# Chapter 2
# IPPR Methodological Foundations

## 2.1 Introduction

The analysis and solution model underpinning IPPR consists in a set of activities that are organized along a common path for each class of reengineering problems, as clustered in the previous Chapter.

Basically IPPR method follows a well established logic which is universally acknowledged as a standard to analyze and solve technical problems. It is grounded on three main phases: (i) situation analysis and representation of the relevant information; (ii) identification of the system criticalities; (iii) individuation of the suitable solving directions. The aim of IPPR is to perform the step-by-step procedure with a constant orientation towards what concerns customer value and perceived satisfaction. To this end, the whole body of the methodology suggests suitable tools and techniques.

However, given the consolidated logic adopted by IPPR (i.e. *analysis* of the problem, *diagnosis* of the reengineering opportunities, *synthesis* of the solutions), each task can be performed by the usage of alternative instruments dedicated to the design of products and processes. Thus, the reader can use his/her own body of knowledge to carry out the activities consistent with IPPR, with regards to his/her competencies in the fields of business process reengineering and new product development. Otherwise, the user can benefit from the original tools illustrated in Chap. 3, which highlights the preferred employment of value-oriented instruments for each step of the methodology.

According to the objectives of this Chapter, the introductory parts of the Subsections belonging to 2.2 report an overall description of IPPR by providing an overview of the main methodological steps and their partial outputs. Subsequently, the remaining content of the Subsections reports a detailed description of the tasks, activities, expected results foreseen by each step of the methodology. As a whole, the presentation of the coverage is organized on the basis of the classification of the business problems already introduced in Chap. 1.

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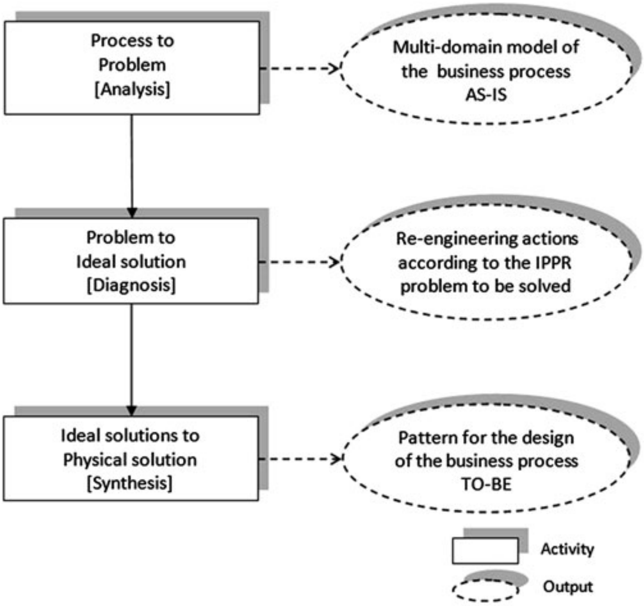


**Fig. 2.1** Workflow and partial outputs of IPPR methodology

As a result of the description of IPPR structure, the main activities to be carried out are summarized in Sect. 2.3.

## 2.2 The Logic and the Structure of IPPR: Steps, Activities and Outcomes

IPPR methodology leads the user to the identification of feasible process/product innovations by means of an analysis and solution path based on three main steps. The workflow of activities and the arising outputs are depicted in Fig. 2.1.

However, in order to successfully carry out the depicted activities, IPPR practitioners are requested to preliminarily acquire the information about the problem to be investigated. With this aim, the Sect. 2.2.1 discusses the objectives to be attained with regards to the collection of the essential elements of knowledge.

The aim of the *Process to problem* step is to obtain an exhaustive description of the AS-IS situation by investigating the industrial operations and their outputs. The result of this phase is constituted by a model of the business process capable to represent all the aspects related to both the functional and economic domains. Such a multidimensional approach allows to manage the cross-disciplinary nature of the

**Table 2.1** Organization of the content related to each phase of IPPR methodology within the present Chapter in function of the class of business process problem to be addressed

| | Problem to process | Process to ideal solution | Ideal solution to physical solution |
|---|---|---|---|
| Class 1 and Class 2 | 2.2.2.1<br>2.2.2.2<br>2.2.2.3 | 2.2.3.1 | 2.2.4.1 |
| Class 3 | 2.2.2.2<br>2.2.2.3 | 2.2.3.2 | 2.2.4.2 |

business process. This is the key feature enabling a comprehensive analysis of a large amount of common industrial problems.

The loss of competitiveness of a business process occurs when the provided outputs are no longer able to satisfy the customer expectations, nor to attract market segments through appealing and original product designs. The causes that determine such situation have been already extensively described in Chap. 1 and, generally speaking, they may be related to aspects falling into the sphere of industrial process and/or of the delivered product. Such causes represent what we can call *value bottlenecks*, since they somehow impact (negatively) the customer perceived value.

