

## **ASSESSMENT OF PROJECT PORTFOLIO MANAGEMENT ON PUBLIC RESEARCH INSTITUTIONS: A CASE APPLIED TO AGRICULTURAL RESEARCH IN BRAZIL**

Paulo Henrique Nogueira Biscola – Embrapa Gado de Corte

Davi José Bungenstab – Embrapa Gado de Corte

Gabriel Lopes Alves – Universidade Federal de Mato Grosso do Sul

Nibia Queiroz de Paula – Embrapa Gado de Corte

José Roberto de Souza Freire – Embrapa Gado de Corte

### **Abstract**

Portfolio management can be a major tool for selecting projects where scarce public resources will be invested with the best returns for society. This study aimed to propose a model for diagnostic of project portfolio management (PPM) on public research institutions and to apply it over a case study. The methodology used was literature review and a single case study applied to Embrapa Beef Cattle, a Research Center of the Brazilian Agricultural Research Corporation (EMBRAPA). Conclusion is that the model can be used for the diagnostic of PPM on public research institutions. The importance given to strategic orientation by the studied research center became evident throughout the work. This need to integrate project portfolio with institutional strategy influences the three dimensions of the model. From the results obtained it becomes evident that putting into practice an effective strategic planning for public research institutions is paramount for project portfolio success. The tool can be enhanced through incorporation of new criteria and dimensions, serving as a starting point for further work focused on public management.

### **Keywords**

Project portfolio management; Strategy; Public management; Innovation; Agricultural research.

### **1. Introduction**

Economies undergoing constraints on public funding lead public research institutions to carefully analyze their agenda (21). In industrialized countries, the private sector is responsible for a large share of R&D, having well-defined targets. A different scenario prevails in Latin America for example, where government is responsible for the largest share of research funding (15). In such

areas, finding out how to better apply public resources into scientific development becomes a rather important challenge. Managing R&D projects portfolio more effectively is socially mandatory, since it is funded by taxpayers. For R&D institutions individually, this becomes vital when considering the intense competition for resources among organizations. They have higher demand for research in new frontiers of knowledge and the need to socially justify their existence and continuity (4).

In fact, public research institutions play an important role in society. They not only participate, but actually initiate the innovation process, aiming its future application, as well as they test and transfer knowledge and technologies (33). These fundamental actions can generate new initiatives from where new industries may arise (12).

A survey carried out by Cohen et al. (10) found out that results from public research have substantial impact on R&D of industrial organizations from different areas. This happens through transference of mechanisms and techniques, consulting and informal communication. These findings indicate that public research has larger influence than estimated. The authors add that public research, besides providing ways to solve problems, suggests new project ideas for the private sector.

Innovation applied to public administration and policy-making has been receiving attention in literature recently, yet, it seems not fully integrated into the approach of New Public Management (NPM) (31). The NPM attracted great interest from several countries and deed reforms took place to turn old-fashioned bureaucracies into market-oriented institutions with high levels of effectiveness, flexibility and feedback to society. Currently, many studies in this area address implications on management of public institutions having citizens as customers (32). This approach brought by NPM is actually relevant for both, public and private sectors because it applies management techniques from private to public sector, aiming to improve efficiency (3). Even though many regular management practices from private sector can be applied to public institutions, a simple carrying over, without proper validation, may not have the expected effect, since both have considerable differences in their structures and goals (2; 8; 18; 26; 27).

Public research institutes face many challenges regarding structural issues, such as unstable availability of resources, inadequate funding infrastructure, little private sector participation and incipient tax incentives for innovation (30). It is always important to bear in mind that R&D activities are mostly long-term undertakings. They are built on uncertainty of results, what increases their risk. Therefore, public funded research projects have may not necessarily generate a specific product or process. They are predominantly scientific, rather than economic, what makes project selection and resources allocation more difficult for public institutions (9; 21; 23).

Project managers in the public sector must answer directly to a wide range of stakeholders, including several governmental bodies, citizens, interest groups and media. Each of these participants have the right to criticize decisions on projects because of their public nature (26; 27).

