Lessons from Terminated Projects as Means for Other Projects Success

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Abstract--**This paper explores the mechanisms of actually and consciously using the outcomes of terminated projects at new projects that enter the pipeline. The case study was made at an R&D Center of a Brazilian Chemical company with B2B operations in many markets and countries. The authors analyzed a series of terminated projects linked to later projects to map the relations. The study found that the outcomes of killed projects may be formally or informally used. When formally, the earlier project is used to build the scope of the new project mainly at phase zero of its development. When informally, researchers and managers naturally bring the lessons learned to present and use it to bypass steps and accelerate development at any phase of development. The interviews show that the informal practice is considered to be the most common and natural mechanism for applying the lessons learnt with earlier unsuccessful projects.**

I. INTRODUCTION

Learn by doing is the most common way of acquiring competences. Doing the same thing often enough improves our competence to do it. Therefore, "the best way to teach anybody is to let them work on a job that requires the skills we are trying to teach" [24].

Organizational learning research sees organizations as "learning by encoding inferences from history into routines that guide behaviour" [17]. By "routines", the literature understands "the forms, rules, procedures, conventions, strategies, and technologies around which organizations are constructed and through which they operate" [16].

The Knowledge-Creating Company, as defined by [23] and later by [22], uses the learning spiral to transform tacit knowledge – the personal knowledge that one can not explain – into explicit knowledge – the one that the whole company can use to improve its methods, processes and products.

Project Portfolio Management (PPM) research deals mainly with project selection and little is said about alternative generation [21]. The literature regarding project termination is also limited, with researchers paying more attention to factors [1; 3; 4; 5; 7; 8; 12] and psychological and managerial consequences of wrong termination [12; 15; 26; 29] than to what is done to the knowledge, resources and competences after termination.

As said [1] "the success of future projects may depend on not only the success of past ones, but also on how unsuccessful projects were treated by the organization and its stakeholders".

How do companies nowadays learn with their failed projects to get more success on the forthcoming projects? How do they adjust their portfolio so that the terminated projects help its overall success?

To help answering these questions, we studied one company in order to describe how the R&D managers and researchers treat the unsuccessful projects and how they learn with the errors in order to improve the success rate of the other projects.

The article begins presenting its objectives and methods, and then performs a literature review on the most important research regarding the relevant themes to the paper. Finally, the case study, a large Brazilian Chemical company, is described and analyzed later in the discussion and conclusions.

II. RESEARCH QUESTIONS

The research intends to begin answering the fundamental question "*How companies use the knowledge, capabilities and resources created by a terminated project in new projects?"* More specifically, the present paper aims at answering the question "*Which mechanisms are used to transplant useful parts of a terminated project into the new projects in the pipeline?"*

A. Objectives

As an exploratory study, the objectives of the present work are to:

1. Review the literature on project termination, learning cycles in product development and new alternative generation for NPD;
2. Assess the managers' inclination for using terminated projects outcomes in the process of generating new ideas for the project portfolio; and
3. Describe mechanisms used by companies to recycle resources and capabilities freed and generated by terminated projects.

III. METHODS

Two distinctive methods were used for the present research. On Part I – Literature review, published documents such as articles and books were read and analyzed in order to build an overview on the relevant literature for the studied matter. On Part II – Case study, on the other hand, the Case Study methodology [31] was applied. It will deal with Documents analysis, in which non-published company documents are sources of relevant information to understand the research problem [25].

We interviewed four managers, three for each application market served by the studied company (Home & Personal Care, Agrochemicals and Industrial Markets) and the R&D manager. The interviewees were asked to give the procedures of what is done to the projects after their termination. It was asked where the information about the terminated projects is kept and how the company uses this information for improving other projects' success. It was assessed in which

phases of the project the knowledge can be introduced and what kind of information is used. Then, the interviewees were asked to name projects that used terminated projects' outcomes and cite how they used such information. Finally, the authors analyze the data and build a framework to explain learning from terminated projects.

The observation was completed with a daily presence in the company studied, which configures a participant observation. During the daily routine, the matter was discussed many times with different involved people, checking in this wider internal setting if and how formal procedures are actually implemented.