The second step, named *Problem to Ideal solution*, is focused on the clear identification of the recalled value bottlenecks and eventually of potential innovation opportunities. Moreover, once the critical aspects of the business process have been analyzed, proper reengineering actions are defined in order to remove the value bottlenecks and preserve or regain the market competitiveness. These guidelines are expressed in the form of new process requirements for the problems belonging to the class 1 and 2, while they are depicted as directions for the transformation of product profiles, with reference to the class of problem 3. The emerging hints represent the inputs of the subsequent design activities which are aimed at identifying suitable technical solutions for the implementation of the ideas of the new process or product.

The last step, namely *Ideal solution to Physical solution*, suggests the suitable and acknowledged instruments to support the design activities of the physical solutions concerning the introduction of new industrial process phases, the improvement of the existing ones, the reorganization of the resources allocation programs, the production of innovative items and the delivery of novel services.

The sequences of activities summarized in Fig. 2.1 are customized according to the business process problem that should be addressed. Table 2.1 indicates the sections of the present Chapter in which the reader can find the relevant criteria to shape each step of the IPPR methodology according to the class of reengineering problems defined in Chap. 1.

**Table 2.2** Checklist providing the overall set of relevant information to be gathered according to the class of problem to be faced

| Problem to be solved | Information to be gathered |
|---|---|
| Class 1 and Class 2 | Phases of the business process |
| | Flows of materials, energy and information |
| | Elapsed duration of each phase, labour time, dead times |
| | Involved technologies |
| | Occupied space |
| | Involved human skills and knowledge |
| | Other phase expenditures |
| | Control and evaluation parameters governing each phase |
| | Customer requirements and their relevance in determining the customer perceived value |
| | Contribution of each phase in determining the product requirements |
| Class 2 | Determinants for delighting the customer |
| | Determinants for avoiding the customer dissatisfaction |
| Class 3 | Product attributes of the treated product and of the competing ones |
| | Performances levels at which the product attributes are delivered |
| | Kind of benefits perceived by the user in delivering product attributes |

### *2.2.1 Performing Information Gathering for IPPR*

The information gathering is a preliminary activity to be performed in order to widen the knowledge of the IPPR user about the business problem to be treated. The additional information to be collected with the aim of carrying out the subsequent tasks in a more rigorous way strongly depends on the nature and the role of the practitioner (product manager, analyst, CEO, researcher, etc.) and thus on the main individual lacks of knowledge.

In order to address the sources of information to be preliminarily consulted, Table 2.2 summarizes the aspects to be treated within IPPR with reference to process and product reengineering.

Commonly, the activity is carried out by taking in consideration several information sources. At the beginning of the information acquisition, sources like books, reports, manuals and catalogues play a significant role for the definition of the background of the industrial sector to be analyzed [1]. Subsequently, more detailed and explicit information can be extracted through the consultation of domain experts and involved personnel [2].

The ideal result of the information acquisition would be the extraction and codification of tacit knowledge, which plays a significant role especially within the description of processes, by highlighting human practices when performing operations. The concept of tacit knowledge was introduced by Polanyi [3], who defined it as personal, with no possibility to be codified. Since then, the possibility of acquiring and disseminating tacit knowledge is a very debated issue. Many scholars, such as Nonaka [4], have developed Polanyi's conception of tacit knowledge in a practical direction to enhance organizational knowledge creation, assessing the possibility to elicit it. Coherently to this vision and purpose, the task of acquiring tacit knowledge implies to meet directly the employees; the consultation on the shop floor recalls the concept of “gemba”, a Japanese term meaning “the place where the truth can be found”, firstly introduced by Mazur [5] within Quality Function Deployment (QFD) [6].

Also when the attempt of collecting elements of tacit knowledge results an excessively challenging and time-consuming task, it is recommended to take into account the viewpoint of multiple experts. However this can result in contradicting issues arising from overlapping competencies of the involved specialists. In order to overcome the difficulties dictated by the emergence of conflicting visions, different approaches can be chosen:

- a final conjoint consultation of the experts can be organized to conciliate the diverging viewpoints;
- IPPR steps 1 and 2 can be performed separately by multiple experts and then the resulting reengineering directions are compared and integrated;
- with reference to the classes of problem 1 and 2, which employ more quantitative coefficients, statistical tools generally dedicated to deal with uncertainty can be favorably employed to the outcomes of steps 1 and 2, leading to a “best” description and analysis of the process.

### *2.2.2 Process to Problem Phase*

The aim of the first step is to schematize the business process into a general model of the problem, allowing to perform the subsequent analysis steps foreseen by the IPPR methodology.

Such a model describes how the system works in both the technical and economic domain. It summarizes the sequence of the performed phases and their mutual relationships expressed through the flows of inputs/outputs and involved resources such as: material, energy and information, technologies, human skills and know-how, elapsed times and monetary expenditures.

