Plasma treatment is the key technology for processes such as micro-cleaning, surface activation and plasma coating of the surface of almost all types of materials: from plastic, metal and glass to cardboard, fabrics and composites. Conventional industrial pretreatment methods are increasingly being replaced by plasma technology in order to make processes more effective and compatible with the environment.

It plays an important role in improving the sustainability, economy and efficiency of firms' production processes. Many of the complex and polluting chemical processes adopted by industry today can be replaced by plasma technology

So the main industries in which this technology can be relevant are:

Aerospace and defense, automotive, manufacturing, medical device, print, packaging, film extrusion and converting, paper, panels, sheets and foams, textiles and nonwovens, metal.

The advantages of plasma technique with respect to other pre-treatment methods are:

- Higher process reliability: stands out for its high safety in case of failure and the reliability of the process
- Excellent cost / performance ratio: The high speed of the process, even over several shifts, and the low percentage of waste ensure a high level of process efficiency. Thanks to the flexibility in the choice of materials, the plasma method also allows the use of less expensive materials
- High degree of activation
- Large process window: Plasma allows you to work with a large process window. The risk that the treated components suffer thermal damage is in fact extremely low compared to flaming.
- Easy to integrate: Compared to mechanical treatments such as granulation and sandblasting, normal or corundum, the plasma treatment can be easily integrated in-line into the existing process.
- Ecocompatibility: allows for surface pretreatment without solvents and VOCs. Compared to electrochemical processes, such as galvanization or galvanic pickling and chromium plating, it is not necessary to resort to the aid of wet chemistry.

3.2.1.2. Waste-to-energy Treatments

Thermal plasma torches convert electricity to high-temperature thermal energy by applying a high voltage across a flowing gas stream. Plasma torches are used extensively for producing metallic and ceramic coatings and also for vitrifying hazardous materials, such as asbestoscontaminated wastes. In the last decade, several thermal plasma processes have been proposed for treating municipal solid wastes (MSW) as an alternative to the conventional waste-

to-energy (WTE) by grate combustion. To mention two prominent thermal plasma technologies that are presently under development: The Alter NRG "Westinghouse" process in the U.S. and the Europlasma process in France. MSW is a heterogeneous fuel containing a very wide variety of solid wastes. Due to the presence of some post-recycling materials, such as paper fiber and plastics, its heating value can be high and plasma-assisted gasification proposes to take advantage of this.

Plasma processes have been widely used for the destruction of hazardous waste, such as asbestos, but this requires a high consumption of electricity. The high temperatures generated by plasma torches have the unique ability to melt and destroy any chemical bond and reduce it to gas and vitrified ash. A classic Waste-to-Energy plant can be assumed to produce 500 kWh net of electricity per ton of waste The capital costs associated to such a plant are about $50/ton of MSW processed. The labor costs are considered to be the same for both a classic combustion and a plasma gasification plant and represent $10/ton of waste for a plant of the size studied. Capital costs for the latter are expected to be higher that the grate combustion plant, but the production of electricity is also much higher.

3.2.2. Non-thermal Plasma

Cold plasma, also referred as non-equilibrium plasma or non thermal plasma is a classification of plasma. It has numerous application in bioengineering, medical and therapeutics. Cold plasma is used for sterilization of biomedical surfaces, treatment of living biological tissues, and surface modification of biomedical dvices and materials, owning to its antimicrobial and bacterial properties.

The global coldplasma market is driven by less requirement of water for the process reducing waste water treatment cost; medical applications such as enhancement of tissue repair, control of bleeding, destruction of cancer cells; and its application in packaging industries. However huge capital incurred for implementing cold plasma technology is a key hindrance for the market. Conversely the growing need for medical research for developing treatment of lung, bladder, skin, and brest cancer offers lucrative opportunities for market growth.

Also superficial plasma treatments can be performed with Non-Thermal Plasma depending on the needs and what is the object to be achieved by its use.

3.3. Plasma tecnologies industry analysis

The aim of this study is to further develop IRIS business unit related toplasma technologies that are the superficial plasma treatments and the GreenPlasma machine. In order to be successful IRIS must put in place superior competitive advantages to its rivals. However, in order to individuate and sustain these advantages, an industrial analysis and deinition of its key market player and degree of rivalry must be carried out.

3.3.1. Superficial Treatments

Currently, Europe is holding the highest market value concerning the plasma surface treatment industry, which accounts for over 35% and the emerging market players in the region are also creating lucrative opportunities for the plasma surface treatment market growth across the region. The country is currently focusing on developing the automotive industry and is flourishing the country with electric vehicles. Such treatments are helping automotive components to increase their shelf life. For instance, the shelf life of the headlight in the vehicles is extended by utilizing plasma treatments which protect the headlights from the exposure of water vapor. Moreover, the developments in the automotive industry in European countries are fuelling the plasma surface treatment market demand. Europe is expected to witness healthy growth with a CAGR of 13% during the forecast period.

The low-pressure plasma segment is witnessing healthy growth among the other segments and is expected to reach a market value of over USD 2000 million by the year 2025. Some of the key end-user applications are garments, household, protective, medical components, automotive, shoes, and bags. The increasing investments in the medical sectors globally are impacting the growth of the plasma surface treatment industry in the medical sectors. Moreover, the up-gradation of several medical infrastructures and facilities are impacting the overall growth of the plasma surface treatment industry during the forecast period.

The increasing demand in the automotive and textile industries is creating new plasma surface treatment market trends in recent years. The plasma surface treatments are rapidly increasing as they are effective in modifying the natural and synthetic fibers of the textiles and enhancing the dying behavior of the fabrics. Such factors are considered as the major market driver of the plasma surface treatment industry

On the other hand, the rising number of textile industries is significantly affecting the overall growth of the plasma surface treatment industry. The plasma treatments are intensively used in the textile industries as they effectively improve the surface properties of the natural and man-made fibers.

However this treatments have not been introduced yet to small and medium-sized firms.

The main players operating in this industry are the following companies

- Nordson Corporation (US)
- Plasmatreat (Germany)
- AcXys Technologies (France)
- Enercon Industries Corporation (US)
- Plasma Etch, Inc (US)
- Plasmalex SAS (France)
- AST Products, Inc (US)
- Henniker Plasma (UK)
- 3DT LLC (US)
- Eltech Engineers Pvt Ltd (China).

Porter's Five Forces

A number of researches have demonstrated that exists a relationship between the industry structure, the strategies that companies implement and the results they obtain. Porter formulated the five forces model that is a must do for a first overview of the sector.

Threat of new entrants

In the plasma treatment industry the barriers to entry are high, since to operate in this sector is necessary a specialized know how, and technological capabilities that are not easily achievable for a new entrant. Moreover it is an unpredictable market and to develop technologies and products in this field huge capital investments on R&D are required. Therefore the threat of new entrant is low.

Threat of substitutes

There is not a high pressure from competitors operating in the italian manufacturing industry wich means that buyers cannot compare quickly prices and quality. However the superficial plasma technology is itself a "substitute" to the existing technology and methodologies currently used by buyers, which means that more that a threat of substitute, in this case there is a threat of lock-in effect, meaning that buyers won't substitute their current technology with the plasma one. Therefore the threat is high.

Bargaining power of buyers

High price sensitivity, since the product or service will have a great importance as a proportion of total cost. However they have a few firms to choose from and little control over prices. There are switching costs and there is product differentiation which makes hard for buyers to find alternative firms. Considering these factors, the bargaining power of customer is quite low.

Bargaining power of suppliers

In this framework a network with supplier is in the process of being build, but since it is a new value/production chain, suppliers may be not ready to a change in demand in case of an exponential market demand of superficial plasma treatments products which may give them higher market power. Moreover is not easy to find substitues to generators and gas (e.g. Ar, O2), and there aren't many supplier in the market of there products which gives them a fair bargaining power, especially to the supplier of gernerator which is a technically sophisticated component.

Internal rivalry

The rivalry intensity is capable to influence the industry profit as well as strategic decisions. It depends on a series of fators and in this framework the most important determinant of industry rivalry are the following. The pace of development is high which means that companies can have more opportunities to find little rivalry or none in some segment of the market. The product is definitely not a commodity which means that it is not easily replaceable. The number of competitors is not so high but is growing, as it is projected to grow also the demand for plasma treatments. However since it is a new market and the demand is still unpredictable is hard to define the value of concentration and the risk for new entrants to enter a saturated market is high. There are high exit barriers, which means there are high cost associated with capacity leaving an industry. Moreover the rivalry is turbulent and

unpredictable since the companies are different in origins, strategies, management which gives place to a higher competition. Overall we can say that rivalry is fairly strong.

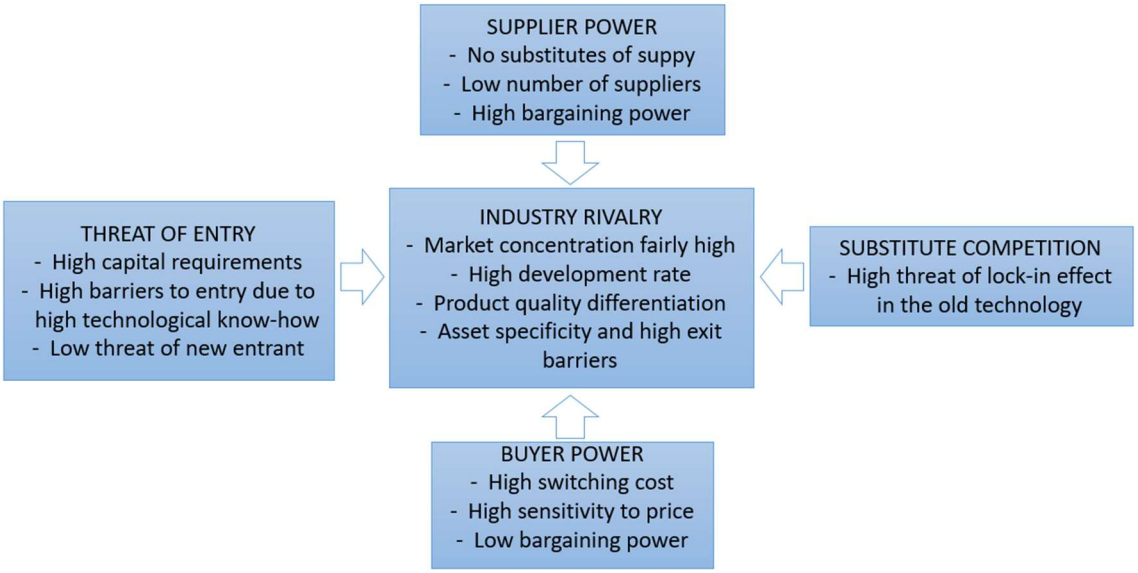


Figure 11: Porter's five forces in superficial plasma treatment industry, elaboration from Porter M.E., Competitive Advantage, Boston, 1988

3.3.2. Plasma for Waste-to-energy treatments

The Thermal plasma technology exploited for the achievement of a waste-to-energy conversion, can be positioned as a subgroup, a niche technology, of the whole waste-to-energy technologies, therefore operating in the vast waste-to-energy industry. To give some figures, the European waste-to-energy (WtE) market reached USD 17.28 billion, and it is anticipated to reach USD 24.12 billion by 2027, registering a CAGR of 4.2% during the forecast period. Factors such as the increasing amount of waste generation, growing concern for waste management to meet the need for sustainable urban living, and rising focus on non-fossil fuel sources of energy are driving the demand for waste-to-energy solutions. The market growth is expected to be restrained by the expensive nature of incinerators, if energy prices decline, several plants cannot cover operating costs. Furthermore, several European countries plan to focus more on recycling, which saves three to five times more energy, thus restraining the waste-to-energy market.

