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Integration of experience feedback into the product lifecycle: An approach to best respond to the bidding process

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Abstract: Bidding process allows a client to choose a bidder to realize an embodiment of work, supply or service. From the bidder point of view, there are several obvious risks when responding because he bets on a future development that hasn't been yet realized. We propose to assist the bidder with decision support tools based on past experiences to detect, report and minimize these potential risks. In this paper, we present the definition of a conceptual architecture to integrate experience feedback into the product lifecycle taking into account all stages of product lifecycle to best respond new bidding processes.

Keywords: bidding process, experience feedback, product lifecycle, preliminary design, risks.

1. INTRODUCTION

The working relationship between industrial partners often begins by a tender procedure by which a client company asked potential providers a commercial proposal in response to the detailed formulation (specifications) of his needs (product or service). This step or bidding process (BP) is very important because the decisions made during the preliminary design phase set the conditions of these relationships and the responsibility of the partners of the collaboration.

The BP is based on competition and each potential contractor commits resources and time to developing a proposal that may not be accepted. The BP is highly constrained because, to be accepted, the proposals must meet the specifications while remaining economically viable for the provider.

The objective of this work is to articulate the concepts of bidding process, experience feedback and risk management in order to propose a methodology for the design of a system. Thus, the bidder will be able to make a proposal ensuring optimal performance of the requirements expressed in terms of reference. In other words, this will allow one to use a knowledge base in order to reuse or adapt information to minimize the risk from the phase of response to bidding.

This document is organized in four sections as follows.

– Section 2 introduces key concepts such as the bidding process, experience feedback, risk management and design process. In this section, we set the BP in a design using different approaches and show the role of experience feedback in this process.
– A matching "Product Lifecycle – Experience Feedback" using a methodology of experience feedback is detailed in Section 3. Here, we explain the importance of total integration rather than just focusing on the design process. Then, we detail each product lifecycle sub-processes and describe the mechanism of capitalization of experiences.
– In Section 4, we present a model for the integration of the product lifecycle with the experience feedback. We identify the processes of capitalization on and exploitation of experiences that focus on risk assessment. Then, we set the BP and define the methodology of relying on past experience to design a new system.
– Conclusions and perspectives are presented in Section 5 and show the results obtained in the first phase of research.

2. BIDDING PROCESS AND EXPERIENCE FEEDBACK

2.1 The bidding process

Bidding is a procedure that allows the client to choose the company best able to carry out a provision of works, supplies or services [Benaben, 09]. Each actor responds to the bidding but, in order to be accepted, the proposals in response to the specifications must meet the expectations, while remaining economically viable. In other words, they are highly constrained because they must achieve the minimum cost while still serving the functions of the customer specifications.

According to [Chalal et al, 06], the bidding process (BP) is the first phase of the product life cycle and includes the following steps:

– receipt of invitation to tender (ITD) and related documents (customer specifications),
– feasibility (study of options including primary technical and financial analysis),
– decision to continue coupled with strategic business decisions,
– development of the response, scoring and evaluation,
– negotiation.

A key feature of BP is its short duration. The company has between two to eight weeks to develop a response for the client, which imposes severe constraints. On the first contact with the client, it is necessary to demonstrate as clearly as possible the expertise of the company in order to gain the client's trust.

The BP is conducted in a hypothetical manner since the product does not yet exist and the information available to the company is often fragmented. We must therefore anticipate the potential development of the product in order to establish, consistent with the financial and commercial means of the company, the proposal which will be sent to the client. For this purpose it is necessary to know not only the customer's requirements but also the methods and procedures of product development.

2.1.1 BP Modelling

In [Chalal et al, 06], the authors propose a model of BP as an issue of corporate knowledge during these phases in order to better respond to new invitation to tender (Figure 1).

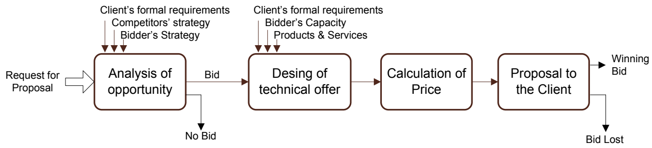

Figure 1. BP adapted model from [Chalal et al, 06]

In this model, the first step calls for decision-making to further the bidding with respect to strategic guidelines of the concerned company. It takes into account not only commercial and competitive criteria but also considers the company's ability to meet demand. The definition phase of the technical offer begins when the company elects to continue. This definition is based on the product definition documents provided by the client and the know-how and expertise of the company. Its purpose is to define the principles of solution to meet customer requirements. The next step in cost calculation is performed using the concept of the chosen solution, an assessment of development costs and manufacturing and integration of client settings. Finally, the offer is sent to the client who will issue a positive or negative response to the offer.