The final outputs of the process are represented by the customer requirements which are fulfilled by the manufactured products and delivered services. These attributes are depicted throughout their performance or offering level and their relevance in determining customer satisfaction and/or avoiding buyer’s discontentment. The Fig. 2.2 shows, in a schematic way, the input data and a conceptual representation of the output model provided by this step.

In order to accomplish the above mentioned objectives, the *Process to Problem* step requires the execution of the following specific activities:

- industrial process modeling;
- product information elicitation;
- product modeling.

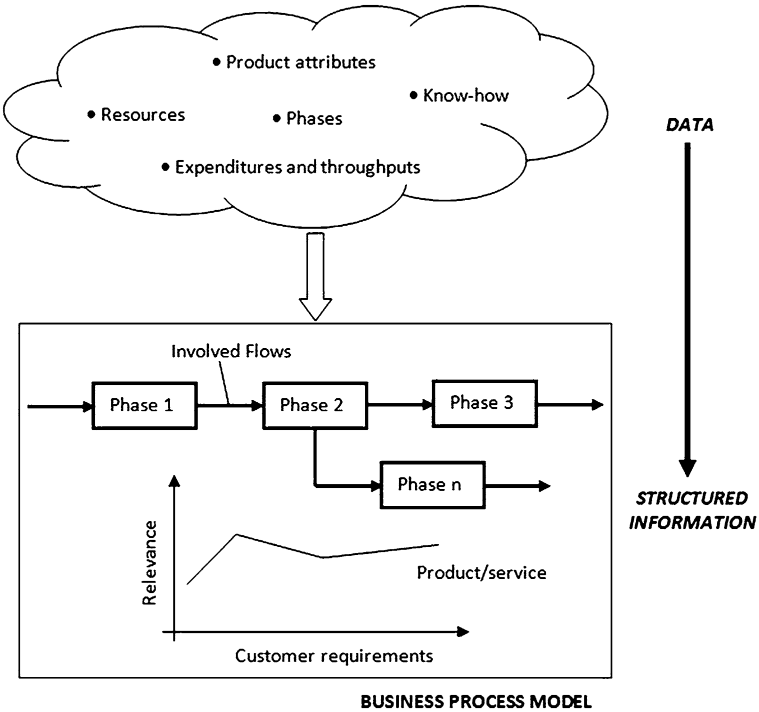


**Fig. 2.2** The "Process to problem" step brings to the definition of a model of the business process (from both the industry and the customer perspective) in both the technical and economical domains. This model is used to perform all the subsequent analysis tasks

Here in the followings these tasks are described in detail, according to the class of reengineering problems to be addressed.

### 2.2.2.1 Process Modeling

For the problems belonging to the classes 1 and 2, the collected data have to be organized in order to build the process model, a structured representation of the AS-IS situation. Several representation methods with diverging formalisms are available in the literature to support the modeling of industrial activities. However, the various techniques significantly differ in the ability to model the system according to different domains and perspectives. Some techniques focus primarily on the data flows, others on the deployed functions or on the assigned roles of human resources within the process, etc. [7, 8].

A customized multi-domain model, presented in Chap. 3, is suggested to represent the information and data needed to implement the IPPR methodology. Its advantages arise as a result of the hybridization of different modeling techniques, each one tailored to represent different facets of a business process.

Whereas the user would prefer the employment of mastered modeling techniques, the representation of the process has to include at least the following important aspects:

- *Functions*: the model has to report the process phases in terms of performed functions, input and output flows;
- *Multi-domain features*: for each phase of the industrial process, the model has to summarize the involved flows of resources in both the technical (i.e. flows of energy, materials and information) and economical (i.e. monetary flows or equivalent indicators) domains;
- *Control variables and performances*: the model has to allow a clear representation of the control parameters governing each process phase (e.g. cutting speed of a machine tool, bill of materials), as well as the required performances.

#### 2.2.2.2 Product Information Elicitation

The information that is schematized within the process model (classes 1 and 2) supports the identification of a large set of features that the product should have. Indeed, the designed transformations of channeled resources into desired outcomes are justified in terms of the fulfillment of the customer requirements. However, in order to represent a comprehensive record of the process outputs in terms of the elements that currently participate to the building of customer value, suitable checklists are proposed within this step of IPPR.