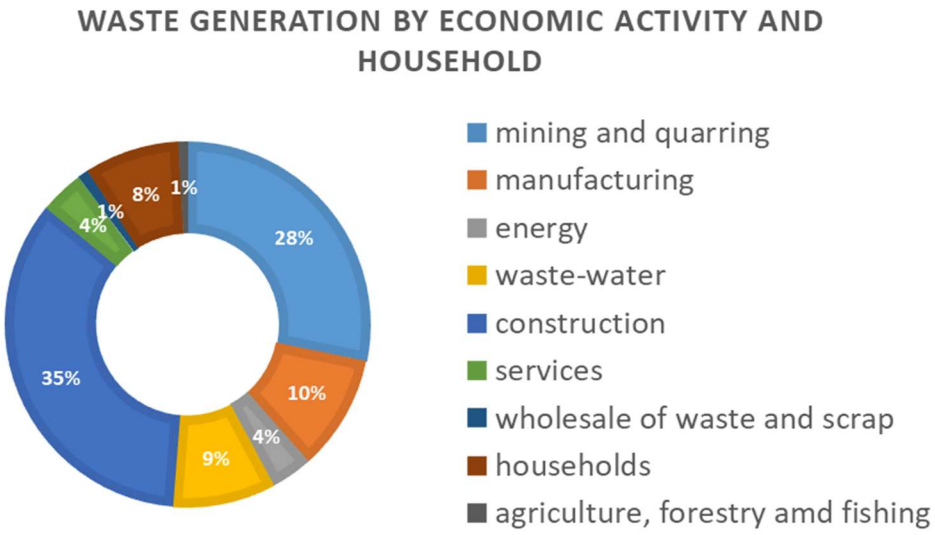
Thermal technology is expected to dominate the waste-to-energy market thanks to the increasing development in incineration and gasification technologies and the growing amount of waste generated in European countries. However alternative waste-to-energy technologies are emerging, such as Dendro Liquid Energy (DLE), four times more efficient in electricity generation, with additional benefits of no emission discharge and effluence problems at plant sites, are expected to create significant opportunities for the market players over the coming years. In the present scenario, incineration is the most well-known waste-to-energy technology for municipal solid waste (MSW) processing. However, waste-to-energy technologies, particularly incineration, produce pollution and carry potential health safety risks. To reduce

particulate and gas-phase emissions, incineration plant owners have adopted a series of process units for cleaning the flue gas stream, which has, in turn, led to a significant improvement in terms of environmental sustainability.

The European waste-to-energy (WtE) market is moderately fragmented. Some of the major players operating in the market include Mitsubishi Heavy Industries Ltd, Martin GmbH, A2A SpA, Veolia Environnement SA, and Hitachi Zosen Corp.

It is a very competitive and highly fragmented, there are a few dominant players between others but is not so easy to individuate them. It can be pointed out that the technological research of the waste to energy market has concentrated its efforts on large scale implants for mainly municipal waste.

However, a high percentage of total waste production is represented by the waste coming from industries, the figures of industry's waste production are comparable to the household ones as can be noted in the fig. 12



Figue 12: Waste generation by economic activity and households (Source: Eurostat2014)

In this framework the GreenPlasma technology represents a small-scale solution which can deal also with industrial waste in the same location of where they are generated (which involves less CO2 generation for the waste transportation) and can give energy to those industrial manufacturing processes that are well-known that use energy intensive machinery. There will not be any kind of pollutant released in the air, which makes it particularly safe for the health of employee.

The GreenPlasma is a compact device for the pyrolysis of non-recyclable undifferentiated waste (e.g. marine waste, plastics, medical waste, agricultural sector waste).

The GreenPlasma machine is made up of the following parts:

- A reactor: it is mainly made up by iron, and it represents the volume in which the pyrolysis occurs. This process is induced by means of an external heat source (induction generator) at a temperature higher than 800°C. In this area the pyrolysis process takes place which converts the waste into syngas (a gas made up of hydrogen, carbon monoxide, methane, ethylene, and other compounds to a lesser extent).
- A trap for catching condensate for collecting the condensable component present in the syngas
- A filter with expanded clay filler for the collection of impurities;
- A thin filter to protect the blower for the collection of fine particles;
- A blower which guarantees that the system is kept at minimum depression (about 1 mbar).

The waste material is introduced into the reaction chamber at about 1000°C for the conversion of the material into syngas.

Since the Green Plasma machine is innovative both in terms of dimensions smaller than average, and in terms of the plasma technology at the basis of its pyrolytic functions, it is an innovation exploring a new segment of the waste to energy market, for this reason the Porter's Five Forces analysis will be conducted for this new technological solution with respect to traditional solutions which represents the substitutes and the main competitor of the technology that will prevent its diffusion, as of today, in the industry.

Porter's Five Forces

Threat of new entrants

In classical waste to energy industry the barriers to entry are high, because in order to operate in this sector specialized know how is necessary along with technological capabilities that are not easily achievable for a new entrant. Huge capital investments are required. And there can be also some legal barriers of permission to build in certain areas. Therefore the threat of new entrant is quite low.

Threat of substitutes

As of today a lot of advancement has been made in the waste to energy market. It's the technological progress of technologies in this market that enabled to build inside city centers waste incinerator for the recovering of energy. Since it is a sector with high innovation rate the threat of substitute is high, especially from those solutions that do not release harmful effluents that pollute waterways or the surface of the land. From the traditional waste to energy facilities point of view, GreenPlasma technology is istelf a "substitute" because manufacturing industries instead of acquiring energy, maybe produced in a near incinerator in the area, can produce energy by themselves and recover their non-recyclable waste, reducing simultaneously the cost of energy bills

Bargaining power of buyers

High price sensitivity, since the product or service will have a great importance as a proportion of total cost. However there aren't other firms selling a product with the same GreenPlasma technology to choose from, in fact it is product differentiated which makes hard for buyers to find alternative firms, so for this reason control over prices il low for buyers. Same story in the case of traditional incinerators the buyers are those who buy the energy and there

is no bargaining for them on the energy cost. Considering these factors, the bargaining power of customer is low.

Bargaining power of suppliers

In this framework a network with supplier is in the process of being build, but since it is a new value/production chain, suppliers may be not ready to a change in demand in case of an exponential market demand of GreenPlasma machinery which may give them higher market power. However what is needed to build the machine are quite commoditiesand there are a lot of supplier in the market of those goods which gives them a low bargaining power.

Internal rivalry

The pace of development is high which means that companies can have more opportunities to find little rivalry or none in some segment of the market. The product is definitely not a commodity which means that it is not easily replaceable. The number of competitors is not so high. However since it is a new market and the demand is still unpredictable is hard to define the value of concentration and the risk for new entrants to enter is high. There are high exit barriers, which means there are high cost associated with capacity leaving the industry.

Overall we can state that rivalry is fairly strong.

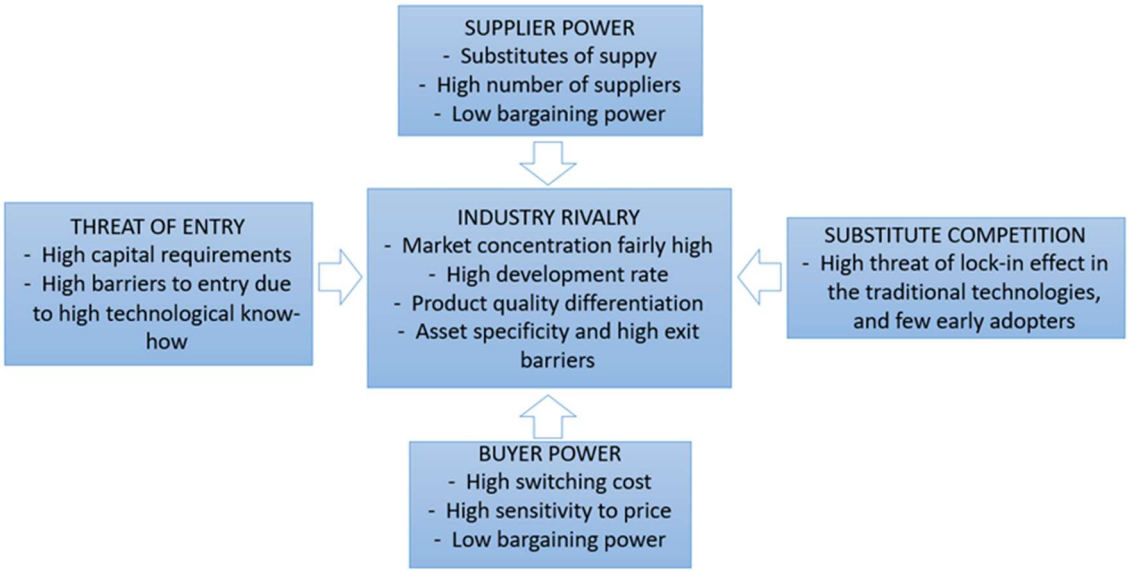


Figure 13: Porter's five forces in waste to energy industry, elaboration from Porter M.E., Competitive Advantage, Boston, 1988

3.4. Criticalities of application

The plasma treatments can be intensively utilized in the manufacturing industry as they are considered more economical and ecological compared to the conventional wet-chemical processing processes. As plasma surface treatments do not require much time and are considered clean and environment-friendly processes, the demand for plasma surface treatments is rapidly increasing.

Unlike the conventional methods, the modifications in the chemicals can be made endlessly in terms of gases or chemicals, which offer flexibility for the operators and the manufacturing sectors. Moreover, the processes don't require more water or energy for drying the treated substrates. Such factors significantly reduce the expenses for the industries and are considered as the major market drivers of the plasma surface treatment industry.

However, the lower pressure plasma treatments are not preferred for the upscale in the commercial sectors, as they impose limitations in the continuous processing as of today. The size of the reactor plays a significant role in carrying out the processes. Whereas the higher pressure large-scale reactive plasmas demand large size vacuum chambers and complex vacuum equipment for the processing instead, which are considered as the major hindering factors for the overall growth of the plasma surface treatment industry. The running costs of the atmospheric-pressure plasma treatments are higher as the process will operate with the higher flow rate of the filling gas.

The lack of ideal plasma treatment techniques for the manufacturing industry is considered as the major challenge for the plasma surface treatment market growth. The ideal technique has to be selected by the respective industry considering the attributes and strengths of the techniques and the requirement of the industry. These plasma treatments are highly reliant on the systems, which restricts the adaptation rate in the industry. The flow rate, gas pressure, and power input vary according to the varied species. This factor affects the production rate in the textile industries and thereby presents challenges in the plasma surface treatments market growth.

Whereas speaking about the Green Plasma machine, as every innovative product on the market, it is in the phase where the sales are addressed to some early adopters. However the company should be ready for an increase in the demand with its network of suppliers when the early adopters will remain satisfied from the product and will start to diffuse among the majority of manufacturing industries.

4. Identification and Analysis of markets in which expand the business

The framework of plasma technology and its commercial viable solutions, has been defined. In order to develop a proper strategy for IRIS's plasma technologies line (which to simplify the development of this thesis we will call it Plasma Business Unit), the industries in which the company wants to propose its services and products must be defined and analyzed beforehand.

4.1. Identification of industries of interest

The competitive strategy and the business unit strategy are tightly related. The strategic business unit (SBU) is an operative unit which sells products or services to a homogeneous group of potential clients and face a definite number of rivals. According to Abell (1980) the enterprise in exam (i.e. IRIS) should define in which business wants to compete and must take decisions regarding

- Which needs wants to satisfy
- Whom needs wants to statisfy
- How wants to satisfy those needs

These decisions are the key to define strategies at business level since they represents sources of competitive advantage towards competitors and also direct the ways in which the company can compete. However, in order to correctly develop this strategy and answer these questions comes to the rescue the creation of a database and gathering of informations, all of this with the support and structure given by the use of Project Management principles.

If managers are unable to forecast technology and demand, then to manage risk, they must be alert to emerging trends while limiting their exposure to risk through avoiding large-scale commitments. During the early phases of development of superficial plasma technology and Green Plasma machine, both belonging to the Thermal plasma technology Business Unit, careful monitoring of and response to market trends and customer requirements is essential to avoid major errors in strategy implementation of the product and services.

For this reason it appeared to be vital, in these early stages of these new projects devoted to plasma treatments and Green Plasma, to define beforehand some industries and markets to approach, with the aim to work with companies operating in those sectors, in order to narrow the range of possible industries application since there are vast possibilities of application in almost any manufacturing industry.

The industries to whom IRIS will presents its Plasma business unit, according to IRIS management, should have the following characteristics:

- Main players based in Europe
- Europe should represent a good share of the total market
- The industry sector with growing projections
- External forces that can potentially induce the player of the market to being interested in upgrading their current technology to plasma treatments

Relying on these guidelines, the designated industries where IRIS will propose its thermal plasma technologies to the companies operating in them, are: eyewear industry, textile industry and packaging industry.

4.2. Analysis of industries of interest

4.2.1. Eyewear

Even considering the European market, Italy is the first producer and first exporter in the world of high-end sunglasses and frames, with an annual turnover of about four billion euros, 75% of which is the result of exports, according to data from Anfao, the Italian Association of Manufacturers of articles opticians. The Italian eyewear sector is a leading global industry. Italy ranks among the countries recording the highest eyewear revenue and hosts some of the most important enterprises of the sector worldwide.