Another challenge is turning scientific knowledge into practical results for society as well as generating innovation that contributes to strengthening the productive sector (4; 12; 25).

One must consider that academic institutions such as Universities and Technology Institutes have taken multiple roles in modern society. Educational institutions have evolved to research institutions where new science and technology fields can arise. Their roles as scientific and technological development hubs are recognized and their sponsors demand more results in an increasingly competitive world (12).

In this context, project portfolio management becomes a rather important tool for selecting projects where scarce public resources are invested aiming the best returns for society. Several portfolio management models are found in the literature, but few are focused on public management. Thus, major goal of this study was to propose a model for diagnostic of project portfolio management on public research institutions and to test this model over a case study on agricultural research in Brazil.

## **2. Theoretical background**

### **2.1. Project portfolio and its management**

Project portfolio consists of a set of projects that are funded, carried out and managed by a specific organization (20). Portfolio management is a broader concept, defined as a dynamic decision process, where a corporate list of upcoming and ongoing R&D projects is constantly updated and revised. In this process, new projects are evaluated, selected and prioritized while existing projects can receive extra support, can be discontinued or no longer prioritized, having their resources reallocated to other current or new projects (11).

Decision making in portfolio management is often characterized by uncertainty, insufficient information, dynamic opportunities, multiple objectives, several strategic considerations, different locations, interdependence among projects and high number of decision makers (11). Project portfolio management, therefore, deals with simultaneous management of projects, having them as a large entity. Meskendahl (20) points out that this issue is recently gaining more importance in theory and practice.

The model here proposed considers the framework presented by Meskendahl (20) adjusted according to recent literature, especially when regarding project portfolio management for public institutions, since, as mentioned before, these present significant differences to private companies.

Project portfolio management encompasses three dimensions: project portfolio structuring, project portfolio success and public research institution success. Each dimension has associated attributes, which have their accomplishment evaluated through criteria that, in this work, were obtained from specialized literature.

## 2.2. Project portfolio structuring

Working under project portfolio structure requires periodic selection of new projects and evaluation of ongoing projects in order to keep them consistent with organizational goals while not exceeding available resources, and not trespassing institutional restrictions. In this dimension, attributes considered are: diligence, integration, consistency and formalization (20).

The process of structuring a portfolio is usually carried out by committees and commissions, in which the major organizational functions are involved. In this sense, the attribute integration reflects how deeply institutional functions are involved on the structuring process, i.e. to which extent all relevant functions are involved and how their different perspectives are taken into consideration (20).

When promoting specific technological innovation, success depends on integrated work, combining knowledge and specialties from different players who intend to develop and launch a product that has a particular content and involves new features for commercial application. Product development depends also on institutional ability to select, develop and transfer technologies accumulated in previous projects to new ones (17). Some studies found out that this integration is not trivial (7; 24); for instance, Song and Song (29) identified cultural barriers, difficulties in communication and single departments' own goals as factors that may hinder the process.

Some practical alternatives proposed to overcome these difficulties are: inter-functional teams, participation of R&D personnel in market research, physical proximity, project leaders with technical and management skills (17), internal and external communication, inter-institutional relationships, knowledge transfer and senior management support (14; 22). Specifically for the public sector, consent for informal flow of information can also increase innovative capacity (31).

Another important attribute for portfolio structuring is consistency, i.e., having set goals for a portfolio prior selecting projects. This enhances achievement of institutional goals. Consistency reflects the degree to which strategic planning provides a basis for portfolio orientation and how close strategy and portfolio planning are to each other (20). Institutions having specific strategies aimed at a new product have superior performance in this process (19). In this respect, strategies for developing technologies must be connected to business strategies. It means that it is necessary to deal with technological abilities and constraints, as well as with market opportunities during development of new products (19; 35).

The third attribute for project portfolio structuring refers to formalization, considering aspects like assuring appropriate and accurate data recording, objective and explicit criteria, reasonable and clear rules as well as well-known and transparent procedures. Process formalities need to be checked for both, new and existing projects (20).

On its turn, the attribute diligence demonstrates whether the institution has a clear picture of a target portfolio to be achieved and if the structuring process is appropriate to select the "right" projects.