Furthermore, with the objective of accurately characterizing the business process, the elicitation is a crucial activity of the relationships existing among the phases and the terms contributing to the perceived customer value. At the firm level, the phases can be considered like the segments that constitute the value chain, as defined in the literature by Porter [9] and some other scholars. According to this concept, each function performed along the investigated process contributes in fulfilling the characteristics of the final product or service, thus in the generation of value. Basically, the extent of such a contribution depends on the number of properties of the elaborated inputs that are modified by the function, as well as by the magnitude of such changes. In the context of product development strategies, the recalled QFD investigates the interplay among customer expectations and engineering characteristics that meet the needs of the end-user. With a similar logic, the proposed task requires mapping the features underlying the accomplishment of each customer requirement. Subsequently the phases, properly identified in the modeling step, that modify or deal with those features are monitored by the business process experts in order to define their accounted ratios in fulfilling the customer requirements (CRs). For instance, the requested speed of a courier service is achieved by the correct functioning of all the phases impacting the delivery time of some goods, thus all the operations concerning the scheduling, the warehousing and the transportation of the sent items. The relative contributions

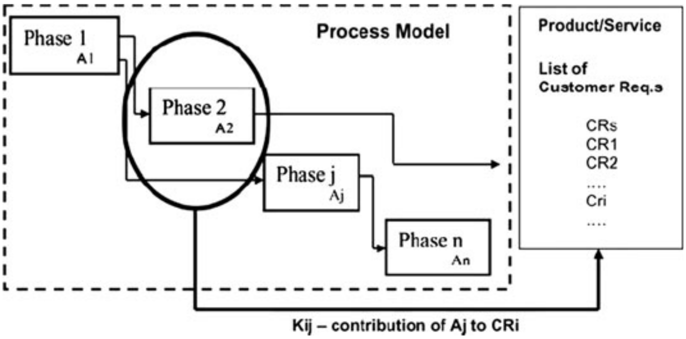


**Fig. 2.3** The coefficients $k_{ij}$ represent the contribution of the j-th phase to the satisfaction of the i-th customer requirement

addressed to the j-th phase in ensuring the achievement of the i-th customer requirement (CR) will be further on indicated with the variable $k_{ij}$. As represented in Fig. 2.3, the coefficients $k_{ij}$ can be evaluated as a correlation between the properties of the objects modified by each function and the CRs of the final product.

With reference to the problems concerning product reengineering (class 3), the objective of the activity is the elicitation of the information related to the dimension of customer satisfaction. A suitable tool is proposed with the aim of individuating the circumstances potentially guiding to the emergence of sources of value, regardless they have been already exploited or not. The structured search should therefore lead to the individuation of a comprehensive set of offered product attributes and, eventually, if required by the case study, to ease the monitoring of the competition. Additionally, the mapping process may allow the discovery of disregarded performances or characteristics, thus facilitating the task of designing a new product profile.

#### 2.2.2.3 Product/Service Modeling

The product model summarizes the offered value profile according to the competing factors of the market where the business process operates. This activity is aimed at identifying the product attributes delivered to the customer, their relevance and role in determining the customer satisfaction.

Within IPPR, different representations are adopted for the process related problems (classes 1 and 2) and product oriented reengineering tasks (class 3).

The first circumstance requires a description of the process output in the perspective of the company, by shedding light on *how much* the product delivers value or avoids dissatisfaction. A basic activity concerns therefore the classification of the customer requirements through a criterion capable to highlight the extent in impacting the customer contentment. As widely acknowledged in

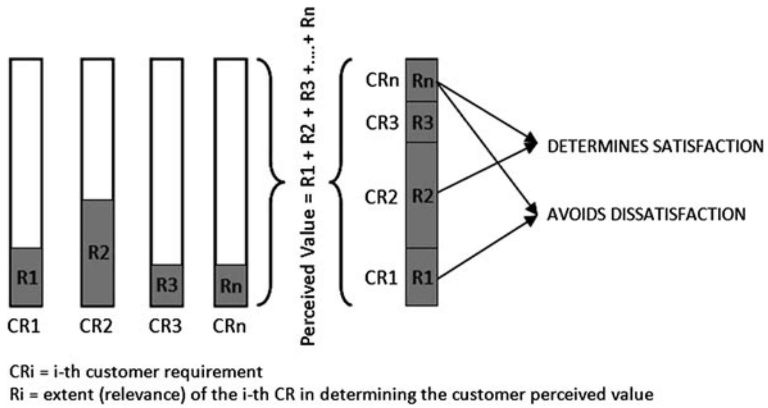


**Fig. 2.4** The classification scheme of the customer requirements according to the relevance in determining the customer perceived value and the role played in impacting the customer satisfaction/dissatisfaction

the literature [10], some product characteristics are able to generate satisfaction for the end-user, while the presence of some other characteristics is merely motivated by the need to avoid the customer dissatisfaction. Moreover, the extent in determining the customer satisfaction and/or avoiding dissatisfaction depends on the importance of each product feature within the perceived value. Thus, the twofold properties characterizing the customer requirements suggest the adoption of a scheme (Fig. 2.4) to describe the attributes in terms of:

- the extent (relevance R) at which they impact the customer perceived value;
- the role in determining the customer satisfaction and avoiding the product rejection.