2.2 Experience Feedback

According to [Rakoto, 02], the experience feedback (EF) is a structured approach to capitalization on and utilization of information from the analysis of positive and/or negative events. It implements a set of human and technological resources that must be managed to reduce repetition of errors and promote successful practices. Experience feedback is an approach that allows the creation of knowledge from the analysis of events.

Experience feedback concerns the analysis of a fact or a past event in order to utilize the resulting knowledge. Following the positive or negative effects of the analyzed situation, the objective will either be to reproduce or avoid a similar situation. We call "experience feedback base" all the experiences collected for reuse. Two types of activities of feedback can be readily distinguished:

– the activities of "capitalization" for everything concerning the supply of experience and knowledge base,
– the activities of "exploitation" in relation to the use of experiences in the base. The base is used when encountering a new situation or in the case of prevention or training ... The experiences can be used specifically (a problem has been solved and its solution is directly applied or adapted) or generally (several problems have been resolved and it is possible to define general rules that will prevent their recurrence).

The focus of the experience feedback process and knowledge management is the articulation of memory on these two central processes, capitalization and exploitation. In our approach, we consider the positive and negative events for the capitalization to assist the decision support for utilization. The goal is to prevent or anticipate the risks.

The architecture of experience feedback which supports this work is a generalization of existing approaches of industrial applications. This architecture has been established by Rakoto in his research work from a state of the art based on industrial systems and formal models of experience feedback [Rakoto, 02]. The main change concerns the position of the context analysis step that occurs when the definition of experience.

2.3 Risk Management

Risk is traditionally seen as the result of a chance occurrence of a damaging event and the prospective severity of this event, corresponding to potential losses. Risk is often seen as the probability of the occurrence of an unwanted event and the severity of potential losses induced. The danger can be seen as a state and risk as the measure [Verger et al, 08]. In general, the risk is a situation with potential unintended negative consequences resulting from the occurrence of one or more events whose occurrence is uncertain. However, in our approach we see risk as a negative or positive event.

Risk assessment is often given by the equation (1), where the hazard represents the likelihood of occurrence of an event and the vulnerability associated with potential losses:

$$Risk = Hazard * Vulnerability \qquad (1)$$

To characterize the risk as acceptable, it is necessary to link the constituents of experience and risk. Adding the information of the gravity of the events is a first step, but we need to find a link between experience and the causes of the event. An experience is defined by a context that includes the conditions of the occurrence of an event. Given a sufficiently detailed context, the analysis provides a usable approximation for identification of the causes of the event.

Analysis of a context includes the projection of the causes of the event described. Ideally, it is best to build context using all the information about the causes of each event. As part of this work we propose to use a simple construction, starting from the general context and leading to the construction of sub-assemblies through causal analysis.

2.4 Design process and product life cycle

The BP is part of an important process that is the design and product lifecycle. To integrate the BP and the EF, we believe it is necessary to consider the overall process, meaning that the team that defines the specifications is not the same one that carries them out.

The product design is a process that meets customer needs through the articulation of a set of product specifications. This is an interaction between what the client wants and how to achieve it. There are many methods and design practices, according to the type of product design or design context. Most approaches, however, use the following criteria [Gumus, 06]:

– know and understand the customer needs,
– define the problem to be solved,
– conceptualize potential solutions,
– optimize the proposed solution,
– verify the design resulting from the requirements set.

When designing a product, each actor will make the constraints to be fulfilled to create a good product. The resulting product is then a compromise [Matthews et al, 02] which corresponds more or less with the various constraints identified, as these are often conflicting or contradictory. Failure to comply with any of these constraints entails risks that are assessed in order to choose between the alternatives associated [Pitiot et al, 10]. It is important to note that the choices made during the design phase induce a very significant cost of the product lifecycle [Ullman, 03]. Generally, policy makers do not have all the necessary data to make these choices during the design phase. There are validation tools, but most are not suited to the preliminary phases of design (research and evaluation of potential solutions that meet the stated needs) because they require a level of formalization of the product has not yet reached at upstream phases [Scaravetti, 05] [Yannou, 09].

