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Purchasing Management and Process Improvements:
The Italdesign Giugiaro case

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ABSTRACT

This thesis work, the result of an internship at the Purchasing department of Italdesign Giugiaro in Moncalieri (TO), has the aim of introducing improvements to the current purchasing process of components for the physical development of a car.

To do this, it is first necessary to provide a general overview of Purchasing Management, basic concepts of Lean Supply Chain and the evolution of Procurement activities, strategic activities that allow companies to have a competitive advantage in the market. The tools, necessary to better address Purchasing Management problems, which have made the purchasing area definitely important in the business context over the years, have been studied and analyzed in this thesis.

After a brief introduction to Italdesign, a focus on the most important businesses and key activities, the study focuses on the standard procedures used by the company's purchasing department for the choice of assigning a supply and on the performance indicators to which the department must refer; the goal was to identify possible areas for improvement and to propose solutions both in the short and medium - long term suitable for improving the present situation.

Analyzing the situation, it was found that, from a purely operational point of view, the activity that requires greater effort is the phase of identifying suppliers, sending quotation requests, collecting offers, "make or buy" analyzes, comparing suppliers and nomination. Starting from the available data deriving from the DaVinci project, a tool for improving activities in the short term has been implemented: an automated benchmark that analyzes all aspects of quality, costs and timing, which must be constantly monitored by buyers and management to immediately understand which corrective actions must be taken into account to address the critical issues encountered. Attention has fallen on the analysis of the costs allocated to the most critical product classes, precisely because the inefficiencies related to these classes certainly have a greater impact on the development of a vehicle and on the total costs associated with it. Each product class was identified within the Kraljic matrix, in order to be able to compile an efficient action plan in relation to relations with suppliers; for each of them the Cost Breakdown Structure has been identified to understand where to operate in case of criticality and have negotiating power; for each one, the constant control of the achievable Saving and comparison with the relative Budget was highlighted.

As a study of medium-long term improvements, a multi-criteria analysis method for decision-making (MCDA) called Analytic Hierarchy Process (AHP) was studied and applied. This mathematical model has made it possible to relate both quantitative and qualitative criteria in terms of Quality, Costs and Timing, by prioritizing the various alternatives, in order to obtain an objective and clear compromise solution, in a complex problem such as the supplier nomination.

Finally, the results obtained with respect to the objectives will be described. Generally, both the short-term objectives and the changes expected for the medium-long term, result an improvement in Procurement activities in terms of reduction of subjectivity in purchasing decisions, increase in process efficiency, cost savings, timing cut and quality enhancement.

ACKNOWLEDGMENTS

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NOMENCLATURE

IDG	Italdesign Giugiaro
IG/B	Italdesign Giugiaro Purchasing Department
BU	Business Unit
KPI	Key Performance Indicator
NDA	Non-Disclosure Agreement
OEM	Original Equipment Manufacturer
PSC	Pre-Series Center
ULSP	Ultra-Low Series Production
PO	Purchase Order
RIA	Request for Investment Authorization
PR	Purchase Request
RFQ	Request for quotation
RO	Request of Offer
PI	Profit Impact
SR	Supply Risk
CFK	Reinforced Carbon Fiber
OTD	On Time Delivery
MCDA	Multi Criteria Decision Analysis
AHP	Analytic Hierarchy Process

1 INTRODUCTION TO PURCHASING MANAGEMENT

The main objective of Purchasing management is to study and develop strategic purchasing practices that help companies improving and maintaining their competitive position in a rapidly changing business environment.

Purchasing management is many times linked to the concept of *strategic purchasing*, in fact the purchasing activities are linked to the process of *strategic business planning*.

An explicit definition of strategic purchasing was written by Carr A. S. and Smeltzer Larry R.:

"Strategic purchasing is the process of planning, implementing, evaluating, and controlling strategic and operating purchasing decisions for directing all activities of the purchasing function toward opportunities consistent with the firm's capabilities to achieve its long-term goals".

These new methodologies have permitted to achieve important results, obtaining drastic cost reductions, reduced development times for new products and important improvements in terms of quality.

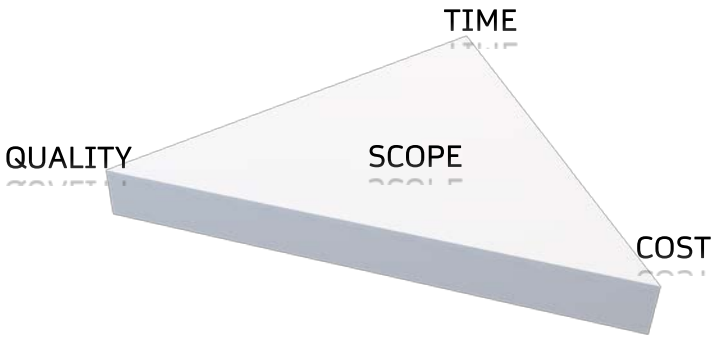


Figure 1- Scope and the Triple Constraints

The main objective of these models is to position the Purchasing Management on the border between the external corporate organizations and internal company network.

Within the corporate network we find the activities (internal processes of company organization), the staff (business unit-BU) and the resources owned by the company. On the external side of the industrial network there are the activities (supplier activities or joint activities between customers and suppliers), the suppliers and the resources owned or jointly owned by them.

Internal company network	External company network
Internal organizational tasks:	**External collaboration tasks:**
Collaborate with the internal network	*Collaborate with the external network*
Operating purchasing decisions	*Manage supplier relations*
Define purchasing strategies	*Coordinate joint activities*
Organize the boundary interaction	*Monitor, evaluate and develop suppliers*
PURCHASING MANAGEMENT	

Table 1 - Purchasing Management role

Only recently the terms "strategic" and "purchasing" have begun to be juxtaposed, as purchasing has undergone many changes in recent decades. In the past, purchasing techniques were predictable: when the corporate BU requested the purchase, the buyer sent suppliers a request for quotation and the most competitive one was chosen. Buyers won short-term contracts based on price by not committing to meeting overly demanding performance measures. This model performed relatively well until new competitors from around the world found new ways to manage procurement and the supply base.

An increasing number of world-class competitors, both nationally and internationally, have forced companies to improve their processes to remain competitive. As a result, customers have been able to take advantage of this abundance of choice, requiring more and more superior quality, fast deliveries and products and services tailored to their individual needs lower total cost.

Historically, the speed with which information moved was slower than it is today, and companies appreciated customer loyalty by signing agreements in the short term. With the advent of Industry 4.0, companies have focused on collaborating with a few major suppliers, signing long-term contracts and agreements most of the time.

Managers also realized that producing a quality product is not enough. These contracts require a high level of engineering, design and production in order to support the growing market needs.

With the improvement of organizational skills, managers began to realize that inputs of materials and services from suppliers have had an important impact on their ability to meet customer needs. This led to greater attention to the supply process and purchasing responsibilities. With the awareness that the competitive advantage can be achieved by managing suppliers upstream and customers downstream, executive managers have started to request the hiring of professionals and technicians who took care of these processes, to obtain performance improvements.

There are five factors that have increased the importance of suppliers' management within the business processes and the Supply Chain, which according to Trent R.J. and Monczka R.M. are:

1. The need to control unit costs

2. The need to reduce the total cost of the acquisition

3. The growing influence that suppliers have on the buyer's ability to satisfy the end customer, especially in terms of timing

4. Greater dependence on fewer suppliers

5. The willingness of buyers to rely on suppliers for the design and construction of entire subgroups and subsystems.

These factors also contributed to the diversification and increase in the volume of suppliers.

Therefore, companies have focused on supply chains due to the following factors:

- The low cost and the greater availability of information resources among the subjects in the supply chain

- The level of competition on the market that requires organizations to be fast, flexible and agile

- The expectations and needs of increasingly demanding customers

- Structured supply chains allow identifying problems, mitigating risks and minimizing downstream supply interruptions of both the product and the services.

Today, companies that have the best supply chains manage to gain a competitive advantage over other companies: competition is won over the quality of the supply chains of these companies.

1.1 Importance of purchasing

Value

The supply base is an important part of a supply chain. Suppliers have a significant impact on the total costs of a company, on the characteristics of the final products and in particular on the value of the final good or service.

Purchasing can and must contribute to company profitability; this means that it must use strategies to help companies to have the expectation of generating Competitive Advantage.

Savings

It is estimated that purchases in the manufacturing sector cover about the 55% of sales (Lars Bedey, Sofia Eklund, Nojan Najafi, William Wahrén, Karl Westerlund).

Therefore, being able to save on the costs incurred by the company during the purchase phase, allows you to have an important competitive advantage on the market (i.e. avoiding extra costs by responding actively to the request for price increases from suppliers).

Relationships and Innovation

The innovative approach to reduce the price is not simple bargaining, but it is building relationships with suppliers to study the costs of the product or service and expect suppliers to contribute innovative ideas to increase the value of products and services of a company.

When it comes to establishing a climate of trust between the parties and both the buyer and the supplier benefit from the investments, it is possible to develop innovative ideas.

Quality and Reputation

Companies seek to increase the percentage of parts, components and services to be outsourced, by outsourcing, in order to concentrate on their areas of specialization and expertise.

The management of purchasing and supplies has an important impact on the quality of the product and service. In fact, in the selection process, it is of paramount importance that the quality of the supplier is not poor: this would affect the entire supply chain and especially from a competitive point of view on the company's reputation.

Reducing Time to Market

The purchasing area acts as a link between suppliers and the technical area. When the purchasing area has technical skills to involve suppliers in the product and service design production process, there are improvements in costs, greater suggestions for process improvement and reduction in supply times and market exit with the product or service to offer to the customer.

Reducing Supplier Risk

The involvement of a supplier presents a potential risk: a delay in delivery, financial instability, operational instability, problems, delays in transport or even the loss of an entire supplier due to a bankruptcy. These risks have been amplified by global sourcing strategies.

However, establishing relationships with the supplier allows for greater supervision of the supplier, useful for mitigating and managing these risks.

1.2 Purchasing objectives

Objective 1: Supply Assurance

Purchasing supports:

- The needs of the operations through the purchase of high-quality services, raw materials, components, subassemblies and maintenance items required by the internal network

- Technical and engineering groups, in particular during the development of new products / services and the outsourcing of key processes. Today, thanks to the increase in outsourcing, companies are looking for more external suppliers in order to procure not only materials and products, but also services, design consultancy technologies.

- The requirements of the physical distribution centers responsible for the conservation and delivery of spare parts or finished products to end customers

To support this flow, purchasing need to do the following activities:

- Source of products and services at the right price;
- Source from the right source;
- Source of the right specifications that meet user needs;
- Source in the right quantity;
- Organize delivery / assistance services at the right time to the right internal customer.

Objective 2: Manage the Sourcing Process Efficiently and Effectively

Purchasing must manage their internal operations efficiently and effectively, by carrying out the following operations:

- Determination of staffing levels
- Development and adherence to administrative budgets
- Offer professional training to employees
- Introduction of improved purchasing channels within procure-to-pay systems that lead to better visibility of spending, efficient billing and payment.

Purchasing management has limited resources available to manage the purchasing process and must constantly work towards better use of these resources. Limited resources include employees working within the department, external consultancy, training, travel and IT budget limitations, other planned funds, time, information and knowledge.

Companies are focused on introducing people with the skills and knowledge required to deal fully with the activities that face purchases. Procurement people need to focus on continuously improving work at a transactional level through the efficiency of purchasing systems that keep suppliers satisfied, which simplifies the lives of internal users.

Objective 3: Supplier Performance Management

One of the most important objectives of the purchasing function is the management of suppliers through the selection, development and maintenance of relationships.

Purchasing must keep up with current supply market conditions to ensure that:

- competitive suppliers are selected;
- new suppliers who have the potential for excellent performance are identified;
- closer relationships with existing and consolidated suppliers are developed.

In this way, purchases can select and manage a supply base capable of providing performance advantages in terms of costs, quality, technology, delivery and development of new products.

Objective 4: Achieve Aligned Goals with Internal Stakeholders

Global organizations have evolved the organizational structures, that have led to having departments in constant interaction, to obtain better performing results.

Purchasing area must communicate closely with the functional groups that represent their internal network. Therefore, purchasing activities are largely driven by stakeholder requirements. If suppliers' components cause production problems, purchasing must find ways to improve the supplier quality. Similarly, if marketers plan to launch an important advertising and campaign promotion, then the purchase must work to understand the capabilities of suppliers and help build effective service-level agreements and prices. To achieve this, purchases must work closely with these internal stakeholder groups, which can mean having procurement professionals integrated into these groups, which may include marketing, production, engineering, technology, IT, human resources and finance.

Objective 5: Develop Integrated Supply Strategies that Support Business Goals and Objectives

The most important goal for offering management is to support business objectives. While this seems easy, purchasing goals do not always match the organization's goals. This objective implies that purchases can directly (positively or negatively) influence the growth, revenues, results and long-term operating plans of the interested parties and business units. For example, suppose that an organization has the goal of reducing the amount of working capital along its supply chain. Purchasing area can work together with suppliers to deliver smaller quantities more frequently, resulting in lower inventory and lower working capital levels. These policies will appear as improved performance in the company's balance sheet and income statement. In this way, the purchase can be recognized as a strategic asset that offers a strong competitive advantage on the market.

A supply management executive actively involved in corporate strategy discussions can provide key market information on supply, budget forecasts and other information that contributes to more effective strategic business planning.

Examples of such inputs include:

• Updates on the conditions and trends of the supply market (e.g. significant price increases, shortages, changes in suppliers) and translation of these impacts on the main corporate results;

• Identification of emerging service materials and technologies to support company strategies in key performance sectors, in particular during the development of new products;

• Development of bidding options and contingency plans to reduce risk;

• Support the requirements for a diversified and globally competitive supply base.

1.3 Purchasing and Supply Management

There are differences between Purchasing and Supply Management.

Purchasing is simultaneously a functional group, i.e. an organization chart entity, and a functional activity.

Purchasing must comply with "the five rights" to have an excellent performance:

obtain the right quality, the right quantity, at the right time, at the right price, from the right source.

The purchasing area follows a working process which includes:

- Research in the procurement market, identification and selection of suppliers;
- Purchase, negotiation and contracts;
- Measurement and improvement of suppliers;
- Development of purchasing systems.

Supply Management is a broader concept than Purchasing. Supply Management means the strategic approach to planning and the acquisition of current and future company needs, through effective management of the supply base, the use of processes in collaboration with the inter-functional team to achieve the business mission.

These strategies exclude simple routines, day-by-day decisions and long-term relationships between a buyer company and selected ordered suppliers, as expected from the traditional purchase.

Supply management is the process of identification, evaluation, selection, management and development of suppliers for the performance of the supply chain better than that of competitors. It is cross functional, in the sense that it implies a purchasing area connected by professionals, engineering, supplier and other related functions that work together as a single team, at the beginning, to achieve common objectives, with an important impact on long-term company performance. It envisages mutual benefits for both parties, through the sharing of information, data and resources; furthermore, through frequent help to suppliers, it is possible to obtain continuous improvements in performance, above all on total costs, therefore on the money that leaves the company through constant price reductions.

Throughout this thesis, the terms “Purchasing,” “Strategic Sourcing” and “Supply Management” will be interchange.

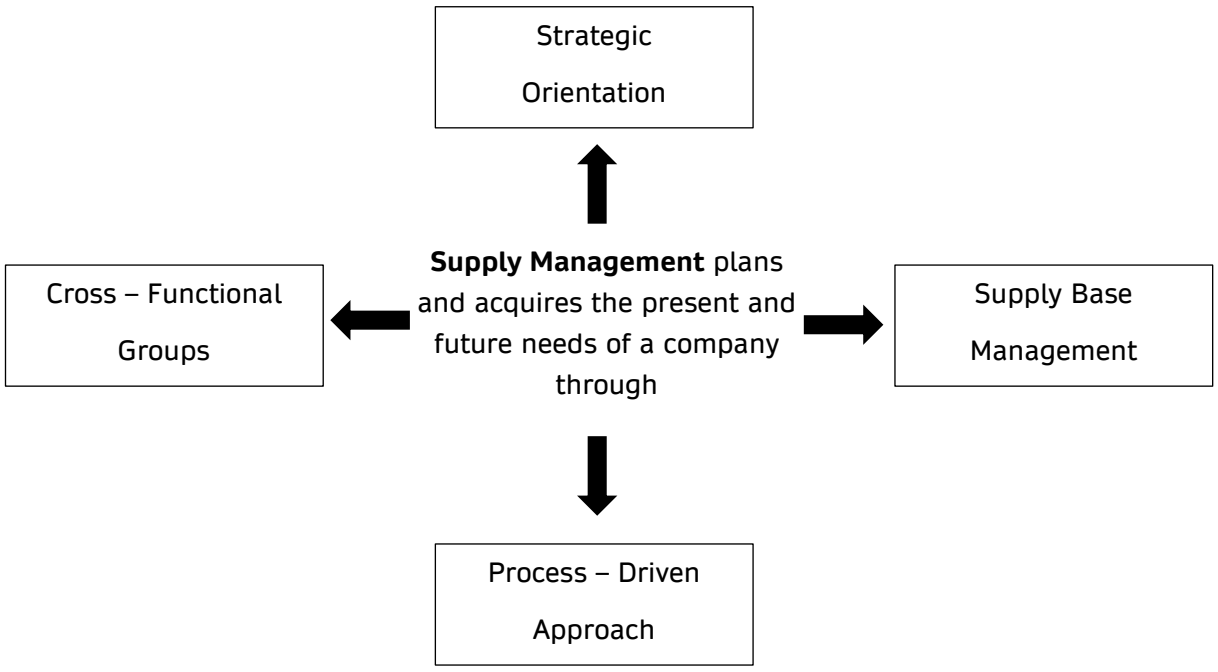


Figure 2 - Supply Management definition

1.4 Purchasing, Supply Chain and Value Chain

A Supply Chain is a set of three or more entities in a company, which are connected by one or more streams of data, products, information, services, finances and people.

Supply Chain Management involves the management of the strategic value of operational activities and flows within the chain and therefore involves the analysis and coordination of the two-way movement of goods, services, information and funds.

An improved perspective shows Supply Chains as being composed of processes rather than tasks.

Process means a set of related tasks or activities to achieve a specific goal or result. Some examples of critical organizational processes are: new product development, supplier evaluation and selection, demand and supply planning, etc.

The difference between a Value Chain and a Supply Chain is to consider the latter a subset of the former.

The Value Chain of a company is composed of all primary and support activities that can lead to a competitive advantage if configured correctly. The accumulation of these activities contributes to the total value of the company. All staff within an organization are part of a Value Chain. The same is not true of Supply Chains.

Historically, the concept of Value Chain focuses mainly on internal participants, while a Supply Chain, by definition, is focused both internally and externally.

The current concept instead expands the original Value Chain model to include suppliers and customers residing upstream and downstream of the organization. The Extended Value chain reaffirms once again that competition is no longer between companies but between the Supply Chains of companies.

It turned out that Supply Chain management has become very complex due to countless factors including:

- the increase in globalization through the strong use of outsourcing which has significantly lengthened the chain;
- the increase in the level of uncertainty regarding the economic trend, which creates a strong variability in the final demand and then has a cascade effect on the entire chain, making forecasts increasingly volatile, difficult and less reliable;
- the reduction of the life cycle of the products and the rapid technological obsolescence of the same increase the risk of obsolescence of the stocks;
- consumer demand must be met with ever shorter lead times and an ever-higher level of service: the consumer is no longer willing to wait long to see his needs satisfied;
- a reduction in the offer by suppliers forced to rationalize their production, means that often they are not able to satisfy peaks in demand in a short time;
- the increase in the occurrence of external environmental events that can severely affect the performance of the supply chain.

From an operational point of view, a large network of suppliers, increasingly demanding customers, as well as the existence of strong interdependence between different companies, entail coordination of the entire chain that is truly complex and subject to many risks. Furthermore, increasing integration and streamlining of the supply chain make the effects of uncertainties and volatility of demand more likely on the other links in the chain. Supply Chain disruptions can also have numerous other consequences, including:

- loss of customers;
- damage to image, reputation and brand;
- economic charges;

- reduction of the level of customer service;
- the inability to meet legal or regulatory requirements;
- delays in projects, productions or other strategic growth plans.

1.4.1 Supply Chain in automotive sector

For automotive products, which have multiple products, technologies and processes, the supply chain is quite complicated.

A simple example of a Supply Chain for an automotive company such as Italdesign is shown in the Figure 3.

The automotive company's supplier base includes thousands of companies that supply items ranging from raw materials, such as steel, plastic and carbon, to assemblies and subassemblies, such as transmissions, brakes and engines.

Managing relationships with other parties in a chain becomes crucial as participants are willing to share this information only when there is trust between members.

Therefore, organizations rely on relationships called "partnerships" that require shared resources, such as dedicated skills, specific, technological information, so that the whole chain can benefit from them.

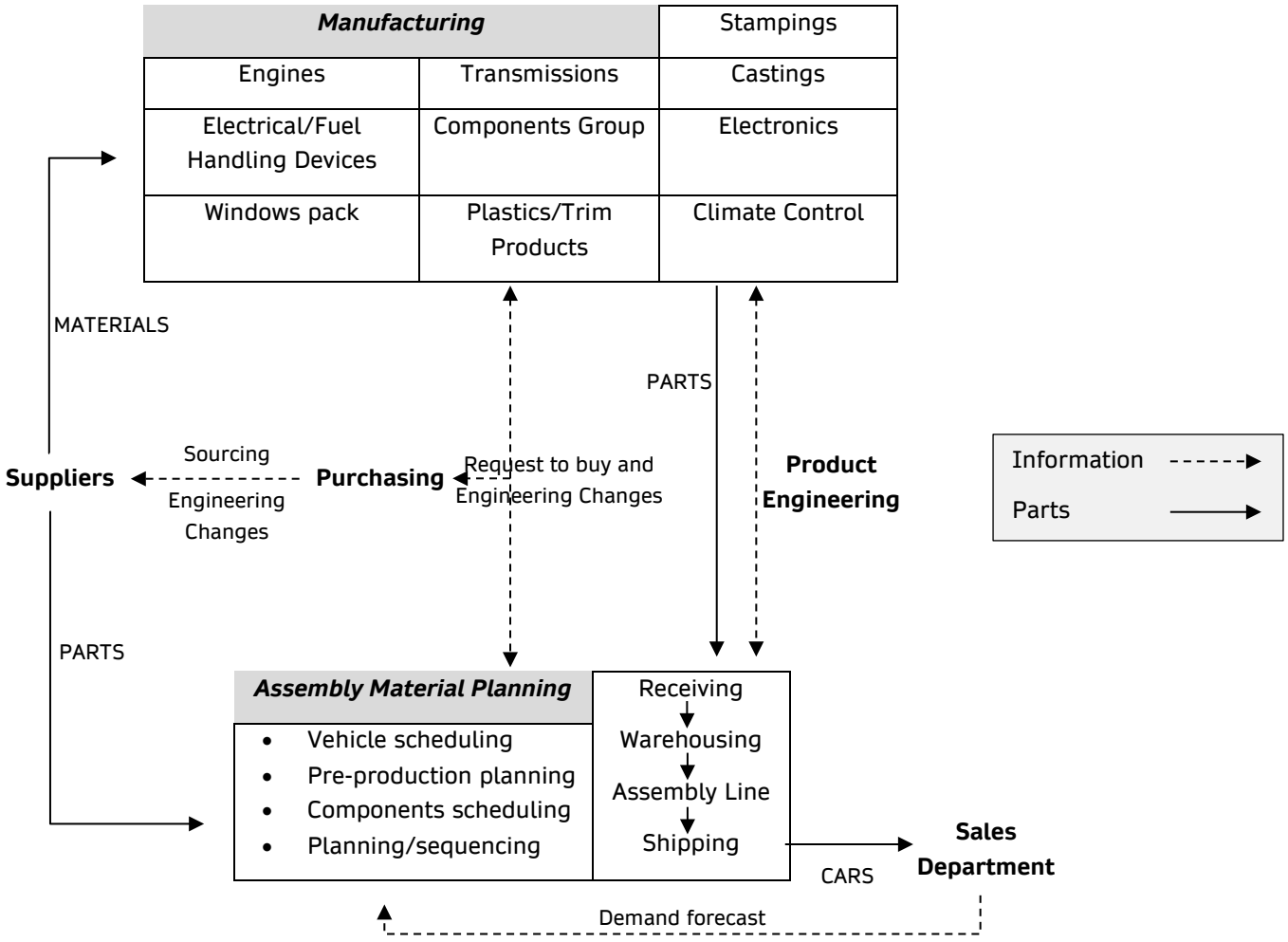


Figure 3 - An Automotive Supply Chain

2 INTRODUCTION TO ITALDESIGN GIUGIARO

Italdesign Giugiaro is one of the leading Italian companies worldwide in the supply of development services for the automotive industry. It deals with the study and supply of many services dedicated to the development of new vehicles and industrial products, deals with styling, engineering, prototype production, testing and validation.