Nevertheless, certain circumstances can invalidate the prerequisites for which the distinction is meaningful between attributes aimed at, respectively, generating satisfaction and avoiding discontentment. Such conditions characterize all business processes intended to fulfill just customer requirements imposed by regulations, standards or requested by the purchaser (i.e. for third-parties or suppliers), as well as merely focused at replicating the performances of the products in the marketplace. Beyond imitation, the last case is common for companies facing the need to achieve certain product characteristics to stay competitive, but whose business is affected by unpredictable external problems (e.g. shortage of materials, soaring prices of certain required resources, etc.). Thus, whenever the reengineering task is oriented towards the achievement of predefined targets, ranging outside the sphere of the company decisions, the qualitative classification of the role played by the product features in impacting the customer satisfaction misses the original sense. According to this assumption, all the business process problems falling into the first class do not require the classification of the customer requirements, being the definition of the relevance scores sufficient to characterize their contribution in building value.

Among the classification hypotheses regarding the different kind of features determining the customer satisfaction, the model employed by IPPR adopts the categories introduced by Kano et al. [10], representing the most established clustering criteria available in the literature.

With the aim of supporting the problems belonging to class 3, a suitable representation of the product profile is proposed, which emphasizes *how* the attributes deliver value and whether their offering level is adequate for the current demand from the customer viewpoint. For the scope of product reengineering, a suitable clustering of the fulfilled attributes supports the identification of the most favorable directions to attain new value profiles. Such a categorization concerns the distinction of the product features according to the functional role played in determining positive outcomes for the customer, in avoiding limitation of undesired effects or in giving rise to the reduction of required resources, with reference to the terms that contribute to "Ideality" as suggested by TRIZ [11].

### *2.2.3 Problem to Ideal Solution*

This step is aimed at identifying "what should be changed" in the AS-IS business process in order to increase the benefits for the company, as a result of the enhanced customer value. The customer satisfaction is evaluated as a direct function of the delivered product attributes.

As recalled, according to the classes of reengineering problems defined in Chap. 1, the actions to be undertaken may regard the process, the product or both of them.

The faced difficulties regarding the process may concern the hurdles in entering a new market due to under capacities in providing mandatory product characteristics (class 1) or the loss of competiveness for a consolidated business (class 2). In both circumstances this step is aimed at highlighting the value bottlenecks that hinder the maximization of the customer satisfaction according to the available resources and the buyer demands. This analysis is the starting point for the effective reorganization of the process pursuing the increment of the value delivered to the end-user.

Otherwise, if the lack of competitiveness is due to a product that is definitively no longer capable to appeal the marketplace, it is necessary to define a new value profile. The redesign of the industry outputs can be obtained by rethinking the overall business model and, more specifically, by identifying the product characteristics that can be worthily introduced, emphasized or eventually removed without particular consequences.

With reference to the classification of the industrial problems suggested in the Chap. 1, the implementation of the following tasks is required:

- *Identification of what should be changed in the process*: it is required to solve business problems related to the competitiveness of the industrial process, i.e. problems belonging to the classes 1 and 2.
- *Identification of what should be changed in the product*: it is required to solve problems of product competiveness, i.e. problems falling into the class 3.

In the following paragraphs the activities aimed at identifying what should be changed in the process or in the product, are described in detail.

#### 2.2.3.1 Identification of What Should Be Changed in the Process

Value Engineering, the well known methodology developed by Miles [12], represents a useful starting point with the purpose of identifying the business shortcomings. However, according to the considerations performed in Sects. 2.2.2.2 and 2.2.2.3, the value assessment strategy suggested by Miles requires a shift in order to be employed for the aim of IPPR, from the system perspective to the viewpoint of generated customer satisfaction. More precisely, instead of considering the revenues (as a function of the technical performances) provided by the process functions and the spent resources, the generated benefits should be measured in terms of satisfaction for the customer. Within this vision, the logical path followed by IPPR to identify process bottlenecks, is constituted by three main activities as shown in Fig. 2.5. The involved tasks allow the assessment of the phases' worthiness by exploiting the information gathered in the *Process to Problem* step.

With reference to the industrial problems grouped within the class 2, the coefficients $k_{ij}$ give the possibility to evaluate for each phase suitable indexes, namely *Phase Customer Satisfaction* (PCS) and *Phase Customer Dissatisfaction* (PCD), that express the potential to bring customer contentment and the contribution in avoiding dissatisfaction. Such values represent, respectively, the opportunity for a phase to delight customers and the risk to harmfully impact the product perception. Thanks to PCS and PCD it is possible to determine the contribution of each phase to the general customer contentment by means of an indicator named *Phase Overall Satisfaction* (POS), which is assumed as a measure of the benefits provided by the phase.