As an exploratory study, we do not intend to generalize its results, but rather to describe how one company learns from unsuccessful projects and apply this learning for improving success rates for new product development projects. A single case study may be quite revealing to this kind of research question [31].

IV. LITERATURE REVIEW

This section will try to give an overview on the most relevant literature for this paper's theme. We will begin with a review on Project Portfolio Management (PPM) research, especially the literature regarding interactions between projects on the portfolio. Project termination will also be mentioned. Finally, we will quickly review organizational and individual learning literature, with special attention paid to competences generation trough projects.

A. Project portfolio management

[10] defined Project portfolio management (PPM) by:

> Portfolio management is a dynamic process, whereby a business's list of active new product (and R&D) projects is constantly up-dated and revised. In the process new projects are evaluated, selected and prioritized, existing projects may be accelerated, killed or de-prioritized; and resources are allocated and re-allocated to the active projects.

[9], at their article surveying new idea-to-launch methodologies companies are adopting, mention post-launch reviews as means for continuous improvement. They say "if results are measured and deficiencies are identified but no action is taken, there's no improvement and one keeps repeating the same mistakes" [9]. The same paper postulates that PPM and individual projects management should work together to better enforce strategy on the company through the projects. The idea of post launch reviews is not new. [30] already suggested it and dedicated a whole chapter on how to capture, disseminate and apply this knowledge.

B. Projects interdependencies and interactions

One of the main criticisms by [21] to what he calls the Project Selection Paradigm (PSP) is that the present research on PPM does not pay enough attention to project reformulation after assessing and evaluating their project interactions and interdependencies, treating each project as an entity. Some literature indeed mentions that this matter should be managed, but the discussion mostly remains at the portfolio evaluation level.

The relative importance of the theme however is growing. Projects are interdependent when the success of one project depends on other(s) [16]. According to [6; 13; 27], there may be resource, market, outcome, learning or financial dependencies.

The learning dependence, as defined by [6], means the resource and time economy that a project gets through the learning curve of another project. The authors showed examples of a difficulty level reduction of 20% when developing drugs for the same disease.

C. Project termination

A project may be killed by three different forms [21]: extinction, inclusion or integration. Termination by extinction means the project is completed (either successfully or unsuccessfully). Inclusion means the entire team, resources and equipment has been moved to another division. Integration, the most common, means that the resources, equipment and personnel are absorbed as part of the original organization.

Factors that lead to project termination was studied by many authors [1; 3; 4; 5; 7; 8; 12; among others), and in another paper we also give our contribution to the discussion.

Once terminated, a post-audit review of the killed project is of great importance. The report can provide senior management with insights on how to improve future projects [1].

D. Learning

Learning can be achieved either by the individuals or the organization [29]. Individual learning is translated into personal memory, experience and capabilities, while organizational learning is more complex and is more than the sum of the individual learnings [14; 28].

[19] defined organizational learning as "any modification of an organization's knowledge occurring as a result of experience". The authors conclude that successful learning of an organization is reflected by a change in performance.

As indicated by [30], organizational learning is materialized in procedures, tools/methods, process, structure and principles. To achieve that, it is necessary to establish learning mechanisms. As Total Quality Management suggested, people must be trained and have official opportunities to find problems, establish their relative significance, elaborate solutions and recommend changes in the above formal systems. People also must get recognition by their courage in making learning errors and receive incentives to take the effort required to correct them and remove their causes. Those are the basis of continuous improvement in operations, as well as in product and process development and R&D.

A classical model for assessing the quality of organizational learning is given by [2]. The model divides the learning in two types: single-loop and double-loop. The

single-loop learning corrects perceived deviations in the process without altering the underlying reference system. The double-loop, on the other hand, is the process that alters the reference system in order to improve its sustainability. The double-loop learning is, according to the authors, the higher quality learning an organization may have.

[22; 23] took the discussion further when analyzed how the top Japanese companies dealt with their learning cycle. They described the "spiral of knowledge", where Tacit knowledge is converted into Explicit knowledge through a cycle of (1) socialization, (2) externalization, (3) combination, and (4) internalization.