It was founded in Turin on 13 February 1968 by Giorgetto Giugiaro and Aldo Mantovani under the original name of SIRP Società Italiana Realizzazione Prototipi S.p.A.

Today, Volkswagen AG holds the entire shareholding of Italdesign Giugiaro, introduced the company to the German group and placed it under the control of the Lamborghini holding, Italian subsidiary of Audi.

Italdesign logo pays tribute to Italdesign's roots: the letter 'G' is a tribute to Mr. Giugiaro; the 'I' and 'D' stand for 'Italianess', hence the cultural, creative, methodological, innovative and quality heritage that has always characterized Italian products, and 'design', in the true British sense of the word, namely a perfect combination of style and planning, form and functionality.

The company headquarter is in Moncalieri, however there are other plants in Italy, Germany and Spain. In the future, it plans to extend plants all over the world to have more direct contacts with suppliers and customers, as shown in Figure 4.

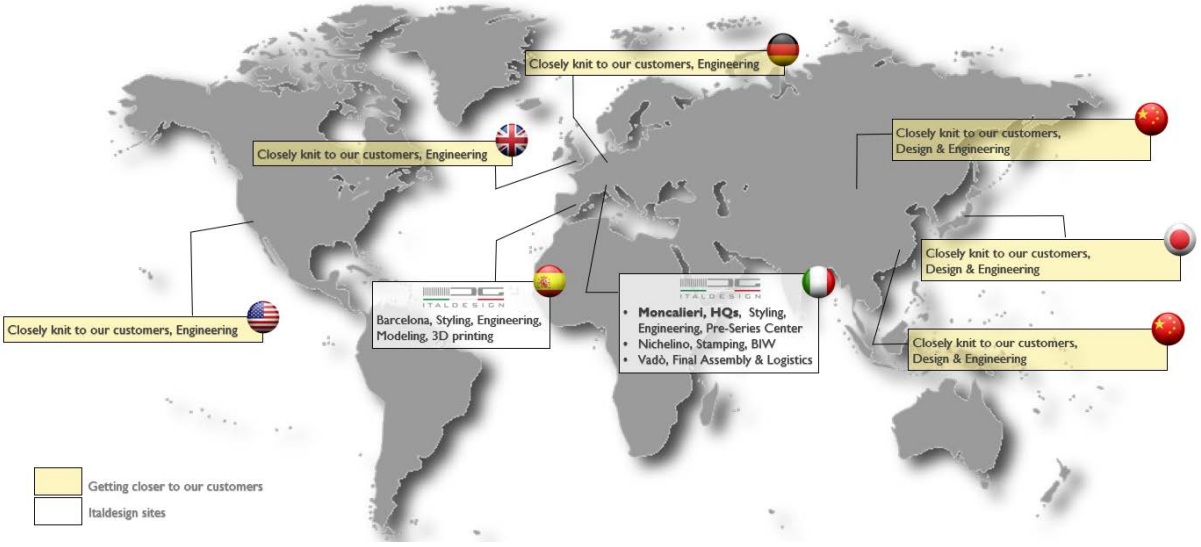


Figure 4 - Company sites

For over 50 years, Italdesign has been partnering major and emerging national and international players in the mobility world, providing an organic and integrated set of methods, techniques and tools aiming to the industrialization of new products, also including the turnkey process.

The company operates in the following major business areas:

Design

The design process starts with the customer's brief, styling research prepares 2D freehand sketches and drafts both for the interiors and exteriors, showing the positions of the vehicle's various components. The research study continues with the development of 3D sketch models, renderings and three-

dimensional virtual models, which also allow animations, interactive management and full-scale moving simulations.

The finishing and modification work are instead left to the dexterity of the modelers, who add craftsmanship to technology, paying attention to the minutest detail like colors and trims. To allow the best study of the design solutions, the models are produced in their natural size and with different materials: Styrofoam, Epowood or special resins.

Once the general styling layout is confirmed, Computer Aided Styling (CAS) phase begins. Starting from the drawings and sketches of the designers, mathematical models are created, which are then studied in detail, subjected to aesthetic analysis and subjected to constant stylistic evolution. Physical models are built using various materials to evaluate design and proportions.

The Models shop department takes care of following a customer who observes a style solution that reflects his desires. The process proceeds with a pre-feasibility study and with a real scale model in a virtual reality simulation environment.

Thanks to the application of craftsmanship and skill, the modelers use various materials and products such as polystyrene, resins, clay, to obtain practically perfect realistic surface models. These models will then become pieces to be exhibited as a show car.

Engineering

Italdesign is a reliable and flexible partner for important engineering development projects well known by professionals and Original Equipment Manufacturers all over the world. The constant exchange of data and the full sharing of data through the application between Engineering and Styling allows to optimize development times and costs.

The first technical input of the engineering development begins with the definition of the vehicle packaging (wheelbase, track, main external and internal dimensions). The first milestone of the process is represented by the study of the complete platform of thrusters, chassis and mechanical components and systems, according to customer needs.

Italdesign main role is to assure a homogeneous and consistent development and integration of all components and systems in coherence with functional, quality and cost targets, within the timing.

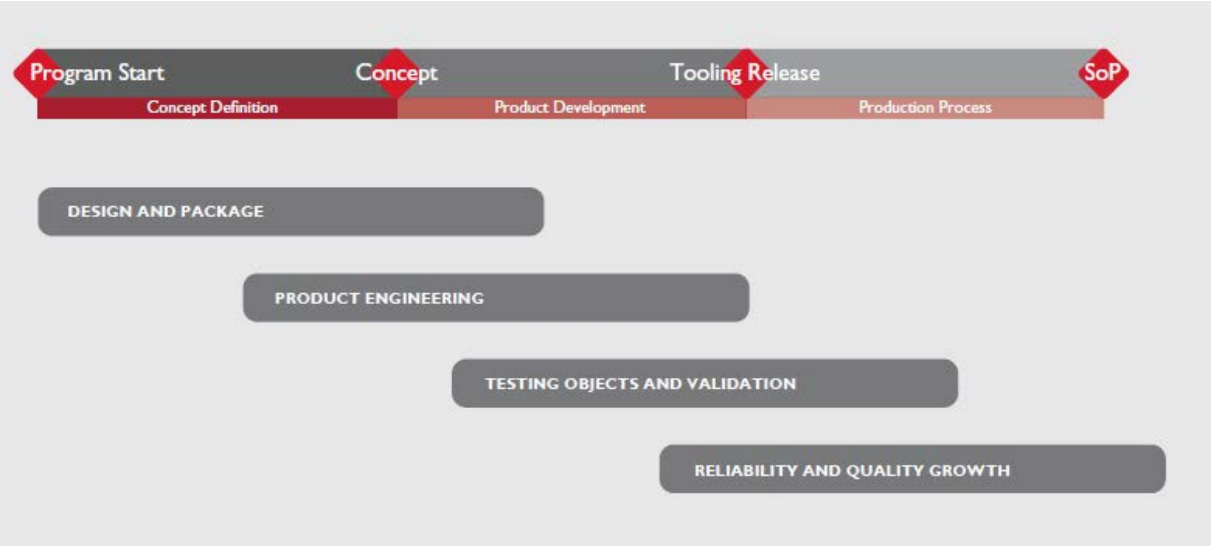


Figure 5 - Project steps

The main departments of the engineering section are the following:

- *CONCEPT DEVELOPMENT - SHOW CARS*

Italdesign develops vehicles to produce ultra-low volumes and show cars with exclusive characteristics.

Starting from the customer's requirements, the concept development department, supported by the design, bodywork, chassis, electrical, electronics and simulation departments, creates a product for the Series Development Department.

- Definition of the concept:

  Starting from the needs of the market or the customer, we define the vehicle package, the external dimensions and the internal layout.

- Concept car construction:

  Italdesign identify the best technical solutions for the product, reconciling the requirements of all the parties involved in the development and technical and technological constraints, ergonomics, performance and costs.

  This process leads to the creation of the first virtual concept car.

- *PRODUCT / PROCESS INTEGRATION*

There is a department that has the task of assembling thousands of car elements to practically create the entire vehicle, monitoring, managing the process and continuously integrating information from different departments (i.e. Engineering, workshop, procurement, etc.).

Nowadays, projects generally aim to reduce development times, while containing costs, especially unwanted ones, and increasing competitiveness and quality. This is why Italdesign studies and uses ways to improve the efficiency of the overall development process, which will lead to greater use of virtual rather than physical models in the future.

- *COST ENGINEERING*

The cost engineering department aims to make quality cars at competitive prices by adopting a design-to-cost approach. In Italdesign, cost information is managed through a system that allows better and more structured monitoring for each milestone of the project, from the conceptual phase to its evolution and modifications.

- *PRODUCT DATA MANAGEMENT*

The BOM department is responsible for the Bill Of Materials organizational tool used to describe and manage the properties of each vehicle and all its components during the engineering, logistics and physical production phases (prototyping and series production). The bill of materials complies with the planning and release processes of the project and includes all the phases, starting from the prototype phase and the completion of production.

- *BODY EXTERIORS DEVELOPMENT*

The Body Exteriors department has the task of managing the development of the vehicle, from the idea to the start of production, taking into account all the needs of the market and combining them with the design, legal, weight and cost requirements, ensuring the integration with all other components.

It deals with the creation of:

- Body in white;
- Closures;
- External coating.

- *INTERIORS DEVELOPMENT*

The interior development department plays a key role in ensuring the right interaction between user and vehicle. In fact, thanks to the use of a wide range of technologies (materials and processes) and flexible solutions, users can have a high perception of the quality of a car, the visual arrangement of its components and how they can be combined, the touchable surfaces, the smell of leather or plastic, the quality of sound insulation, ergonomics and comfort.

The key competences of Italdesign internal development are:

- Dashboard and central console;
- Door trim panels;
- Upper, lower and luggage compartment cover;
- Places.

- *NUMERICAL SIMULATION*

The functional validation departments combine the simulation results with the CAD data developed by the different engineering units.

The simulation activities cover all engineering areas throughout the development process, using cutting-edge methodologies. More specifically, Italdesign can perform:

- CFD analysis for external forms, engine cooling and internal
- HVAC analysis
- Evaluation of the static and dynamic rigidity of the body in white / mobile parts
- Analysis of durability, resistance and improper use
- Passive safety analysis: complete vehicle accident, occupant protection, pedestrian protection
- NVH / acoustic simulations
- Evaluation of vehicle dynamics
- Structural validation of the frame

- *PASSIVE / ACTIVE SAFETY DEVELOPMENT*

The active and passive vehicle safety department has a significant influence on vehicle development. The department deals with the study of ADAS & Connected Car, Cyber security. It takes care of preparing the entire vehicle at the Italdesign headquarters, defining the test plan (activities and test objects) and then sending it to the test facilities. After the test, the vehicle is sent back to Italdesign for final measurements, comparative analyzes, controls and feedback.

- *AERODYNAMICS, AIR CONDITIONING AND THERMAL MANAGEMENT*

The aerodynamics, engine cooling and air conditioning department deals with studying internal and external air flows, studying the external and internal design of the vehicle. The vehicles are prepared at Italdesign testing facilities and tested at both internal and external facilities at Italdesign.

Aerodynamics, air conditioning and thermal management performance engineers are able to achieve the required performance in their fields, mainly due to the close collaboration between the CAD / CAE engineers, who have access to a large amount of test objects to work on.

- *ELECTRICS & ELECTRONICS*

The Electrics & Electronics department deals with the study of complete electric traction, the calculation and integration of Hybrid Vehicle batteries, electric motor, power and charge units and wiring development. This sector is a constantly growing reality within Italdesign. There is a workspace that deals with the development and integration of the front, rear and interior lighting, applying the latest technologies such as Matrix-Beam or front laser lighting. Another growing field is the one which deals with HMI and Infotainment, where Italdesign offers development services for the user, user graphics and necessary components such as displays, switches, antennas or speakers. In addition, there is an area with a lot of experience in the construction of prototypes and show cars, as well as testing components and cars.

- *WHOLE VEHICLE DEVELOPMENT*

The complete vehicle development department is dedicated to ensuring that the strictest customer requirements are respected and integrated into the project. This department follows the project from the first conceptual decisions, from the definition of the vehicle characteristics, to the launch on the market. Constantly monitors the performance of vehicles in terms of quality, reliability and functionality of the entire vehicle.

The main areas of development are:

- Acoustic;
- Corrosion;
- Approval;
- Layout engine housing and floor;
- Vehicle planning;
- Squeak and Rattle;
- Work test;
- Weight.

Preseries center

The Italdesign pre-series center creates master models with extremely high levels of precision, mule cars and fully functional prototypes in every detail. In addition to the creation, the departments cooperate to validate the design calculations and improve the technical data before the final release of the production tools.

The pre-series center department uses technologies such as CNC milling machines, presses, laser cutting stations, production robots and welding stations.

Prototype parts, close-to-series dies, small series, cars of any size and commercial vehicles parts in steel or aluminum are made. The robotic cells with roller hammering guarantee a high level of quality for all types of hang on parts (hoods, hatches and doors) of the Body in white. The interiors are produced with "additive manufacturing techniques", fiber laminate, aluminum inserts, exposed carbon parts carefully studied with precious materials; everything is integrated with the latest generation of electrical, electronic and HMI systems.

Through the procurement and logistics process, Italdesign manages complete prototypes and / or small production programs ensuring the traceability of all components.

Ultra Limited series – Automobili Speciali

Italdesign Automobili Speciali is the company's logo (Figure 6) that identifies the Ultra Limited Series Productions, designed, developed and built by Italdesign for enthusiasts and collectors. The company has made

significant investments in technology and training for the development of Ultra limited series vehicles for the main OEMs in the world and for collectors (B2B and B2C projects). The portfolio of services underlying this department includes styling, engineering, testing, validation and homologation, production and assembly, marketing and sales.

Figure 6 - Italdesign Automobili Speciali Logo

New Mobility Solutions

The mobility solutions department focuses on the study of mobility flows, on the design of integrated systems that regulate mobility, on first / last mile products and on projects the new concept of transportation and the new solutions to solve mobility and urban planning problems in large urban centers, which are becoming increasingly important for the topic of environmental sustainability.

The most important are:

- Pop up

A small two-seater land vehicle (created with Audi) which is equipped with an aerial device for vertical take-off and landing (VTOL) (created with Airbus). Its characteristics are intramodality and modularity.

- InTO

An experiment in the city of Turin, which offered to provide metro passengers with an immediate and simple service to improve their experience on board. Some LEDs have been installed above the doors that serve the access on board the carriages of the Re Umberto subway station; when the train arrives at the station, the LEDs light up indicating the percentage of occupation of each carriage: green if it is free, yellow if it is half busy, orange when it is completely crowded.

- WheeM-i

It is a mobility service organized for wheelchair users. It consists of a "wheeled" system, which means that the user can move directly with the wheelchair. it has integrated systems that allow users to avoid collisions with fixed or mobile obstacles and to easily overcome architectural barriers.

Product design

The list of projects developed by Italdesign over the years is not only vast but varied. Products range from electronics to the food industry, to the mobility and public and commercial transport sectors, to agricultural vehicles and production tools, to office furniture and home interiors, medical instruments and equipment and sporting goods. In addition to the traditional elements of style, comfort, safety and ergonomics, Italdesign focuses on the development of new projects capable of satisfying customers' needs, creating projects of strong character, which triumph on the market.

3 PURCHASING ORGANIZATION

Purchasing plays a fundamental role in bridging the operational, tactical and strategic company figures.

The purchasing functions are structured on four levels:

• Sourcing: purchasing must create a bidder list of suppliers to be investigated, to obtain the supply;

• Selection and Negotiation: purchasing must select the most economically feasible supplier (s) from the list of approved suppliers and start the negotiation process in order to obtain a quality product in the shortest possible time and at the lowest possible cost. This is the most strategic part.

• Ordering: mainly includes the administrative side of purchasing in the form of purchase orders. This is a purely operational activity;

• Management of the supply chain: purchasing must ensure that they synchronize the incoming material flows with the rest of the company's operations.

These functions should not be isolated from each other. The efficiency of the process can increase if, in addition to having the specialization of the operators on the strategy, the operational operations are controlled by the same person. This allows for better alignment of material and information flows throughout the organization.

This type of control is defined as *centralized* and is characteristic of small and medium-sized companies, where there are no feasible criteria for the division of control and therefore decentralization would not provide advantages.

However, the *decentralized* purchasing solution is considered advantageous when there are substantial differences between the various sites of a large company.

In this case, it is preferable to leave in the headquarter the following tasks:

• The development of purchasing strategies, policies and standards;

• Negotiations for strategic articles;

• Management of resources between sites;

• The research and information service;

while at local sites:

• Sending orders for common items;

• Negotiation of non-strategic items used locally.

It should be noted that total centralization and total decentralization of functions are the two extremes of a strategy. However, hybrid solutions exist, in which companies are halfway between these two extremes and take advantage of both configurations.

The advantages and disadvantages of the two strategic configurations, according to Purchasing and Supply Chain book, are shown in the Table 2 below:

	Centralized	Decentralized
Advantages	• Higher bargaining power for buyers • Higher contact with the supplier network • Higher professionalism of buyers and power in the corporate hierarchy • More efficient allocation of the purchase budget, use competitive purchases from other departments • Higher efficiency through the development of structured tools and procedures	• Higher integration of the company • Important contact between buyers and specialists in engineering or production • Improvement of contact with the local reality and greater efficiency in purchasing activities
Disadvantages	• Less integration of the purchasing department with the other departments • Less direct contact between supplier and buyers • High purchasing power, harmful for the supplier, who must adapt to lower prices	• Poor efficiency in the management of inbound material flows due to an unclear overview • Difficult coordination between different sites • Function of the purchasing department characterized by low specialization and low bargaining power

Table 2 - Advantages and Disadvantages of Centralization

Internal collaboration

The interaction between the purchasing area and the internal corporate network through the exchange of information and documents, when well structured, clarified and standardized, constitute a point of the competitive corporate strategy.

The level of involvement of purchases depends on a project and its complexity; however, many times the knowledge of the buyer has to be supported by engineers, the development team and the executive team.

The integration of purchases connects purchasing plans and practices with the corporate vision and shapes senior management's perceptions of the strategic role of procurement in the company.

The purchasing department does not have to coordinate all contacts with suppliers, in addition to selecting them, signing contracts and monitoring them. Other important departments such as Research and Development, Production or Sales may have the main and significant knowledge on a product and supplier market and therefore close collaboration between the departments is crucial.

The involvement of purchases in research and development has become the key to the company's strategic success and long-term profitability.

An effective collaboration between purchase and product development can lead to a better general management of materials in downstream processes within the company and the total costs can be drastically reduced.

It is expected that increasing levels of innovation and complexity of the project will lead to an increasingly intense collaboration between purchases and the R&D department regarding specific components, materials and technological solutions.

As illustrated in the following Table 3 taken from Purchasing Management book, there may be different configurations: in general, the collaboration could have a basic commitment (buyers require full time in development projects), a part-time basis (purchasing operations) or a coordination role in which the purchasing

team supports the project work. What influences this type of collaboration is the type of engineering knowledge possessed by purchasing.

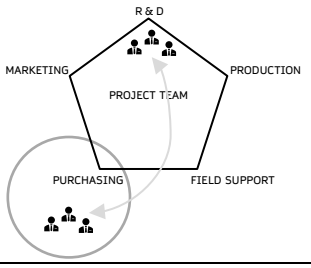
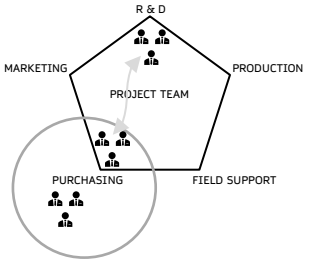
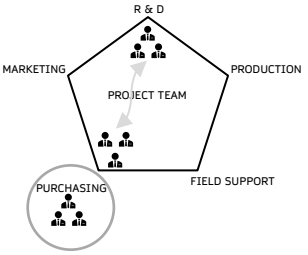
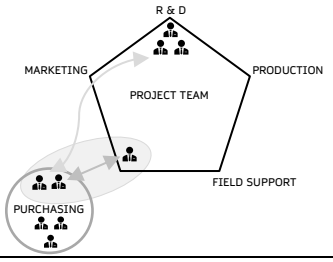
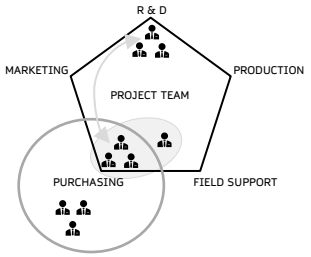
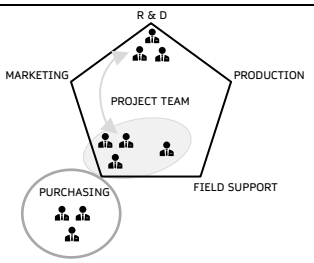
INDIRECT PURCHASING INVOLVEMENT ON AN AD HOC BASIS	
INTEGRATED PURCHASING INVOLVEMENT ON A PART-TIME BASIS	
INTEGRATED PURCHASING INVOLVEMENT ON A DEDICATED BASIS	
PURCHASING COORDINATOR	
PART-TIME INTEGRATED PURCHASING INVOLVEMENT IN COMBINATION WITH PURCHASING COORDINATOR	
DEDICATED INTEGRATED PURCHASING INVOLVEMENT IN COMBINATION WITH PURCHASING COORDINATOR	

Table 3 - Internal structures

3.1 Italdesign Organization

The Purchasing Department plays a strategic role within Italdesign because it provides indirect support to the corporate business and is therefore required to ensure compliance with the Strategic Principles summarized in Figure 7 based on two fundamental pillars:

• *Four Eyes Principle*: the principle according to which it is necessary to correctly carry out processes and transitions; it is protected and guaranteed by the supervision of two approvers, different according to the procedures and authorization limits established in such a way as to ensure transparency, integrity and fairness through the division of responsibilities;

• *Lean Process*: the process is safeguarded from periodic reviews to keep pace with the growing quality standards, aimed at satisfying customers' requests and expectations, eliminating those activities that do not have added value and above all reducing timing and costs related to the procurement process.

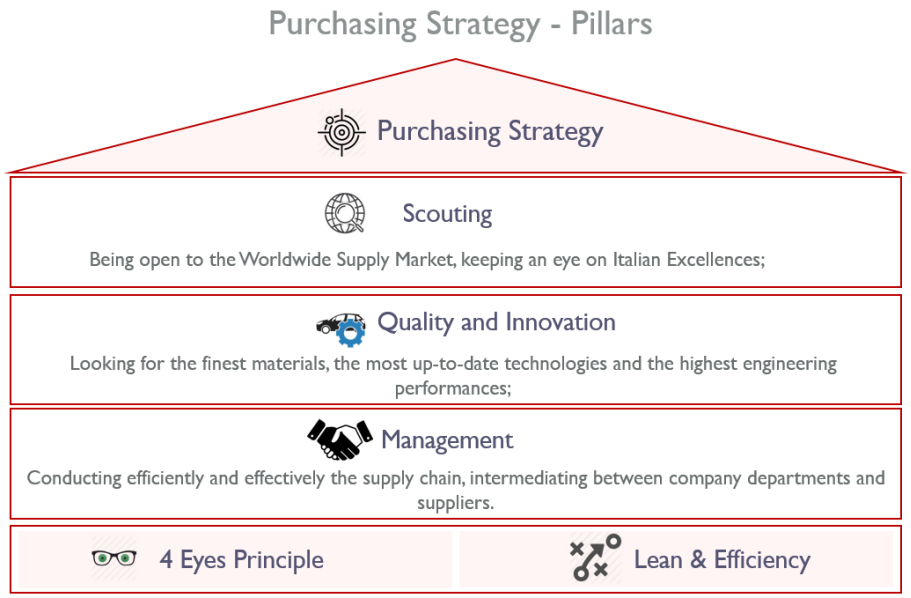


Figure 7 - Strategic principles

The Purchasing Department IG/B is made up of two operating sub-units called IG/B-1 (General Purchasing) and IG/B-2 (Project Purchasing) respectively.