A review of the literature shows the availability of metrics for the calculation of indexes to evaluate overall appreciation of products as a function of the terms expressing positive and negative evaluations by the customers (such as PCS and PCD, respectively). Commonly the impacts of satisfaction and (avoided) dissatisfaction are related through linear and non-linear equations to the overall satisfaction. Among them, the one receiving the widest consensus has been obtained through a research work performed by Mittal et al. [13] and has been adopted as a reference for the IPPR methodology. The employed equation is non-linear and it states the asymmetric influence of positive and negative evaluations, with a greater role played by dissatisfaction factors in impacting the general customer

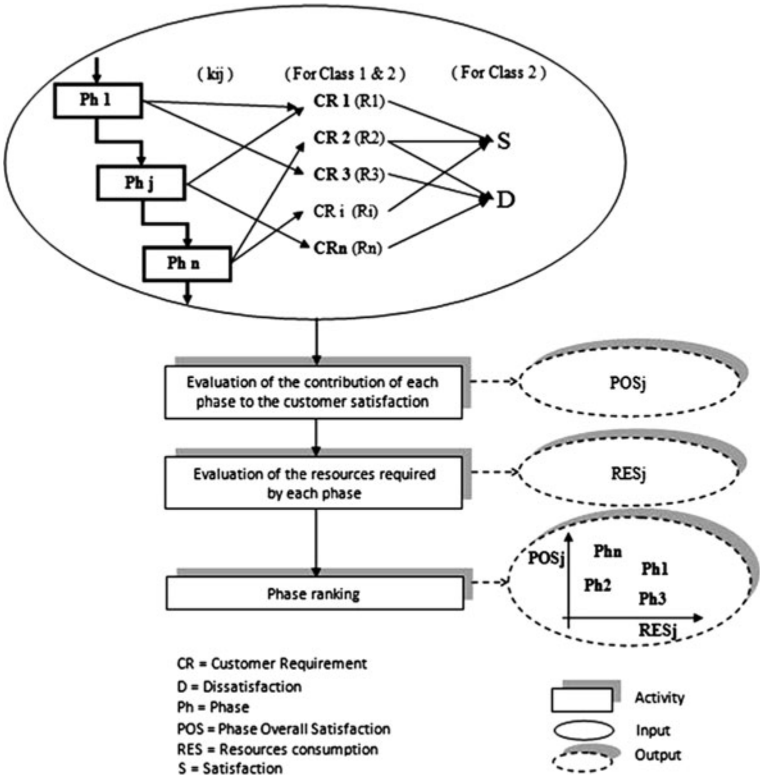


**Fig. 2.5** The logical path suggested by IPPR in order to identify what should be changed in a process

contentment. More details about such model and the metrics adopted for the calculation of PCS and PCD coefficients are provided in Chap. 3.

For the business problems categorized within the class 1, due to the missing of diverse contributions to satisfaction and discontentment, the calculation of the POS is performed by taking into account just the $k_{ij}$ coefficients and the relevance indexes R of the attributes.

Once the POS coefficients have been calculated, the next step requires the evaluation of the resources spent by each phase and eventually the estimation of undesired effects resulting as the process is displayed. Within the context of business processes it is suitable to consider the whole range of resources (occupied space, information and know-how, labor, energy, materials, dead times) and measure their extent, in order to use value formulations for calculating quantitative indicators. Long elapsed times to perform the phases represent relevant hurdles for the business, especially for those industries (e.g. fashion), and kind of firms (e.g. third-parties, suppliers) for which timeliness is a crucial competing factor. All the other kinds of employed resources can be compared in terms of the resulting expenditures, so to be evaluated with uniform units of measurement. With regards to significant harmful effects and their consequences (e.g. pollution and measures to limit its impact, noise, need to introduce particular safety systems), they have to be soundly considered as undesired elements within the business process and its phases. In certain cases they can represent even barriers to carry out the process and then to access the market. In other circumstances the harmful functions can occur in the shape of problems affecting the stability of the system, as well as the repeatability of the process.

When monetary costs, meaningful elapsed times and harmful effects coexist in the business process, experts have to weigh their relative relevance, introducing corrective coefficients for the overall estimation of undesired issues. Further on, with the term *resources*, we will indicate the total mix of expenditures, drawbacks and inconveniences that emerge as the phases of the business process are displayed.

Thanks to the results obtained by the previous assessment activities, it is possible to characterize the phases constituting the process in terms of generated benefits versus spent resources. The insightful analysis of the phases leads towards the individuation of the process bottlenecks in a value-wide perspective.

The ratio between POS and the spent resources provides an *Overall Value* (OV) index suitable to globally identify strengths and weaknesses of the process. Those phases showing a high OV can be considered to be tailored to the business process and their employed resources are well spent in generating customer satisfaction, whereas the ones with low scores represent problematic issues.