The Italian fashion industry generates about a billion euros of turnover annually from eyewear industry. One of the most important local systems in Italy is the eyewear district indeed. The district has lost most of its traditional features and inter-organizational relations have significantly changed Environmental Analysis. The district is characterized by the presence of a limited number of medium and large-sized companies and a dense network of small entrerprises (usually sub-contractors). The former expanded in recent years with growth rates of around 10% per year, while the latter are finding it difficult to defend their sales levels, when not in fact fighting to survive. The district is changing, particularly in regard to inter-firm relations between the leading companies (main-contractors) and sub-contracting units. Core-firms are drastically re-thinking their sourcing choices, the supply chain and the involvement of the local sub-contracting system.

Eyewear production favored inter-firm work distribution, however, internationalization has gradually modified those aspects (optimal dimension of scale, specialization advantages, and costs of local transactions) that constituted the competitive advantage of the district. All the main-contractors firmly believe that the ability to innovate processes and products has become a critical competitive factor.

4.2.1.1. Environmental Analysis

Changes in the macro-environment factors can have a direct impact can impact other players in the Apparel Stores. The macro-environment factors can impact the Porter Five Forces that shape strategy and competitive landscape. They can impact individual firm's competitive advantage or overall profitability levels of the Services industry.

POLITICAL

Italian eyewar industry is globally present representing the most of the sales in US and in Europe, the two regions remain relatively politically stable. Most of manufacturing output is divided between Italy where the HQs are located and Asia. In Asia, a continuous tension is growing between Hong Kong and China. On Global scale the main political effects would result from the ongoing US-China trade war where both countries increasing tariffs on imports.

ENVIRONMENTAL

The pandemic has changed the attitude of consumers in all directions, even in the world of eyewear. The phenomena we witnessed in 2021, in the internal market, are certainly linked to an increase in the use of digital screens (of all sizes) and to a greater attention to consumption related to the person and health. In this sense, a greater use of eyeglasses often more and more premium is explained, the consumer is no longer willing to the first price but when it comes to his well-being he makes more and more quality choices that go in the direction of his satisfaction and satisfaction of his needs.

SOCIO-CULTURAL

Always more people are buying glasses that today appear to be more than just glasses, but thery represents a social status such as cars and watches. Moreover, several new social behaviour and demographic changes are contributing to the increasing demand of eyewear and some to diminishing of it. The high usage and exposure of digital and electronic devices in our daily lives, especially for youngsters, results in increasing sight deficiencies. The growing diffusion of sight deficiencies among elders such as myopia, hypermetropia and presbyopia, together with increasing awareness of eye checking and easy access to labs, are boosting the growth of eyewear market. In many parts of the world, like the Asia-Pacific region, eyewear perception is changing to a resemblance of status and fashion than a practical tool.

TECHNOLOGICAL

Science is studying solutions to substitute glasses in order to restore sight. However this seems to not having a huge impact on the eyewear especially the solar ones. The technology behind the construction of glasses is not very sophisticated, companies can differentiatetheur product by different kind of materials and having efficient CNC machines can improve production lead time and quality. Technology has been developing fast in the recent years. The most notable technological trend taking place in the eyewear industry is the development of smart glasses.

4.2.1.2. Industry Analysis

The global eyewear market size was valued at USD 157.9 billion in 2021. It is expected to expand at a compound annual growth rate (CAGR) of 8.4% from 2022 to 2030.

Porter's five forces analysis

Threat of new entrants

One of the main barrier to entry is the economy of scale. Since the incumbent are already big enough they can produce more efficiently and take advantaeges also from economies of learning. Another barrier is represented by the high capital requirements and brand loyalty. And also by the difficult access to distribution channels that already have agreements with incumbents.

Threat of substitutes

The eyewear industry satisfies many market segments for different demands and few substitutes exist, the medical eyewear consumers have few alternatives characterised by the

contact lenses and vision corrective surgeries, together they value of less than 10% compared to eyewear's market value, but it could exert a higher threat in the future due to technological advancements that leads to lower costs and better consent from customers. For sunglasses, almost zero substitute exists that could satisfy customers demand of sun protection or making a fashion statement.

Bargaining power of customers

With the high concentration in the industry, the customers have a few firms to choose from and little control over prices. The switching costs are low but the fact that the product differentiation is high within the industry makes it hard for customers to find alternative firms producing a product. Considering these factors, the bargaining power of customer is rather low.

Bargaining power of suppliers

Eyewear frames can be found in a variety of materials, from plastics such as cellulose acetate and nylon, to metals such as titanium, stainless steel, and flex-on. Most of materials used can easily be found from a variety of suppliers all around the world. Moreover prices are set globally and since most of eyewear manufacturers have factories and logistic centres spread all around the world there aren't asymetries of informations, therefore suppliers have little bargaining power and capacity to act in an opportunistic behaviour.

Internal rivalry

In general, rivalry is strong and the industry is highly concentrated. Whenever a competitor makes changes within their company, everybody in the industry will notice, so the information asymmetry is reduced which leads to a lower internal rivalry. However, the fixed costs are high and so are the exit barriers due to the capital invested high asset specificity of investments. In addition, the diverse strategies of firms within the industry cause them to compete because there is a history of brands switching from one company to another in recent years.

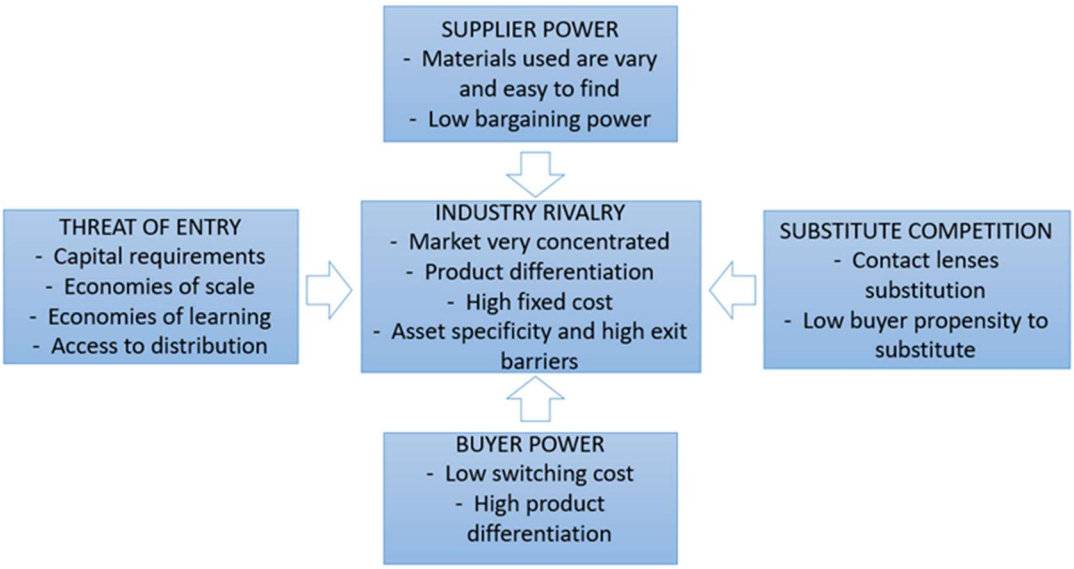


Figure 14: Porter's five forces in the eyewear industry, elaboration from Porter M.E., Competitive Advantage, Boston, 1988

Overall the industry structure in Europe is characterized by:

- An oligopoly, there's the concentration of a few firms
- There are some barriers to entry represented to initial capital requirement for machinery, economies of scale and learning economies
- There is potential for product differentiation
- Not perfect availability of information

4.2.1.3. Segmentation Analysis

According to eyewear market analysis, the market is segmented on the basis of

- Product type
- Mode of sale
- End user
- Region

On the basis of product type the eyewear market is categorized into prescription glasses, sunglasses, and contact lenses. The prescription glasses segment garned the highest eyewear market share in 2020 due to increased rate of education and longer life expectancy across the world, which has resulted in growth of demand for prescription glasses

According to mode of sale, it is fragmented into retail stores and onlne stores. The retail stores segment has led the market in 2020. This is attributed to the fact that the market players have equipped their eyewear retail store with the largest technology and services, coupled with a wide range of local as well as international eyewear brands to meet consumer need.

As per end user, the market is divided into men and women. Men sgement is anticipated to dominate the eyewear market, this is due to men preferring superior quality and design sunglasses which according to them define a social status.

Region wise, the eyewear market is analyzed across North merica, Europe; Asia-Pacific, and LAMEA. Several companies that operate the global eyewear market have adopted product launch and acquisition as their key growth strategies to sustain the intense competition in the market and increse their market presence.

4.2.2. Textile

Home to some of the world's most famous fashion brands, Italy occupies a special niche in the global market of fashion and clothing. An important pillar of the economy is the production of high-quality products such as in the machinery, textiles, industrial designs, food and furniture sectors. These products contribute substantially to the country's exports.

Italy's economy is driven mainly by services and manufacturing. Small and medium-sized enterprises (SMEs), of which many are family-owned, comprise 95% of Italian businesses and produce 66.9% of Italy's GDP. After mechanical engineering, the textile and fashion sector is the second most important industry sector.

The exceptional nature of the Italian fashion chain is largely due to a series of non-measurable and intangible factors. The turnover of the Italian textile and fashion industry as a whole was around 56 billion euros in 2019 in the pre-pandemic period (source: Sistema Moda Italia). According to Sistema Moda Italia (SMI), in 2021 the textile and clothing sector made a strong recovery in terms of exports, growing by 18% to reach 32.4 billion euros.[11]

There are approximately 45,000 textile and fashion companies in Italy; the majority are small in size: 82% have fewer than 10 employees and 16% are medium-sized (fewer than 50 employees). The Italian textile districts are concentrated in Biella, Prato, Como, Busto Arsizio and Vicenza. Thanks to the collaboration of the district to which it belongs, each company can specialise in a specific activity: spinning, warping, weaving, dyeing or finishing. In this way, a high degree of skills is created and production is differentiated, as in a large, vertically integrated company. The economic results of the companies belonging to the districts are often above the industry average.

[11] (Confindustria Moda, italian textile tries to recover, 2021)

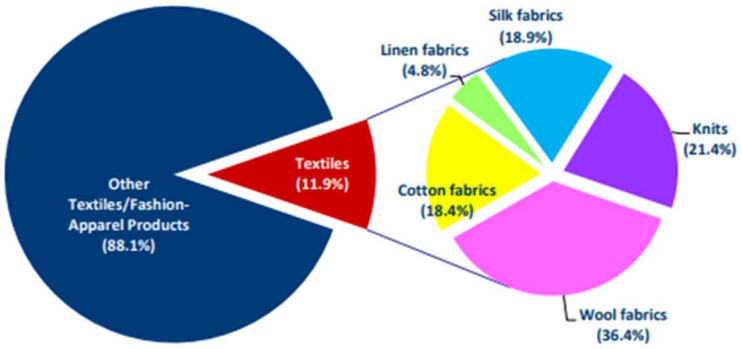


Figure 15: The role of textiles in the italian textiles-apparel industry suply chain (2020)
Source: Confindustria Moda

4.2.2.1. Environmental Analysis

POLITICAL

The Italian government's National Recovery and Resilience Plan pays particular attention to the textile sector and focuses on regenerating 100% of textile waste over the next few years, by strengthening the network of separate collection and involving textile hubs, new plants for recovery, reuse, and treatment/recycling. Textile companies that want to document their commitment to sustainability make use of system (ISO) or specific (e.g. GOTS, GRS) environmental certifications. In the Prato textile district, there are already 400 GRS (Global Recycled Standard) certified companies for instance. For these reasons the production of recycled textile material is projecte to grow in Italy.

ECONOMICAL

The Recovery and Resilience Plan (RRP) under the Next Generation EU programme put in place by the European Union to respond to the crisis caused by the Covid-19 pandemic, will provide resources for the technological and cultural change of the Italian textile and clothing industry in order to answer to the changing demand

SOCIO-CULTURAL

The confindustria Moda said that the structure of the Italian textile and clothing industry will have to undergo a 'a cultural change'. Because people are always more aware of the environmental impact of the textile industry, so in order to prevent the decline of demand, the

industry must address a crucial issues: the evolution towards a production system that is more environmentally sustainable

TECHNOLOGICAL

The industry must adderss a second crucial factor that is the digitisation of the supply chain, which must include SME players. In fact the Association of Italian Textile Machinery Manufacturers (ACIMIT) has accelerated its Digital Ready project for certifying Italian textile machines that adopt a common set of data, in order to more easily integrate with the operating systems of their client businesses.

4.2.2.2. Industry Analysis

The italian textile and garment industry is expected to make a complete recovery in 2022 to pre-pandemic levels of 2019, and then return to growth in 2023, according to industry watchers and players

Porter's Five Force Analysis

Threat of new entrants

There are no major barriers that are faced while entering, except the fact that the industry is capital-intensive. A lot of funds are needed to establish the machinery to produce textiles, therefore there are also economies of scale. And also by the difficulties to get access to distribution channels that already have agreements with incumbents. The result is that there are some barriers to entry but not so high.