The area of competence IG/B includes:

- Control and operational management of the IG/B-1 and IG/B-2 units;

- Process optimization and digitalization activities;

- Purchases on the "generalist" category including raw materials, semi-finished products, tools and consumables, stationery, personal protective equipment, maintenance material, packaging material, paint products, etc.;

The perimeter of IG/B-1 (General Purchasing) includes:

- Purchases of general and industrial services (HR services, training, translation and interpreting, event organization and corporate communication, transport and logistics);

- Purchases of assets, catering services, fixed and mobile telephony, IT services, maintenance services, cleaning services, security and surveillance services, waste disposal services, business travel.

The perimeter of competence IG/B-2 (Project Purchasing) includes:

- Scouting and supplier relationship management in the following areas:

  - Purchasing of services (engineering, style, experimentation, workshop, consultancy, approval);
  - Purchasing of products, molds, assembly equipment and services for prototype constructions, style models, show-cars, industrial design and production of limited series (ULSP);

- Support activities to the BU during the definition of the needs priorities and collection of the technical specifications of the product to be purchased, coming from the BU, Engineering, PSC and Quality;

- Technical interface activities towards the supplier for:

  - product specifications;
  - quantity of the supply batch;
  - detail of the timing of delivery and delivery;
  - manufacturing requirements;
  - packaging;
  - confirmation of receipt of goods with the support of the bodies responsible for acceptance;

- Monitoring activities of the supplier appointed to solicit and guarantee compliance with the agreed timescales and quality requirements. The team that deals with this activity is called *Readiness*.

4 TENDER PROCESS IN ITALDESIGN

The Project Purchasing by IG/B-2 is briefly illustrated below in Figure 8.

The Business Unit that needs goods and/or services communicates in writing to the Purchasing Department its procurement needs and, assisted by the Readiness Team, provides all the information necessary to uniquely identify the product/service required (technical specifications or specifications, CAD data, chemical and mechanical characteristics of the materials, quality requirements, job description, estimated hours of activity, date of delivery of the goods or service, budget and type of contract to better identify the activity according to the security regulations DLgs. 81/08).

Based on the needs of the BU and/or the type of project, the requests received are committed to a Project Buyer and one or more Readiness resources, chosen according to the knowledge and skills of these resources on the product categories and/or the specific supply perimeter.

During the Offer Request (RO) phase, the BU provides a budget for the project and it has the right to propose the suppliers to be involved and is an active part in the assignment process, in order to ensure compliance with technical specifications, quality and timing. Buyer and Readiness are in charge of verifying the minimum documentation necessary to reduce risks during the procurement process and, together with the technical body receiving the supply, process the information to create the data package to be shared with suppliers (product specifications, quantity of the supply lot, detailed timing and delivery, manufacturing requirements, packaging, etc.).

In this phase of sourcing and collection of technical data, the Buyer draws up a list (Bidder List) to which to forward requests for quotations (RFQ).

Once the supplier submits the formal offer under the established conditions, the BU evaluates the offers from a technical point of view and, subsequently, the Buyer makes an economic comparison of the offers considered technically suitable, functionally verifying the proposed prices following the Best Practice (with reference to the IDG history of the object/service purchased and the "make or buy" analysis).

This phase is very critical as it requires a greater effort in managing a large amount of data. If managed in a simpler way, it can bring benefits from the point of view of identifying critical issues and from the point of view of relations with the supplier.

On the basis of the result of the technical-economic evaluation and the approval of the sourcing committee, a ranking of offers is established that will allow to proceed with the negotiation of all those that have satisfied the required level, from which the most competitive supplier will emerge.

During this sourcing phase described above, for all intents and purposes "Make or Buy" analysis, the BU, through the ERP system, formally issues the Purchase Request (PR), which must report the available budget and the technical specifications of the product to be purchased. The Make or Buy analysis includes total cost of ownership comparison between both the make and the buy scenario. It is certainly easier to evaluate the costs of the buy scenario rather than determinate each cost element in the case of make. In fact, often, costs of various kinds arise, which are difficult to predict.

The Buyer, after having carried out the appropriate checks, nominates the supplier and assigns the supply by issuing a Purchase Order (PO).

The assignment to the supplier can be formalized in different ways, depending on the case, however the most common is:

- Standard PO;

- Price list (in case of repetition in the purchase of certain products and/or services during a given business year), the release of which is managed directly by the BU responsible.

In compliance with the company's procedure, the document of assignment to the supplier is signed by 2 proxies in electronic mode through a Mail Workflow, respecting the authorization limits, and sent, in PDF format via email, to the supplier.

The supplier must examine the order document, re-send a signed copy to the Purchasing Department and/or deliver the goods/performance, thus certifying its formal acceptance.

The subsequent delivery of the completed good/performance and the documentation issued by the supplier falls within the competence of the Finance Department and the Warehouse/Logistics Department, with which the Purchasing Department collaborates constantly to ensure consistency and correct matching of all the documentary part of the company's liability cycle (PR, PO, Invoices and transport documents).

After the Supplier nomination, the Readiness team is responsible for monitoring the procurement process by organizing periodical reviews and comparing with the project team on the status of the supply, to ensure compliance with the agreed timing and quality requirements, until the confirmation of receipt of goods with the support of the bodies responsible for acceptance.

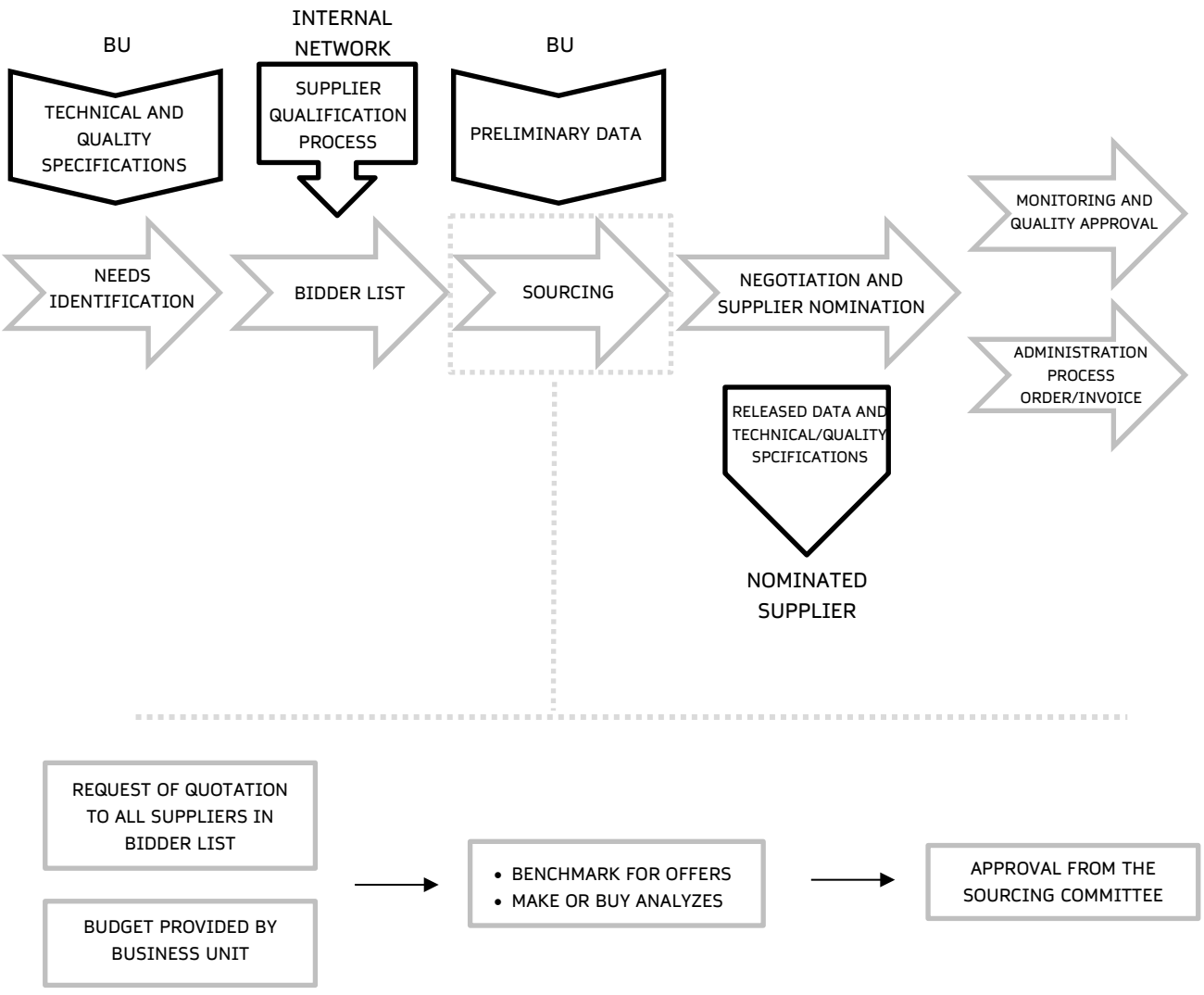


Figure 8 - Tender Process

5 SUPPLIER MANAGEMENT

Supplier management involves several stages, which are explained in detail in the next paragraphs. These stages could be labelled as follow:

- *Scouting*

- *Qualification*

- *Rating*

- *Coding*

- *Monitoring*

5.1 Suppliers Scouting

Scouting activities are carried out in conjunction with normal procurement activities and include the search for potential new suppliers to be included in the Bidder List.

The exploration of procurement markets can be carried out both online and through participation in dedicated events, fairs and conferences.

In order to ensure the reliability of suppliers of goods and/or services, once identified, potential suppliers must be qualified and coded on the appropriate storage medium, i.e. the supplier portal.

5.2 Supplier Qualification

The qualification process is applied during the sourcing phase and is preparatory to the continuation of the procurement process, with the aim of ensuring compliance with regulatory requirements, company expectations and respect for strategic principles, as well as ensuring the reliability of suppliers of goods and/or services.

Faced with the need for a new supply, the Buyer, assisted by the BUs concerned, submits a request for information to potential suppliers by means of a Request for Information (RFI):

- Company presentation request;

- Confidentiality Statement;

- Security Guidelines for External Companies;

- Request for any ISO certification;

- Rating Process;

- Request for OS / TISAX certification for suppliers who manage activities and information at a high level of confidentiality.

The data collected are evaluated to verify IDG's interest in the supplier's activation and, if so, the Purchasing department solicits the compilation and signature for acceptance of the documentation necessary to regulate the coding and supply conditions.

The qualification of suppliers, aimed at their inclusion in the appropriate register, is subject to a verification of adequacy in terms of resources, structures, processes and ability to provide products or services according to the expectations of the company and customers. The checks are carried out by purchasing department staff together with the BU concerned and are documented in the inspection report and recorded in the supplier register.

OS / TISAX certification is mandatory in order to collaborate with Italdesign in projects of Volkswagen Group. Therefore, if not present during the qualification phase, the supplier is required to intervene and obtain it from the competent agencies.

An integral part of the supplier qualification process is also the client, who has the right to propose his own suppliers (who are considered qualified and included in the supplier register in the specific field for which they are proposed) and evaluate Italdesign suppliers for special processes or specific requirements.

The process ends with the notification of the outcome to the supplier, sharing the result obtained with a view to mutual improvement and communicating any corrective actions whose application will be subsequently verified: this is part of the consolidation of the supplier base.

The Supplier Register reports, for each supplier, the areas and any limitations to qualification and is periodically updated in relation to:

- Qualification of new suppliers;

- Possible cancellation of inadequate suppliers;

- Qualification of active suppliers.

5.3 Supplier Rating

The rating system aims to identify, for each macro-area of competence, a small number of suppliers with adequate quality and reliability characteristics, allowing to identify possible areas of deficiency of suppliers in a given product sector and to determine possible supply volume budgets for specific suppliers, allowing numerous advantages also at an economic level.

The value of the supplier rating is the parameter that contributes to the choice of the most suitable supplier for the assignment of the activity to be supplied.

The main supplier rating criteria are:

- General Quality and Safety Criteria (Confidentiality);
- Technical Criteria;
- Economic Criteria;
- Certifications of conformity of the product/service supplied and quality of the documentation issued;
- Traceability and identification of materials and products;
- Certifications of confidentiality based on the service provided;
- Adequacy of supply to standards (overall quality of processes / products / services);
- General aspect of the structures/machinery and adequacy of the working environment to product/process requirements;
- Verification of efficiency and safety of equipment and means supplied;
- Presence of means of transport suitable for the delivery of the product and verification of the suitability of material stowage;
- Management of non-conformities and willingness to propose alternative solutions;
- Conformity of the product with the technical specifications/chapter and/or CAD data provided;
- General operational suitability during the execution of the activities;
- Availability of technical support;
- Competitiveness of the supplier on the market;
- Willingness to negotiate and, in general, to cooperate;
- Availability to have the inspection carried out;

- Overall timing of the procurement process;
- Saving obtained in the past;
- Flexibility on volumes (how much the supplier is able to vary the quantities delivered with modest forecasts);
- The attitude of the supplier to take care of the collateral aspects of the supply (for example: the truthfulness of information, sensitivity to reminders, the timely restoration of waste, the stimulus for innovation, the loyalty).

The following departments carry out the evaluation:

- Quality
- Security and confidentiality
- BU - Technicians
- Purchasing
- Finance

The Table 4 summarizes the main supplier evaluation criteria, divided according to the skills of the departments involved in the evaluation.

General criteria of Quality and Safety / Confidentiality	***Technical criteria***	***Economic, Financial and Readiness Criteria***
• Certifications of conformity of the product / service provided and quality of the documentation issued; *• Traceability and identification of materials and products;* *• Certificates of confidentiality based on the service provided, compliance with security procedures and confidentiality of information in the storage / transfer of data;* *• Adequacy of supply to IDG standards and procedures: overall quality of processes / products / services;* *• General appearance of the structures / machinery and adequacy of the work environment to the product / process requirements;* *• Check the efficiency and safety of equipment and vehicles supplied;* *• Presence of means of transport suitable for the delivery of the product and verification of suitability for material stowage;* *• Management of non-conformities.*	*• Product compliance with the technical specifications / specifications and / or CAD data provided;* *• General operational adequacy during the execution of the activities;* *• Available equipment;* *• Technical support availability;* *• Management of non-conformities.* *• Adequacy of supply to IDG standards and procedures; overall quality of processes / products / services.*	*• Competitiveness of the supplier on the market;* *• Willingness to negotiate and, in general, to collaborate;* *• Willingness to have the inspection carried out;* *• Overall timing of the procurement process; Compliance with execution / delivery times.* *• Saving obtained;* *• Management of non-conformities and initiative and propose alternative solutions;* *• Shared growth proactivity;* *• Economic and financial stability confirmed by the Duns number;* *• Presence of historical economic data compliant with IDG standards;* *• Structure of invested capital and sources of financing;* *• Profitability of operational, current and overall management.*

Table 4 - General Supplier Evaluation Criteria

One target is to optimize coordination between the customer and supplier supply chains, logistical and production integration and synchronization of the supply flow with internal production activities.

The other target is the project connection between companies that are co - designers in the development of a project / product; in this case, the supplier is integrated into the product development team and therefore understands the customer's needs and problems first and better. The role that a supplier can assume within the process of developing a new product changes in relation to the moment of involvement and the degree of responsibility entrusted to it and consequently its evaluation will depend on these two factors.

The technological, technical, financial and economic potential and relational factors are fundamental when we want to establish a partnership, in which the parties jointly undertake (generally in the long term) to improve productivity and quality by sharing risks and profits.

The measured quantitative parameters must meet the following basic requirements:

1. intuitive and coherent, i.e. providing numerical results;

2. discriminating, i.e. providing numerical results that significantly differentiate different supplier performances;

3. sensitive to the right point, that is, highlighting the suppliers' progress (or regress) tendencies without being excessively influenced by occasional situations;

4. easy to understand and use.

THE SUPPLIER RATING SYSTEM

The Supplier Rating corresponds to the supplier's compliance index with the expected requirements and it is the result of the average of the values expressed by each entity. Within the register, the values are summarized in five parameters:

Rating	Qualification status	
NA	Unknown	Unqualified - to be evaluated
1	Seriously insufficient	Unqualified - to be excluded
2	Insufficient	Unqualified - to be re-evaluated
3	Sufficient	Qualified with Derogation
4	Good	Qualified
5	Excellent	Qualified

Table 5 - Evaluation parameters

The assessments are divided and specific for each department in which the supplier is present or potentially usable; for each supplier there are several assessments according to the fields of application in which the supplier can operate, different according to the product category.

The evaluation is shared with the supplier in meetings c/o supplier or c/o Italdesign.

These meetings also suggest, discuss and identify any corrective actions to improve the evaluation, with a view to shared growth and consolidation of the relationship with suppliers.

To summarize, the objectives of the supplier rating phase are the following:

1. give preference to the best suppliers;

2. rationalize and quantify a multiplicity of aspects traditionally managed in a detached way;

3. make the relationship with suppliers transparent;

4. systematically monitor the evolution of the supplier with a periodic calculation of the quantities in question;

5. periodically update the ranking of suppliers;

6. set realistic and progressively more ambitious stimulating goals for the supplier.

The individual supplier is therefore not subject to a single evaluation but is evaluated as many times as the product families of the product it supplies. It should also be emphasized that it is not of interest to measure absolute performance, but in relation to the usefulness that can derive for the company.

5.4 Supplier Coding

The qualified supplier of goods and/or services is subject to coding. This process applies to all suppliers that are suitable for the assignment of procurement, who are required to produce the necessary documents to obtain the IDG supplier code, preparatory to the sending of the PO.

The Buyer proceeds by forwarding to the supplier the documents necessary for the coding, asking for their subscription and signature. Together with the other entities responsible for the control, depending on the type of document, the Buyer is then responsible for verifying that the supplier has produced all the information necessary for the correct completion of the purchase process. Once the correctness and validity of the documents have been verified, forwards the data collected to the Administrative Department, which will encode the supplier on ERP.

The most delicate aspect is the presence of confidential information: in this situation the supplier, even if already encoded, is required to produce an additional specific Non-Disclosure Agreement for the supply or service under negotiation. Once the process of encoding and document control has been completed, the Buyer continues with the issuance of the NDA.

5.5 Supplier Monitoring

The supplier management activities that fall under the responsibility of the Readiness include both support activities for the Buyer during the collection of the supply specifications, and activities of technical interface and monitoring of the supplier. The Readiness has to solicit and guarantee compliance with the supply towards the technical specifications (agreed timing and quality requirements), guaranteeing the two fundamental principles of Quality and Time.

After the nomination, the Readiness deals with managing the technical interface between the supplier and the Italdesign entities, providing support in the phases immediately preceding the start of the activities and monitoring the production and delivery times of the parts. The supplier is responsible for the delivery of the ordered goods, in useful time; if the Readiness has doubts on the respect of delivery dates, they must take corrective actions in good time, as request a rapid transportation or find an alternative supplier.

The Readiness is also required to technically interface with the supplier and to organize periodic reviews to verify compliance with the agreed specifications and timelines and their possible updates, in order to prevent any delays and / or critical issues that may compromise the project.

The Readiness periodically updates the rest of the project team on the supply status, promptly reporting any deviations, blocking points or critical issues and requesting the intervention of the competent bodies when necessary.

The monitoring activity ends upon confirmation of receipt of the goods with the support of the bodies responsible for acceptance, with which Readiness collaborates not only to know the delivery status, but also in the event of movement of the goods from / to the supplier.

CRITICAL PATH

When there is a critical supply, Readiness is an active part in verifying potential solutions and in determining the supply plan on a critical path.

In the first place, the Readiness is responsible for organizing joint visits with the project team at the supplier, to verify the blocking criticalities on the place and support the bodies involved and the supplier himself in identifying the corrective actions applicable to guarantee compliance with the agreed supply.

The project team and the supplier evaluate the updating of the supply times with respect to the general project planning, and to determine the critical path of the supply plan. The Readiness manages the communications and directives of the IDG entities towards the supplier and checks that the supplier incorporates and implements the requested actions, signaling the progress of the activities to the entities involved.

6 PURCHASING PORTFOLIO MODELS - KRALJIC MATRIX

There are several different models of purchasing portfolios.

The most applied is the ***Kraljic Model*** (mentioned for the first time in Harvard Business Review in the article "Purchasing must become supply management" in 1983).

The Kraljic Model can be considered the watershed between the "day by day" era and the era of management., It is essential to identify within the trends of market, those ones with strategic value, by having a managerial and not simply an accounting approach to control costs; therefore, a rigorous knowledge of the costs and of the factors that compose them is necessary.

Company experience suggests that:

• each system tends to evolve in the direction in which measurements and checks are made;

• systematic monitoring and control are the first prerequisite for continuous improvement.

Therefore, it is necessary:

• identify the significant indicators of the "phenomenon" you want to check;

• have a continuous measurement of the values assumed by these indicators.

The goal of the model developed by Kraljic is to identify differentiated supply policies, in order to optimize the use of resources in the process, guaranteeing the supply in terms of time, costs and quality.

One of the main concepts of the approach is that it is designed for a portfolio of products, hence a collection of different but related items.

The approach focuses on the individual product of the supply: the classification of purchases and the definition of the related policies is carried out starting from the analysis of the characteristics of the product.

The approach is divided into five steps:

1) Grouping of the supply into homogeneous classes;

2) Classification of products;

3) Market analysis;

4) Strategic positioning;

5) Action plan.

Step 1 - Grouping into homogeneous classes

All the products and services purchased have to be aggregated into product classes, defined as a set of products and services which can be considered as a homogeneous set of purchasing supplies from potentially interchangeable suppliers, due to their similarity in terms of:

- technologies used

- common raw materials

- construction cycles

Each class follows common evolutionary trends and allows you to define common management logics.

Step 2 - Classification of products

The model develops around a classification of purchases according to 2 fundamental variables: the relevance of purchases (*Profit Impact*) and the complexity of the supply market (*Supply Risk*).

- *Supply risk* is the complexity of the supply market in terms of availability of the good or service, number of alternative suppliers, power of the supplier, presence of barriers to entering the sector, cost and logistics complexity;
  The availability of a class, therefore, is always determined by the number of suppliers known to the customer and available to supply. In addition to determining whether a class has high or low availability, it is important to evaluate the causes of low availability in order to address any corrective actions (for example oligopolies and monopolies, constraints deriving from precise business choices, etc.),
- *Profit impact* is the importance of the purchased good in terms of added value, economic impact, impact on profitability. It is basically an economic determinant, as it is assessed based on how much the volume of a commodity class affects the purchase turnover. As a first approximation, classes that invoice on average a share greater than or equal to 10-30% of the total purchases can be considered of high importance; in cases of very dispersed purchases on numerous product classes, however, a class that reaches 5% can also be considered "high". Ultimately, the low / high importance assessment relates to the company being analysed.

PROFIT IMPACT *Importance of Purchasing*		
	Materials management Focus on leverage products	**Supply management** Focus on strategic items
	Purchasing management Focus on non-critical items	**Sourcing management** Focus on bottleneck products
	SUPPLY RISK *Complexity of supply market*	

Table 6 - Stage of purchasing sophistication

The parameters that make it possible to classify purchases as shown in Table 6 , which are the Profit Impact (PI) and the Supply Risk (SR), depend on three other types of factors.

In particular:

$$PI = f\ (E, S, I)$$

E: economic factors (the value of use, the level to which the purchase contributes to the added benefit of the product, the profitability of the product to which it belongs, etc.)

S: factors related to the skills required for the purchase and any increase in the internal technological skills provided by the same.

I: supplier image factors (image, brand, safety, external impact, etc.)

$$SR = f\ (P, E, M)$$

P: factors related to the characteristics of the product supplied (technological level, complexity, innovation)

E: factors related to environmental risk characteristics (possible opportunistic behavior of suppliers, lack of information on the characteristics of the companies and products offered)

M: factors related to the characteristics of the supply market (bargaining power, commercial skills and supplier technologies)

ABC ANALYSIS

The ABC analysis (no relationship with the Activity-Based Costing, despite the acronym), sometimes also referred to as "Pareto Analysis" or "80/20 Analysis", aims to highlight the contribution of the different elements of a whole (such as supplies) upon reaching a total (the total purchase turnover).

By applying this type of analysis to the classification of supplies, the product classes are arranged in decreasing order of importance and increasing volumes (on the abscissas) and the cumulative curve of their total value (on the ordinates) is constructed. The name "ABC" derives from the common practice of dividing the elements into three groups (A, B and C, in fact). Linked to the achievement of a certain fraction of the total:

groups A and B contain the top product classes, which together constitute about 80% of the total costs, group C represents the 'tail' of the distribution and contains the product categories with less impact, higher volumes and which make up 20% of the total costs.