[Pahl & Beitz, 96] proposes a model design process with four phases: definition of specifications, design principles, overall design and, finally, detailed design. Each phase is divided into successive steps describing the activities carried out. This process involves sequential phases, but may be iterative via feedback to adapt the specifications or technical solutions considered. The application of this process assumes that the company is the source of proposals in relation to a market that it seeks to meet the need of using the resources available.

We study the activities of the designer during the bidding process. In general, regardless of the design model under consideration, the process generally mirrors that proposed by Pahl and Beitz. In order to present a methodology for integrating EF with BP and assessing the risks associated with a choice, it is important to identify the common phases to BP and the design process.

We propose to mesh the two processes from an overview of the design process and the identification of inputs and outputs of the BP. We have identified, compared to the previous design process, what could be the phases with the same objectives as those of BP from the identification of the availability of a requirement to the proposed concept. The activities carried out during the BP correspond, depending on the design process in question, with those of the preliminary design and creation of the concept. We believe that when we are on the preliminary design, we are not far from the BP because it is a global vision before the project development.

2.4.1 Preliminary design

We are interested specifically in the upstream phase of the design process, called "preliminary design". Often, the needs are not articulated or defined completely. The first task of the designer is then to define the complete specifications of the product to be achieved. Then he has to turn those needs into technical requirements and ultimately choose from among the proposed design solutions, which will be studied specifically in detailed design phase. The detailed design is often more costly and time-consuming than previous phases. Many efforts are devoted to the expense of the preliminary design [Chenouard et al, 07]. Scaravetti in [Scaravetti, 05] shows that a more rigorous preliminary design saves time, reducing iterations and allowing for a better understanding of the complexity of the product in the detailed design phase. The preliminary design consists of two processes running parallel in an iterative way [Yannou, 09]:

– Conceptual Design, which highlights the creativity at different levels of decomposition of the system and the exploration of different solutions in principle, leading to the selection of the concept to meet the needs,
– Embodiment Design, in which the choice of technologies, components, main dimensions and topology are listed and made [Gumus, 06], [Chenouard et al, 07]. The result of this phase is the architecture of the product.

The interactions between these two processes are difficult to control. On the one hand, the design of the product architecture requires the formalization of design variables. On the other hand, this formalization reduces the range of possibilities for designers in search of concepts and requires extra effort, which can be costly for many different solutions studied. We propose a mechanism for the consideration of all design alternatives using a tool that allows one to filter based on the experience accumulated in the most relevant cases.

2.4.2 Design activities in the BP

In bidding process, the goal is to provide a response to the client from the documents he transmitted. To define the successive actions that require the creation of a solution concept, we rely on the comparison that [Benaben, 09] outlined with the steps constituting a process of conventional design. We consider the design process proposed by [Pahl & Beitz, 96] with the aim of extracting the different steps that are of particular interest. Analyses carried out have concluded that the phase corresponding to BP in the design process is equivalent to Preliminary Design. That's why we focus on this step. We have defined a model to represent the design activities into the BP. In Figure 2, the development of technical offer is the creation of functional structure and the search of solution principles.

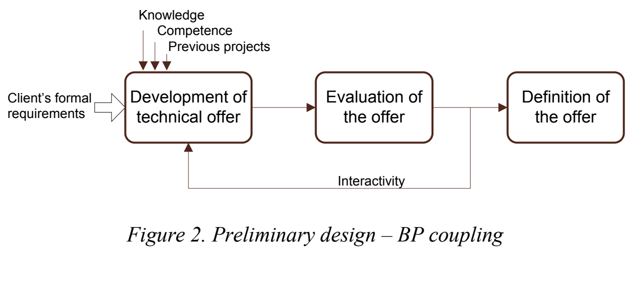

Figure 2. Preliminary design – BP coupling

The evaluation of the offer corresponds to the choice of solution concept. Finally, the definition of the offer is the creation of the solution block diagram. Our model adds a loop which represents the fact that the definition of a system, in response to a call for tenders, is a cyclical process that will not stop until a solution is found ("Definition of the offer").

3. INTEGRATION OF EXPERIENCE FEEDBACK INTO THE PRODUCT LIFE CYCLE

As part of our work, we define the product lifecycle generally as the receipt of the tender until it is out of order. Then, we associate it with the experience feedback process, which gives an overview of the whole process. We think it is important to take into account all stages of the product lifecycle because the events, resulting in risk, may occur during any phase with undesirable consequences for future products or systems. These events then serve as an experience to capitalize on and consider during future biddings.