Threat of substitutes

For textiles there are almost zero substitute existing that could satisfy customers demand.

Bargaining power of buyers

With the low concentration in the industry, customers have a wide range of brands to choose from and more control over prices which means that buyers have a high sensitivity to price and. The switching cost are low and since there are a lot of brands it's easier to customer to find alternative products. As a result they have the power to influence the price charged. Considering these factors, the bargaining power of customer is rather high.

Bargaining power of suppliers

Clothing industry is a saturated industry, hence the number of suppliers available are immense. Instead, many brands have followed a backward integration and started their own back end work. Moreover, the brands have tie ups with their own set of suppliers. Considering these factors the bargaining power of suppliers is low.

Internal rivalry

In general, rivalry is strong and the industry is fragmented with a low CR4 value. As the number of players in the market is high there is availability of affordable clothing brands as well as well established brands, the competition from industry is very high. Products can be easily differentiated so competition tends to fous on quality, brand promotion rather than price. However, the fixed costs are high and so are the exit barriers due to the capital invested into high asset specific machinery and processes.

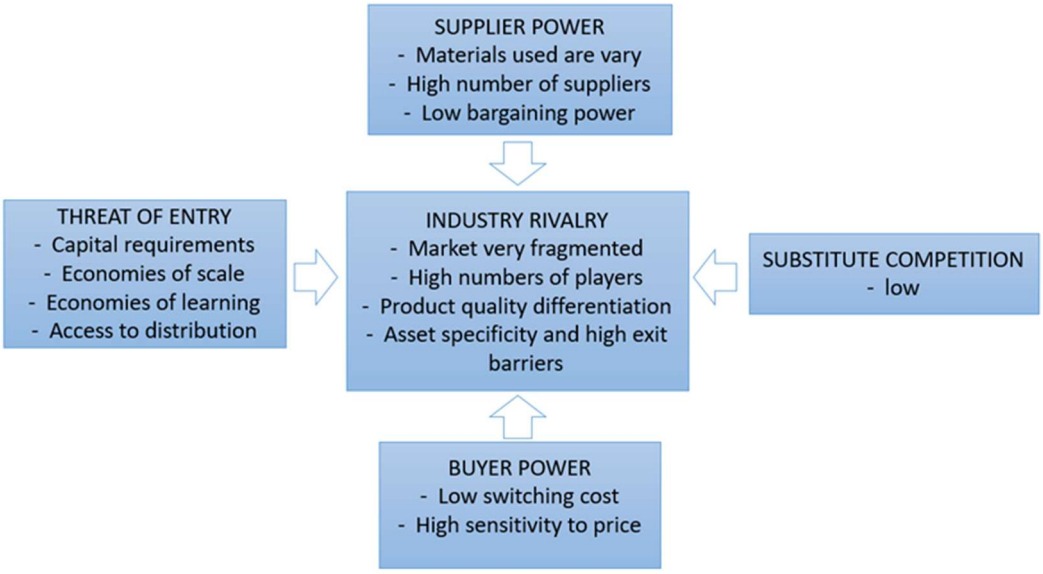


Figure 16: Porter's five forces in textile industry, elaboration from Porter M.E., Competitive Advantage, Boston, 1988

Overall the industry structure din italy is characterized by:

- Low concentration with the presence of a lot of firms, circa 45,000 textile and fashion companies
- There are moderate barriers to entry represented by initial capital requirements for machinery, economies of scale and economies of learning, and finding channel distributions and suppliers.
- Fragmented and highly competitive market

The global textile market is dominated by the national player. The major strategies adopted by these companies include product innovations, expansions, and mergers and acquisitions.

4.2.2.3. Segmentation Analysis

The global textile market is segmented by:

- Raw material
- Application
- Region
- Process

On the basis of raw material, that is the fiber that made up the textile, the market is fragmented into the plant based fiber, synthetic fibers, animal based fibers and fibers from cellulose. Cotton is anticipated to be the major shareholder in the market owning to its outstandind durability and its ability to resistance to hypoallergenic and dust mite.

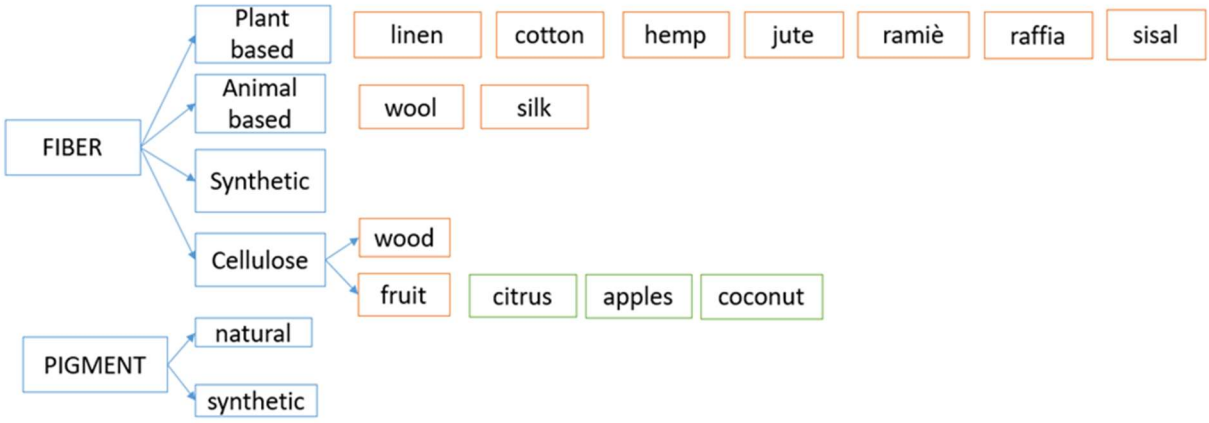


Figure 17: Schematic representation of classification of textiles

Furthermore, based on the apllication, the market is grouped into clothing, industrial, and household. Clothing holds the major share based on the application this is because there is increasing growth of clothing industry due to an increase in promotional activities, marketing and advertising on social and print media and others are resulting to propel the growth of the market.

Speaking of process the segment are the woven and non-woven.

4.2.3. Packaging

When thinking about a product, we usually think in terms of the final product. But we do not often linger to think that every single usable product comes in a package. Depending on the product the packaging itself can have an intrinsic value in representing the product (e.g. perfumes), can be functional to the product use (e.g. liquid soap), or can have just the function to contain the product (e.g. pack of pasta)

In this framework, the packaging industry is a significant industry, in perpetual research to enhance performance, quality, reliability and design. In fact the package of a product very

often brings together both the engineering of material with the sciende of design. The Packaging Industry In Italy is expected to grow at a CAGR of 3.5% over the forecast period 2022 – 2027. The Italian domestic market sales grew up 3.2% on 2020 which marked a continuation of the positive trend already in progress. Continental Europe remains the largest Italian partner.

Since it is a vast industry, for convenience it can be divided into two macrocategories:

1) Food and beverage packaging

The food sector's technology purchases increased by 8.8% compared to 2020, while the beverage sector's purchases fell by 3.4%. The combined result for the two segments was a 3.4% increase relative to 2021 and a turnover of 4.7 billion euro.

2) Non-food packaging

Topping the ranking of non-food sectors was tissue, tobacco and other machinery, which overtook pharma with 1.5 billion euro, an 18.2% share of turnover and 16.8% growth with respect to 2020. Next came the pharmaceutical sector with 1.4 billion euro and a 17.1% share of total revenues. The cosmetics sector ranked third, stabilising after its strong growth in 2020 and generating sales of 341 million euro last year.

4.2.3.1. Environmental Analysis

POLITICAL

Concern regarding the environmental impact of packaging that comes with goods will probably give rise to more emendament and regulations regarding the packaging that come with goods. Moreover in this area of packaging legislation the EU has been a pioneer with its drive towards circular economy principles. There is a particular focus on plastic waste, and as a high-volume, single-use item plastic packaging has come under particular scrutiny. A number of strategies are advancing to address this, including substituting to alternative materials, investing in the development of bio-based plastics, designing packs to make them easier to process in recycling, and improving recycling and processing of plastic waste. The current year is likely to be less dynamic than 2021 due to the many problems we are facing, including soaring raw material and transport costs and difficulties in procuring certain components, an issue that prevents companies from shipping completed machines, all of this along with the difficulties caused by the sanctions imposed on Russia.

ECONOMICAL

General expansion in the global economy is expected to continue over the next decade, boosted by growth in emerging consumer markets. In general however, incomes are expected to rise, increasing consumer income for spending on packaged goods.

SOCIO-CULTURAL

The global population will expand which translates into increase consumer incomes for spending on consumer goods, as well as exposure to modern retail channels. Rising life expectancy will lead to an aging of the population, as it is happening in Italy, will increase demand for healthcare and pharmaceutical products. Simultaneously there is a need for easy opening solutions and packaging adapted to the needs of elders. Another key phenomenon can

be the rise in number of single-person households which is pushing demand for goods packaged in smaller portion sizes, as well as more convenience like reasealability or microwavable packaging. As people are becoming more sensitive to environmental sustainability issues can be more incline to buy products that comes with more sustainable packaging materials and designs that demonstrably show the commitment to the environment. Moreover the growing desire to recycle most of the waste materials across the packaging industry in Italy is, thereby, helping the industriesvin further development across the pckaging sector

TECHNOLOGICAL

Technology can have a major impact. For example, modern flexible formats like high-barrier pouches and retort cooking add extra shelf-life to foods, and can be especially beneficial in less developed markets where a refrigerated retail infrastructure is missing. Much R&D is going into improving packaging barrier technology, including the integration of nano-engineered materials.

Minimising food losses also supports the wider use of intelligent packaging to cut waste within distribution chains and reassure consumers and retailers on the safety of packaged foods.

4.2.3.2. Industry Analysis

The Packaging Industry In Italy is expected to grow at a CAGR of 3.5% over the forecast period 2022 – 2027. Packaging materials are used to contain and preserve materials, enable safe transportation, and inform end customers of the material characteristics and contents. The Packaging industry in Italy is driven by various trends prevailing in the market. There is an increase in the living standard and personal disposable income, fueling consumption across a broad range of products, along with subsequent growth in demand for the packaging of different products

Porter's Five Force Analysis

Threat of new entrants

There are no major barriers that are faced while entering, except the fact that a lot of funds are needed to establish the machinery, therefore there are also economies of scale. And also by the difficulties to get access to distribution channels that already have agreements with incumbents. Established firms may have a unit cost advantage over entrants. The result is that there are some barriers to entry but not particularly high.

Threat of substitutes

For packaging solutions there are a lot of substitutes along with the many solutions available in the market. Which means that demand is elastic with respect to price, in fact, the existence of close substitutes means that customers will switch to them in responde for price increase of the product

Bargaining power of buyers

With the low concentration in the industry, buyers more control over price charged and have high sensitivity to price. The switching cost are low and since there are a lot of solutions and substitutes for the same packaging solution it is easier for customer to find alternative

products. As a result they have the power to influence the price charged. Considering these factors, the bargaining power of customer is rather high.

Bargaining power of suppliers

The number of suppliers available is high. Moreover many brands have followed a backward integration and started their own pacjaing production in-house. Moreover, the brands have tie ups with their own set of suppliers. Considering these factors the bargaining power of suppliers is low.

Internal rivalry

In general, rivalry is strong and the industry is fragmented with a low CR4 value. As the number of players in the market is high and since the product is near a commodity and not so easy to differentiate in many cases, the companies are competing on price advantage, which means that competition from industry is very high.