With this classic technique, areas with high potential or, on the other hand, sources of losses can be identified easily and quickly. In this way, it is possible to develop targeted and direct initiatives to the problems of greater strategic importance.

This type of analysis can be applied in addition to individual product classes, to any factor to be monitored of strategic and competitive importance: suppliers, customers, geographic sales areas, etc.

The Figure 11 helps to understand the analysis mechanism:

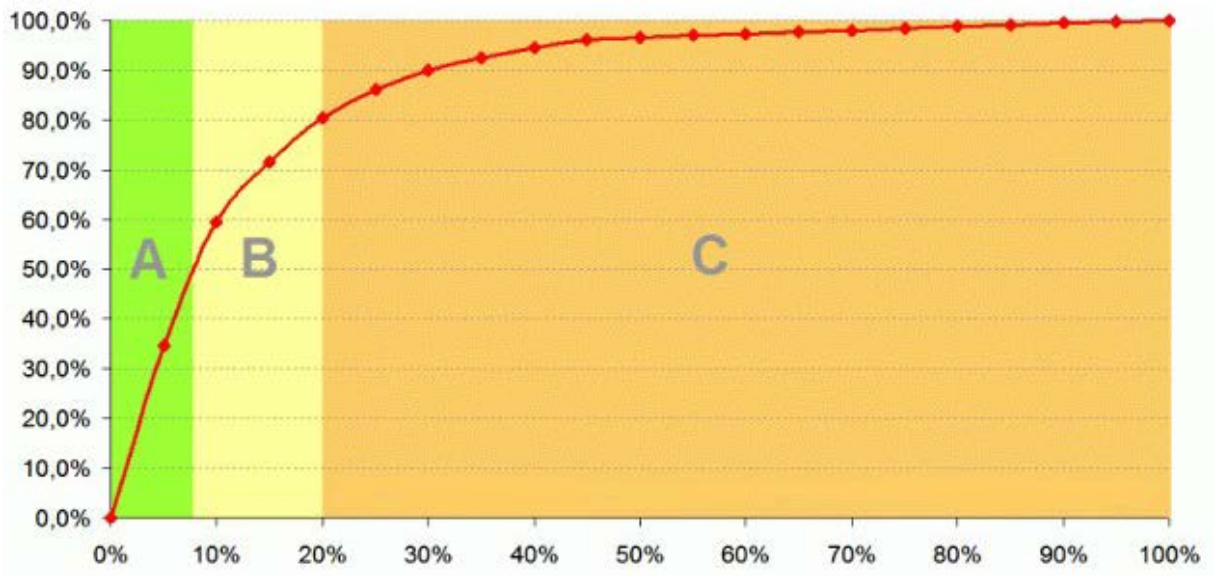


Figure 9 - ABC Analysis

STRATEGIC ITEMS, LEVERAGE ITEMS, BOTTLENECK ITEMS AND NON-CRITICAL ITEMS

The application of the classification parameters and the ABC analysis allows the distinction between purchases of high or low strategic importance, and a management of the relationship with the supplier with high or low complexity. In relation to these variables, it is possible to obtain four types of items:

Non-critical, Bottlenecks, Strategic and Leverage.

1) ***Strategic items***: rare materials, high value components, located in highly risky markets; they are the most critical for the company. They are important for the company both in terms of economic impact and for supply conditions from complex and / or risky markets. They are characterized by a high supply risk because the number of suppliers on the market is relatively limited and the technical specifications make it difficult to identify any products capable of replacing them. For example, there are products, which, by design choice, can be made by a single supplier. The choice of the supplier is more or less fixed, therefore the small changes in the supply specifications are treated directly with the existing supplier.

They are typically class A/B codes, generally they represent 25-30% of total expenditure, although they are not numerous in terms of items (10 percent of items purchased).

A purchasing strategy for this type of supply should be built over a medium to long term horizon; partnership agreements are usually developed with suppliers as these goods / services are the basis of the company's competitive advantage. Given their strategic importance, these purchases are often subject to a "make or buy" evaluation, because guaranteeing their supply is of fundamental importance. Following the development of a supply relationship, actual performance is monitored.

2) ***Leverage items***: this material includes all the materials or services that have a "leverage effect", i.e. characterized by a high profit impact (their cost significantly affects the total cost of the product or service created) or strategic (impact direct on the quality or perception of the customer), but with a low complexity of the supply market (abundance of alternative sources). The set of potential suppliers to choose from is large and the wide value justifies a frequent and in-depth selection and rating process.

They are typically class A/B codes, generally they represent 25-30% of total expenditure, although they are not numerous in terms of items (15 percent of items purchased). The strategy must seek the most effective means of obtaining the best possible supply in the continuous competition between alternative sources. The high impact of the material or service on profit and the simultaneous presence of numerous suppliers makes it possible to exploit the dominant position of the company, making potential suppliers compete on the price, quality or service covered by the relationship.

3) ***Non-critical items***: these product categories typically fall within the class C of the ABC analysis: despite being a very large number of items (around 80 percent of the total purchase codes), they generally represent 5-20% of the purchasing turnover. The standard characteristics of this type of purchase reduce its complexity from the supply market point of view (there are many suppliers capable of satisfying the customer's requests and identifying replacement products); the purchasing strategy for this type of supply should therefore aim at the search for maximum efficiency in the purchasing process to minimize the expenditure of resources. Due to the limited economic impact of the purchase, it will not be convenient to repeat the supplier rating process frequently. Efficiency must be sought in the study and construction of simple purchasing processes that can be managed with the minimum use of resources.

4) *Bottleneck items*: the products and services that generate bottlenecks are characterized by a low level of impact on company profit but are essential to ensure the continuation of the business. The interruption of the supply of these products / services could have serious consequences for the company, which must guarantee its supply or protect itself if it is missing. The management of these components is aimed at creating medium-long term collaboration relationships between customer and supplier to ensure continuity of supply, without making use of particular negotiation practices to put pressure on costs.

The classification carried out does not have and cannot have absolute value, as availability and importance may change over time according to changes in the market scenario and / or changes within the company.

Step 3 - Analysis of the supply market

The second phase of Kraljic's approach concerns the analysis of the market, through a comparison between the negotiating power of suppliers and the strength as buyers. It involves evaluating factors such as the saturation of the production capacity of suppliers, the uniqueness of the products supplied, past variations in the use of the production capacity of the main production units, the potential costs of non-deliveries and inadequate quality. Considering them all together, the approach leads to a deep understanding of the strengths of both suppliers and the company.

Purchasing and Negotiation Power

Purchasing power represents the strength of the buyer in working in a specific supply market.

PURCHASING POWER SOURCE	***DESCRIPTION***	***EXAMPLE***
KNOWLEDGE OF THE NEGOTIATOR	It is the power that comes from knowing as much as possible about the interlocutor	Typically, "tough" interlocutor at first but it becomes more reasonable as negotiation progresses
SITUATIONAL POWER	It is a power that is born in the specific situation	When negotiating the purchase of a product, a series of factors can influence the negotiation in favor of the seller / buyer (e.g. product availability, demand vs offer)
PERSONAL POWER	It is the power that derives from the ability of the buyer in particular from the ability to create trust	The interlocutor is in an excellent position technical position ... but it is poor in terms of negotiation skills

Table 7 - Purchasing and Negotiating power

Negotiation is the formal communication process through which two or more organizations meet to make mutual agreements regarding issues. Each organization wants something that the other organization has. The "want" is what the supplier asks for. The "need" is the underlying motivation that drives the "want".

The interactive process has the step by step objective of persuading the other organization, to achieve something in its own interest.

Negotiating strategies and tactics include:

- Preparation for negotiation (negotiation planning, list of possible concessions)
- Definition of the target price for negotiation
- Conduct the negotiation by developing the skills to manage the right relationship with the supplier.

The good negotiation goes beyond the "want" and asks why to find out the real motivation of the request and appropriately guide the negotiation in particular to expand the number of negotiable points (i.e. boundary conditions, logistics, packaging ...).From a "win-win" perspective, both for the supplier and the customer, it is essential to understand exactly the real need of others.

Starting from the type of product and the related Supply Risk and Profit Impact, the Figure 8 describes the classifications of the suppliers, indicating the relative purchasing and negotiation power, operating as a buyer.

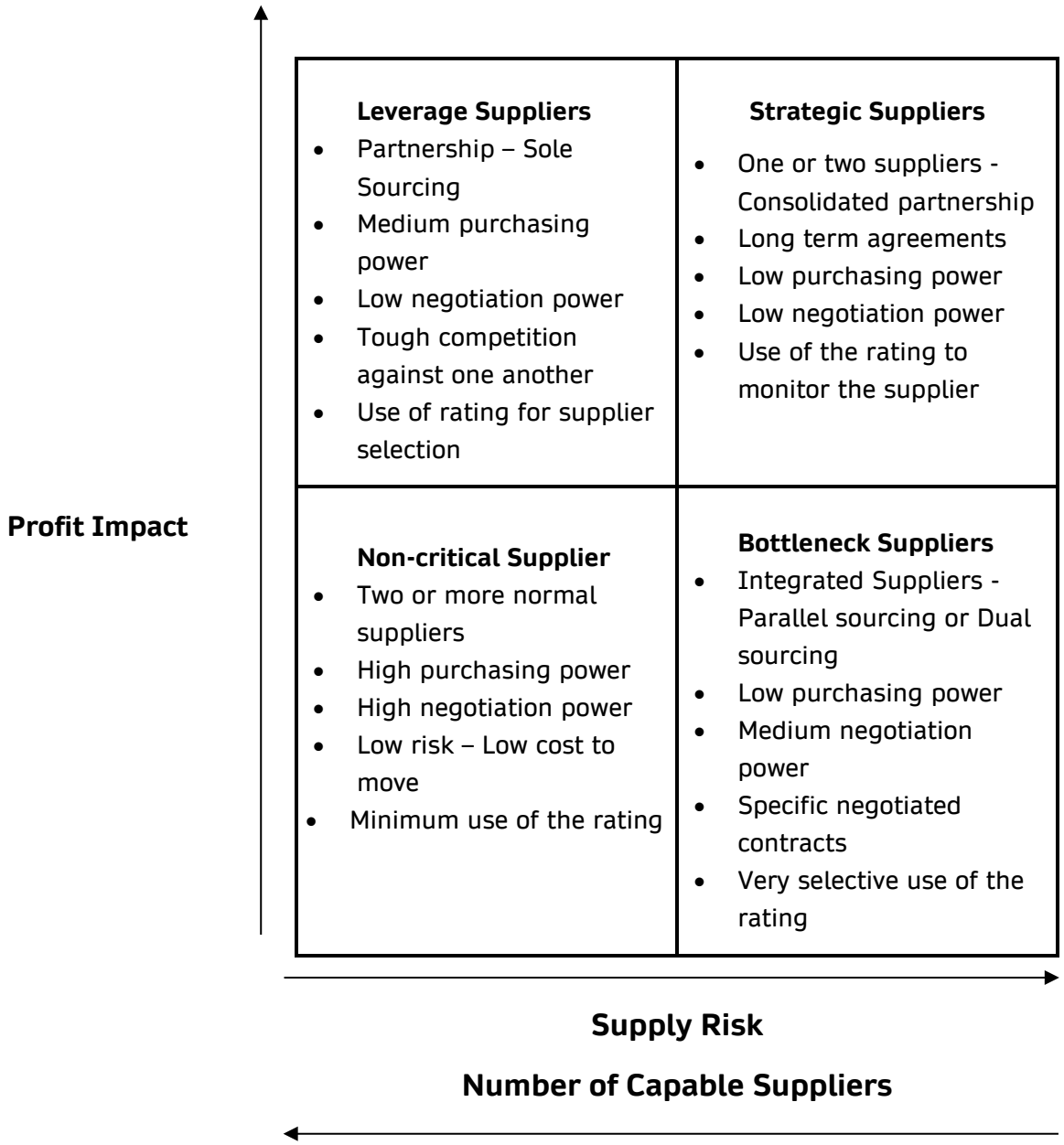


Table 8 - Suppliers Classification

The policies proposed in the model show that the attention of the company must focus on the management of the suppliers that allows the guarantee of the supply in terms of time, costs and quality, without excessive expenditure of resources. In fact, many times it is preferable to integrate suppliers instead of negotiating the lowest price with them, because the price is only one component of the cost. Therefore, to reduce the cost, all its components must be under control.

Depending on the level of relationship between customer and supplier, the supplier can be classified as:

- *Partner*:
  - High level of operational and technological integration;
  - Cooperation in product development (usually the key role of designer and coordinator of first level suppliers is left to the customer);
  - Coordination of common strategies and investments in R&D and technologies;
  - Information exchanges on programming, processes, cost structures;
  - Price reduction after the PO.

- *Integrated*:
  - Long-term relationships revised periodically to correct any inefficiencies and exclusion from competitive comparisons in market benchmarking;
  - Operational (for the management of reliable logistics activities) or technological integration;
  - Variable price based on predefined criteria, such as direct resources and fluctuations in the average market price of the supply sector;
  - Frequent supplies in small volumes (Just in time Purchasing).

- *Normal*:
  - Wide selection and selection criteria based on the required quality standards;
  - Selection based on cost reduction;
  - Essential communications limited to volumes;
  - Transactions focused on single short-term orders but possible long-lasting relationships;
  - Variable Quality Control Procedures, in fact reliability is not always monitored.

Step 4 - Strategic positioning

On the basis of the results obtained in the first 3 steps it is possible to define a matrix of strategic behaviours, shown in Table 9 (which was originally developed thinking above all about "strategic" products and which in more recent evolutions of the approach has been extended to all 4 categories of the matrix by Kraljic).

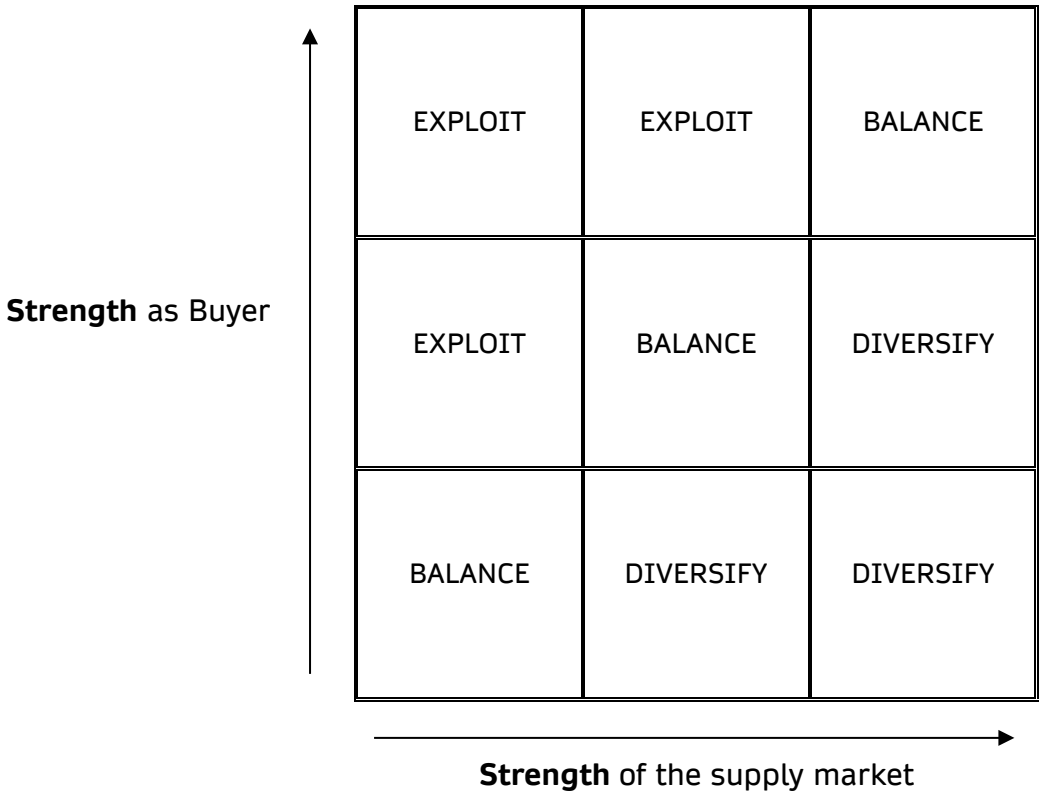


Table 9 - Strategic Positioning

The basic strategies (exploit, diversify, balance) must be applied to all the key elements of the supply process: volumes, price, contractual coverage, new suppliers, stocks, own production, substitute products, logistics and design processes.

For example, if a company has a dominant role in the market and the strength of the supplier is low, the strategic behaviour would be categorized as an exploit. This means that the company has the opportunity to be aggressive and to achieve good results with the supplier.

On the other hand, if the supplier strength is high and the company has low market dominance, the strategic behaviour would be classified as diversify, so the company should try to look for other suppliers.

Step 5 - Action plans

In the original approach, medium-long term plans have to be developed in order to implement the strategies focused on phase 4: plans that ensure the security of supply sources, according to the risk sources that the company has to face.

The company should look at purchasing strategies, which include volume, price, inventory policy and supplier selection. This should help explore different scenarios with different suppliers and be able to secure long-term relationships with a supplier or to take advantage of short-term relationships.

In this phase, decisions are made, for example, on factors such as the decentralization or not of purchases, on the frequency with which purchasing must be updated, on the actions that the company is carrying out on the market, on the quantity and quality of information and on consequent information systems that need.

PROS AND CONS

The Kraljic Model provides important strengths at the company level.

- It leads to differentiating procurement strategies based on the characteristics of the groups of suppliers.
- It induces to take the right consideration of mutual interdependencies with suppliers and the potential negative side effects of these interdependencies.
- It increases the coordination between the purchasing strategies of multiple business units, which act practically independently, increasing the leverage and synergy.

Among the weaknesses of the model, it is possible to find:

- The mutual interdependence between supplier and buyer and the corresponding power relationship;
- The model is based on non-objective and generalizable measures, very sensitive to the choice of factors and relative weights.

6.1 Dynamic Kraljic Matrix

A greater articulation of the strategies and recommendations to be adopted in the different quadrants of the matrix is proposed as shown in the Figure 13:

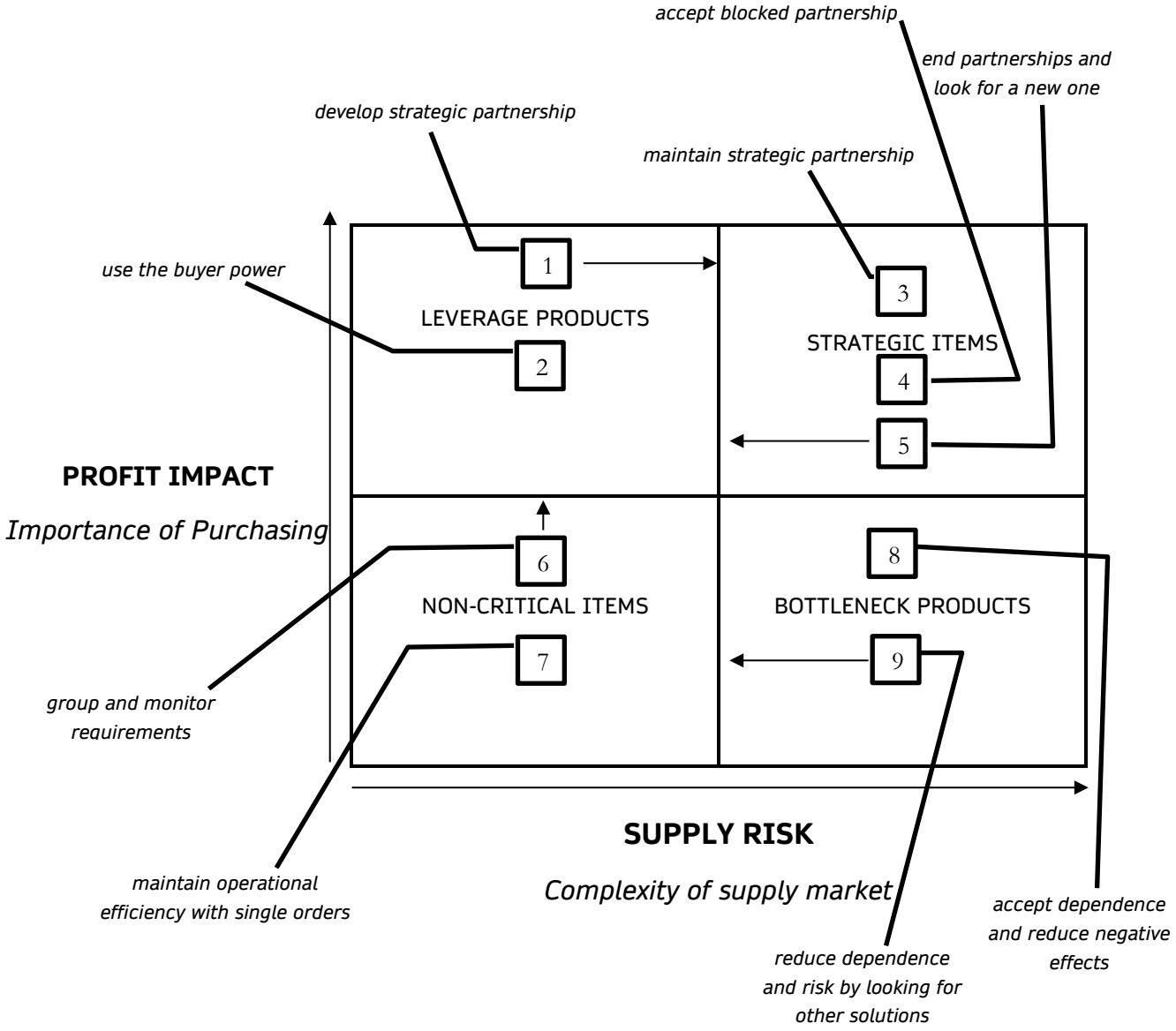


Figure 10 - Dynamic Kraljic matrix

7 PURCHASING KPI - KEY PERFORMANCE INDICATORS

Key Performance Indicators (KPI) are used for:

• the evaluation of the results;

• monitoring of performance within the purchasing process;

• guarantee the effectiveness of sourcing and purchasing processes;

• the maximization the performance of the supplier base;

• the performance evaluation in terms of reliability, cost-effectiveness and quality.

The Table 10 shows the most important performance indicators for evaluating buyers and suppliers.

INDICATOR	***DEFINITION OF INDICATOR***	***UNIT OF MEASURE***
SAVING	o $\boldsymbol{Budget - Purchase\ Order\ Price}$ *For the product categories relating to consultancy / services in the style, engineering and PSC fields, products, molds, assembly equipment and services for prototype constructions, Style Models, Show-Cars and Industrial Design.* o $\boldsymbol{Budget\ for\ Average\ Hourly\ Rate - Weighted\ Average\ Hourly\ Rate\ calculated\ on\ the\ purchase}$ *For product categories relating to consultancy services / services in the field of style, engineering and PSC, finalized in hours or on multiples* This index must annually be kept above a certain threshold	Eur
ORDER COMPLETION	$\frac{\boldsymbol{Orders\ sent\ to\ suppliers}}{\boldsymbol{Total\ orders\ scheduled}}$ This index represents the performance of the buyer in fulfilling orders	%
ANNUAL TOTAL OF THE ORDERED PER SUPPLIER	$\frac{\boldsymbol{Annual\ Turnover\ of\ purchasing\ for\ the\ X\ supplier}}{\boldsymbol{Annual\ Turnover\ of\ purchaing\ for\ the\ total\ supplier\ base}}$ This index allows both to monitor how the purchasing turnover is divided into the supplier base, and to enter into commercial agreements with suppliers that provide annual bonuses on turnover.	%
NUMBER OF SUPPLIERS ACTIVATED ANNUALLY	$\frac{\boldsymbol{Number\ of\ Suppliers\ in\ year\ N - Number\ of\ suppliers\ in\ year\ N-1}}{\boldsymbol{Number\ of\ suppliers\ in\ year\ N-1}}$ This index represents the ability to diversify the supplier base	+%
NUMBER OF ITEMS PURCHASED ANNUALLY PER SUPPLIER	$\frac{\boldsymbol{Number\ of\ items\ purchased\ annualy\ for\ the\ X\ supplier}}{\boldsymbol{Number\ of\ items\ purchased\ annualy\ for\ the\ total\ supplier\ base}}$ This index allows to monitor the purchasing volumes of the items within the supplier base	%

Table 10 - Purchasing KPI

8 SHORT TERM IMPROVEMENT ACTIVITIES

From the analysis of the purchasing processes currently followed in IG/B-2, the first aspect that emerges is the need for a well-structured tool available to buyers, in order to make decisions in the most objective way possible. The decision-making context relating to the supplier selection and sourcing process is articulated: the different phases assume different connotations, in terms of objectives, activities carried out and techniques used, in relation to the different supply situation, to the type of products supplied and the type of Customer-Supplier relationship.