The conjoint analysis of the POS and the spent resources helps in characterizing the nature of the bottlenecks: when a low OV is due to a high denominator, i.e. great amount of resources, the focus of the reengineering actions must be oriented towards saving policies. Besides, when a poor OV rate is due to a limited contribution to customer satisfaction, the reengineering initiatives should evaluate the opportunity to eliminate the investigated phase by assigning other segments of the process its functions, substitute the technology adopted so far, introduce new features to be fulfilled without a meaningful increase of the needed resources.

With reference to the reengineering problems pertaining class 2, it is possible to perform further evaluations of the phases, by considering separately, with reference to the spent resources, their capability to achieve customer satisfaction and/or to fulfill the basic requirements of the product. A tailored graphical representation introduced within IPPR illustrates the coupled appropriateness of the process phases in delighting customers and avoiding their dissatisfaction.

In the Chap. 3, all the models and formulas to determine the above described parameters are provided, as well as the suggested representation diagrams.

#### 2.2.3.2 Identification of What Should Be Changed in the Product

Such task refers to the most critical activity involved in the New Product Development cycle.

As stated in the previous Chapter, most of the methods developed to support NPD initiatives are based on the so called "Voice of the Customer" (VoC). The business strategy based on this approach entrusts the main choices of innovation task to the end-user of the manufactured product or the delivered service. However, as noticed in Chap. 1, the VoC commonly brings just to the design of incremental innovations, bounded within what customers can already conceive. As a consequence breakthrough solutions, capable to provide substantial competitive advantages, are not diffused.

These evidences have been confirmed also by several scholars in the field of product innovation management. They have demonstrated that business strategies based on the definition of an innovative set of product features for the reference industry of the company, allow to create new market space by performing a New Value Proposition (NVP). Hence, aiming at radically modifying the product, the tools suggested by IPPR for the third class of business problems are oriented towards the achievement of a strategy based on NVP, rather than being addressed to the fulfillment of explicit needs.

With this scope, the most critical aspect related to NVP initiatives is represented by the definition of the new elements of value to be delivered to the customer. As recalled in Chap. 1, the most established approaches, such as those swiveling on increased servicing (PSSs, SPE), represent just a specific strategy within the creation of new value for customers. On the other hand, despite the general appraisal received in the industrial world, the tools proposed by the BOS are affected by scarce applicability, since their nature is predominantly descriptive rather than prescriptive.

In order to overcome the limits of the recalled methodologies an original tool has been developed within IPPR, namely *New Value Proposition Guidelines* (NVPGs). It consists in a set of recommendations capable to orientate the strategic decisions about the definition of a new product profile. The NVPGs, by complementing the general scheme offered by the Four Actions Framework (FAF), identify which value shifts result the most advantageous with respect to the consolidated industrial standards.

The NVPGs have been developed by performing an in-depth analysis of successful market stories, aimed at pointing out common patterns of value evolution. More in detail, the performed survey has individuated which categories of competing factors are preferentially transformed within the treated value transitions, according to the functional features.

On the basis of the performed classification, the NVPGs provide a collection of suggestions in terms of types of new valuable product attributes to create, existing properties to enhance, current features whose performances are viable to be reduced and eventually product characteristics to be eliminated without relevant drawbacks. Hence, the guidelines represent useful recommendations to support value transition tasks within strategies based on business model innovation and NVP.

### 2.2.4 Ideal Solution to Physical Solution

This step of IPPR addresses the application of the appropriate measures to attain the new process/product specifications, as a result of the *Problem to Ideal Solution* phase. The emerging indications have to be translated in technical objectives and organizational changes, allowing to put in practice all the needed business process modifications.

Thus, the objective of this step is the identification of the proper functions to be performed and the search of appropriate technical solutions for their implementation.

According to the class of business process problems to be addressed, the *Problem to Ideal Solution* phase consists in the following tasks:

- Class of problems 1 or 2: finding physical solutions for process reorganization and resources allocation.
- Class of problems 3: finding physical solutions for implementing the new product profile.

In the following subsections some references about appropriate methodological approaches are provided in order to guide the reader in the selection of the most suitable instruments to support the aforementioned activities.

#### 2.2.4.1 Finding Physical Solutions for New Process Implementation

The value indexes, extracted as seen in Sect. 2.2.3.1, address the patterns for the overall reengineering of each phase of the business process. As already recalled, the directions to be followed can be classified in three main categories:

(1) Increasing the phase value through the improvement of its performance or in terms of efficiency, i.e. through the reduction of the involved resources, while preserving the same benefits. Such objective is classically pursued by technological enhancements, more efficient organization systems, broader employment of ICT to optimize the flow of resources within the process.
(2) Increasing the phase value by supplying new customer requirements. The scope can be attained by exploiting partially used resources or by-products in fruitful ways, capable to head towards the generation of additional features. With such aim, the business process model represents a suitable starting point for the individuation of not fully exploited resources.
(3) Suppressing low value phases, with the consequent modification of other process sections which are the candidates for the fulfillment of the consequently unsupplied customer requirements. In order to perform the task, it is useful to highlight further phases employing similar kinds of resources, technologies, know-how.