In addition, it evaluates the use of scenarios, the perception of project's inter-dependencies and the mix of innovative and long-term projects (20). In this respect, it is necessary to build up an organizational culture focused on priorities, with well-defined targets to direct institutional efforts (25). Table 1 synthesizes the above described criteria associated with project portfolio structuring.

**Table 1** - Criteria related to project portfolio structuring.

Criteria	Authors
<i>Associated to integration</i>	
Involvement of organizational functions mainly affected by the decisions made when structuring project portfolio.	Meskendahl (20)
Ability to select, develop and transfer technologies from previous projects to new ones.	Jugend and Silva (17)
Inter-functional teams.	
Participation of R&D personnel in market research.	
Physical proximity.	
Project leaders with technical and management skills.	
Internal and external communication.	Felekoglu et al.14, Nagano et al. (22)
Inter-institutional relationships.	
Knowledge transfer and senior management support.	
Consent for informal information flow.	Vigoda-Gadot et al. (31)
<i>Associated to consistency</i>	
Portfolio targets set before project selection.	Meskendahl (20)
Proximity of business strategy with portfolio planning.	
Specific strategies for projects aiming new products.	Mendes and Ganga (19)

Strategy for technology development linked to organizational strategy.	Mendes and Ganga (19); Zapata and Cantú (35)
Resources allocated in the portfolio aligned to strategy.	Meskendahl (20)
<i>Associated to formalization.</i>	
Adequate and accurate data.	Meskendahl (20)
Criteria are objective and explicit.	
Reasonable and clear rules.	
Transparent and well-known procedures.	
Formal procedures applied regularly to both, ongoing and new projects.	
<i>Associated to diligence.</i>	
Clear picture of a target portfolio to be achieved.	Meskendahl (20)
Appropriate structuring process to select the "right" projects.	
Use of scenarios.	
Interdependencies among projects are considered.	
Mix of basic long-term and applied innovative projects.	
Organizational culture focused on priorities with well-defined focus.	Pinheiro et al. (25)

Source: Elaborated by the authors.

### 2.3. Evaluating project portfolio success

Success when implementing a project portfolio is rated by its attributes regarding strategic fit, balance, use of synergies and average single project success. The average single project success considers traditional aspects such as budget, schedule and quality, but extends this view to consumer needs and market, which are reflected into product specifications (20; 16; 19). Although some of these aspects are not new, their presence in recent literature evidences the importance of using up to date project management techniques for public institutions (1; 26; 27).

With regard to consumer needs and market, knowledge transfer is referred as rather relevant for public institutions, since they should promote academy-industry cooperation, consolidating and handing over technological advances, easing technology transfer or selling research outcomes. Thus, magnifying market outlook for scientists becomes necessary, and this is only possible when market needs are understood (18). Improvement on market view brings great contribution to development of new products. Examples of such initiatives could be new ideas, market assessments and studies on technical or commercial feasibility of new projects (19).

According to Rogers (28), acceptance of a product can be faster when the relative advantages it offers are considered. The author mentions the importance of a product's compatibility with users' existing values and past-experiences, its complexity, which is the level of difficulty to understand how the product works or how the consumer will recognize its value. Finally, there is testing, representing the degree customers can try a product and their ability of observation, which considers how the outcomes of a given innovation can be viewed by potential consumers.

The attribute regarding synergies consists in the use of technology, market, knowledge and resources synergies among component projects of a portfolio, once the coordinated management of all projects in the portfolio can deliver benefits beyond each project's individual results. This subject also considers practical actions to reduce rework (20).

Strategic fit of portfolio analyzes the degree to which the sum of all projects reflects the strategy of the institution. It considers the alignment of project objectives and resources with company's strategy i.e. to what degree the portfolio reflects the overall strategy (20).

Portfolio balance takes into consideration the balance between short and long-term benefits of projects, as well as the generation of incremental and radical innovations, risk and adequacy level throughout their execution (20). According to Vigoda-Gadot et al. (31). The innovation process is risky by nature and risk itself should also be an important feature of innovation initiatives for public institutions as it is on private companies. Table 2 synthesizes the criteria associated with project portfolio success.