If this is not an influential problem for standard products, for products which are critical in terms of costs, volumes, quality and timing of the service, it is fundamental to have an instrument that guides the choice intuitively.

In addition, another problem that emerges is the management of the flow of information from suppliers to the company: in fact, they use their own sending methods and format (email and excel, pdf, word files) which many times are complex to manage and compare each other.

Once the most problematic aspects of the present situation have been highlighted, in this part of the work a possible short term improvement action will be identified and proposed with the intention of introducing a tool, as objective as possible, accessible to all and capable of making improvements in daily work of all.

The project in question was born from the need to draw up a structured and automated benchmark that can be used in the future by Italdesign buyers during the phase of economic comparison, which uses the information deriving from suppliers through a standard RFQ template, to make a comparison between quotations, delivery times and supplier ratings.

Considering the decision support role achieved by a benchmark, the following specific objectives can be identified:

- *Structuring the decision-making process*: we want to rationalize the decision-making process by introducing principles of objectivity and transparency of choices through the formalization of objective algorithms and choice parameters, so as not to rely exclusively on the experience of the buyers. Most of the time is spent to the operational management of the order but buyers need to be more focused on strategic and tactical aspects. Furthermore, the objectivity of the criteria makes the relationship with suppliers more transparent, who, knowing the parameters on which they are assessed, can draw indications on how to improve future customer performance.

- *Systematic monitoring of performance*: it is a matter of exposing the performance of suppliers to management, in order to highlight the results of the expected improvement activities, as well as moving to a better alternative in the event of an irremediable negative trend.

This chapter is focusing on one of the most important IDG projects, presented in a world preview at the 2019 Geneva Motor Show: ***Da Vinci***. (Figure 14)

Starting from the data deriving from the development of the project DaVinci:

- The set of main product classes in the purchasing process is illustrated and the critical ones to manage will be identified through the Kraljic portfolio model in the paragraph 8.4.
- The Cost Breakdown Structure for each product class is described. The main advantage of the in-depth study of CBS for each product of each class of products, allows to have a competitive advantage in the quotation and negotiation phases.
- The benchmark of each product class applied to the project data will be shown, to highlight its clarity of reading and analysis.

Consequently, by intervening on the most critical product classes, it is possible to associate this need with the opportunity to monitor and increase the KPI of purchases and have a quick comparison with the project Budget.

Figure 11 - Italdesign DaVinci

8.1 Italdesign DaVinci

DaVinci is a *design concept* for a purely electric drive and powered GranTurismo car.

4981mm long and 2124mm wide, 2900mm wheelbase and with a height of just 119mm from the ground, able to comfortably accommodate four passengers, the DaVinci presents the sporty soul and elegance that place it within the Premium segment.

The study for this concept is easily adaptable to a series production and in line with the family feeling of different brands.

Motorizations

DaVinci is developed by exploiting the potential of a typical electric platform capable of accommodating the two motors, one on the front axle and one on the rear, and the batteries inside the chassis floor.

However, with a few tricks, given its adaptability, DaVinci could be ready for production with an internal combustion engine and mechanical transmission. For this solution, the main changes naturally involved the front, which in this case takes into account the housing of the radiator and the front engine and, as regards the interior, the re-design of the central tunnel to accommodate the transmission and the universal joint for all-wheel drive, without however distorting the overall layout. In the version taken into consideration, DaVinci is also able to house a 4-liter V8 engine.

The exteriors

The fully electric setting has allowed the designers to re-design some elements present in the most recent Italdesign production, taking them to the extreme. This is the case, for example, of the Y Duct presented for the first time on the 2017 Zerouno. On the DaVinci, the system of conveying air through the front hood is much more evident. Not having to insert the traditional radiator grille, the openings that form the Y-duct, here occupy a large part of the front section of the car and the surface of the hood, determining its general setting.

The rear explicitly recalls the Italian tradition of Gran Turismo cars and is characterized by the classic truncated tail, which combines an aesthetic element and aerodynamic function. The active spoiler, positioned above the headlamps, extends on the sides.

The few "exotic" concessions, typical of a show car, are concentrated in the expansive gullwing doors (Figure 15), which allow access to the car at the same time as the passengers, the rear lights and the side aerodynamic fins, integral with the doors.

Figure 12 - DaVinci exteriors: gullwing doors

The Interiors

The interior layout is in line with DaVinci's premium positioning; it combines technology and precious materials, highlighting the space on board as true added value.

The dashboard is asymmetrical (Figure 16), slightly oriented in favor of the driver; three screens, one to replace the control panel behind the steering wheel, one in front of the passenger and a third, larger, above the central tunnel, accommodate all the main functions: from infotainment to travel data, from climate regulation to those for driver and passenger comfort. The hexagonal vents set inside the dashboard regulate air-conditioning on board; the lining of the central part of the dashboard has been transformed into an information surface: from Alcantara itself, the icons relating to the keys below and the indication of the interior temperature emerge backlit.

Figure 13 - DaVinci Interiors

8.2 Problem Data

In this thesis work, the focus is on the study of the direct costs allocated on the product classes made up of finished products that the suppliers have to realize and then the Pre-series department of Italdesign has to assemble for the physical development of the vehicle. The study will focus on the most important product classes, which make slightly less than 90% of the *total direct costs* associated to the vehicle development, as shown in Figure 17.

In the following graph, which shows the total direct costs associated with the components for the development of the car, the left columns highlight the weight of the costs negotiated with suppliers for each product class compared to the total, while the right ones that refer the budget available for each class of product.

It is observed that the classes with the most relevance out of the total are the car body components in laminated aluminum alloys and in Reinforced Carbon Fiber (CFK), all those structural and aesthetic components necessary for the development of the car body.

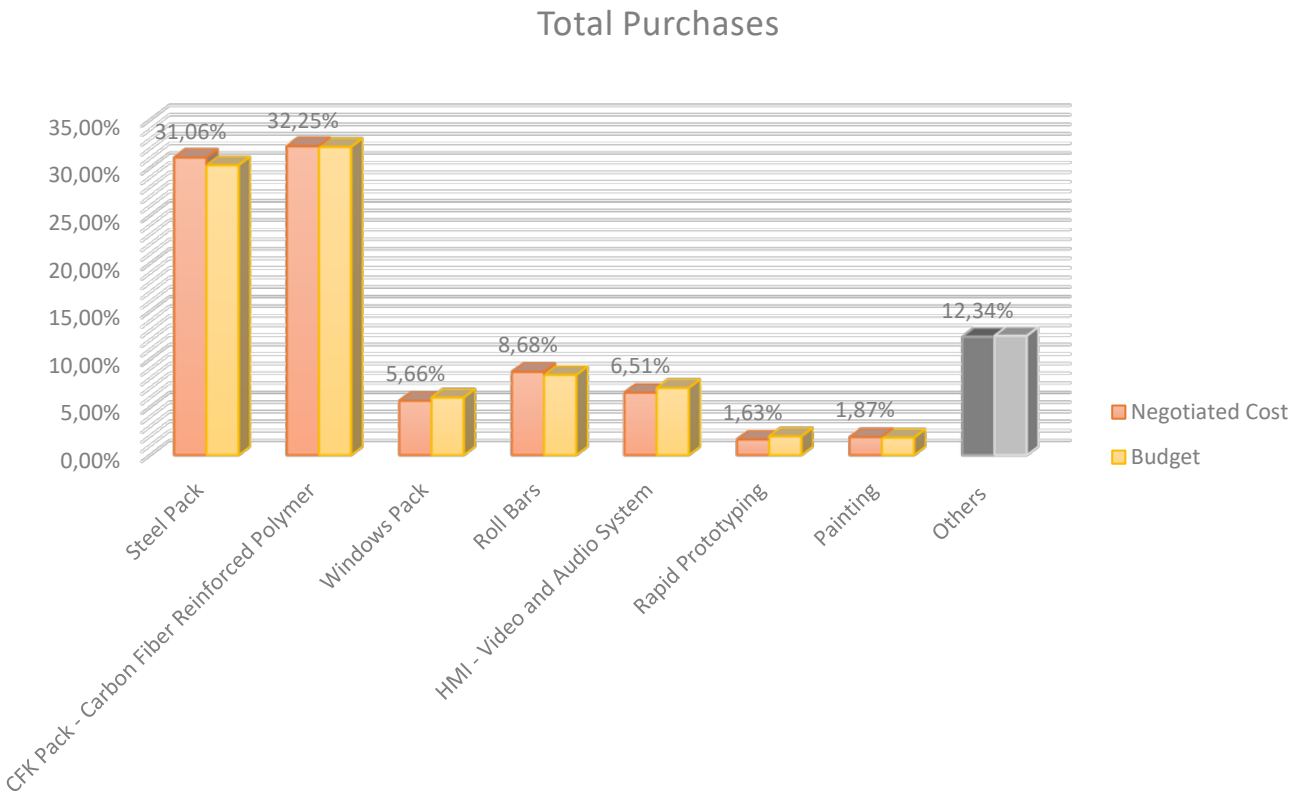


Figure 14 - Total Purchases

8.3 Benchmark description

The benchmark structure is based on Office Excel, in this way it is easily accessible to all buyers. It is spread over several sheets and summarizes all the data collected during a tender. These sheets are connected to each other through functions and Macros, therefore most of the time it is enough to make a change to a single cell and then find this change on other sheets.

BIDDER LIST AND RATING SHEET

This sheet allows the buyer to collect the bidder list of suppliers participating in the tender and the information deriving from the other departments.

Supplier Name	RATING (Aesthetic)					RATING (Not aesthetic / Structural)						
	IG/Q	IG/P	IG/B-2 Buyer	IG/B-2 Readiness	IG/F	IG/Q	IG/P	IG/B-2 Buyer	IG/B-2 Readiness	IG/F	Remarks	GLOBAL
SUPPLIER 1	4	4	4	NA	4	5	4	4	NA	4	Note:	GO
SUPPLIER 2	NA	4	4	NA	4	NA	4	4	NA	4	Note:	GO
SUPPLIER 3	3	3	2	NA	NA	3	3	2	NA	NA	Note:	STOP
SUPPLIER 4	3	3	3	3	4	3	3	3	3	4	Note:	HOLD
SUPPLIER 5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Note:	GO

Table 11 - Bidder List and Rating

The main characteristics of this table (Table 11) are:

• Supplier List: it is mainly drawn up by the IG / B-2 Purchasing Departments, however the technical departments can contribute to its creation; by selecting from the filter, the buyer can immediately view all the information relating to a supplier.

• Rating: it is mainly divided by the components that are important from the mechanical point of view, in Aesthetics and Structural.

The rating is collected by investigating the departments of:

- Quality (IG / Q): it expresses a judgment based on the structural and aesthetic quality of the components, starting from previous projects

- Pre-series center (IG / P): it expresses a judgment based on respect for the integration of the components within the development of the vehicle, starting from previous projects

- Purchasing and Readiness (IG / B-2): they express an opinion on the commercial area of the supplier company, therefore on the possibility of collaboration, punctuality in the exchange of information and flows of mathematical data and components, and on the cost-effectiveness, based on previous projects.

- Finance (IG / F): it expresses an economic and financial opinion on the supplier, based on accounts analysis and evaluation of past collaborations.

Each department gives a vote using the Table 5 and can justify its vote with Remarks, collected on the right side.

With the Global Rating, the possibility of considering or not a supplier in the tender is identified through an automated "traffic light" code [Go / Hold / Stop].

The rules for this rating are:

- It is possible to consider a supplier if his votes are all: 4, 5 and NA

- It is possible to consider a supplier with a derogation if there is at least a 3 among his votes. This vote must be accompanied by the derogation of the department that assigns it.

- It is not advisable to consider a supplier who has at least one 1 or 2 among his votes.

RFQ TEMPLATE AND CBS SHEET

The buyer has to complete this sheet, who then sends it to the supplier who has to fill in the missing information. The buyer performs the same operation for all the suppliers present in the bidder list and collects the various offers, which will subsequently constitute the benchmark.

This sheet contains:

- Italdesign and Supplier Information (Table 12): Contacts of both parties, IDG Project number, date and number of the supplier offer;

ITALDESIGN Request for Quotation		Supplier Information	
		Supplier	Supplier Name
		Contact Person	Name Surname [MAIL]
		Tel.	0123456789
RfQ Date:		Offer Number	RfQ 0001

Project	Italdesign Information	
IDG 1234-5678	Purchasing Contact Person	Name Surname [MAIL]
	Technical Contact Person	Name Surname [MAIL]
	Tel.	0123456789
	Note	

Table 12 - Italdesign and Supplier Information

- Part Number and Product description (Table 13) for the n components to be purchased.

Part Number	Product Description
000XXX	
001XXX	
002XXX	
,,,	
00nXXX	

Table 13 - Part number and description

- Main Cost Elements (Table 14)

Quantity of ***PRODUCTS***	***Unit Price***	*Total Price of* ***PRODUCTS***	*Quantity of* ***MOLDS***	***Unit Price***	*Total Price of* ***MOLDS***	***Price of CRT***	***Price of ASSEMBLY TOOLING***	***Price of SURFACE TREATMENT***	***Price of …***
I	€ -	€ -	I	€ -	€ -	€ -	€ -	€ -	€ -
I	€ -	€ -	I	€ -	€ -	€ -	€ -	€ -	€ -
…	€ -	€ -	…	€ -	€ -	€ -	€ -	€ -	€ -
I	€ -	€ -	I	€ -	€ -	€ -	€ -	€ -	€ -

Table 14 - Main Cost Elements

This horizontal development table analyzes the Cost Breakdown Structure associated with each product. The objective of cost analysis is to identify all the main Cost Drivers, thus identifying the correct value in the formulation of the supplier offer. The main advantage of the in-depth study of CBS for each product of each class of products, allows to have a competitive advantage in the quotation and negotiation phases. The more detailed the analysis and evaluation of the individual values, the higher the possibility and the opportunity to negotiate better with the supplier.

Among these Cost elements, depending on the product class being analyzed, there are:

- *PRODUCT ELEMENTS*: these ones represent the volume and the main cost to which all the other cost elements are referring;
- *MOLDS*: these cost elements are present in the product classes and are the most affecting total costs. They are decidedly critical since the cost associated with them often exceeds the cost of the elements produced. The costs associated with them can be considered semi-variable as they are formed by a fixed component, which does not vary according to the volume of production, and by a variable component, which depends on the quantity produced.
- *CRT* (Controls): these cost elements are most often included in the quotation of the elements produced as they consist of checking the quality and safety parameters that the supplier carries out before sending them to the customer. The costs associated with the quality controls are more often considered variable as they depend strictly on the volume of production and on the number of quality checks requested by the customer.
- *ASSEMBLY TOOLING*: these cost elements are represented by all the accessory elements related to the finished product, necessary for assembly. These costs are variable.
- *ASSEMBLY*: assembly activities can be contemplated in the case of product classes that require professionalism in the composition of multiple parts produced by the same supplier. These costs depend on the volume of pieces produced, which has to be assembled. Therefore, they are variable.
- *SURFACE TREATMENT*: the activities related to the treatment of surfaces according to the customer's dispositions have costs strictly related to the volume of the pieces to be treated, therefore they are considered most of the time variable.
- *CNC MACHINING*: these cost elements are reserved for a few product classes, which require the use of numerical control machines during the production phase. As molds, they are considerable most of the times semi-variable.
- *ENGINEERING SUPPORT*: the engineering collaboration activities between supplier and customer concern particularly customized product classes and the costs associated with them do not depend on the production volume, therefore they are fixed costs.
- *PROJECT MANAGEMENT*: the management activities of the production process linked to the project commissioned by the customer have costs not strictly related to the production volume, therefore considered fixed.

- *RE-SET UP*: in the event that the customer is not satisfied with the first prototype, the supplier provides an evaluation of the costs in the event that its production should start again from the initial point. These costs are considered fixed costs.
- *TRANSPORT and PACKAGING*: these cost elements could already be included in the offer of the supplier. When taken into consideration, these costs can be considered as variable.

Therefore, the costs within the sheet are divided, according to the variability with respect to the production volumes, in
- Fixed costs
- Variable costs
as shown in Table 15.

At the bottom there is the calculation on the total:

	Tot *Fixed Costs*	Tot *Variable Costs*
	€ -	€ -
	€ -	€ -
	€ -	€ -
	€ -	€ -
	€ -	€ -
TOTAL OFFER (Full Costing)	€ -	

Table 15 - Full Costing

These costs could be classified into:
- Direct costs: attributable unequivocally to the cost element, because they are caused by it
- Indirect Costs: caused jointly by two or more cost elements and so not objectively attributable to any single object separately. By their nature they should be allocated through the use of one or more company bases.
This type of classification consists into the grouping of multiple cells in correspondence with several cost elements, however from the point of view of total costs this classification has no influence on the role of purchasing area in the evaluation, but rather in the internal management of company resources both customer and supplier.

The ***cost*** of a product is used to compare suppliers and is often the discriminating factor for choosing one instead of another. Cost minimization must not penalize sources capable of ensuring good quality of the product purchased or induce anticipated orders due to the existence of discounts for quantities or contingent factors of opportunity. A possible indicator, relative to the single product of the supply, could be of the type:

$$Cost\ Indicator = \frac{\left(\frac{C_m}{C}\right) + \left(\frac{C_e}{C}\right)}{2}$$

with C_m average cost of the product in reference to the sector, C_e cost estimated internally, and C cost actually quoted by the supplier. The first part of the index compares the average cost of the sector with that actually quoted by the supplier; the second part is useful to make evident any non-compliant increases by the supplier.

- ***Timing*** for the tool set up, for part realization and for delivery with the related Dap-Incoterms, or the Delivery at Place method (the supplier fulfills the delivery obligation by making the goods available to the buyer on the means of transport of arrival ready for unload at the agreed place).

Timing 1) Tool Set Up	X Weeks	Note:
Timing 2) Part Realization	X Weeks	Note:
Timing 3) Delivery	X Weeks	INCOTERMS: DAP

Table 16 – Timing

The operational performance of the supplier requested by the customer relates to the timeliness and reliability of delivery times. The discriminating parameter between the suppliers to be compared is the *Lead time*, the time interval between the instant when the order reaches the supplier and the actual delivery time.

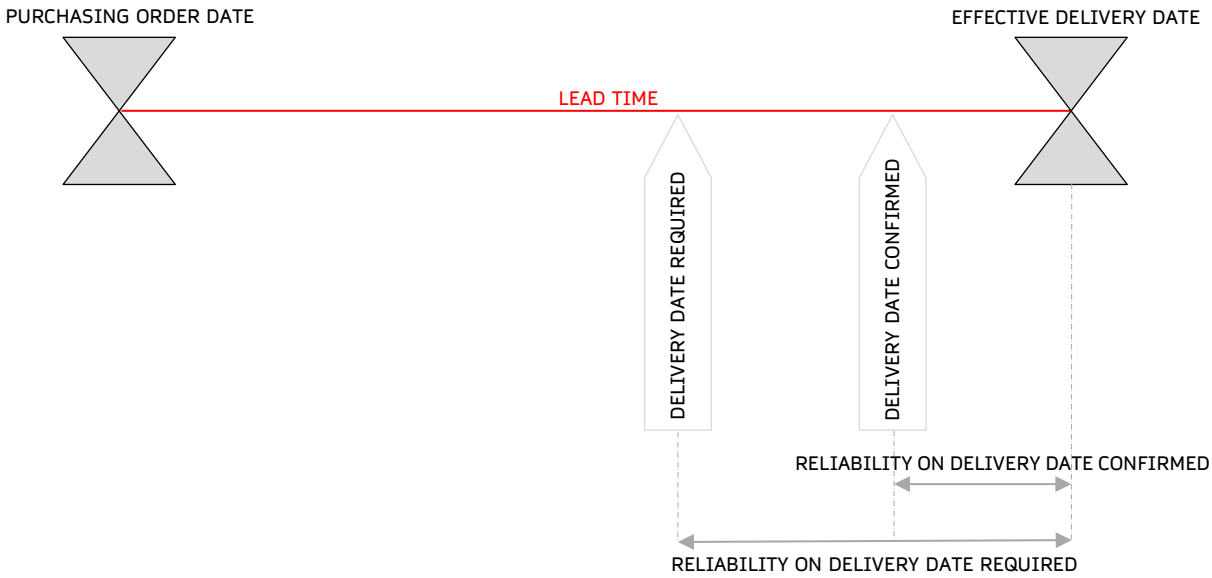


Figure 15 – Service timing

In addition to evaluate the timeliness (speed) of delivery by comparing the Lead Time with the required standard, it is also necessary to evaluate the performance of the supplier in confirming the dates requested by the customer and the reliability of the actual deliveries compared to the confirmed dates. Reliability (punctuality), is the ability to respect the agreed times can be measured by calculating the On Time Delivery. Timeliness means the ability of the supplier to accept and fulfill orders with lead times lower than the reference ones.

On Time Delivery is a measure of process and supply chain efficiency which measures the amount of finish goods or services delivered to customer on time. It rarely refers to a specific date; in fact it refers to a range of dates defined as:

- X Weeks

- Y days before …

- Z days after …

OTD can be globally controlled by the following formula:

$$OTD = \frac{units\ or\ order\ delivered\ on\ time}{total\ units\ or\ orders\ scheduled}$$

The percentage of on-time deliveries within a predefined time interval, relating to a certain number of scheduled deliveries.

The four crucial factors that influence OTD are:

- Late buy actions: delay of purchasing department in the order emission;

- Items in compression: purchase order issued, but the supplier is having problems;

- Late supplier position: supplier divides the sending of items, breaking the client's schedule;

- Push / Pull / Cancel Messages: message manipulation to bypass the due date.

- Payments conditions and Payments Plan for Fixed and Variable Costs (Table 17):

PAYMENTS CONDITIONS	Note: Xgg dffm , Bank Transfer			
Payments Plan for FIXED COSTS	Note:	PO	FOT	PPAP
		30,00%	60,00%	10,00%
Payments Plan for VARIABLE COSTS	Note: Receving products			

Table 17 - Payments conditions and plan

- Payment conditions: the supplier indicates the days between the end of the month in which the billing takes place and the methods by which the payment is made (i.e. bank transfer).
- Payments Plan for Fixed Costs: the supplier indicates the payment trances respectively in the moments of Purchasing Order, First Off of Tool (First Proto) and Production Part Approval Process (i.e. 30% / 60% / 10%).
- Payments Plan for Variable Costs: the supplier indicates the moment in which the payment of the variable costs must take place, which usually coincides once the products are received.

- Details of the Cost Breakdown Structure

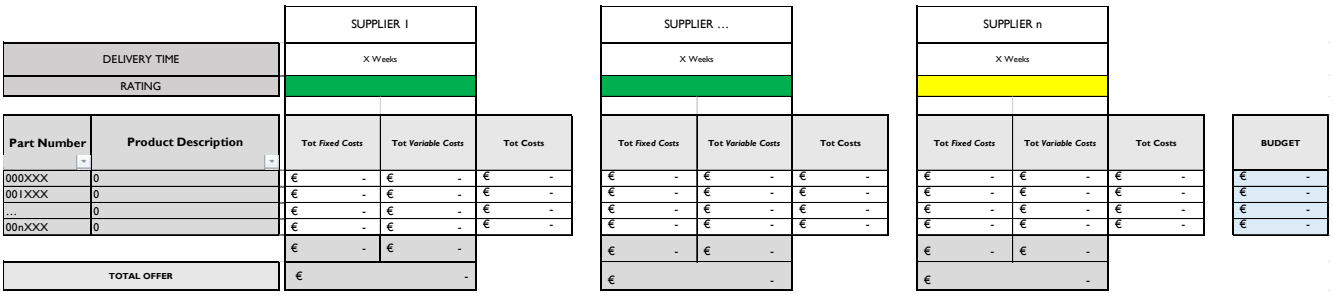
Breakdown Costs											
Fixed Costs per Unit	**Quantity**		**Unit Cost**		**Total Cost**	*Variable Costs per Unit*	**Quantity**		**Unit Cost**		**Total Cost**
Raw Materials	0,00	kg	0,00	€/kg	€ -	*Packaging*	0,00	pz	0,00	€/pz	€ -
Machine Cost	0,00	h	0,00	€/h	€ -	*Transport*	0,00	pz	0,00	€/pz	€ -
Measurement Tool	0,00	h	0,00	€/h	€ -	CTR	0,00	h	0,00	€/h	€ -
Manpower	0,00	h	0,00	€/h	€ -						€ -
Total Amount Fixed Costs					€ -	**Total Amount Variable Costs**					€ -

Table 18 - Breakdown Structure

The Breakdown Structure indicated in Table 18 can be filled by the supplier if, during the quotation phase, he already knows the data associated with the production in advance. This table can definitely be filled with hypothetical or forfeit data, because it is very complex to know in advance the precise volume of hours necessary for the operation of machinery, necessary for workers or the quantity of raw materials used.