According to the above objectives, the authors put forward a set of acknowledged methodologies, aimed at addressing the task of identifying conceptual solutions.

Classical TRIZ tools, e.g. the *76 Standard Solutions* [11], represent suitable instruments to increase the performance or the efficiency of the phases (directions 1 and 2). More precisely, once the critical function of the phase to be enhanced has been identified, the Standard Solutions constitute general strategies to increase its effectiveness, through the introduction or modification of appropriate substances and/or fields (standards belonging to class 1.1) or through a more efficient use of the existing resources (standards belonging to class 2).

Many methodologies deal with policies within manufacturing environments and they are mostly tailored to reduce useless resources, so that they address the first direction for phases modifications. In this context, *Lean Manufacturing* [14] and *Quick Response Manufacturing* (QRM) [15] provide valuable suggestions for business improvements. Lean Manufacturing proposes a large set of tools that aim at reducing wastes, meant as those activities carried during the production stages that do not bring any added value. Lean Manufacturing introduces a pull-based supply chain, whereas procurement and production are demand driven and thus coordinated by actual customer orders. The supplying and the purchases are ruled by *Just in Time* (JIT) strategy that aims primarily at the reduction of in-process inventory. Besides, the reduction of the operational times can be obtained through the means of QRM, whose target is the minimization of lead-times. In order to provide further benefits, QRM methodology should be applied to the whole supply chain, strengthening the cooperation among the involved business units that participate in the generation of the value.

The assignation of new properties to a certain phase can be supported by the individuation of existing techniques in dedicated knowledge bases. Scientific documents and especially patents represent the widest available source of technical information close to the technological frontier. The individuation of proper ways to put in practice additional features of the phases can be done also with function retrieval tools. In the scope of TRIZ, *Function-Oriented Search* (FOS) [16] is especially suitable to find and apply existing functions, also from different technical fields. FOS is an evolution of the TRIZ concept assessing that the shortest path to an effective solution is to use an analogy. The tool leads the user in the identification of the key problem, the formulation of a generalized function to be achieved, the individuation of the most appropriate industrial area to be investigated, the selection of the technologies closest to required functional parameters.

#### 2.2.4.2 Finding Physical Solutions for New Product Implementation

According to the results coming from the previous step of IPPR, a new set of product specifications in terms of value attributes is obtained. Thus, before performing any conceptual design activity, such attributes must be translated in candidate Engineering Requirements (ERs) of the new system. Among the others, a useful method used to support the preparation of the ERs list is the QFD, that helps

**Table 2.3** The chart summarizes the flow of activities foreseen by IPPR for each class of BPR problems to be addressed

| Phase | IPPR activity | Class of problems 1 and 2 | Class of problems 3 |
|---|---|---|---|
| *Step* 1 | | | |
| Process to problem | Process modelling | • | |
| | Product information elicitation | • | • |
| | Product/service modeling | • | • |
| *Step* 2 | | | |
| Problem to ideal solution | Identification of what should be changed in the process | • | |
| | Identification of what should be changed in the product/service | | • |
| *Step* 3 | | | |
| Ideal solution to physical solution | Finding physical solutions for new process implementation | • | |
| | Finding physical solutions for new product/service implementation | | • |

to translate customer wants into product requirements. Moreover, through the QFD, the designer can have a clear vision of the criticalities related to design problem, since these tools allow the identification of any positive or negative correlation among the product requirements. Along the translation of customer requirements into engineering specifications, an iterative process is common to refine both lists, e.g. by highlighting possible new advantages arising by the profile conceptualization or the emergence of (at least apparently) mutually not compatible demands.

According to the nature of the design problem and its complexity degree, it may happen that no inventive step is required to obtain the successful solution, but just the application of the knowledge already available within the design team. The recalled TRIZ *76 Standard Solutions* are an excellent structured checklist which allows to browse the team knowledge with a systematic approach. Alternative methods to support this kind of design task are presented in [17].

Besides, if the previous analysis points to the necessity to overcome the emergence of conflicting requirements, the design task requires the application of tools for the identification and solution of contradictions, such as the techniques suggested by the TRIZ [11]. As a result, a conceptual solution is generated in terms of physical properties of the system that allows to satisfy the conflicting requirements according to the available resources.

## 2.3 Summary of IPPR Flow of Activities

The flow of activities foreseen by IPPR to address the problems of classes 1, 2 and 3, is summarized in Table 2.3, according to what is reported in the previous Section.

The reader can refer to this chart in order to easily identify the relevant tasks involved in each step of the method, that are required to address the faced reengineering problem.

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