In this section, we identify all the stages from which experiences are capitalized on when receiving a new bid. We also identify the different exploitation experiences axes in the lifecycle. Finally, our proposal is set specifically in the preliminary design activity that will be detailed further.

Based on the fact that BP corresponds the initial phase of a conventional design process, we described the product lifecycle (see section 2.4) where we set the BP. In our model, we have identified and detailed four sub-processes: the invitation to tender, the bidding process, the development/production, and the support/maintenance. We describe below the four sub-processes identified with their mechanism of experience capitalization.

3.1 The invitation to tender

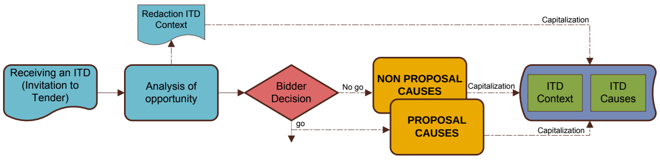

Figure 3. Invitation to tender sub-process

Figure 3 shows the "invitation to tender" sub-process, where the first step is the receipt of the invitation to tender (ITD) including associated documents such as terms of reference, documents appendices (normative references, as part of the customer...) with all requirements and specifications of the product to be provided. Once the bidding is received, it must be analyzed to determine whether the company should continue the process by making a proposal or whether to stop and save resources. In this analysis, we must take into account customer requirements and competitive strategy and business. At that time, the company will make a decision on the continuation or cessation of the bidding.

If the bidder decision is to continue the process, the next step (the BP) begins and the capitalization of proposal causes is made. Conversely, if the decision is not to bid, it will require a thorough analysis of the causes of non-proposal (non-responsiveness, project not important enough considering the size of the company, insignificant gain, etc.). Once the causes of non-proposition are established, we must capitalize by associating it with its context. It is always easier and more interesting to formalize experience by associating it with its context because it is from this context that we can reuse the analysis (when we place the BP, known only in the current context). This information may be useful for the understanding the proposal rejection.

3.2 The bidding process

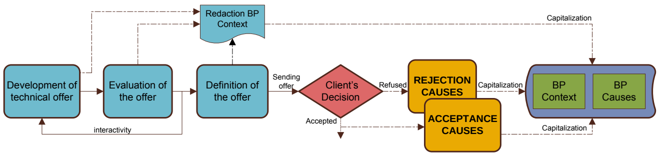

Figure 4. Bidding sub-process

The "Bidding" sub-process begins when the decision to move forward is taken. This phase aims to define proposals for solutions that meet customer requirements. This preliminary design is the upstream phase of the design process. During this phase, designers must devise design solutions to meet the needs expressed in the specifications. Figure 4 shows the stages of this sub-process and its mechanism of capitalization of experiences.

When the bidder decides to continue the bidding process, development of technical offer stage starts. First, he considers the different design alternatives with the design team to select the alternatives to be offered to the customer. They must take into account not only the strategic directions of the business, commercial and competitive criteria, and the company's ability to meet demand (feasibility) but also experience.

Once all alternatives are represented, there must be a first choice of the most viable alternative to evaluate and characterize. We propose to conduct an assessment using the past experiences in an interactive way according to the choice of designers. Thus, it is possible to adjust a proposal based on issues and in respect to past choices (a component, a supplier, a method, etc...).

Although the alternative design has already been evaluated and adjusted several times until a viable alternative is proposed, the next step is to finalize the offer to propose to the client. Note that the company may propose one or more bids according to its capacity and customer requirements. It is assumed that if there are more alternatives, there will be more opportunities for the bid to be accepted. In this regard, we are faced with a structure based on multiple choices, that is to say that the bidder can choose from all the design solutions proposed. Note that it is also possible that the client will choose the option that best suits him. In our approach, we propose to evaluate the risks associated with the choice of alternatives. These risks are multiple in nature, such as exceeding the budgets, non-compliance with technical requirements, missed deadlines, etc... In other words, it is important to identify possible risks, in order to avoid incidents that could affect the project success.

Finally, it remains only to send the selected offer so that the customer makes a refusal or acceptance. In the latter case, the ongoing process and the company must implement the strategy to continue to develop the product based on the technical offer proposed in the previous step. In case of refusal, the BP is finished and must then initiate a process of capitalization of experiences, namely an analysis of the causes of non-acceptance. It will also involve them in the context and it will be possible in the future to reuse this information to determine the risk that might lead to a bid being refused.