**Table 2** – Criteria related to project portfolio success.

Criteria	Authors
<i>Associated to average single project success</i>	
Considers market and consumer needs.	Haverila (16); Lee and Om (18); Mendes and Ganga (19); Meskendahl (20)
Management of budget, schedule and quality.	Meskendahl (20)
Uses modern project management techniques.	Abbasi and Al-Mharmah (1), Project Management Institute (26); Rosacker and Rosacker (27)
Promotes cooperation with the industry, transferring and strengthening technological advances.	Lee and Om (18)
Facilitates technology transfer and trade of research results.	Lee and Om (18)
Carry out studies on market and technical feasibility for new projects.	Mendes and Ganga (19)
Considers attributes that increase new technologies acceptance.	Rogers (28)
<i>Associated to the use of synergies</i>	
Shares technologies, market insights, knowledge and resources.	Meskendahl (20)
Manages coordinately all projects in the portfolio.	
Strives to reduce double work.	

<i>Associated to strategic fit</i>	
The sum of the projects reflects the strategy of the institution.	Meskendahl (20)
Project objectives fit the strategy.	
<i>Associated to portfolio balance</i>	
Balance between short and long term benefits.	Meskendahl (20)
Project risk analysis.	Meskendahl (20); Vigoda-Gadot et al. (31)
Balance in generating incremental and radical innovations.	Meskendahl (20)

Source: Elaborated by the authors.

#### 2.4. Success of public research institutions

Moral justification for innovation in modern bureaucracies considers that citizens deserve increasing living standards and that this improvement should be disseminated to society as a whole, since society delegated political power to the government (31).

New Public Management (NPM) suggests that some moral principles risk to be neglected, being endangered when powerful market mechanisms are instilled into government doctrines, like the pursue for greater efficiency and costs reduction, which can lead to a dangerous moral indifference from public administration. A new approach must rely on long-term principles for human progress, incorporating transnational policies and better distribution of goods, knowledge and practices among nations and societies (31).

Usually, results from R&D in public science and technology institutions is more evident than its fundamental contribution to the leverage of national science and technology levels and to the competitiveness of a country's industry and consequently to social well-being (18).

It is expected that in public administration, innovation explores new ways to create social well-being, creates innovative ways to empower citizens and increases its democratic involvement (31).

In this regard, Mohan and Rao (21) mention some criteria that can indicate success of public research institutions, namely: impact of innovation from the project over academy (scientific impact); extent of cost savings resulting from new technologies developed by the project (economic

effect); impact of project results in society (social objectives); possibility of project resulting in patents and publications and the possibility to sell outcomes from the project.

Bloch and Bugge (5) name some examples of common goals for initiatives towards innovation in the public sector, i.e. facing societal challenges; comply with new regulations; to increase efficiency; improve service quality; improve user satisfaction; improve online services and improve working conditions.