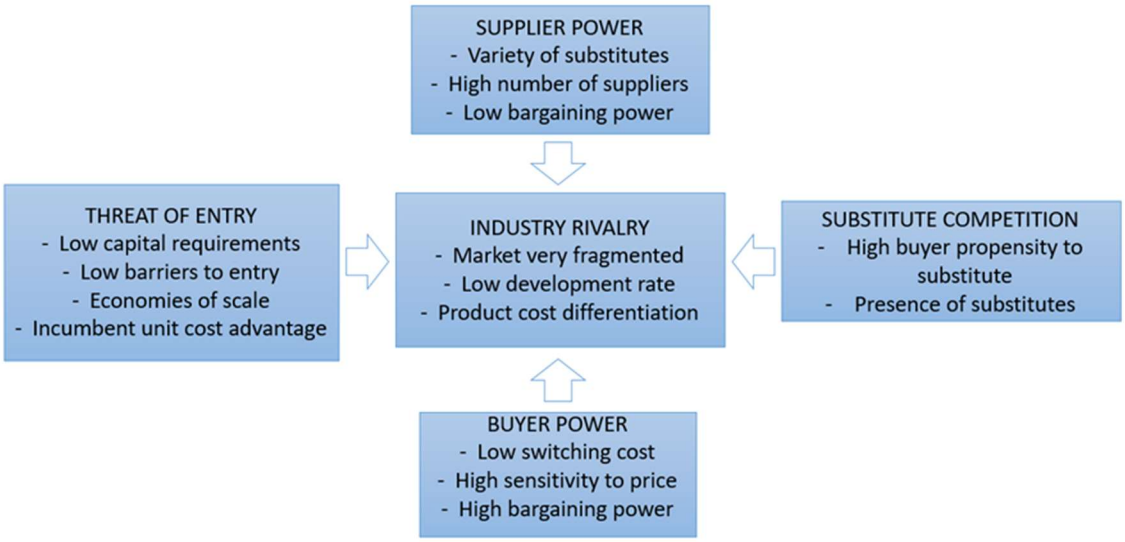


Figure 18: Porter's five forces in packaging industry, elaboration from Porter M.E., Competitive Advantage, Boston, 1988

4.2.3.3. Segmentation Analysis

- By Material: Paper, Plastic, Metal, Glass, Other Material
- By Packaging Type: Rigid Packaging, Flexible Packaging
- By End-user Industry: Food, Beverages, Pharmaceuticals, Personal Care, Other End-user Industries

The packaging industry in Italy is characterized by the domination of the food industry, in 2020. In food industry, flexible packaging was the most widely used pack material in 2020,

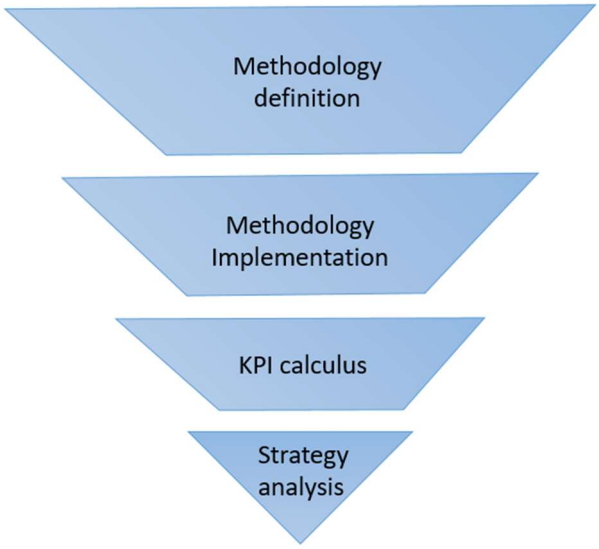
followed by rigid plastics. The demand for flexible packaging in food products is mostly attributed to its high consumption in bakery & cereals, dairy food, and pasta & noodles, wherein consumers tend to look for products that offer convenience (zip locks, re-sealable seals, light weight, cost efficient and easy to carry). In contrast, rigid plastics provide the benefits of safe delivery, protection, and transportation, ensuring the product freshness, especially perishable food products such as dairy food, meat, and savory & deli foods. The non-alcoholic beverages industry was the second-largest consumer of pack materials in 2020. In non-alcoholic beverages, rigid plastics were the most used pack material.

5. Business Development in the identified markets

In this chapter, the project management methodology is defined in the first place. The methodology is defined beforehand, with the aim to simplify and guide the monitoring process of the business development project. An Excel file is used as the tool to implement this methodology which makes it easier to put in place the actions to be followed. The creation and programmation of this Excel file is very useful because since it is a pilot project, it can be improved during the implementation, in order to strive for continuous improvement and can be used also for future projects. Moreover this Excel tool created has a double function:

- As a *Monitoring tool*
- As a *Market Analysis tool*

In order to correctly perform this crucial phase, with the support of project management principles, the following steps are:



- *Definition of a methodology*: the methodology that is going to be used for customer interaction and action monitoring, and the definition of the KPI of interest that will be calculated.
- *Methodology implementation*: The steps are customer interaction and then action monitoring, which will be performed following the methodology defined, and the actions monitoring will be performed using the Excel file tool that has been programmed in order to simplify and improve the monitoring activities such as tasks control and deadlines, and management of clients.
- *KPI calculus*: for the GreenPlasma and Superficial Plasma technology will be calculated these KPIs that are important indicators to support strategy decisions.
- *Strategic analysis*: the informations deriving from KPIs database and its informations will be further used as a tool for strategic analysis.

5.1. Methodology Definition

Once the markets of interest have been defined and analyzed. The methodology of how to proceed for all the following steps must be defined.

The definition of the methodology follows these phases: identification of market problems, definition of added value of technology, get in contact with companies. By doing so the new technologies and IRIS' services and solutions will be proposed as an alternative to their

current state of technologies, but also to give new features to their current product such as improved printability. This will give to IRIS a feedback and a worhty perspective regarding the demand arising from the market and its possible clients.

The company will presents the two services that offers:

- *Consulting service*, it supports the clients when has some issues to be resolved, or when needs to make improvements which is performed by IRIS through sampling and testing or analysis. The consultancy can also be an economic one with respect to the business, referring to the implementation to the process or line, but also performing a cost-benefit analysis.
- *Development and integration of solutions*, following the consulting analysis according to clients needs and will, IRIS will develop solutions. IRIS can, according to client needs and will, both execute the solutions developed on behalf of third parties or sell to the client the machine developed by IRIS. All of this individually-tailored according to the specific needs of the client and its industrial process.
- *Machine sales,* IRIS can sell machines both for the Superficial treatments and for the Green Plasma machine, dedicated to the wate treatment, it will be studied together with the client the best solution to integrate the machines to their production process.

Then, it has been defined a standard method on how to proceed when contacting companies, depending on their response, for all the possible combinations. In fact, according to project management principles this will help to follow the numerous clients in a more structured, reliable and efficient way. A Flow Chart is used to set the market approach and project start-up methodology:

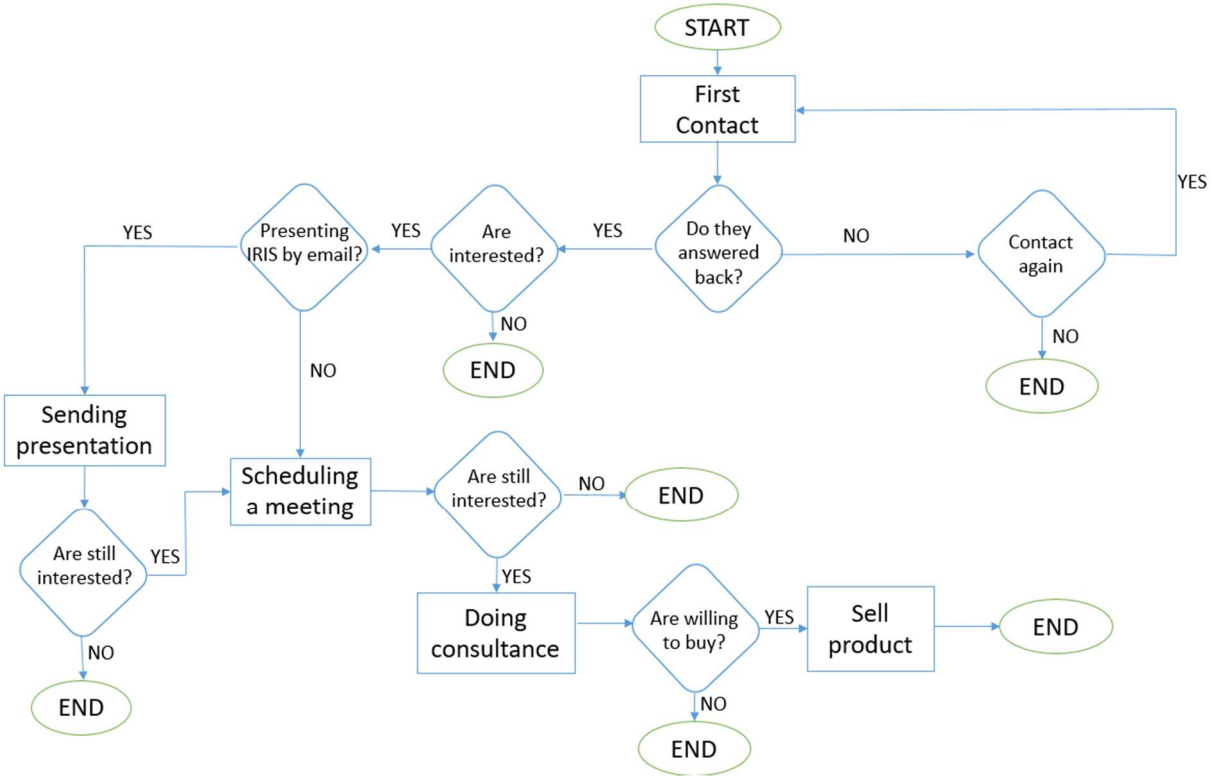


Figure 19: Flow Chart of standardized operation flow for market approach

Such a graphic modeling language is useful to represent the control flow of operations, it describes schematically the operations to be performed, represented by conventional shapes and the sequence in which they must be performed, represented by connecting arrows. The processi is automatically terminated after one iteration of the loop defined.

Every company contacted is reported on the Excel file with all the relevant informations, such as the technology proposed (GreenPlasma or SurfacePlasma), the type of relationship, on which channel they have been contacted the first time as showed in the picture:

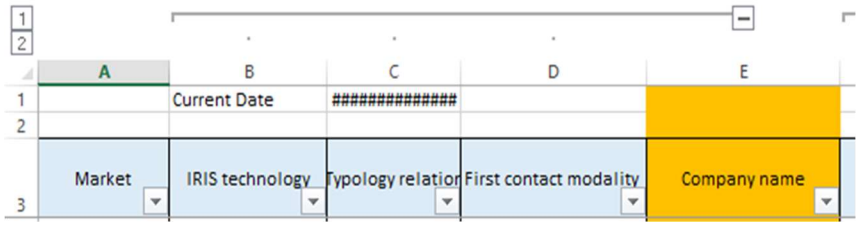


Figure 20: Extract from the Excel file for account management

Then, as there will be a lot of companies to manage, to each company will be assigned:

- A status: which defines the status of the relationship, at which step the relationship currently is, among:
  1) preliminary discussion
  2) in depth discussion
  3) offer
  4) order
  5) machinery/prototype delivery

- A priority: which is automatically assingned, both the value and the color correspondent to that value. The priority value is assigned according to criteria that have been given as an input by programming some cells of the file, according to the formulas showed:

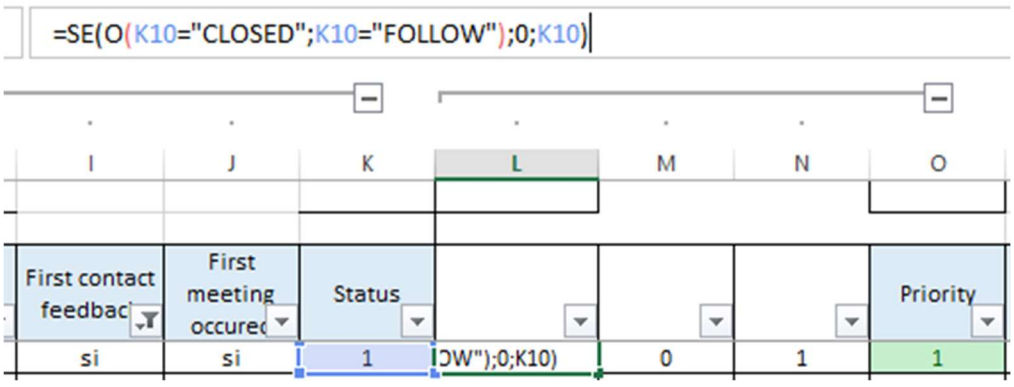


Figure 21: Close up, formulas for priority assignment Part 1

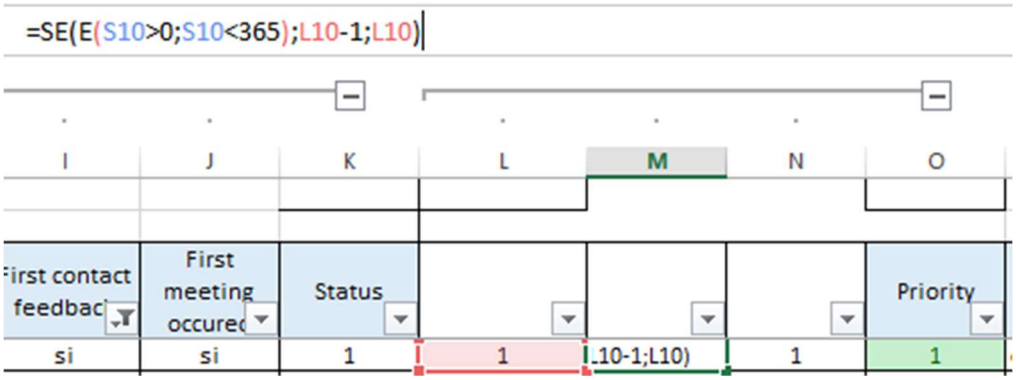


Figure 12: Close up, formulas for priority assignment Part 2

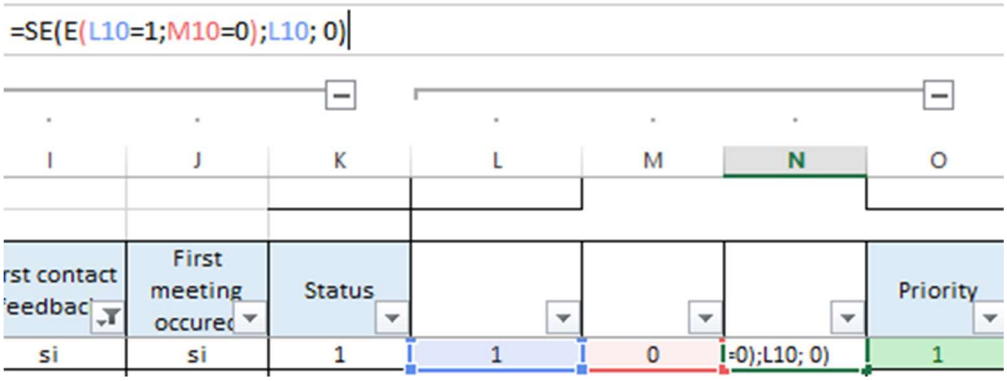


Figure 23: Close up, formulas for priority assignment Part 3

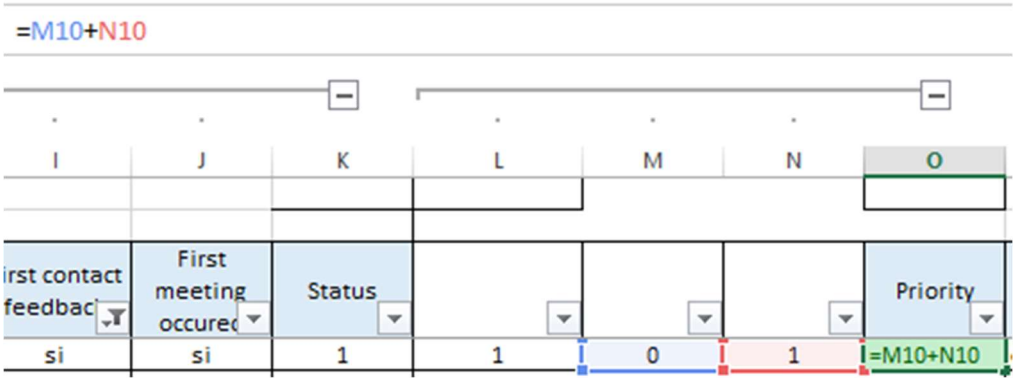


Figure 22: Close up, formulas for priority assignment Part 4

The account and project management tool can be used to elaborate some KPI in relation to the market response

The KPIs are fundamental because they measure some key aspects according to the company, with the aim to adequately support and inform the decision-making process.

The KPIs of interest that will be obtained from the database are, for the superficial plasma technology:

- *KPI of answer*; it measures the interest of companies to the technology, it is an important indicator because gives an idea of potential future workng relationships.
- *KPI of consulence*; it measures the willing of companies contacted who firstly resulted as interested, to have a prior consulence service of the technology applied to their products after being explained the potentiality of the technology.
- *KPI of outsourcing preference*; it measures the preference of companies to do not integrate in-house the plasma technology solution proposed by IRIS consulence, but prefer that IRIS itself deals with the superficial plasma treatment.
- *KPI of buying the machine preference*; it measures the preference of companies to integrate in-house the plasma technology solution proposed by IRIS consulence.
- And for the Green Plasma machine:
- *KPI of answer*; as stated before, it measures the interest of companies to the Green Plasma machine, it is an important indicator because gives an idea of potential future machine orders.
- *KPI of consulence*; it measures the willing of companies contacted who firstly resulted as interested, to have a prior consulence service of the Green Plasma machine potentiality if applied to their waste products, after being explained the potentiality of the technology.
- *KPI of willingness to buy*; it measures the willingness of companies to buy the machine and integrate the solution in-house to their production process.

5.2. Monitoring and Account management

Once the steps and the modality on how to proceed are identified, it is possible to proceed with the accounts and projects management. The first set of data to be reported are the specifications of the contact for each company. After that every contact is contacted following the Flow Chart in figure. The Excel file tool has been programmed to made possible to keep track of the evolution and status of the relationships with companies, and thanks to a gantt chart to visualize future actions to perform and relative deadlines, as is showed in Fig. 25.

First contact modality	Company name	Status	Priority	Action	Action owner	Due date	Action Delay	Last contact / meetin	Delay for first feedback
Fair XXX	XXXcompany	3	2	Prepare offer	MM	20/10/22	4		NA
Fair YYY	YYYcompany	5	4	Deliver prototype	MM	10/10/22	14		NA
Fair ZZZ	ZZZcompany	1	1	Ask status	MM	30/9/22	24		NA
Fair WW	Wwcompany	FOLLOW	0				NA	21/09/2022	33

Figure 25: Features of the Monitoring tool

The coloured priority cells, whose values are automatically assigned, are a useful tool to improve efficency and reliability in the monitoring process. Moreover, for companies with more than 10 positive days of Actions delay the cells have been programmed to automatically turn into yellow, with the result of a more easy immediate and efficient monitoring process. In fact IRIS has had the issue to properly follow in a structured way all its contacts befaore the creation of this tool which enables to follow all the tasks and priorities for all circa 270 companies without leaving any tasks and company behind.

6. KPIs calculus

In this paragraph the KPIs are calculated for each market analysed, by doing so the account and project management tool is now used as a "Market Analysis Tool".

6.1. Eyewear

A sample of 26 firms have been individuated and contacted. 81% of them declared to be not interested, whereas the 19% was initially interested and willing to know more what plasma technology is about. What come from this is that superficial plasma technology, although diffused in some niche industries, is still not known in many other industries such as in the eyewear one. In fact most of these firms had never taken into consideration the possibility to exploit plasma technology in their processes because weren't aware of its existence and possibilities. The firms belonging to the 81% of the sample who claimed to be "not interested" (even to a meeting with the focus to simply explain possible application and benfits of plasma technology in the eyewear processes) were:

- Established SMEs with low investments on R&D projects
- New entrants in the market who couldn't afford additional investment out of the ones already planned

The 19% of the firms who gave a first positive feedback of interest were established companies with investment strategy on R&D projects. These initially interested companies partecipated to an explanatory meeting of both plasma technology and what are IRIS services (i.e. consulting and machine/process development). With 40% of them wasn't possible to find a deal but with 60% of them was possibile to further proceed with a consulting service

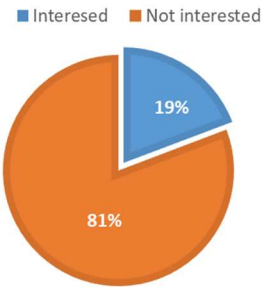


Figure 26: percentage of companies initially interested in the eyewear industry

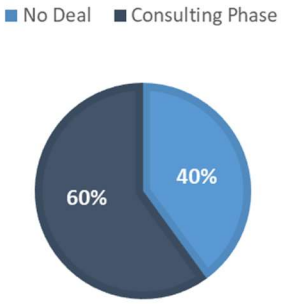


Figure 27: percentage of companies willing to proceed with the consulting services in the eywear industry

Regarding the superficial plasma treatments the companies between treating on behalf of third parties and buying the dedicated machine and treating in-house, 80% of them claimed to prefer the latter.

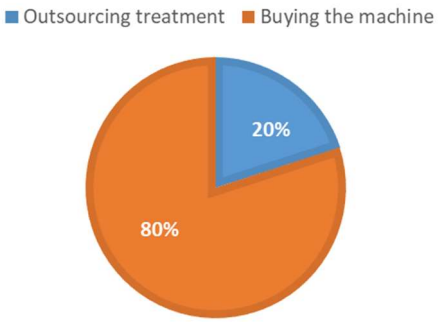


Figure 28: Preference between buying the machine or outsourcing in the eyewear industry

This is due probably because of the high number of volumes produced daily by these eyewear manufacturer who can't rely on a third party, the vertical integration of the process for small pieces and high volumes is the most suitable solution.

The KPIs in this case are:

KPI of answer = 0.19

KPI of consulence = 0.60

KPI of outsourcing preference = 0.20

KPI of buying preference = 0.80

6.2. Textile

There is an emerging environmental awareness and social concern regarding the environmental impact of the textile industry, highlighting the growing need for developing green and sustainable approaches throughout this industry's supply chain. Upstream, due to population growth and the rise in consumption of textile fibers, new sustainable raw materials and processes must be found. The physical and chemical modification reactions yielding fibers are of high commercial importance today. Recently developed technologies allow the production of filaments with the strongest tensile performance without dissolution or any other harmful and complex chemical processes.

A sample of 21 firms operating in the textile industry have been contacted. As previously stated in Italy there are 45,000 textile and fashion companies;

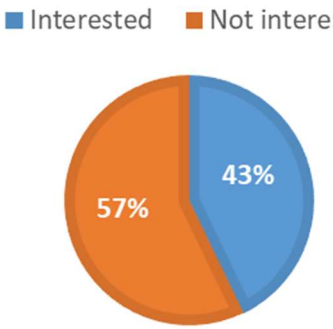


Figure 29: Percentage of companies initially interested in the textile industry

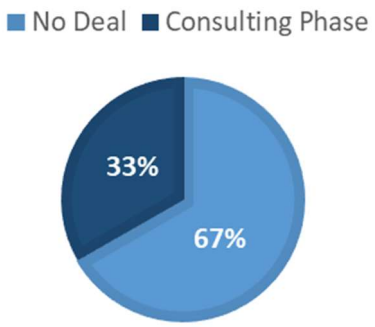
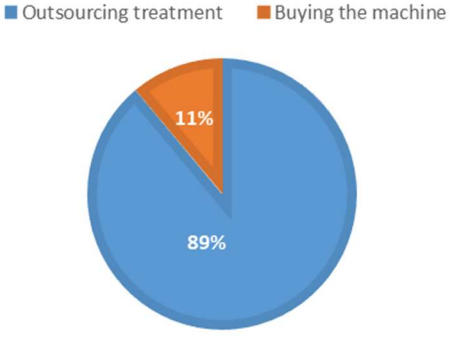


Figure 30: Percentage of companies willing to proceed with the consulting services in the textile industry

the majority are small in size: 82% have fewer than 10 employees. 57% of them declared to be not interested while 43% declared to be interested and willing to know more about what plasma technology consist of and if it can provide useful solutions for their activity. Of which, this second category initially interested, with the 67% was not reached a deal whereas with 33% of them was found a deal for proceeding with the consulting phase.

In orderto achieve the desired results a fair amount of studies on each sample of textile have to be performed in order to have the desired results by the clients, which means an initial investment of time and money. For this reason, since almost the totality of these companies where SMEs, because of the actual economic insecurities and high risk, there is a lot of retention to invest in new projects. In fact a larger share of textile company contacted was interested with respect with the incumbent companies in the eyewear industry. However a deal for consulting services wa sfound only with a small share as well for these reasons.

Moreover, in this case, asking the company what they would prefer between buying the tailored machine or making the superficialplasma treatment on behalf of third parties, the preference was clear:



This is probably due to the core competencies of these companies, which can be found in their knowledge and textile products developed and designed. Their business model is not based on machine asset capacity and scale economies. So, initially, they are not willing to invest in a new machine to vertical intergrate the new process, but would prefer to outsouce the work. In this framework IRIS has an opportunity to develop its network.

Figure 31: Preference between buying the machine or outsourcing in the textile industry

The KPIs in this case are:

KPI of answer = 0.43

KPI of consulence = 0.33

KPI of outsourcing preference = 0.89

KPI of buying preference = 0.11

6.3. Packaging

Application of cold plasma in the food industry, microbial decontamination of food products, packaging material processing, functionality modification of food materials and dissipation of agrochemical residues.