This table can be useful in the case of re-setup, therefore re-starting from the initial point of production, because the cost associated with each cost element can already be estimated with more completeness and precision (the cost elements can be added in addition to those already present in the table).

BENCHMARK SHEET



		SUPPLIER 1			SUPPLIER …			SUPPLIER n			
DELIVERY TIME		X Weeks			X Weeks			X Weeks			
RATING											
Part Number	Product Description	Tot *Fixed* Costs	Tot *Variable* Costs	Tot Costs	Tot *Fixed* Costs	Tot *Variable* Costs	Tot Costs	Tot *Fixed* Costs	Tot *Variable* Costs	Tot Costs	BUDGET
000XXX	0	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
001XXX	0	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
…	0	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
00nXXX	0	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
		€ -	€ -		€ -	€ -		€ -	€ -		
TOTAL OFFER		€ -			€ -			€ -			

Figure 16 - Benchmark

This sheet contains the benchmark (Figure 19) of the offers collected by the various suppliers that the buyer will use for the nomination of the final supplier(s).

Using direct links with the other sheets and with the presence of Macros, it shows immediately:

- *Delivery time*: it is recovered from each supplier quotation sheet, as indicated in Table 16

- *Supplier rating*: it corresponds to the Global Rating of Table 11

- *Costs*: they are directly downloaded with the "Download Offers" button, which is associated with a Macro that reports the costs of each type and for each product.

For each product it is possible to know the total cost (beside the individual supplier tables) and the total offer on the listed components (below respectively the individual supplier tables).

In addition, the total cost for each product is constantly compared with the available budget shown on the right. Through conditional formatting the various total costs are compared with each other and their cell is colored with:

- *Green*: when the total cost is less than the budget;

- *Yellow*: when the total cost is very close to the budget;

- *Red*: when the total cost is higher than the budget;

- *White*: when there is no quotation, therefore the total cost is 0.

Thanks to this powerful and customizable tool, the buyer can make quickly and intuitively a comparison between quality, costs and timing, continuing to manage a large amount of data.

Once the set of products to be purchased from each supplier has been chosen, the buyer can proceed with the negotiation.

By comparing the total budget available for the project and the total negotiated costs relating to the products to be purchased, the benchmark automatically shows the Key Performance Indicator "Saving" reached by the buyer in the tender.

BUDGET	BEST OFFER	NEGOTIATION	SAVING
€ -	€ -	€ -	0,00%

Table 19 - Budget, Total cost negotiated and Saving

8.4 Application of the Kraljic Model

This part of the study defines the composition of the purchasing portfolio by using the Kraljic matrix.

As can be seen from the Table 20, the products purchased have been inserted within the matrix, based on the two dimensions Supply Risk and Profit Impact.

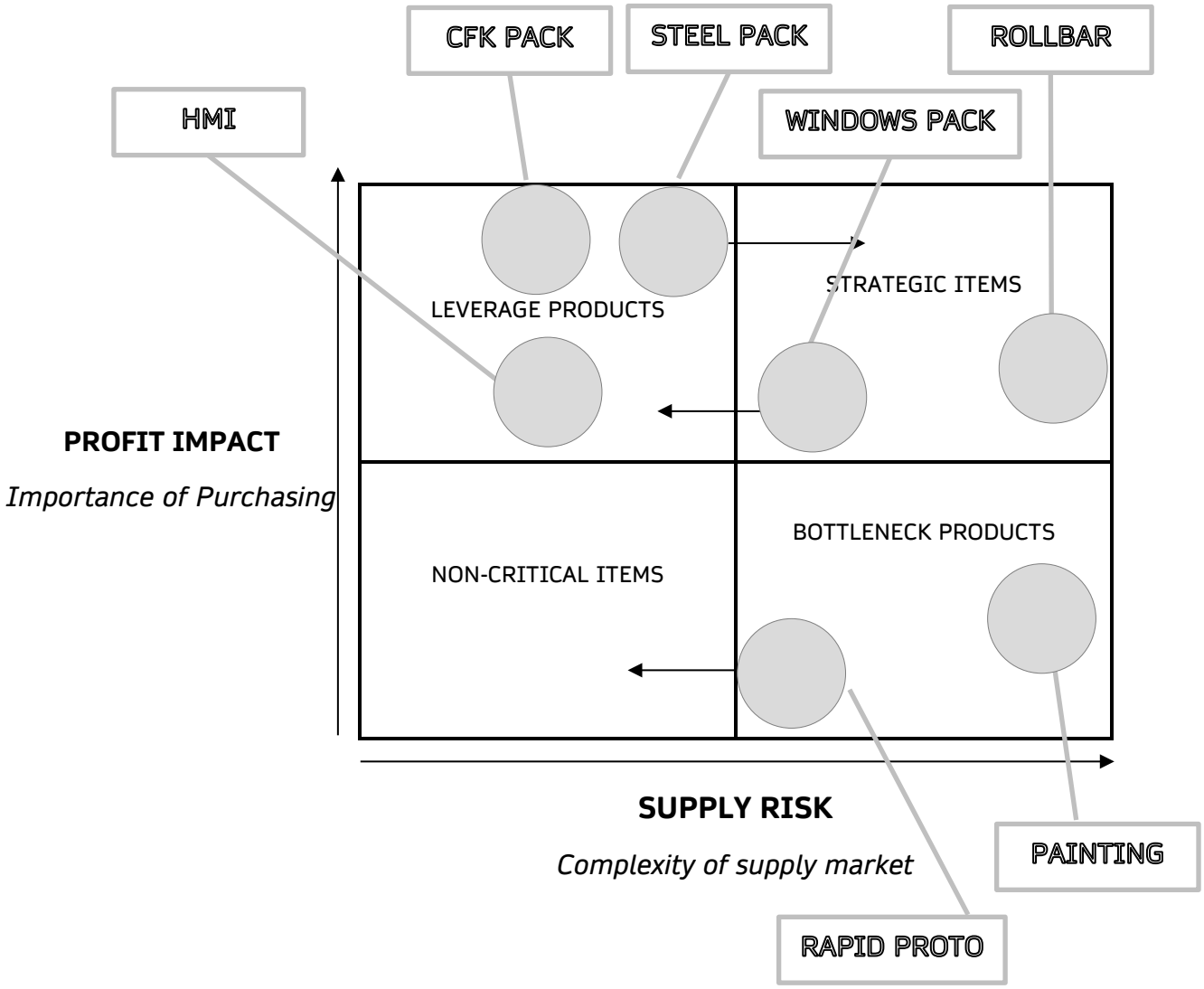


Table 20 - Purchasing portfolio in the Kraljic matrix

The next step is to analyze in detail each quadrant of the matrix to understand the location of the different components within each quadrant:

- ***Leverage Products***: these products are strategically important, they have a high impact on profit, however they are characterized by the presence of a large set of potential national and international suppliers to choose from, consequently with a medium - low level of management complexity of the relationship.

The following components fall into this category:

o Steel pack

o CFK pack

o HMI (Video and Audio system)

The Steel pack and the CFK pack constitute more than 63% of the total costs, and the volume of components purchased is quite small compared to other classes of products (less than 5% of total volume). Therefore, it is clear how in the typical ABC analysis they fall into the A / B classes. Their Profit Impact is therefore the highest of all product classes. Otherwise, for the costs relating to the HMI, they reach 6.5%.

The number of suppliers available for the supply of these products is sufficient to launch tenders in which there is a good competition (exploit behavior) between suppliers at the proposed price level, quality and timing of the service.

The positioning of the Steel Pack close to the class of strategic articles is not accidental: in fact, in the event that there is a continuity of projects in which this type of product is necessary, it is recommended to choose strategic suppliers with whom create partnerships and work together. For this category of products, the purchasing and negotiating power are medium-low, therefore the objective is the balancing and diversification, keeping suppliers as partners or integrated.

CFK Pack and HMI system are more recent and technological products and in continuous evolution; they have a vast national and international supplier base. Therefore, it is easier to choose the best supplier to whom to entrust the order.

- ***Bottleneck products***: these products are characterized by a low strategic importance of purchasing, however necessary for the continuation of projects. The interruption of the supply of these products could have serious repercussions on the project timing. To this category belong:

o Painting

o Rapid Proto

The Painting appears to have a high complexity of supply management, because many times the suppliers are in low numbers, and a medium-low profit impact, reaching only 1.87% of the total costs. For this product, given the complexity of the purchase, the medium-low purchasing and negotiating power, it is recommended to create medium-long term relationships, without however putting too much pressure on the prices set by the supplier. The goal, as a customer, is to balance and diversify the supplier base.

Rapid Prototyping components, on the other hand, are characterized by a lower supply risk: being used new technologies and new production processes such as 3D printing, laser cutting, special materials, a large number of suppliers are present. Their profit impact is decidedly low. In addition, the volume of components purchased that fall under rapid prototyping are part of part C of the ABC analysis (over 70% of total volume). Therefore, for these reasons, this class of products could also be included in non-strategic items. The goal is therefore to leverage on the supplier base, exploiting the strength as a buyer in the purchasing process to reduce the risk of supply.

- ***Strategic products***: these products are characterized both by a high strategic importance of purchasing and by a high complexity of managing the relationship with suppliers; in fact, in this case there are few suppliers, some difficulties in switching suppliers, which therefore leads to the stipulation of medium-long term contracts and the development of suppliers with the aim of achieving a partner relationship in order to reduce the complexity of supply.

The following components belong to this category:

o Windows Pack

o Rollbars

It is clear that the strategic importance of these components is high without considering that all the components inserted in this quadrant are indispensable for the production of the final product. During the ABC analysis they fall into the A / B classes, due to the small volume of components purchased, that belongs to this class (less than 5% of total volume).

The Windows pack constitutes 5.66% of the total costs, therefore characterized by a medium profit impact. The Supply risk relating to these components is medium, as there are few suppliers and with a high power. Therefore, it is preferable in the case of poor efficiency in the purchasing process, to end partnerships and diversify by seeking more performing solutions. In the event that it is possible to diversify, reducing the risk of supply, this product falls into the leverage items, with a consequent change in the management action plan.

The purchasing of Rollbars, despite the medium Profit impact (8.68% of the total costs), is characterized by a very high risk. There are only few suppliers in this status. It is advisable to have a consolidated partnership, given the low purchasing and negotiating power. However, it is essential to monitor constantly the supplier, in such a way to have the product with high structural quality; it is therefore very difficult to change it with the same product of another supplier. This peculiar feature of the Rollbars derives from the fact that the costs associated with the equipment of a higher quality product are decidedly high.

This detailed study allows to undertake:

1. actions on suppliers (negotiation, agreements and relations, year-end bonuses, ...), which can and must lead on average to a percentage recovery on the total purchase cost ranging from a minimum of 2% to a maximum of 10 %;

2. actions on items (value analysis, price analysis, discount quantity, ...) which can and must lead on average to a percentage recovery on the overall purchase cost ranging from a minimum of 5% to a maximum of 20%.

8.4.1 CFK pack

The composite components (reinforced carbon fiber) present on the car perform structural, aesthetic and users comfort functions. In fact, they are characterized by high mechanical strength, rigidity and tensile and compression resistance; they are hardly subject to aggression by atmospheric agents and resistant to corrosion. Finally, they are characterized by an unbeatable resistance to weight ratio, by the possibility of obtaining anisotropy in their mechanical characteristics and plasticity, that is their inclination to be easily modeled to obtain any shape.

Suppliers of these components play a fundamental role in the development of the car, because they must supply products with high quality standards; furthermore, it would be preferable to develop strategic partnerships with them in such a way as to co-design the finished products together and, during the negotiation, to reach costs lower than project budget, given their high profit impact.

Analyzing the Cost Breakdown Structure associated to the CFK pack, there are:

- Molds: components in resin or plastic materials (medium-low density), usually CNC machined, with surface treatments suitable for custom molding in certain volumes. The work phases for their creation are:
  - design,
  - tool paths,
  - construction of the dummy masses,
  - milling
  - surface preparation.

  Molds are the components to be studied and designed in every detail to obtain a specific final product, that is the reason why they constitute 70-85% of the final cost of each component. Furthermore, depending on the number of elements to be produced with the same mold and therefore on the type of surface prepared, they are semi-variable costs, therefore, depending on the case, they can be considered fixed or variable;
- CFK Elements: there are several methods to obtain carbon fiber elements. The two most proposed by the suppliers are: the production of composite parts with autoclave and infusion.
  The first technique involves the lamination of the components following the technical operational precautions dictated by the plybook, the insertion of the laminate into a "vacuum bag" in such a way as to extract all the air present inside and the autoclave cycle for the fusion of the resin matrix and carbon fibers.
  In the infusion technique, on the other hand, the resin is injected under pressure into a cavity, formed by a rigid mold and counter-mold, within which the preformed dry fiber has been placed.
  The cost associated with the elements is 10-20% of the total and they are variable costs;
- Control (CRT): the control phase is fundamental to guarantee the aesthetic and mechanical quality standards of the components, both structurally and superficially. The cost associated with this phase is variable and is less than 5% of the total costs;
- Assembly tooling: the components are equipped with various templates useful for cutting, drilling, trimming, gluing and all those essential operations to be able to assemble the various components. The costs associated with this equipment is variable and is 5% of the total costs (if present);
- Surface treatment: according to the customer's requests, the suppliers produce the carbon elements with various surface characteristics. For example:
  - Simple CFK, purely structural parts without superficial aesthetic devices;
  - CFK Look, structural parts and with surface treatments such as to present the typical look of carbon fiber;
  - CFK Painted, parts painted with the appearance of carbon fibers;
  - CFK Hybrid, both Carbon look and painted parts.

Depending on the treatment there are certain costs, of a variable type and usually included in the final price;

- Engineering;
- Re-Setup;
- Transport and Packaging.

COST UNIT	TYPE OF COST	% ON THE TOTAL COST
Molds	Fixed/Variable	70-85%
CFK Elements	Variable	10-20%
Control	Variable	<5%
Assembly tooling	Variable	<5% / included
Surface treatment	Variable	included
Engineering	Fixed	included
Re-Setup	Fixed	<5% / included
Transport and Packaging	Variable	included

Table 21 - CFK pack CBS

In the Figure 20 the Benchmark is represented working for the component list on the left:
fenders, structure body panels, carpets, imperial, tailgate, hood, bumpers, spoiler, brancardi and truck luggage.
For each supplier the Lead time, the Global Rating and the split between fixed and variable costs are recalled, with the total on the right.
The comparison is intuitive and transparent; by using this comparison the buyer can choose the set of components to be purchased from each supplier.
The suppliers in question have a yellow and green global rating, therefore from the rating point of view there are no critical issues. Most suppliers have 4 weeks of lead time for the listed components.
Analyzing the benchmark, it is observed that the Tailgate Assembled (Inner and External) and the Brancardi Front and Rear (Left and Right) are the most critical products in the quotation phase, because there is only one supplier quoting them, also very close to the assigned budget. The other products, on the other hand, have more varied quotations; therefore, they present less critical issues.
It should be noted that in the realization of the purchasing portfolio, after the negotiation, a Saving of 5-10% can be achieved.

	SUPPLIER 1			SUPPLIER 2			SUPPLIER 3			SUPPLIER 4			SUPPLIER 5			
DELIVERY TIME	4 Weeks			5 Weeks			4 Weeks			4 Weeks			4 Weeks			
RATING																
Product Description	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	BUDGET
Front Fender (1 LH + 1 RH)	€ 13.600,00	€ 4.600,00	€ 18.200,00	€ 11.000,00	€ 5.200,00	€ 16.200,00	€ 9.800,00	€ 4.800,00	€ 14.600,00	€ 17.000,00	€ 4.040,00	€ 21.040,00	€ 29.430,00	€ 4.160,00	€ 33.590,00	€ 25.000,00
Rear Fender (1 LH + 1 RH)	€ 12.800,00	€ 4.000,00	€ 16.800,00	€ 14.000,00	€ 6.000,00	€ 20.000,00	€ 13.000,00	€ 4.950,00	€ 17.950,00	€ 14.600,00	€ 5.600,00	€ 20.200,00	€ 21.500,00	€ 4.800,00	€ 26.300,00	€ 22.000,00
Front Structure Body Panel (1 LH + 1 RH)	€ 13.500,00	€ 5.600,00	€ 19.100,00	€ 14.400,00	€ 7.200,00	€ 21.600,00	€ 8.000,00	€ 6.700,00	€ 14.700,00	€ 18.600,00	€ 5.000,00	€ 23.600,00	€ 27.750,00	€ 3.700,00	€ 31.450,00	€ 19.000,00
Rear Structure Body Panel (1 LH + 1 RH)	€ 13.500,00	€ 5.600,00	€ 19.100,00	€ 14.400,00	€ 7.200,00	€ 21.600,00	€ 8.000,00	€ 6.700,00	€ 14.700,00	€ 18.700,00	€ 5.000,00	€ 23.700,00	€ 25.250,00	€ 3.700,00	€ 28.950,00	€ 19.000,00
Front Carpet (1 LH + 1 RH)	€ 10.000,00	€ 5.600,00	€ 15.600,00	€ 12.600,00	€ 7.200,00	€ 19.800,00	€ 6.200,00	€ 3.100,00	€ 9.300,00	€ 10.100,00	€ 10.500,00	€ 20.600,00	€ 28.000,00	€ 5.600,00	€ 33.600,00	€ 15.000,00
Rear Carpet	€ 7.000,00	€ 6.500,00	€ 13.500,00	€ 7.000,00	€ 4.300,00	€ 11.300,00	€ 4.900,00	€ 3.100,00	€ 8.000,00	€ 8.980,00	€ 7.040,00	€ 16.020,00	€ 40.000,00	€ 5.600,00	€ 45.600,00	€ 13.000,00
Imperiale	€ -	€ -	€ -	€ -	€ -	€ -	€ 5.200,00	€ 2.500,00	€ 7.700,00	€ 14.208,00	€ 4.600,00	€ 18.808,00	€ -	€ -	€ -	€ 12.000,00
Tailgate Assembled (INNER - EXTERNAL)	€ -	€ -	€ -	€ -	€ -	€ -	€ 15.700,00	€ 6.200,00	€ 21.900,00	€ -	€ -	€ -	€ -	€ -	€ -	€ 25.000,00
Hood (INNER - EXTERNAL)	€ 6.500,00	€ 3.200,00	€ 9.700,00	€ 7.600,00	€ 3.800,00	€ 11.400,00	€ 5.000,00	€ 2.800,00	€ 7.800,00	€ 4.450,00	€ 3.350,00	€ 7.800,00	€ 9.850,00	€ 2.500,00	€ 12.350,00	€ 10.000,00
Rear Bumper	€ 7.500,00	€ 4.500,00	€ 12.000,00	€ 8.600,00	€ 4.800,00	€ 13.400,00	€ 8.500,00	€ 5.550,00	€ 14.050,00	€ 15.500,00	€ 7.200,00	€ 22.700,00	€ 26.000,00	€ 12.980,00	€ 38.980,00	€ 14.000,00
Front Bumper	€ 2.800,00	€ 1.450,00	€ 4.250,00	€ 3.600,00	€ 3.200,00	€ 6.800,00	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 5.000,00
Rear Spoiler	€ -	€ -	€ -	€ 4.300,00	€ 3.300,00	€ 7.600,00	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 9.000,00
Brancardi Front and Rear (1 LH + 1 RH)	€ -	€ -	€ -	€ 13.900,00	€ 9.900,00	€ 23.800,00	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 25.000,00
Truck Luggage	€ -	€ -	€ -	€ -	€ -	€ -	€ 5.800,00	€ 3.200,00	€ 9.000,00	€ -	€ -	€ -	€ -	€ -	€ -	€ 12.000,00
	€ 87.200,00	€ 41.050,00		€ 111.400,00	€ 62.100,00		€ 90.100,00	€ 49.600,00		€ 122.138,00	€ 52.330,00		€ 207.780,00	€ 43.040,00		
TOTAL OFFER	€		128.250,00	€		173.500,00	€		139.700,00	€		174.468,00	€		250.820,00	

Figure 17 - Benchmark CFK pack

8.4.2 Steel pack

The vehicle body is made of stamped metal sheets. Metal components are the most important elements of the vehicle as they perform various structural, aesthetic, aerodynamic and user comfort functions. Steel is the most popular material in cars for the large market as it is resilient, inexpensive, modular in mechanical characteristics and easy to work with. With this material, it can be made from bodywork plates, rims, structural components of the chassis and suspensions.

Even in this case, as in the case of the CFK pack, suppliers play a fundamental role, as components with high quality standards are required and with their costs have a high profit impact. Therefore, also for the Steel pack it is advisable to make partners the suppliers.

The main stages of creating steel components can be summarized as follows:

- Cold stamping of individual elements with presses;

- Assembly by welding;

- Deoxidation and degreasing of surfaces for subsequent assembly by welding;

- Surface treatments against corrosive atmospheric agents.

Analyzing the Cost Breakdown Structure associated to the Steel pack, there are:

- Molds: the models for stamping steel are typically made of resin. The work phases for their creation are:
  - design
  - tool paths
  - construction of the dummy masses
  - milling, or laser cutting
  - surface preparation.

  Molds are the components to be studied and designed in every detail to obtain a specific final product, that is the reason why they constitute 50-85% of the final cost of each component. Furthermore, depending on the number of elements to be produced with the same mold and therefore on the type of surface prepared, they are semi-variable costs, therefore, depending on the case, they can be considered fixed or variable;
- Steel Elements: the stamped elements, depending on the size, complexity and quality standards required, constitute variable costs ranging from 20 to 50% of the total costs;
- Control: the control phase is fundamental to guarantee the mechanical quality standards of the components, both structurally and superficially. The cost associated with this phase is variable and is less than 5% of the total costs.;
- Assembly tooling: the costs associated to the assembly, if not included in the total quotation, constitute 5-10% of the total costs;
- Assembly: assembly operations, when required, involve costs of less than 5% of the total depending on the complexity of the operation. These operations may be subject to "make or buy" analysis, because the convenience of performing them internally is evaluated;
- Engineering;
- Re-Setup;
- Transport and Packaging.

COST UNIT	TYPE OF COST	% ON THE TOTAL COST
Molds	Fixed/Variable	50-85%
Steel Elements	Variable	20-50%
Control	Variable	<5%
Assembly tooling	Variable	5-10% / included
Assembly	Variable	<5% / included
Engineering	Fixed	included
Re-Setup	Fixed	included
Transport and Packaging	Variable	included

Table 22 - Steel pack CBS

In the Figure 21 the Benchmark is represented working for the component list on the left:
external bodyside, roof panel, inner and external doors, inner and external pillars, reinforcements for pillars. For each supplier the Lead time, the Global Rating and the split between fixed and variable costs are recalled, with the total on the right.

Suppliers in this case are few, because only slightly more than half have a global rating of yellow / green code. This is a first critical point for this class of product. In addition, they provide for a Lead time ranging from 4 to 6 weeks for the list of components they quote.

By analyzing the benchmark, it has been noted that there is the Supplier number 7, which could potentially produce the entire list of components, because in terms of timing, ratings and quotations it is the most competitive. This result is part of the previous analysis of the identification of product classes within the Kraljic matrix, when it was anticipated that the steel pack can be considered a strategic item: potentially Supplier number 7 could also become a partner for future projects.

It should be noted that in the realization of the purchasing portfolio, after the negotiation, a Saving of 5-10% can be achieved.