Learning may also come through projects, as postulated by [11], which analyzed firm renewal by its new product development projects. The author finds a relation between product innovation and the creation of new competences in a dynamic system that keeps the firm competitiveness up to date.

This learning dynamic is also studied by [19]. The authors affirm that the knowledge gained in failed projects was often instrumental in achieving subsequent success in their sample, while successes may result in unlearning of the process that led to the original success. The authors then formulated the "new product learning cycle", in which commercial successes and failures alternate in an irregular pattern of learning and unlearning.

V. CASE STUDY OF A BRAZILIAN CHEMICAL COMPANY

The studied case is the R&D Center for a Brazilian chemical company (Chemical). Chemical is a 40 years old company, with operations in many business-to-business markets, such as Agrochemicals, Home Care, Personal Care, Oil & Gas and Paints & Coatings. Recently it has begun its internationalization, by acquisitions in countries in Latin and North America. Its R&D Center, located in Brazil and with yet relatively small operations in Mexico and USA, was founded along with the Company itself, as a mean for acquiring foreign technology and develop new technologies internally.

The R&D Center has its own information system, hence forthwith called System, in which the business' managers and researchers keep records of all the projects that enters the pipeline. The System has all the information about every finished and unfinished project from 2005 to present, as well as the records for projects related to other projects, which can indicate refurbished, linked or parent projects. The present study, therefore, used these information to map the projects that are liked with other projects, analyzed them to see what kind of link exists and selected those that indicate unsuccessful terminated projects that influenced new projects on the pipeline. Then, the mechanisms Chemical uses for recycling resources, information, knowledge and results were discussed with the managers.

Chemical has its own policy on project management, made available on leaflets that discriminates and details each phase on R&D projects. Figure 1 shows the phases into the Chemical's Innovation Funnel.

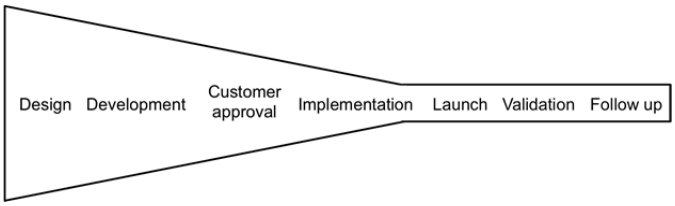

Fig. 1 – Chemical's project phases.
Source: Modified from Chemical's institutional material.

Below, we describe quickly these phases:

- Design – Preparation of the Value proposition and previous analysis of the project. New ideas are evaluated at this stage.
- Development – The longest phase, when the product is actually obtained. At this phase, the researchers perform regulatory, toxicological and environmental analysis, pilot plan test, first draft specification and all information required for defining the product, the manufacturing process and the application are defined.
- Customer approval – At this stage samples are presented to the customer for approval. Here the company and the client define commercial conditions.
- Implementation – This phase is dedicated to approval of raw materials and manufacturing plant. At this stage the official technical documentation is created and technology transfer is made.
- Launch – This phase aims at creating the launch plan: target customers, communication plan and strategy positioning to the new product according to the value proposition.
- Validation – At this phase the customer will confirm the achievement of his needs and expectations. There is also the assessment of the feasibility of all aspects of product implementation, manufacturing capability, sources of raw material, technical documentation and technology.
- Follow up – Finally, the results of margin and volume are monitored for three years. These results are compared to the potential of the project, to flag some necessary actions to assure the project success.

A. Use of terminated projects outcome

The influence of outcomes from previously killed projects may incur in any phase of the development, but the strongest influence happens in Design phase, where the project scope is designed and the bibliographic research is done. System has a detailed search module by keywords, where the project leader can access all the previous projects, including those that were terminated at the idea stage. Table 1 shows the projects that have been reported by the managers.

TABLE 1 – PROJECTS THAT USED TERMINATED PROJECT'S OUTCOMES.