A sample of 36 firms have been individuated and contacted. These are operating in the value chain of packaging industry by performing labelling. 44% of them declared to be not interested while 56% declared to be interested interested and willing to know more about what plasma technology consist of and if it can provide useful solutions for their activity. With the 79% of the second category initiallyinterested was not reached a deal whereas with 21% of them was found a deal for proceeding with the consulting phase.

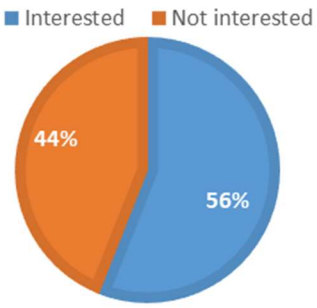


Figure 32: Percentage of companies initially interested in the packaging industry

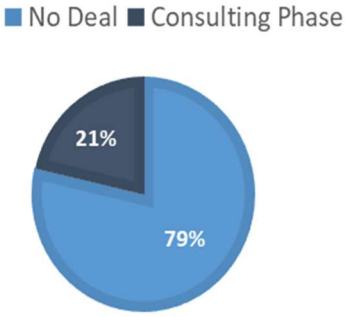


Figure 33: Percentage of companies willing to proceed with the consulting services in the packaging industry

This time when asking the company what they would have preferred between buying the tailored machine or outsourcing the superficialplasma treatment the preference was clear: all of them were willing to buy a dedicated machine to integrate in their actual process.

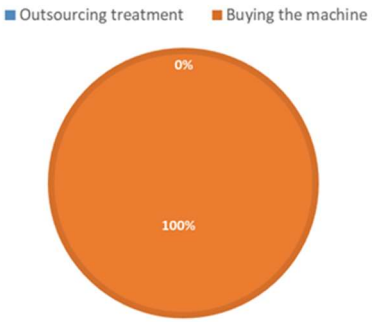


Figure 34: Preference between buying the machine or outsourcing in the packaging industry

This because the manufacturing of packaging and especially labelling must happen in the same structure, it would be inconvenient to outsource just a small task such labelling or printing on the good. Moreover the production is characterized by high volumes and small pieces of consumer good, usually the business model of these companies is based on economies of scale which confirms buying the superficial plasma macine for labelling would be the best solution.

The KPIs in this case are:

KPI of answer = 0.39

KPI of consulence = 0.21

KPI of outsourcing preference = 0

KPI of buying prefernce = 1

6.4. Waste to energy

A sample of 60 firms have been individuated and contacted to propose them the GreenPlasma technology in order to recover energy from their process waste. 30% of them declared to be not interested, whereas the 70% was initially interested and willing to know more about GreenPlasma potentiality. Of which, after showed to those interested the potentiality of GreenPlasma technology, 86% of them decided to proceed further with the consulting phase, a relatively higher percentage of both initial interest and consulting phases reached both in percentage and in absolute numbers.

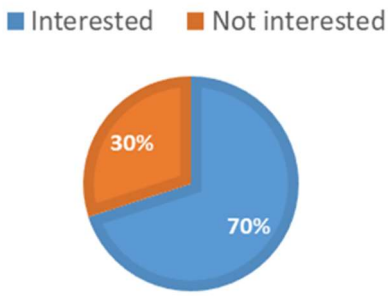


Figure 35: percentage of companies initially interested in the waste to energy industry

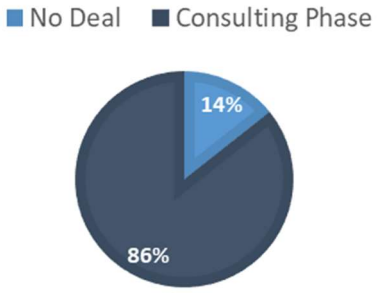


Figure 36: percentage of companies willing to proceed with the consulting services in the waste to energy industry

For the GreenPlasma waste to energy technology, the consulting phase is crucial to determine the potential quantity of electric energy produced by the waste of the client. In fact each company, depending on which market operates, generates a different kind of material as waste. A sample of waste generated should be analyzed in its percentual composition and then the appropriate studies are made along with opex-capex economical feasibility of the energy.

In this case IRIS worked with firms operating in different industries, but the main differentiation can be between

1- Manufacturing firms
2- Ships

For firms producing goods the GreenPlasma machine would help for a transition to circular economy, for reducing the electricity consumption from the grid and consequently lowering the energy bills. Speaking of ships, especially cruise ships these have to integrate solution on board fro the treatment of both wet and dry waste. The dried waste can be handled together with bio-material and other burnable waste. It can be pyrolyzed on-board as an integrated part of the ship's waste management system. The relative market on which the firms IRIS worked with in order to study the feasibility of application of GreenPlasma technology

are the following showed in the table. Obviously in this case the product proposed is not the consulence and then the tailored design of the machine, buti it is the machine itself.

The KPIs in this case are:

KPI of answer = 0.7

KPI of consulence = 0.86

KPI of buying will = 0.09

6.5. Comparison between KPIs through the different industries

	EYEWEAR	TEXTILE	PACKAGING	WASTE TO ENERGY
KPI ANSWER	0.19	0.43	0.39	0.70
KPI CONSULENCE	0.60	0.33	0.21	0.86
KPI OUTSOURCING PREF	0.20	0.89	0	
KPI BUYING PREF	0.80	0.11	1	
KPI BUYING WILL				0.09

Figure 37: KPIs comparison through industries

The resulting values have a great importance in the definition of the business model proposal for the plasma technology business line and its relative product and services (i.e. superficial plasma technology and Green Plasma machine). Are also useful for the strategic decision for the implementation of the business model.

What emerges from these results for the superficial plasma technology is that:

- Looking at the KPIs of answer the companies operating in the eyewear sector were the ones where there was apparently the smalllest share of interest, whereas the textile companies appeared to be the most interested initially.

- Looking at the KPI of consulence, however, the highest value of companies that wanted to proceed with consulence services among the ones that showed initial interest resulted the highest. Whereas in the textile and packaging sector despite the high initial interest a fewer share decided to go deeper with an initial consulence. A possible interpretation to these figure can be: the high interest but lower consulence share can be due to the current economical issues that companies are facing due to the post Covid-19 restrictions, current energy crisis and infation. Many companies stated that were

interested but the timing was not ideal. However it is an important information because means that there is a chance in the future that the market for the plasma technologies can have a higher market share.

- Looking at the KPI of preferences between outsourcing the superficial plasma treatment technology and buying in-house the superficial plasma treatment machine it is evident that companies that produce small-sized products and work on scale economies (i.e. high volume of production) such as eyewear and packaging companies, prefer to vertical integrate the plasma treatment by buying the tailored machine. Whereas those companies that produce less volume of pieces and those pieces are characterized by bigger size such as spool of fabric prefer to not immediately buy the machine but outsource the treatment. The treatment in the textile segment should be performed by IRIS itself.

- Looking at the KPI of willingness to buy the Green Plasma machine it can seem rather low (i.e. 0.09) however since the potential market is large, even a KPI of willingness to buy at 0.09. Thanks to this value it can be estimated the market size of the Green Plasma machine by multiplying it to the SAM (serviceable addressable market) which represent the clients reachable with IRIS' sales/distribution channels.

7. Strategy analysis

In this chapter is developed the reasoning to follow and the key aspects to focus on when performing a strategic analysis, some theoretical fundamentals are explained but also applied to the case study in exam, transforming into practice some informations extrapolated from Chapter 6 analysis. It is written not particularly detailed intentionally, in order to leave to the company the proper margins of confidentiality and to take some sensitive decisions by itself. However the framework of the reasoning to follow is defined.

7.1. Value creation and success factor

Value creation for the client is the key.

As value proposition is intended the value for the client that the company ensures to create through its product or service. In the past those who had a clear value proposition were the ones having success because were capable to differentiate correctly with respect to competitors and was capable to realize what said. Nowadays the continuity of the offer is incline to imitation. With respect to the past the change is more rapid and the value proposition must be continuously adequated to the new technologies and improvements

What are the success factors inside the plasma treatments sector?

The use of models help to find the relationship between the main variables and forces but this does not answer the question on why in the same context some enterprises have success and others do not. A starting point can be toindividuating the success factors in the structure of the existing competition and the one in development. The success factor of plasma technology can be identifies as:

- After sales services
- Ability to innovate

7.2. Resource and capabilities as a source of Competitive Advantage

Resource analysis

An undisputed principle is that the only area over which the company has direct control is that represented by its own resources. Therefore the analysis of resources is particularly important and is the starting point for the development of any strategy

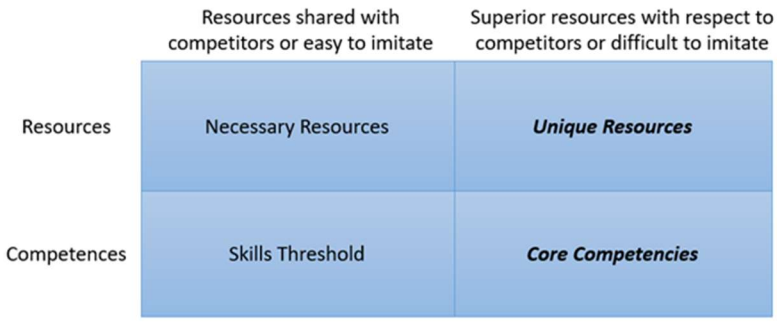


Figure 38: Resources and Capabilities classification (Source: Exploring Corporate strategy, Johnson G., Whittington R., Scholes K., London 2011)

Examining resources and capabilities owned by IRIS is not enough, they need to be compared with those of competitors. According to Ohmae (1983) the research of *success factors* should be focused on the "3C" that are:

- *Competition*; there are leading companies in the plasma market that are financed by some well known multinational companies, so they have a disposition a lot of capital to keep their research and improve the quality of their products. However, they sell machines for plasma treatment aready designed, which have less flexibility of integration in the process line. Their clients are big multinational companies as well. The plasma technology is still unfamiliar in the italian small medium enterprises.
- *Corporation*; company resources. IRIS has superior resources to its rivals since it is a pioneer in the plasma technology application in the italian industrial manufacturing environment, it knows the forces plaing in this context and has superior professional knowledge that enables it to provide tailored solutions to each of its customers.
- *Customer*; what customers asks. According to the analysis performed thanks to the data collected in the database created, clients are asking IRIS to project and build for them the plasma machines that will be tailored on their specific needs and on their actual production machinery in order to do not disrupt excessively their production process.[12]

IRIS has the requisites to sustain its competitive advantages that are:

- The *durability* of the resources; the pace of technology evolution shortens the lifecycle of superficial plasma machines, however capabilities have more durabilities than resources on which are based becuse the company is able to mantain the capabilities through continuous research and specialized know-how.
- *Transparency*; IRIS competitors that want to enter in the same market should find the company competitive advantages and be able to imitate its strategy. However it will be difficult for them because the capabilities involve a varied and complex system of resources, so it will be more difficult for rivals to define their strategies.
- *Transferability*; many resurces and capabilities are not transferable. The knowledge regarding technologies is tacit and it is not formal. It cannot be tranferred with written

[12] (Pelliccelli G., Strategie d'impresa, 2014)

manuals, it is the accumulation of experience deriving from activities carried out by several people over many years. This represents a great barrier to entry.

- *Reproducibility*; competitors could try to reproduce products internally, but for the tacit knowledge this would be difficult to perform as well.