	SUPPLIER 1			SUPPLIER 2			SUPPLIER 3			SUPPLIER 4			SUPPLIER 5			SUPPLIER 6			SUPPLIER 7			
DELIVERY TIME	6 Weeks			6 Weeks			6 Weeks			6 Weeks			4 Weeks			4 Weeks			4 Weeks			
RATING																						
Product Description	Tot Fixed Costs	Tot Variable Costs	Tot Costs	Tot Fixed Costs	Tot Variable Costs	Tot Costs	Tot Fixed Costs	Tot Variable Costs	Tot Costs	Tot Fixed Costs	Tot Variable Costs	Tot Costs	Tot Fixed Costs	Tot Variable Costs	Tot Costs	Tot Fixed Costs	Tot Variable Costs	Tot Costs	Tot Fixed Costs	Tot Variable Costs	Tot Costs	BUDGET
Roof Panel	€ 15.000,00	€ 15.100,00	€ 30.100,00	€ -	€ -	€ -	€ 20.500,00	€ 6.050,00	€ 26.550,00	€ 16.000,00	€ 14.000,00	€ 30.000,00	€ -	€ -	€ -	€ -	€ -	€ -	€ 12.500,00	€ 10.450,00	€ 22.950,00	€ 25.000,00
External Bodyside (1 LH + 1 RH)	€ 45.000,00	€ 37.100,00	€ 82.100,00	€ -	€ -	€ -	€ 57.000,00	€ 15.600,00	€ 72.600,00	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 37.000,00	€ 36.250,00	€ 73.250,00	€ 75.000,00
Front External door (1 LH + 1 RH)	€ 11.400,00	€ 10.100,00	€ 21.500,00	€ 18.600,00	€ 21.850,00	€ 40.450,00	€ 22.000,00	€ 5.300,00	€ 27.300,00	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 11.500,00	€ 17.800,00	€ 29.300,00	€ 30.000,00
Front Inner door (1 LH + 1 RH)	€ 25.400,00	€ 19.900,00	€ 45.300,00	€ 35.000,00	€ 21.450,00	€ 56.450,00	€ 41.200,00	€ 12.650,00	€ 53.850,00	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 14.500,00	€ 16.200,00	€ 30.700,00	€ 40.000,00
Rear Inner door (1 LH + 1 RH)	€ 25.400,00	€ 19.900,00	€ 45.300,00	€ 35.000,00	€ 21.450,00	€ 56.450,00	€ 47.500,00	€ 13.250,00	€ 60.750,00	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 14.500,00	€ 16.200,00	€ 30.700,00	€ 40.000,00
Rear External door (1 LH + 1 RH)	€ 11.400,00	€ 10.100,00	€ 21.500,00	€ 18.600,00	€ 21.850,00	€ 40.450,00	€ 25.000,00	€ 4.150,00	€ 29.150,00	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 11.500,00	€ 17.800,00	€ 29.300,00	€ 33.000,00
Outer Pillar A (1 LH + 1 RH)	€ 7.000,00	€ 6.650,00	€ 13.650,00	€ 8.200,00	€ 5.000,00	€ 13.200,00	€ 9.100,00	€ 3.550,00	€ 12.650,00	€ 8.400,00	€ 8.440,00	€ 16.840,00	€ 8.400,00	€ 7.600,00	€ 16.000,00	€ 8.600,00	€ 8.850,00	€ 17.450,00	€ 8.600,00	€ 6.800,00	€ 15.400,00	€ 15.000,00
Inner Pillar A (1 LH + 1 RH)	€ 9.500,00	€ 9.650,00	€ 19.150,00	€ 12.600,00	€ 8.600,00	€ 21.200,00	€ 9.100,00	€ 3.550,00	€ 12.650,00	€ 10.200,00	€ 8.940,00	€ 19.140,00	€ 8.800,00	€ 7.800,00	€ 16.600,00	€ 10.200,00	€ 10.650,00	€ 20.850,00	€ 10.400,00	€ 8.500,00	€ 18.900,00	€ 17.000,00
Reinforcement Pillar A (1 LH + 1 RH)	€ 6.800,00	€ 4.650,00	€ 11.450,00	€ 4.200,00	€ 4.150,00	€ 8.350,00	€ 7.200,00	€ 2.050,00	€ 9.250,00	€ 6.500,00	€ 5.100,00	€ 11.600,00	€ 8.100,00	€ 7.650,00	€ 15.750,00	€ 6.500,00	€ 6.600,00	€ 13.100,00	€ 4.500,00	€ 4.800,00	€ 9.300,00	€ 10.000,00
Outer Pillar B (1 LH + 1 RH)	€ 8.000,00	€ 7.150,00	€ 15.150,00	€ 8.500,00	€ 5.400,00	€ 13.900,00	€ 9.500,00	€ 4.150,00	€ 13.650,00	€ 8.600,00	€ 8.640,00	€ 17.240,00	€ 8.600,00	€ 7.900,00	€ 16.500,00	€ 8.900,00	€ 9.150,00	€ 18.050,00	€ 8.800,00	€ 7.000,00	€ 15.800,00	€ 16.000,00
Inner Pillar B (1 LH + 1 RH)	€ 9.500,00	€ 9.650,00	€ 19.150,00	€ 13.000,00	€ 9.000,00	€ 22.000,00	€ 9.500,00	€ 4.150,00	€ 13.650,00	€ 10.500,00	€ 8.940,00	€ 19.440,00	€ 9.100,00	€ 8.100,00	€ 17.200,00	€ 10.500,00	€ 10.150,00	€ 20.650,00	€ 11.200,00	€ 8.700,00	€ 19.900,00	€ 18.000,00
Reinforcement Pillar B (1 LH + 1 RH)	€ 7.700,00	€ 5.650,00	€ 13.350,00	€ 4.500,00	€ 4.650,00	€ 9.150,00	€ 7.500,00	€ 7.850,00	€ 15.350,00	€ 6.500,00	€ 5.100,00	€ 11.600,00	€ 8.200,00	€ 7.850,00	€ 16.050,00	€ 7.000,00	€ 7.300,00	€ 14.300,00	€ 5.300,00	€ 4.900,00	€ 10.200,00	€ 11.000,00
	€ 182.100,00	€ 155.600,00		€ 158.200,00	€ 123.400,00		€ 265.100,00	€ 82.300,00		€ 66.700,00	€ 59.160,00		€ 51.200,00	€ 46.900,00		€ 51.700,00	€ 52.700,00		€ 150.300,00	€ 155.400,00		
TOTAL OFFER	€		337.700,00	€		281.600,00	€		347.400,00	€		125.860,00	€		98.100,00	€		104.400,00	€		305.700,00	

Figure 18 - Benchmark Steel pack

8.4.3 Rollbar

The Rollbar is the protective structure in high resistance steel, designed to protect the occupants of a vehicle in the event of a rollover or accident. It is a real cage with very high mechanical resistance to all types of impact: frontal, lateral or following overturning. Usually, especially on high-performance vehicles they are assembled by welding, therefore they cannot be removed after assembly, but guarantee very high safety.

They undergo strict controls before being homologated and assembled because they are devices that require certification: there are few suppliers capable of making the Rollbar "made for the customer", following its development step by step. This criticality, despite the medium profit impact, affects the Supply Risk.

Analyzing the Cost Breakdown Structure associated to the Rollbar, there are:

- Elements: the elements essentially consist of the cage and the brackets. The cage is made up of welded pipes in bent and rolled steel. They constitute 60-70% of the total costs and are of a variable type;
- Control: the control phase is fundamental to guarantee the mechanical- structural quality standards of the components. Visual inspections of the welds are performed. The cost associated with this phase is variable and is less than 5% of the total costs;
- Assembly: the assembly operation is essential to avoid that the stresses to which the car is subjected during use can compromise the safety of the vehicle. The activity is performed with particular attention to the tightness of the original welds. In addition, a welding reinforcement operation is usually expected between the joints of the pipes that make up the chassis of the car. The cost associated with this activity is variable and remains below 5% of the total costs;
- Tooling: the operation involves the creation of equipment and control gauges for bending and rolling, the design of the support frame for positioning the pipes in the equipment and the creation of equipment to support the pipes and main nodes. These activities have variable costs ranging from 10 to 20% of the total cost;
- Engineering: given the structural importance of the Rollbar, the fixed costs associated with the engineering range from 5 to 10% of the total cost of the product. Among the main activities, there are the integration of design between companies, the design and design of pipes and nodes starting from project data such as the maximum speed, the weight of the vehicle or the car market segment;
- Re-Setup;
- Transport and Packaging.

COST UNIT	***TYPE OF COST***	***% ON THE TOTAL COST***
Elements	Variable	60-70%
Control	Variable	<5%
Assembly	Variable	<5%
Tooling	Variable	10-20%
Engineering	Fixed	5-10%
Re-Setup	Fixed	included
Transport and Packaging	Variable	included

Table 23 - Rollbar CBS

In the Figure 22 the Benchmark is represented working for the component list on the left:
cage and brackets.
For each supplier the Lead time, the Global Rating and the split between fixed and variable costs are recalled, with the total on the right.
There are only three suppliers, all with yellow code in the global rating. This underlines the difficulty in supplying these products. All have 4 week of lead time.

Analyzing the benchmark, only one supplier grants a decidedly competitive quotation compared to the others. It is advisable to evaluate his performance during a project and in case of positive results, establish a long-term consolidated partnership, to involve him in other projects.

It should be noted that in the purchase, given the complexity of the market segment in which it operates, a saving of less than 5% could be achieved after negotiation.

	SUPPLIER 1			SUPPLIER 2			SUPPLIER 3			
DELIVERY TIME	4 Weeks			4 Weeks			4 Weeks			
RATING										
Product Description	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	BUDGET
Cage	€ 6.000,00	€ 65.500,00	€ 71.500,00	€ 5.000,00	€ 76.000,00	€ 81.000,00	€ 6.000,00	€ 69.500,00	€ 75.500,00	€ 72.000,00
Brackets	€ 1.500,00	€ 15.000,00	€ 16.500,00	€ 1.500,00	€ 19.500,00	€ 21.000,00	€ 1.500,00	€ 17.500,00	€ 19.000,00	€ 20.000,00
	€ 7.500,00	€ 80.500,00		€ 6.500,00	€ 95.500,00		€ 7.500,00	€ 87.000,00		
TOTAL OFFER	€	88.000,00		€	102.000,00		€	94.500,00		

Figure 19 - Benchmark Rollbar

8.4.4 Windows Pack

The windows of the car have the function of protecting the occupants of the vehicle from the air while driving and from flying parts (e.g. insects or small stones). They have to isolate the internal environment from the external one, in order to guarantee a controlled temperature.

The windows are an integral component of the body car and therefore actively contribute with their conformation to the aerodynamics of the vehicle.

Modern windows are generally made of composite or laminated glass, which is formed by two layers of glass and an intermediate plastic layer, which gives resistance and safety in case of breakage.

For this type of tenders, there are few suppliers capable of creating a customized windows pack, which makes the class of goods at medium-high supply risk.

Analyzing the Cost Breakdown Structure associated to the Windows pack, there are:

- Elements: the elements are made of composite glass and plastic. The cost associated with them is variable with the required volume and constitutes 55-70% of the total cost of each product;
- Control: the control phase is fundamental to guarantee the aesthetic and mechanical quality standards of the components, both structurally and superficially. The cost associated with this phase is variable and is 10-20% of the total costs;
- Curvature: the curvature phase of the glass requires time, professionalism and equipment to make the product suitable for the standards required by the customer, therefore respecting the geometric and dimensional tolerances. The cost associated with this activity is variable and is 10-20% of the total cost associated with each product;
- Assembly Tooling: the windows are integrated into the body car through adhesives and gaskets. Their cost is less than 5% of the total cost and is variable in nature;
- Surface Treatment: the glasses can be customized by applying dyes, films or metal powders on the surface. These treatments involve variable costs that go to cover 5-10% of the total costs associated with the product;
- Engineering;
- Re-Setup;
- Transport and Packaging.

COST UNIT	***TYPE OF COST***	***% ON THE TOTAL COST***
Elements	Variable	55-70%
Control	Variable	10-20%
Curvature	Variable	10-20%
Assembly tooling	Variable	<5%
Surface treatment	Variable	5-10% / included
Engineering	Fixed	<5% / included
Re-Setup	Fixed	<5%
Transport and Packaging	Variable	included

Table 24 - Windows pack CBS

In the Figure 23 the Benchmark is represented working for the component list on the left: windshield, door glasses, rear triangle glasses and rear window.
For each supplier the Lead time, the Global Rating and the split between fixed and variable costs are recalled, with the total on the right.
There are only two suppliers, all with yellow code in the global rating. This underlines the difficulty in supplying these products. All have 4 week of lead time.

Analyzing the benchmark, the buyer has the possibility to choose the set of products to buy from each supplier; it is preferable in the case of poor efficiency in the purchasing process, to end partnerships and diversify by seeking more performing solutions. In the event that it is possible to diversify, reducing the risk of supply, this product falls into the leverage items, with a consequent change in the management action plan.

It has been noted that in the purchase, given the complexity of the market segment in which it operates, a saving of 5-10% could be achieved after negotiation.

	SUPPLIER 1			SUPPLIER 2			
DELIVERY TIME	4 Weeks			4 Weeks			
RATING							
Product Description	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	BUDGET
Windshield	€ 400,00	€ 14.900,00	€ 15.300,00	€ 300,00	€ 14.650,00	€ 14.950,00	€ 16.000,00
Door Glass (1 LH + 1 RH)	€ 400,00	€ 14.400,00	€ 14.800,00	€ 300,00	€ 16.550,00	€ 16.850,00	€ 18.000,00
Rear Triangle Glass (1 LH + 1 RH)	€ 400,00	€ 13.200,00	€ 13.600,00	€ 300,00	€ 14.750,00	€ 15.050,00	€ 16.000,00
Rear Window	€ 400,00	€ 14.500,00	€ 14.900,00	€ 300,00	€ 13.750,00	€ 14.050,00	€ 16.000,00
	€ 1.600,00	€ 57.000,00		€ 1.200,00	€ 59.700,00		
TOTAL OFFER	€	58.600,00		€	60.900,00		

Figure 20 - Benchmark Windows pack

8.4.5 Video and Audio System (HMI)

The HMI allows the occupant of the vehicle to be in direct contact with the machine through:

- visual messages - generally provided by screens, monitors and clusters
- sound messages - speakers and two-way radios
- control actions - switches, buttons, keyboards, interactive surfaces and touch screens

The video and audio system are most often co-designed with international suppliers of the sector. These suppliers play a key role in the success of the project, because the quality of the final product depends almost entirely on them. HMI usage is growing on board the vehicle; therefore, it is a sector that in the future will see more and more suppliers capable of developing customized devices. For some years, Eastern industry has focused on this sector, therefore many times it is easier to find suppliers in this market than in the European and American ones.

Analyzing the Cost Breakdown Structure, it is very streamlined as the realization of these devices is a work-package in the hands of the supplier:

- Elements: purchased items are quoted by suppliers as finished products to be integrated into the customer's project. They constitute 70-85% of the total costs associated with the product and they are of a variable nature;
- Engineering: co-design, integration and feasibility study are part of the engineering activities. The cost relating to this activity is of a fixed nature and falls within the range 10-30% of the total product cost;
- Project Management: many times, the supplier shares the project management activities as he wants to put only the production (manpower, machinery, materials) in the costs of the elements. The cost relating to this activity is of a fixed nature and falls within the range 5-10% of the total product cost;
- Transport and Packaging.

COST UNIT	*TYPE OF COST*	*% ON THE TOTAL COST*
Elements	Variable	70-85%
Engineering	Fixed	10-20%
Project Management	Fixed	5-10%
Transport and Packaging	Variable	<5%

Table 25 - HMI CBS

In the Figure 24 the Benchmark is represented working for the component list on the left: total audio system, displays, instrument cluster and cameras.
For each supplier the Lead time, the Global Rating and the split between fixed and variable costs are recalled, with the total on the right.
All suppliers have a global rating with a green and yellow code. Most suppliers offer a 4 week lead time.

By analyzing the benchmark, it has been noted that the choice could easily fall on the first supplier, who can provide the entire list of products. Despite this, there is the possibility of comparison between multiple suppliers. That is the reason why this class of products is characterized by low supply risk and medium profit impact.

Moreover, it has been observed that for this class of products the buyer usually manages to obtain a saving, after negotiation, ranging from 5 to 10%.

	SUPPLIER 1			SUPPLIER 2			SUPPLIER 3			SUPPLIER 4			SUPPLIER 5			
DELIVERY TIME	4 Weeks			4 Weeks			4 Weeks			5 Weeks			6 Weeks			
RATING																
Product Description	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	**BUDGET**
Total Audio System	€ 3.450,00	€ 8.300,00	€ 11.750,00	€ -	€ -	€ -	€ -	€ -	€ -	€ 3.500,00	€ 10.200,00	€ 13.700,00	€ 5.000,00	€ 13.100,00	€ 18.100,00	€ 12.000,00
Total Instrument Cluster	€ 3.700,00	€ 13.350,00	€ 17.050,00	€ 7.000,00	€ 13.100,00	€ 20.100,00	€ 6.000,00	€ 17.150,00	€ 23.150,00	€ -	€ -	€ -	€ -	€ -	€ -	€ 17.000,00
Total Central Display	€ 3.900,00	€ 11.350,00	€ 15.250,00	€ 7.000,00	€ 16.100,00	€ 23.100,00	€ 6.000,00	€ 16.650,00	€ 22.650,00	€ -	€ -	€ -	€ -	€ -	€ -	€ 17.000,00
Total Rearview Mirror and Cameras	€ 3.450,00	€ 19.350,00	€ 22.800,00	€ 7.000,00	€ 19.100,00	€ 26.100,00	€ 6.000,00	€ 19.150,00	€ 25.150,00	€ -	€ -	€ -	€ -	€ -	€ -	€ 24.000,00
	€ 14.500,00	€ 52.350,00		€ 21.000,00	€ 48.300,00		€ 18.000,00	€ 52.950,00		€ 3.500,00	€ 10.200,00		€ 5.000,00	€ 13.100,00		
TOTAL OFFER	€		66.850,00	€		69.300,00	€		70.950,00	€		13.700,00	€		18.100,00	

Figure 21 - Benchmark HMI

8.4.6 Rapid Prototyping

Rapid Prototyping is a set of industrial techniques that have as their objective the physical realization of the prototype, starting from a three-dimensional mathematical definition of the object, in very short times. Although it is a recent technique, the materials and machines used are constantly evolving. The materials and techniques with which the prototypes are made are different and depending on the technique used, their construction follows different procedures and is entrusted to craftsmen or model makers.

Among the techniques used in question, there are:

- Sintering Print: Sintering is a 3D process of powder bed printing. It uses a laser that melts the nylon micro particles to trace the geometry of the pre-designed CAD mathematical models layer by layer.
- Silicone models: the printing of silicone models takes place by hardening the fluid silicone inside a mold and a counter mold.
- Plexiglass models: Plexiglass models are obtained by heating the sheets of this material and making them acquire the shape of the pre-designed mold.

This class of products is, among those analyzed, the one with the lowest profit impact. Being characterized by medium supply risk, the main objective is to diversify the supplier base as much as possible. This is definitely feasible given the topicality of the sector. By diversifying the base, the purchasing and negotiating powers become those of non-critical items.

Analyzing the Cost Breakdown Structure associated to the Rapid Proto kits, there are:

- Elements: the cost of the elements in the case of Sintering Print can reach 90% of the total cost associated with the entire volume of components to be produced. Differently, in the other two cases, Silicone and Plexiglass models, the variable cost is between 65-80% of the total cost associated with the entire volume of components to be produced;
- Molds: the cost of the molds in the cases of Silicone and Plexiglass models are semi-variable in nature, and this depends on the volume of products associated with each individual mold. The percentage on the total cost is 10-20%;
- Control: the control phase for these components is not as fundamental as for the others. Control is important only on important aesthetic components. The cost associated with this phase is variable and is less than 5% of the total costs;
- Assembly Tooling;
- CNC Machining: for Silicone and Plexiglass models, operations with CNC machines are often required. The cost associated with these activities is often included, is variable in nature and in the case of quotation is less than 5% of the total cost;
- Re-Setup;
- Transport and Packaging.

COST UNIT	TYPE OF COST	% ON THE TOTAL COST
Elements	Variable	65-90%
Molds	Fixed/Variable	10-20%
Control	Variable	<5%
Assembly tooling	Variable	<5%
CNC Machining	Variable	included
Re-Setup	Fixed	<5%
Transport and Packaging	Variable	included

Table 26 - Rapid Proto CBS

In the Figure 25 the Benchmark is represented working for the component list on the left: sintered kit, silicone kit and plexi kit.
For each supplier the Lead time, the Global Rating and the split between fixed and variable costs are recalled, with the total on the right.
There are five suppliers, all with yellow code in the global rating. This underlines the ease of supply of these products. All have 4 week of lead time.

By analyzing the benchmark, it is clear that supplier 1 is more competitive than the others from all points of view on the Sintered kit and on the plexi kit. The plexi kit instead is slightly more critical.

In the event that it is possible to further diversify the supplier base, reducing the supply risk, the class of products obtained through Rapid Proto can fall into non-critical items, with the possibility of exploiting the purchasing power and the negotiating power to establish a very competitive relationship with suppliers.

It has been noted that in the purchase, given the low complexity of the market segment in which it operates, a saving of 10-20% could be achieved after negotiation.

	SUPPLIER 1			SUPPLIER 2			SUPPLIER 3			SUPPLIER 4			SUPPLIER 5			
DELIVERY TIME	3 Weeks			4 Weeks			3 Weeks			4 Weeks			4 Weeks			
RATING																
Product Description	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	Tot *Fixed Costs*	Tot *Variable Costs*	Tot Costs	**BUDGET**
Sintered KIT	€ -	€ 10.400,00	€ 10.400,00	€ -	€ 14.500,00	€ 14.500,00	€ -	€ 20.500,00	€ 20.500,00	€ -	€ -	€ -	€ -	€ -	€ -	€ 12.000,00
Silicone KIT	€ 1.650,00	€ 2.200,00	€ 3.850,00	€ 2.500,00	€ 3.100,00	€ 5.600,00	€ 2.500,00	€ 4.900,00	€ 7.400,00	€ 3.500,00	€ 5.500,00	€ 9.000,00	€ 1.450,00	€ 6.000,00	€ 7.450,00	€ 7.000,00
Plexi KIT	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ 2.400,00	€ 2.400,00	€ -	€ 5.000,00	€ 5.000,00	€ -	€ 4.500,00	€ 4.500,00	€ 2.500,00
	€ 1.650,00	€ 12.600,00		€ 2.500,00	€ 17.600,00		€ 2.500,00	€ 27.800,00		€ 3.500,00	€ 10.500,00		€ 1.450,00	€ 10.500,00		
TOTAL OFFER	€ 14.250,00			€ 20.100,00			€ 30.300,00			€ 14.000,00			€ 11.950,00			

Figure 22 - Benchmark Rapid Proto

8.4.7 Painting

The painting of vehicle interior and exterior parts is the process by which the supplier receives the parts from the customer and treats them superficially, to give them the desired texture and color.

The stages of this process are:

- Preparation of the piece

- Application of the first primer by spray or integral bath in the paint

- Sanding

- Painting and color sampling

- Infrared drying

- Finishing

- Polishing

- Quality check

It is preferable to receive a quotation from suppliers for each phase, both in terms of the raw materials used, both in terms of machinery and skilled manpower.

The market segment specialized in painting is characterized by low Profit Impact but by very high supply risk. The main problem of this segment is the scarcity of specialized suppliers, capable of supplying a high quality and customized product.

Analyzing the Cost Breakdown Structure of Painting, the costs are divided into:

- *FIXED COSTS PER UNIT*

  - Raw Materials
  - Machine
  - Measurement Tool
  - Production equipment
  - Activity management
  - Manpower
  - Rework

- *VARIABLE COSTS PER UNIT*

  - Post curing rough pieces
  - Sanding
  - Fund application
  - Complete painting
  - Polish
  - Packaging
  - Transport
  - CTR

The Figure 26 shows the cost breakdown for one of the suppliers as an example.

The benchmark essentially refers to the last two lines of the figure, where the total fixed and variable costs and the total offer are taken in consideration, the Lead time and the Global Rating are recalled from previous sheets.

Usually the most critical costs are those associated with the complete final painting phase and the equipment for production. However, depending on the complexity of the project that the customer wants to carry out, the costs associated with skilled manpower, activity management and machines could be important.

For this type of product, given the medium-low purchasing and negotiating power of the buyer, the main objectives are:

- create medium-long term relationships, without making too much pressure on the prices set by the supplier, being satisfied with achieving savings of less than 5%

- diversify the supplier base as much as possible.