We can consider the bidding process as a first planning. It is very important to define the product or system in order to facilitate the detailed design and planning of the actual project. It is very advantageous to use the same modelling framework in preliminary design and detailed design. The company will save time by considering that the preliminary design is the first iteration of the detailed design. This causes a reduction in iterations and a better understanding of the complexity of the product in the detailed design phase [Scaravetti, 05].

3.3 The development/production

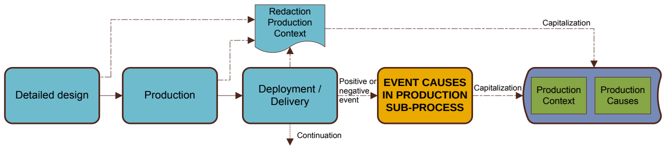

Figure 5. Development/production sub-process

The "Development/Production" sub-process starts when the customer decides to accept the offer by the company (see Figure 5). The bidder now faces the first step of this phase namely the detailed design. This major activity is often more costly and time-consuming than previous phases. Contrasted with the preliminary design, this phase requires much more effort. [Chenouard et al, 07].

Detailed design begins after the preliminary design and after acceptance of the bid by the customer. It is based on the preliminary design file that is the technical definition already accepted by the customer. It is completed by producing a detailed design brief, also called a definition file, which includes the product acceptance among others criteria.

The detailed design phase conducts product development by optimizing the definition of each of its components. It should specify technical requirements in terms of the solution from the bidding process to the design of the components of this solution, and then develop them (where applicable).

Once the detailed design file is obtained, production activity begins. It is simply making the product as it was designed, i.e. the developing system process, which involves all the factors of production (materials, human resources, machines, etc.). In general we can say that the steps of this activity are: the planning of inputs, implementation and verification of components, and assemblies according to the integration plan.

The final activity is the deployment/delivery where a logistics strategy is deployed which will ensure that the customer will receive a product with all the features he wants within the time limit and cost originally drawn up.

If ever one of these activities presents a positive or negative event, it must then be analyzed to find its causes and capitalize with its context, as is done in the previous sub-processes, in order to feed the experience base. It can then be reused when a similar case is encountered. In the capitalization process, we will keep the context formed by the coupling system/project over the analysis of events associated with it.

3.4 The support/maintenance

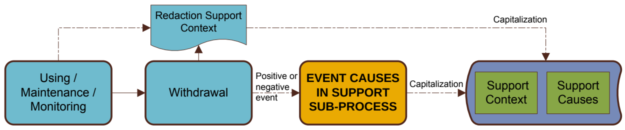

Figure 6. Support/Maintenance sub-process

When the product is delivered to the customer, the "Support/Maintenance" sub-process begins. The product or service takes office from this point. It is important to track and monitor the product in order to detect potential problems that arise in this phase. First, it directly impacts the cost of service (depending on the warranty policy of the company), and secondly, it actually improves the product design and corporate reputation.

The product lifecycle finishes with the withdrawal activity, the last activity of the whole process, which aims to remove the product from the market in order to avoid adverse consequences on the environment. Figure 6 shows this sub-process and the mechanism of capitalization of experiences. Like the preceding sub-processes, if there is ever an event, it must be analyzed to find its causes and its context to feed the base and use it later.

4. PROPOSED ARCHITECTURE AND EXPLOITATION EXPERIENCES MECHANISM

In Section 3, we described the four sub-processes identified in the product lifecycle and we proposed a capitalization on experiences based on an analysis of events. Now, we will show the full integration of the product lifecycle with an experience feedback including exploitation processes. Figure 7 shows the proposed architecture for this integration.

We can see the four sub-processes and the capitalization of experiences in an experience feedback base after a filtering step. This step is the selection of relevant experiences for indexing and generalization. Similarly, we can capitalize knowledge because we can add constraints, rules or exceptions for all cases stored and for those that will be developed in the future.

The exploitation process consists in using the experience/knowledge base and injecting this information into the various sub-processes of product lifecycle. We can then use this information (knowledge + experience) to optimize and improve some practices and procedures throughout the life cycle.

For the ITD sub-process, we can use the experience to guide the choice of whether or not to continue the BP. For the bidding sub-process, it is possible to help offer a viable solution by reducing the risk, as proposed in this work. Support for the design and planning by reusing similar experiences is possible in the development/production sub-process. For the support/maintenance, it is viable to reuse solutions for maintenance problems already capitalized on. It is important to note that all sub-processes of the product lifecycle can be assisted by experiences originating from downstream sub-processes, especially considering risks.