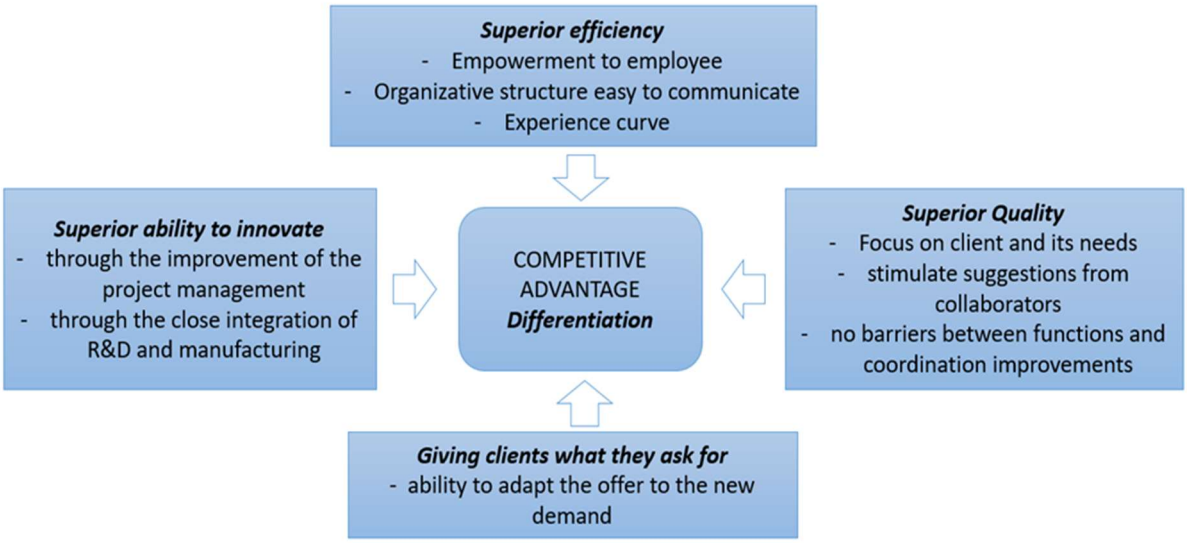


Figure 39: The elements that act on competitive advantage in IRIS case study (Source: elaboration from Hill C. Jones G., Schilling M., Strategic Management Cencage learning 2013)

The main *generic elements* that made up IRIS competitive advantage are:

- *Efficiency*, that can be reached by adopting flexible approach for production, projecting products and services easy to produce, and by building and organizational structure that facilitates coordination of different activities toward the reach of objective, this can be reached through an implementation of a more capillar Project Management organization
- *Quality*; giving a service with a quality that coincide with the expectations of the customer.
- *Innovation*; it is in IRIS values and core to strive for continuous R&D commitment. By improving project management structure, investing in acquisition of outstanding professional skills, and interating R&D with both marketing and production
- *Capacity to answer the client*; markets are highly fragmented but IRIS is capable to answer tempestively to the changes of demand and demand of customization.[13]

[13] (Grant R.M., Contemporary Strategy Analysis, 2016)

8. Business Model development

This paragraph intends to develop a business model for the Plasma based technology business unit according to the strategic analysis performed in the previous chapters. By putting together the different analysis performed throughout the case study in order to propose a suitable business model with the aim to give stability to it. Moreover it can represent a useful starting point for future evolutions and busienss decisions. In general the purpose of creating a model is to help understand, describe, or predict how things work in the real world by exploring a simplified representation. The tool used is the Business Model Canvas which is a concise, structured and static map of a subset of the key elements that make up the business model. But, above all, is also a powerful discussion and communication tool, since it allows a synthetic description of a complex system such as a business unit's business model.

8.1. Business Model Proposition

What emerges from the strategic analysis in Chapter 7 and from the analysis in Chapter 6 can be synthesized and translated into a Business Model Canva. It brings together the four main areas of the business.

The offer side is covered by the Product and the Infrastructure Management. The demand side is covered by the Customer Interface. And the last area is the one covering financial aspects, based on the cost that characterize the side of the offer and the revenues deriving from demand. In this work the Infrastructure, Product and Customer Interface areas will be developed only, whereas the Financial aspects will not be disclosed.

Customer segment (CS)

The key actors in IRIS's Plasma technologies Business Model, to which IRIS intends to serve and provide value to, are: in Europe, operating in the identified markets according to possible pasma applications. The estimation of number of companies can vary in each market with an identified CAGR generally between 3-5%. IRIS activy is a B2B activity, proposing its products and services to other businesses which operate in the eyewear, textile and packging market.

Value proposition (VP)

It is at the heart of the business model. By purchasing and implementing IRIS' superficial plasma treatments, both in form of a tailored machine or by asking IRIS to perform the treatment on behalf of them, will ultimately help manufacturing companies to transition into more sustainable and environmental friendly ones by dismissing the use of traditional chemical components that are toxic both for the environment and for the employees health. And at the same time improving the quality of their products and reducing the processing time. By purchasing IRIS's Green Plasma machine, operative cost deriving from energy expenses will be cut and at the same time waste production will be reduced. This will allow the company to take a further step towards the transition into a more sustainable one by the implementation of circular economy principles.

Channels (C)

The role of channels is not only to sell products and services, but also to follow the customer over its purchasing process, from the initial raising of awareness and evaluation of the product, and all the way to ensuring effective delivery and after-sales support. Since the case study is a B2B situation there won't be involved stores, rather different channels. For the initial awareness raising and product evaluation the main channels will mainly be fairs, in order to spread the existence of IRIS solutions to other manufacturing businesses, IRIS's website in which are showed its services and products. Regarding the after sale support, IRIS capability exceeds in flexibility and time to reply. In fact, since IRIS has innovative technologies that require insight and knowledge about the product, they need to be handled by experts from the IRIS team. Therefore the company always works directly with their end-client.

Customer Relationships (CR)

After having performed a consultancy and having developed tailored solutions for the customer and also after having projected the best way to insert in-house both the Green Plasma or the superficial plasma treatment with a high rate in terms of quality of the service (fast and high quality IRIS reply in problem solving). This create a tighter bond because a relationship of trust competencies is established. And especially if the initial situation of the industrial process change (it may be the development of a different final product with different specifications) IRIS can update the machines to the different set ups.

Key Activities (KA)

Since the business unit in exam is inherently based on innovation, the key activities of its business model will be the ones tightly related to the research and development activities in order to strive for a continuous improvement of the products and services with the aim to mantain the competitive advantage in a fast pacing industry. Therefore the main activities can be identified as the R&D on Plasma technologies, with the aim to constantly update and improving the current products and services proposed. And also activities striving for improving the machiinery efficiency in terms of quality and energy consumption since it is a crucial factor for manufacturing companies. More key activities are the ones that make the company known and present its technologies, such as going to fairs to presents IRIS's technologies. And lastly, in order to make the business model work, another crucial activity would be to study solutions in order to being prepared when the demand will grow and there will be the need to scale up the production.

Key Resources (KR)

An intangible key resource is definitely the IRIS patent for the Green Plasma machine, and the company "know-how" on processes and technologies.

Key Partnerships (KP)

This part of the business model deals with vertical intergration decisions with respect to the key resources. Since IRIS key activities are the ones dealing with Research and Development ones, the company has collaborations with universities, promoting a mutual exchange and growth. This is an aspect already put in place by the company which should

definitely be further implemeneted and developed, which should in no way be abandoned or overshadowed.

The analysis just performed can be further summarized in the Figure 40, in the classic format of the Business Model Canvas.

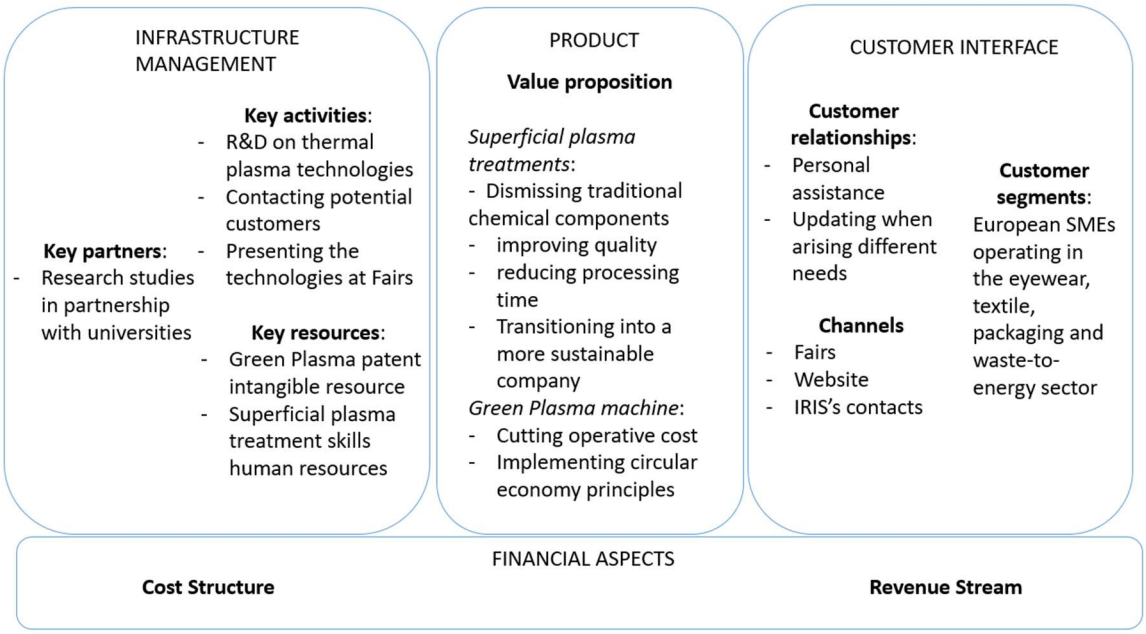


Figure 40: Plasma technologies business unit Business Model Canvas

By looking at the Business Model Canvas developed, it can be stated that from the product side, current IRIS's products and services are already perfectly in line with the value proposition elaborated from the strategic analysis. The company values are already coherent with the products and services developed and proposed to the markets. Moreover the value proposition developed confirms that IRIS's products and services are characterized by an important strenght: thanks to the core values that guide the company, the products and services based on plasma technology deals with the circular economy context and the sustainability in manufacturing processes. These are areas on which goverments and final clients are increasingly looking at and, especially people, are more conscious of. In fact this increasing consciousness may lead IRIS and its solutions to be an important future keyplayer supplier for helping companies operating in the manufacturing industries to become more sustainable and meet some new production regulations imposed by governments. Sustainability is the keyterm, since two of the 17 sustainability development goals listed by the United Nations is "Responsible consumption and production" and "Industry, innovation and infrastructure" to which IRIS with its activuty and product development is contributing to.

However, some key aspects strategically fundamental to put in place in order to give stability to the business, can also be found. By looking at the customer interface side, some aspects, should be further continued, implemented or empowered, because of the importance given by the markets that has been found. One of this aspects is definitely presenting the new technologies at fairs, since are little known by being innovative technologies. This aspect can be reconducted to the Channels on which IRIS wants to reach its future clients. It is a crucial activity to perform and to which IRIS should focus on more in future strategical decisions. Despite IRIS's contacts and website are important as well, they have already been developed and their actual state of the art is satisfying, whereas the main channel to focus on in the future should be fairs. This is due to the customer segment that is represented by other businesses operating in the manufacturing sector.

By looking at the key resources, according the present Business Canvas Model developed confronted with the actual state of the art, IRIS has already made the right vertical integration decisions, by focusing on its core competencies that are put in place in the numerous Research and Development activities. And to build by itself the machines that are the product of its researches. Whereas for the downward side of the value chain it is enough to rely on arm's length transactions given the nature of its suppliers and products availability in the market.

Another action that IRIS can take is linked to the infrastructure management side, which is the further development of the Project Management structure. As the market analysis revealed that the products and services demand is expected to grow in the next years. A demand increase will turn into a production increase and workload increase for teams. This growth of demand should be addressed by a further implementation of organizational management to guarantee the efficiency of processes, the efficiency of information flow between teams, but also to achieve the complete satisfaction of the customer's needs.

9. Conclusions

Since IRIS is an innovative company, the innovation feature carries with itself many unknows, because not all the maket elements are known. For this reason, the exploration of the plasma market in Europe has been fundamental to understand what is the best offer to sell in the market, depending on what the market itself asks. Different solutions based on plasma technologies have been proposed to target clients and the performance has been measured with dedicated KPIs. These indicators have facilitated the understanding of market demand. For instance, it has been understood that for clients operating in the textile and packaging sector IRIS should develop tailored superficial plasma treatment machines to sell and help the clients to integrate in-house the machine to their current procces. Conversely, in the case of clients operating in the textile sector, it would be better to develop a superficial plasma treatment machine dedicated to textiles, do the treatment, and sell the textile treated directly to the client.

From the study has emerged that Project Management principles and tools have been suitable for the support of business development and strategy formulation. In fact, the definition and implementation of a methodology has brought benefits to the monitoring process of the business development project. The common methodology framed activities and processes known to each team member which improved monitoring efficiency. The results have been a reduction of time, and therefore costs, and communication flow improvement between members of the work team and project stakeholders. Moreover, the tool developed can be used also for future projects.

Ultimately, these principles and tools have supported the process of defining a clearer framework of the current plasma technology market and, therefore, a clearer and more complete definition of a business model.

The Business Model Canvas, which is the ultimate output of the present work, in turn represents a starting point to understand what are the current strategic elements that work and which don’t. Since it is the result of a market investigation, it reflects specific market demand and needs that before this study may have been neglected or not implemented as much as they should have been. In order to guarantee the Business Model Canvas indications the main action IRIS should implement is to further develop the Project Managment organizational structure, since the demand of the products and services is expected to grow in the foreseeable future and needs to be correctly managed for a better customer satisfaction.

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