Project	Area	Use of previous knowledge
Project A	Agrochemicals	In Project A, researchers got the history of a previous project (Project B), from which the complete application study of a new thicker composition for concentrated suspension was used. Project B contained anteriority studies, laboratory tests results and documents created during the development. The projects were, then, linked on the System and the relationship is traceable.
Project X	Industrial Markets	Project X was a continuation of Project Y, terminated because of the cost of the toxicological analysis, which characterized the unviability of the project. Years later, Project X came to continue the development where Project Y was abandoned. However, the same problem was observed and Project X also failed. The projects were linked on the System and the relationship is traceable.

Source: the authors

In Chemical, we observed two mechanisms that allow terminated projects to help new projects on its success: the formal mechanism, in which the manager or the project leader explicitly refer to the previous killed project on the phase zero, using this information for building the state-of-the-art study and for proposing the project methodology; and the informal, in which researchers involved in the project along its life cycle will simply bring the knowledge previously acquired in other projects to the present.

There is also a special type of project, highly innovative, that is necessarily developed in order to dominate a technology and allow the development of later derivative projects once terminated. However, this is a special case and should not be mistaken with learning from unsuccessful projects.

Formal mechanism is identified at the two projects (A and X) reported by the managers. We observed a difficulty in identifying other cases of reutilization of project's outcomes. The HPC manager simply could not name an example of such thing happening, under the justification that Chemical's ability to learn from past errors is still concentrated on the researchers that actually do the development.

Managers reported that the most natural and common way of recycling killed projects is the informal mechanism. When experienced researchers are involved in new projects that resemble them of the learning and lessons from the unsuccessful ones they have participated earlier, it is natural to bring this knowledge to the project. However, this kind of mechanism, since it is informal, is not traceable trough the System. This finding was confirmed in informal talks with Chemical's researchers, who reported a strong inclination to use techniques, protocols, and even results from previous projects, sourcing on their own personal annotations from earlier projects.

Figure 2 illustrates the ways Chemicals learn from previous terminated projects.

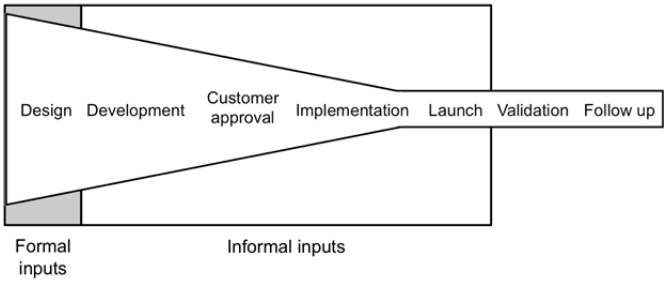

Fig. 2 – Mechanisms of learning from past terminated projects.
Source: Created by the authors based on interviews.

B. What researchers take from terminated projects

There is a series of benefits in using earlier projects outcomes. The information is often used as means for consolidating the project's scope and, in some cases, to continue a development that was interrupted earlier. Other benefit is resource economy by bypassing of exploratory tests that have been already made. Competence, once acquired, improves the focus and success rate of protocols and tests. Finally, key contacts from customers and partners (such as universities and research institutes) can be found, economizing time and strengthening relations.

According to the interviews, when reviewing past projects, researchers may find useful information that can be classified in five groups:

1. Technology – Information such as possible chemical and biochemical routes, process limitations and possible partners for development.
2. Target product – Information on product properties, uses, regulatory issues, toxicological and physical and chemical characteristics.
3. Market – Information on possible customers, competitors with similar products and market size.
4. Customer needs – Information on similar projects for the same customer.
5. Patents and bibliography – Information to be updated about the state-of-the-art of the technology, patent issues that existed in earlier projects, bibliography relevant to the development.
6. As pointed out above, information regarding professional or institutional relationships that can provide relevant and pertinent information.

C. The formal way: Design phase and its need for a bibliographic review

There is a formal step on the company's workplan that requires the project leader to perform a search on the System for previous results of projects that may help the definition of the new project. When a relevant project is found, it is possible to navigate through the correlated projects, both successful and unsuccessful, allowing the researcher to have a complete history of the desired kind of development.