Fixed Costs per Unit	**Quantità - *Quantity***		**Costo unitario**		**Totale *Total Price***	*Variable Costs per Unit*	**Quantità - *Quantity***		**Costo unitario**		**Totale *Total Price***
Raw Materials	-	kg	-	€/kg	€ 2.500,00	*Post curing rough pieces*	20,00	h	20,00	€/h	€ 400,00
Machine Cost	0,00	h	0,00	€/h	€ -	*Sanding*	30,00	h	20,00	€/h	€ 600,00
Measurement Tool	25,00	h	25,00	€/h	€ 625,00	*Fund application*	100,00	h	30,00	€/h	€ 3.000,00
Production equipment	-	pz	-	€/pz	€ 3.500,00	*Complete painting*	100,00	h	35,00	€/h	€ 3.500,00
Activity management	40,00	h	30,00	€/h	€ 1.200,00	*Polish*	25,00	h	20,00	€/h	€ 500,00
Manpower	0,00	h	0,00	€/h	€ -	*Packaging*	10,00	pz	20,00	€/pz	€ 200,00
Rework	0,00	h	0,00	€/h	€ -	*Transport*	-	pz	-	€/pz	€ 2.500,00
					€ -	*CTR*	25,00	h	25,00	€/h	€ 625,00
Totale Costi Fissi Total Amount Fixed Costs					**€ 7.825,00**	**Totale Costi Variabili Total Amount Variable Costs**					**€ 11.325,00**
TOTAL OFFER						**€**					**19.150,00**

Figure 23 - Painting CBS example

9 MEDIUM - LONG TERM IMPROVEMENT ACTIVITIES

The Purchasing dept. by choosing a supplier has to consider that:

- the variables involved can take on a qualitative and / or quantitative nature;

- the measures can be objective and / or perceptive judgments;

- historical and / or expected values in a probabilistic sense are used.

A "choice model" must technically be able to manage this heterogeneity, also taking into account any trade-offs between the same services and the logic of the decision maker.

There are multi-criteria analysis methods for decision-making purposes (Multi Criteria Decision Analysis - MCDA) that support the decision maker when faces numerous and conflicting assessments and allow him to obtain a compromise solution in a clear way.

One of the most used methods is the *Analytic Hierarchy Process (AHP)*.

The objective of the Analytical Hierarchy Process model is to relate both quantitative and qualitative factors in a complex problem, consisting of a large number of criteria and alternatives; the connection takes place by assigning priorities to a series of decision alternatives.

By normalizing these multidimensional scales of measures in a single priority scale, the result is a numerical judgment deriving from the evaluation of all these factors.

The first step of the method involves the construction of the "dominance hierarchy", a logical framework (Figure 24) consisting of two or more levels, in which:

- the first level represents the general objective of the evaluation;

- the second level represents the objectives and intermediate criteria closely related to the higher-level objective;

- continuing in cascade, each of these objectives can in turn be divided into more specific objectives (third level) and so on;

- the last level indicates the possible alternatives.

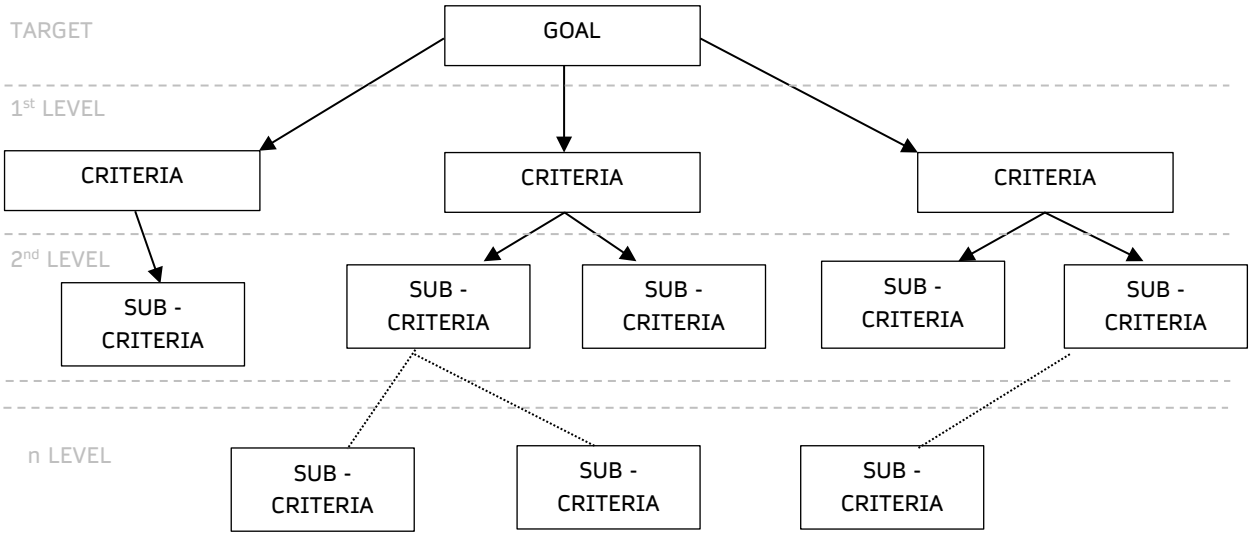


Figure 24 - Logical Framework

In the breakdown of the problem must be guaranteed:

1. *Internal independence*: it is not necessary to compare two objectives or criteria of one level with respect to an objective or criterion of the same or lower level.

2. *External dependence of a level on the upper level*: it must be possible to compare all the elements of a level by taking any of the elements of the upper level as a reference.

The method is based on a series of pairwise comparisons between all elements subordinated to the same element of the hierarchy.

Given the single element A_{ij}, a_{ij} is determined as the numerical value resulting from the comparison between the *n* criteria *i* e *j*.

The result of the $\frac{n\,(n-1)}{2}$ comparisons will generate the matrix A_{nxn} that is used to create the vector of the percentage weights (priorities) of each single criterion.

The elements of each pair are compared in order to establish which of them is more important in relation to the higher-level element, and to what measure:

the result of the comparison is the dominance coefficient a_{ij} which represents an estimate of the dominance of the first element (*i*) with respect to the second (*j*), following the Saaty semantic scale in Table 27 .

VALUES a_{ij}	**INTERPRETATION**
1	*i* e *j* equally important
3	Weak prevalence of *i* over *j*
5	Important prevalence of *i* over *j*
7	Strong prevalence of *i* over *j*
9	Absolute prevalence of *i* over *j*
1/3	Weak prevalence of *j* over *i*
1/5	Important prevalence of *j* over *i*
1/7	Strong prevalence of *j* over *i*
1/9	Absolute prevalence of *j* over *i*
2 , 4 , 6 , 8 , 1/2 , 1/4 , 1/6 , 1/8	To be used in case of greater precision

Table 27 - Saaty semantic scale

The dominance coefficients define the *pairwise comparison matrix*:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix}$$

which is defined as *positive* ($a_{ij} > 0$) and *reciprocal* ($a_{ij} = 1/\ a_{ji}$) as it is constructed.

A generic example with a 3x3 matrix can be:

$$A = \begin{bmatrix} 1 & a & b \\ \frac{1}{a} & 1 & c \\ \frac{1}{b} & \frac{1}{c} & 1 \end{bmatrix}$$

The coefficients that measure the local weight of the individual elements of the hierarchy in relation to the higher-level element, against which they have been compared, can be obtained from the matrix of the pairwise comparisons. Each element has as many locally calculated weights as there are objectives to which it is directly subordinated.

The last step of the algorithm is to calculate applying the principle of hierarchical composition (Saaty 1980) to determine the importance of each element with respect to the general objective of the evaluation.

Mathematically this consists in the use of the matrix product techniques or in "climbing the tree". In this case the local weights of each element are multiplied by those of the corresponding higher-level elements and the products thus obtained are added together. This continues until the local weights of all the elements of the hierarchy are gradually transformed into global weights: the greater the global weight of the intermediate criteria, the more preferable they will be.

9.1 Application of A.H.P. Model to the Supplier Nomination

- *Definition of the dominance hierarchy*

  A reticular structure is created with the "Nomination of the supplier" as the general objective of the evaluation (Figure 25).

  The second level contains the criteria for achieving the objective:
  -Quotation (Costs)
  - Quality
  - Service Timing.

  The third level presents:
  - Quality: Global IDG Rating deriving from the rules mentioned above, crossing the various assessments of the departments, and continuity of quality standards, measured as

$$\frac{Number\ of\ Non\ Conformance\ Complaints}{Max\ of\ Non\ Conformance\ Complaints}$$

  in the last 12 months, i.e. the number complaints formally made to the supplier when the components it procures do not meet the required standards.
  - Service Timing: Lead time and Punctuality, measured as the Number of Delivery Promises broken in the last 24 months.

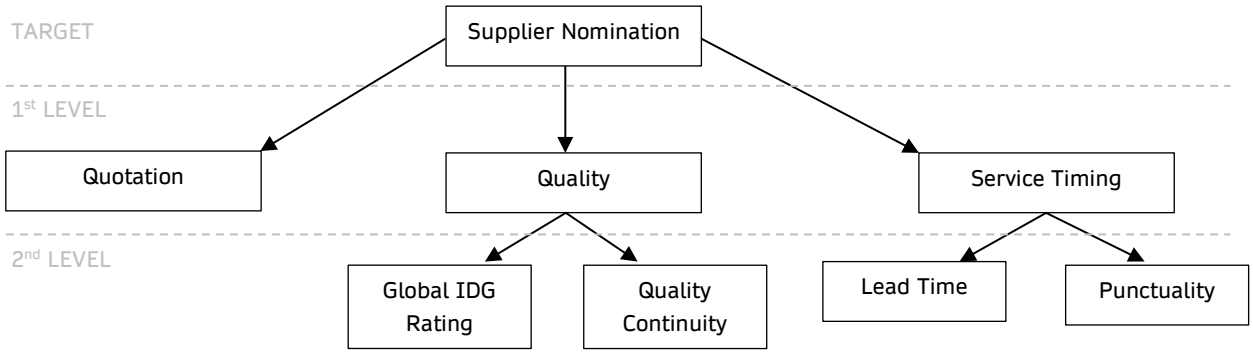


Figure 25 - Logical Framework for Supplier Nomination

Remark: Usually the method works well going to compare a finite number of criteria (up to a maximum of 9) and sub-criteria (up to a maximum of 5 for each criterion).

This method application could be enriched by adding factors such as: innovation, supplier flexibility, payment conditions, assortment of proposed technologies, differentiation, etc.

- *Construction of the pairwise comparison matrix* for the 2nd LEVEL

  All the elements underlying the same criterion are compared in pairs using the Saaty semantic scale, to derive a dominance coefficient of one over the other.

  - QUALITY criterion

  It was assumed that the Global IDG Rating is of weak dominance over the fact that suppliers have a continuity of quality over a 12-month period.
  This assumption stems from the fact that the Global IDG Rating derives from a cross-cutting on several fronts of the company's panoramic quality. This is important compared to the supply in the last 12 months of defective components or components that present a quality lower than the standards required by Italdesign, which however they directly affect the production process and customer satisfaction.

  - SERVICE TIMING criterion

  Starting from the hypothesis that the punctuality of delivery within 24 months is of important dominance over the delivery time.
  This assumption stems from the fact that it is preferable to have a supplier who takes longer to deliver but who is reliable in punctuality, rather than a supplier who promises shorter delivery times but delays in delivery.

The two matrices of the pairwise comparisons for the Quality (A) and Service Timing (B) criteria are shown below.

	Global IDG Rating	Quality Continuity
Global IDG Rating	1	3
Quality Continuity	1/3	1
TOTAL	**1.333**	**4**

	Lead Time	Punctuality
Lead Time	1	1/5
Punctuality	5	1
TOTAL	**6**	**1.2**

- *Normalization of the pairwise comparisons matrices* A and B

  The normalization of the matrices is done by dividing the value in the cell by the total sum of the reference column, and calculating the average per row, which represents the weight of each criterion.

	Global IDG Rating	Quality Continuity	**LINE AVERAGE-WEIGHT**
Global IDG Rating	0.75	0.75	**0.75**
Quality Continuity	0.25	0.25	**0.25**

	Lead Time	Punctuality	**LINE AVERAGE-WEIGHT**
Lead Time	0.167	0.167	**0.167**
Punctuality	0.833	0.833	**0.833**

- *Construction of the pairwise comparisons matrix* for the 1st LEVEL

  The pairs comparison matrix (C) is built for the Quotation, Quality and Service Timing criteria. Considering the business of developing showcars, the hypothesis that the descending order of dominance between the criteria was Quality, Quotation and Service Timing is done.
  This assumption stems from the fact that in this type of business, it is necessary to maintain decidedly high-quality standards even with high costs. Moreover, being long and complex projects, the annual orders are few and more flexible timings can be afforded.

	Quality	Quotation	Service Timing
Quality	1	5	9
Quotation	1/5	1	7
Service Timing	1/9	1/7	1
TOTAL	**1.311**	**6.143**	**17**

- *Normalization of the pairwise comparisons matrix* C

	Quality	Quotation	Service Timing	**LINE AVERAGE-WEIGHT**
Quality	0.763	0.814	0.529	**0.702**
Quotation	0.15	0.163	0.412	**0.242**
Service Timing	0.085	0.023	0.059	**0.056**

At this point all the criteria at all levels have their dominance level, which indicates their relative importance (Figure 26).

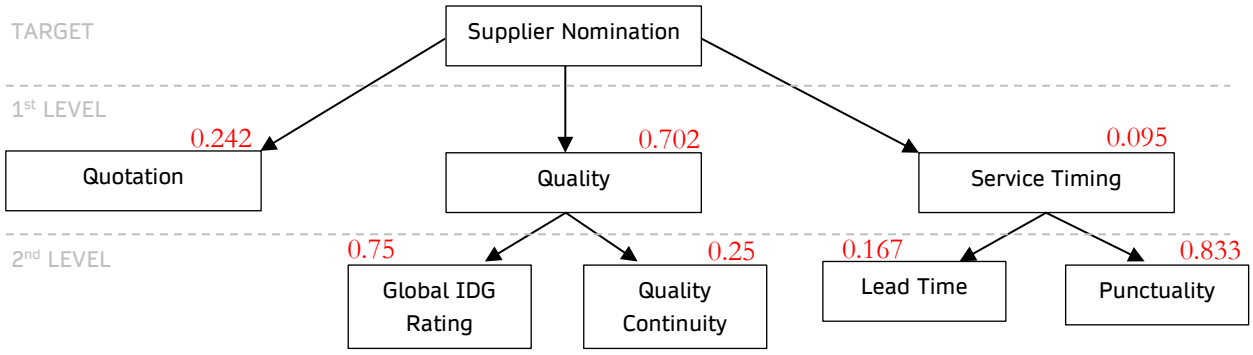


Figure 26 - Dominance hierarchy

- ***Example of the Model Application***

The buyer must nominate a supplier for the purchasing of the imperial in CFK of a show car, having a budget of € 12,500 choosing from the following 3 quotes:

- Supplier 1

- Quotation: 12.000 €
- Global IDG Rating: Green 4
- N° NNC (last 12 months): 1 [max NNC= 12] → Quality Continuity QC= 8.33%
- Lead Time: 4 weeks
- N° Broken Promises (last 24 months): 4 [max BP=24] → Punctuality PUNC= 16.67%

- Supplier 2

- Quotation: 13.000 €
- Global IDG Rating: Yellow 3
- N° NNC (last 12 months): 2 [max NNC= 12] → Quality Continuity QC= 16.67 %
- Lead Time: 3 weeks
- N° Broken Promises (last 24 months): 0 [max BP=24] → Punctuality PUNC= 0%

- Supplier 3

- Quotation: 13.500 €
- Global IDG Rating: Yellow 3
- N° NNC (last 12 months): 0 [max NNC= 12] → Quality Continuity QC= 0%
- Lead Time: 4 weeks
- N° Broken Promises (last 24 months): 1 [max BP=24] → Punctuality PUNC= 4.17%

The following Table 28 has been hypothesized to make the assignment of preference scores as objective as possible during the construction of the matrices:

Δ% QUOTATION $\frac{HIGHER\ QUOTATION - LOWER\ QUOTATION}{LOWER\ QUOTATION}$%	**GLOBAL IDG RATING**	**Δ QC**	**Δ LEAD TIME**	**Δ PUNC**	**SCORE**
0% ≤ X < 5%	GREEN/ GREEN YELLOW/YELLOW	0	0 WEEK	0	**1**
5% ≤ X < 10%	GREEN/YELLOW	8.33%	1 WEEK	0% < X ≤ 8.33%	**3**
10% ≤ X < 20%	YELLOW/RED	16.67%	2 WEEK	8.33% < X ≤ 16.67%	**5**
X ≤ 20%	GREEN/RED	> 16.67%	≥ 3 WEEK	> 16.67%	**7**

Table 28 - Score Table

The basic model for nominating a supplier involves the following procedure:

- Construction of the pairwise comparisons matrices of suppliers with respect to each criterion taken into consideration and calculation of the relative weight of importance through normalization.

  - Global IDG Rating

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3
SUPPLIER 1	1	3	3
SUPPLIER 2	1/3	1	1
SUPPLIER 3	1/3	1	1
TOTAL	**1.667**	**5**	**5**

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3	**LINE AVERAGE-WEIGHT**
SUPPLIER 1	0.6	0.6	0.6	**0.6**
SUPPLIER 2	0.2	0.2	0.2	**0.2**
SUPPLIER 3	0.2	0.2	0.2	**0.2**

- Quality Continuity

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3
SUPPLIER 1	1	3	1/3
SUPPLIER 2	1/3	1	1/5
SUPPLIER 3	3	5	1
TOTAL	**4.333**	**9**	**1.533**

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3	LINE AVERAGE-WEIGHT
SUPPLIER 1	0.231	0.333	0.217	**0.26**
SUPPLIER 2	0.077	0.111	0.130	**0.11**
SUPPLIER 3	0.692	0.556	0.652	**0.63**

- Lead Time

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3
SUPPLIER 1	1	1/3	1
SUPPLIER 2	3	1	3
SUPPLIER 3	1	1/3	1
TOTAL	**5**	**1.667**	**5**

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3	LINE AVERAGE-WEIGHT
SUPPLIER 1	0.2	0.2	0.2	**0.2**
SUPPLIER 2	0.6	0.6	0.6	**0.6**
SUPPLIER 3	0.2	0.2	0.2	**0.2**

-Punctuality

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3
SUPPLIER 1	1	1/5	1/5
SUPPLIER 2	5	1	3
SUPPLIER 3	5	1/3	1
TOTAL	**11**	**0.633**	**4.2**

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3	**LINE AVERAGE-WEIGHT**
SUPPLIER 1	0.091	0.316	0.048	**0.151**
SUPPLIER 2	0.454	0.158	0.714	**0.442**
SUPPLIER 3	0.692	0.526	0.238	**0.406**

- Construction of a matrix for each first level criterion following the procedure: in each cell, the following formula must be applied:

  weight related to the second level criterion · weight of importance of the higher level

  where *the weight of importance of the higher level* is obtained by the comparison in pairs between the elements of the same level. To go up the hierarchy and move to the upper hierarchical level, the values calculated above for each supplier have to be added horizontally.

  - Quality

	GLOBAL IDG RATING 0.75	QUALITY CONTINUITY 0.25	**TOTAL**
SUPPLIER 1	$0.6 \cdot 0.75 = 0.45$	$0.26 \cdot 0.25 = 0.065$	**0.515**
SUPPLIER 2	$0.2 \cdot 0.75 = 0.15$	$0.11 \cdot 0.25 = 0.0275$	**0.1775**
SUPPLIER 3	$0.2 \cdot 0.75 = 0.15$	$0.63 \cdot 0.25 = 0.1575$	**0.3075**

- Service Timing

	LEAD TIME 0.167	PUNCTUALITY 0.833	**TOTAL**
SUPPLIER 1	$0.2 \cdot 0.167 = 0.0334$	$0.151 \cdot 0.833 = 0.126$	**0.159**
SUPPLIER 2	$0.6 \cdot 0.167 = 0.1002$	$0.442 \cdot 0.833 = 0.368$	**0.469**
SUPPLIER 3	$0.2 \cdot 0.167 = 0.0334$	$0.406 \cdot 0.833 = 0.338$	**0.372**

- Construction of the matrix of pairwise comparisons of suppliers with respect to the Quotation criterion and subsequent normalization, which does not present any lower level element

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3
SUPPLIER 1	1	3	5
SUPPLIER 2	1/3	1	1
SUPPLIER 3	1/5	1	1
TOTAL	**1.533**	**5**	**7**

	SUPPLIER 1	SUPPLIER 2	SUPPLIER 3	**LINE AVERAGE-WEIGHT**
SUPPLIER 1	0.652	0.6	0.714	**0.655**
SUPPLIER 2	0.217	0.2	0.143	**0.187**
SUPPLIER 3	0.131	0.2	0.143	**0.158**

- The data is aggregated in a last matrix where the results obtained by each supplier for each dimension are reported and multiplied by the relative weights. The total score is given by the sum on the row of the previously calculated products.
  The alternative with the highest score is the one to choose.

  The preferred supplier will be supplier 1 since he is the one who has obtained a higher score, followed by supplier 3 and finally supplier 2.

	QUOTATION 0.242	QUALITY 0.702	SERVICE TIMING 0.056	**TOTAL**
SUPPLIER 1	$0.655 \cdot 0.242 = 0.158$	$0.515 \cdot 0.702 = 0.361$	$0.159 \cdot 0.056 = 0.0089$	**0.529**
SUPPLIER 2	$0.187 \cdot 0.242 = 0.045$	$0.1775 \cdot 0.702 = 0.125$	$0.469 \cdot 0.056 = 0.0262$	**0.186**
SUPPLIER 3	$0.158 \cdot 0.242 = 0.038$	$0.3075 \cdot 0.702 = 0.216$	$0.372 \cdot 0.056 = 0.0201$	**0.275**

Recapitulating, among the multi-criteria analysis methods for decision-making purposes, the A.H.P. represents a good compromise between the goodness of the algorithm and ease of use.

It has the following advantages:

- Ability to include evaluation at high levels of detail and examine design alternatives characterized by heterogeneous assessment criteria (quantitative and qualitative);

- Simplicity in assigning the score, given that each assignment is made through the comparison between pairs of objects;

- Clear visualization of the importance of the evaluation criteria thanks to a hierarchical vision of them;

- Direct understanding of the consistency of the assessments made;

On the other hand, among the disadvantages there are:

- The presence of simple calculations but use of many matrices;

- Need to repeat the whole process if new elements are introduced into the model.

10 RESULTS

Following the objectives set by Italdesign regarding the study and improvements of the components purchasing processes, after an analysis of the company reality and the possibilities for enhancement, the following actions were carried out:

- Introduction of the concepts and tools related to Purchasing management, on the management of the purchasing process and relations with suppliers;

- Detailed study of the main product classes of a project and components and supplier management policies.

- Implementation of a standard RFQ template and an automated and customized benchmark for each product class;

- Implementation of a mathematical model for the choice of supplier nomination

In this context, it is difficult to describe the results obtained because they are difficult to measure. However, it should be noted that all activities set as short-term objectives would soon be used in the company's daily working life. The main results expected by the company management from the implementation of this project are:

- the reduction of subjectivity in purchasing decisions;

- making the buyer activities leaner and increasing efficiency in the data collection and comparison phase;

- change of vision of the relationship with suppliers depending on the product class with which the company is working, trying to obtain as much as possible a collaborative relationship, where customer and supplier are on the same level and work together to achieve their goals,

continuing to pursue the common responsibilities of the purchasing organization, that are:

- identifying cost reduction opportunities;

- qualifying and selecting suppliers;

- guaranteeing control over pricing;

- guaranteeing quality and punctuality of service.

It is clear that any improvement upstream of the supply chain can directly affect the end customer. This is why the implementation of the AHP mathematical model can bring major improvements to the evaluation in the supplier nomination phase, especially thanks to the cross-reference of historical and present data.

11 CONCLUSION AND FUTURE WORK

By comparing the work carried out within Italdesign with the initially set objectives of improving the component purchasing process, it can be said that, in general, all the activities carried out to achieve the short-term objectives will soon be completed, approved by company management and will already come into use in the company's daily working life.

The medium - long term objectives are not currently assessable; despite this, the models introduced and proposed were received by the company with great enthusiasm, creating optimistic expectations of the improvements expected from their implementation. The company will now take care of carrying out the work started to achieve an increasingly effective and efficient purchasing process in all its parts, with the aim of streamlining processes more and more and establishing transparent relationships with suppliers, and collaborative with a view to continuous improvement.

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