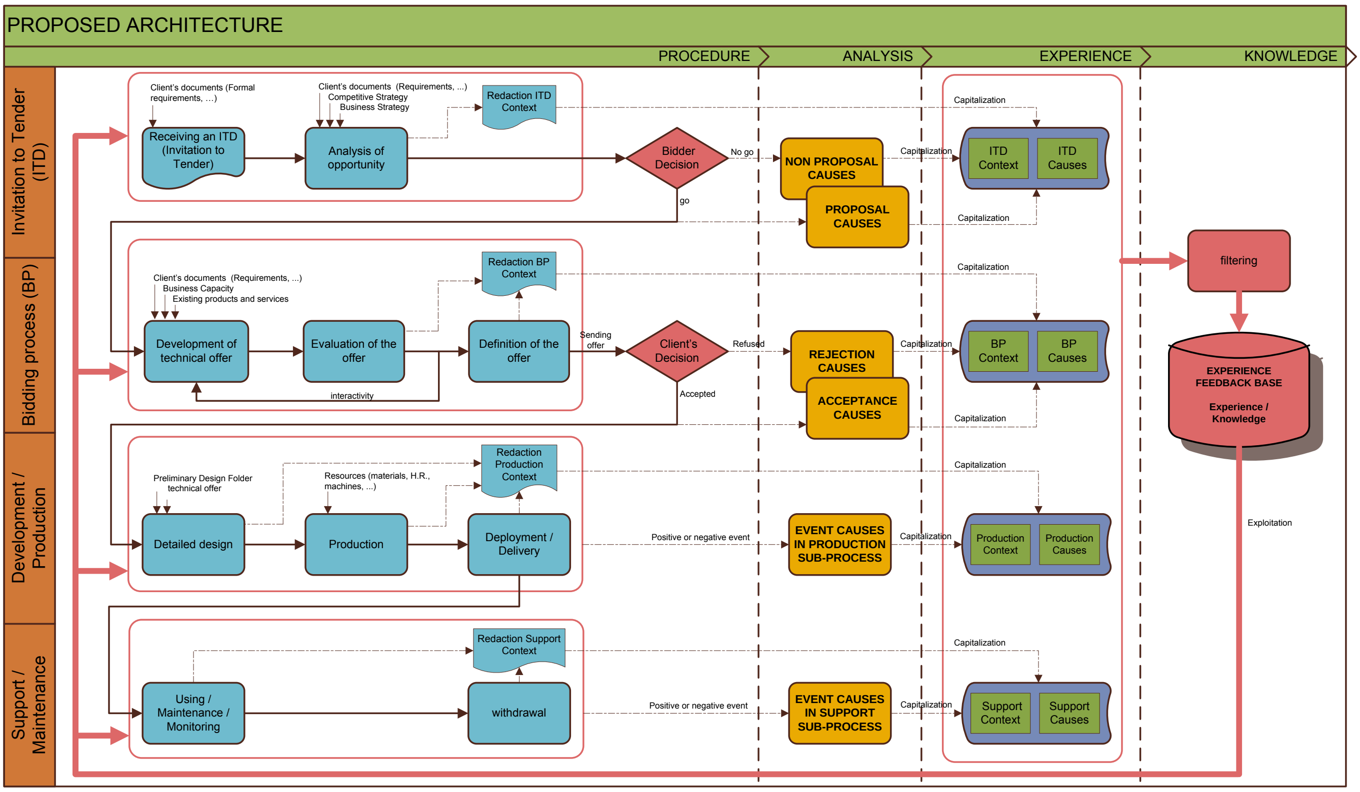

Figure 7. Proposed architecture "Integration of experience feedback into the product lifecycle"

5. CONCLUSION

In this paper, an architecture coupling experience feedback with product lifecycle processes was introduced while focussing mainly on the different capitalization processes. Although our main objective is to assist the bidding process, it is important to consider all experiences that can be capitalized. Indeed, each problem or good practice of the different identified sub-process can be reused during the bidding process itself to give feedback according to risks and opportunities of the current tender.

An important perspective is to model more accurately the relationship between the offer, which rests on a kind of preliminary design, and the actual detailed design so as to be able to predict the critical sections (risks or good practices) of the future product lifecycle.

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