Nevertheless, it was related by an interviewee that the information present on the System is not as complete as it should be. The System permits attaching termination reports, but this feature is rarely used for a limitation in the database size. As this limitation is relatively old, the project leaders got

used to mark the project as terminated and give very summarized reasons for the termination, making it difficult to other researchers in the future to learn with the experience.

However, the projects folders, available on Chemical's network server, is fairly complete and holds precious information on past projects. There is also a physical file, where folders for older projects are kept and available for consulting whenever needed. These resources are very often used.

D. The informal way: Individual learning that emerges at any phase

The project team is the main responsible for introducing outcomes of earlier projects on active ones. This happens in any phase of its development, from Design to Launch. Any relevant experience, material kept in personal files, competence or capability learnt in previous projects may be consciously or unconsciously used to accelerate development of the project.

Besides the formal search, when the project leader or the manager remembers of some specific project that may help on planning or design, the learning happens quicker and in a more efficient way. And, of course, once an incumbent knows about a past relevant project, it is possible to consult with the people that worked on it. The informal way is always happening and frequently drives the formal procedures.

Informal procedure use the same sources of information reported on the formal way. System's information on past projects, projects folders on the company's network server and physical files with physical project folders. But these sources are consulted anytime during the development, whenever a member of the project team needs.

VI. DISCUSSION

Our research revealed two main mechanisms for using information from terminated projects to improve success rate of the portfolio. Formal way is part of the company's workplan and constitutes a needed step on the Design phase, without which the project cannot go through gate review. When this kind of interaction happens, past projects (including terminated ones) influence on the new project scope formulation by providing protocols, tests results, and anteriority searches (patents and articles).

Informal way is not part of the established project management methodology. However, our research has shown that it is the most common and natural kind of interaction between new and past projects. [6] defined a similar interaction, "learning dependence", where resource and time economy is achieved when developing projects on the same learning curve. However, the case related in this paper has particularities not observed by [6] and his colleagues. Our case is not only a matter of dependence, however it may exist in some cases. [6]'s study shows a portfolio with intentional interrelated projects on the same learning curve of pharmaceutical processes and molecules, while our results show that completely different projects may also interact to improve overall portfolio success. It will depend solely on the researcher's ability to reefer to his past experience to achieve best results on the present project. It will depend solely on the researcher's ability to find out relevant connections to the company's accumulated experience to achieve better results on his current project.

The Informal way implies that for a project failure to serve as inspiration for another project's success, the researchers must remember their experiences and have their own notes about past projects they have participated. In other words, the Tacit knowledge is not converted into Explicit, as it rarely goes beyond the Socialization stage. In an extreme opinion, one of the interviewees said that, compared to the company he recently came from (a large B2C multinational operation), Chemical's System has zero capability to permit such interactions between terminated and active projects in a formal way.

Formal mechanisms also rely on individual learning. We noticed that what Chemical's managers call "formal" way also needs previous personal experience of the manager and project leader during the Design phase. However, the formal procedure has the ability to convert Tacit knowledge into Explicit, by externalizing, combining and internalizing the previous knowledge into the new project's scope.

We observed that, in R&D projects, individual learning surpass organizational learning. This means that when the company loses a researcher, it also loses knowledge. When there is organizational learning, it happens in a single-loop way. However, there are exceptions and there may be some projects that are developed in order to achieve a new capability and develop and dominate a new technology the company did not have. These are mainly Innovation projects and give birth to other less risky development projects.

VII. CONCLUSION

This is an exploratory research, therefore, we do not intend to generalize our results. However, we could propose that unsuccessful projects may be an important source of information that could accelerate new projects' development and improve the company's success rate. This is often done informally, despite of formal procedures the R&D management may propose.

It seems clear to us that we are dealing with a problem that may have implications in different research areas such as Information Systems and Organizational Culture and Learning. Our approach was given as a Project Portfolio Management problem, as a contribution to improve the overall success of the portfolio, but it may be better understood with a more interdisciplinary approach.

Some questions, however, remain unanswered. What is the relation between the Information System the company adopts and the organizational learning? How can organization learning can be improved with a better knowledge management system? Is there a relation between the existence

of a database for terminated projects and the success rate of highly innovative projects? Is there any way of improving organizational learning through cultural change independent from information systems?

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