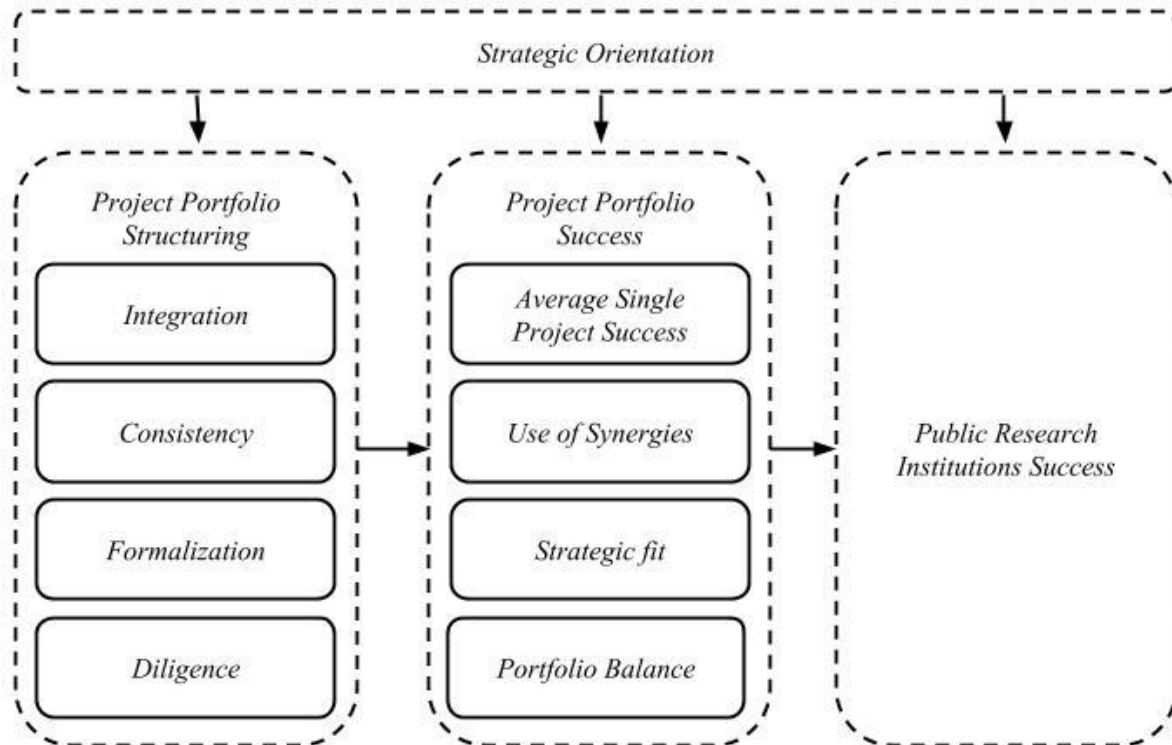
Table 3 shows the summary of criteria linked to public research institution success:

**Table 3** – Criteria related to public research institution success.

Criteria	Authors
Concern for the social and psychological well-being of citizens.	Bloch and Bugge (5); Lee and Om (18); Vigoda-Gadot et al. (31)
Long-term thinking	Vigoda-Gadot et al. (31)
Tackling social challenges and elimination of inequalities.	Bloch and Bugge (5); Mohan and Rao (21); Vigoda-Gadot et al. (31)
Advance of science and technology level.	Lee and Om (18); Mohan and Rao (21)
Expanding competitiveness of industries.	
Improving efficiency, quality and availability of services to society.	Bloch and Bugge (5); Mohan and Rao (21)

Source: Elaborated by the authors.

Based on this literature review regarding project portfolio management in public institutions and its assessment, a tool for diagnostic was proposed. The model encompasses three dimensions: project portfolio structuring, project portfolio success and public research institution success. All dimensions relate to institutional strategic orientation as shown in Figure 1.



**Figure 1** – Model for diagnostic of project portfolio management in public research institutions:  
Source: Adapted from Meskendahl (20).

### 3. Method

A qualitative research approach was defined, and a model was developed as tool for diagnostic of project portfolio management in public research institutions. To test its suitability, the resulting model was applied in a case study assessing a Brazilian public science and technology institution.

A comprehensive literature review was carried out to guide development of the proposed model and to identify criteria to be used on diagnostic. Study's variables are the criteria identified, which are classified into three dimensions: project portfolio structuring, project portfolio success and public research institution success. Regarding model validation, a case study was considered as the most suitable research strategy, since the events examined by the study did not have their relevant behaviors manipulated at any time. This methodology allows investigation to preserve holistic and meaningful characteristics of real life of institutions, such as organizational processes and their changes. Besides, case studies are had as exploratory mechanisms important to support future work (34).

The institution selected was a beef cattle research center, one of the 46 research centers of Embrapa, the Brazilian Agricultural Research Corporation. Embrapa has specialized centers spread all over Brazil, dedicated to generate knowledge and technology for each major agricultural product related to tropical agriculture, with special focus on their suitability for each Brazilian biome. The whole Embrapa counts about 9,700 employees, of which, 2,500 are senior researchers. Its annual budget is equivalent to about 0.65 billion US Dollars (13). Around 80% of its research funds come directly from the Brazilian Government through the Ministry of Agriculture, which is Embrapa's parental institution. Most of the other 20% is raised by individual projects funded by other sources, mostly science supporting public agencies. These external projects follow also Embrapa's project portfolio management practices.

The case study here presented was carried out at Embrapa's Beef Cattle Research Center, which has 234 employees, from which, 57 are full time senior researchers. Document-based evidence, filed records and authors' observation were used on the diagnostic. All authors of this work serve as members of committees or departments involved in the organizational processes assessed by the study. This configuration was intentional, since their participation allows a better understanding of the issues being investigated (6; 34). During 2014 and 2015, a systematic analysis was carried out, examining all available internal documents in the scope of the study. These were mostly reports on processes analysis and improvement, an institutional self-assessment based on the Brazilian national public management framework ("GESPÚBLICA" model), statutes of the Research Center itself and its internal committees and commissions as well as the Center's strategic planning, internally called Agenda of Priorities. In-depth semi-structured interviews were carried out with 12 other local researchers and their assistants, in which they were asked about their perception on each of the model variables (criteria), aiming to identify how the project portfolio management performs in the research center. Explanation building approach was adopted, where collected data were analyzed and an explanation with regard to the case was developed, following Yin (34) approach. For applying the model, a diagnostic was made and suggestions of practices were prepared for each of the criteria related to structuring project portfolio, project portfolio success and public research institution success.

## **4. Results and discussion**

### **4.1. Embrapa Management System ("Sistema Embrapa de Gestão – SEG")**

The Embrapa Management System (SEG) is used by the institution since 2002. It was created to host the institution's complete project cycle: planning, carrying out, monitoring and evaluation. It is intended also to provide better transparency about the institution's research program for society. It has well-established procedures for project induction and resources distribution, being central for Embrapa's Project Portfolio. Its implementation is part of the institutional goals posed by its board of directors and ensures technical and scientific quality through peer reviews, as well as

strategic merit of Embrapa's R&D Program by detailing individual project results. It facilitates a systemic and integrated view of management, seeking to adjust research agenda to institutional strategic goals. In this sense, based on analysis of the external environment, a document was prepared "Visão 2014-2034" (Vision 2014-2034), from which institutional guidelines and strategic goals for Embrapa were established and became part of its Directive Plan (PDE).

Project granting goes through SEG. It is a competitive process and calls are broadly disclosed to the target public. Such proposals can only be submitted by Embrapa senior researchers, but participation of external scientists and partnerships with other institutions is encouraged in order to improve project's competences and infrastructure.

Evaluation flow for project proposals is:

- 1) Researchers of each Research Center write projects on-line using a specific corporate platform (Ideare) and submit them to the local office for research agenda support "Núcleo de Apoio à Programação" (NAP) where two local reviewers recommend or not a project submission to a given call while making suggestions for improvements when necessary;
- 2) The recommended project is sent for appreciation of an internal committee, the "Comitê Técnico Interno (CTI)" composed by employees representing the different sectors of the research center. Half of the members are elected by their peers and the other half is indicated by the Center's Director. This committee analyzes the project's alignment with the Center's strategic plan as well as considers its execution viability;
- 3) After approval by the CTI and eventual recommended adjustments, the CTI's executive secretary submits the project proposal for corporate evaluation. Since their conception, project is directed to one of the six tactical corporate broad project programs, called "Macroprogramas". Broad program managers check the proposals' suitability for the call.
- 4) Proposals fitting the broad program and call's requisites are sent through the on-line platform for analysis of technical merit by at least two peer reviewers from Embrapa or specialists from other research institutions;
- 5) Proposals with their respective reviews are examined by the broad programs technical committees, called "Comissões Técnicas de Macroprograma (CTMPs)" formed by specialists from Embrapa's body and external scientists. These members are nominated by Embrapa's Executive Directors. Based on technical merit, the CTMPs might recommend or not the approval of each project for the General Program Management Committee (Comitê Gestor da Programação CGP);
- 6) The CGP is formed by Embrapa's Executive Directors, by the Head of the Research and Development Department, Managers of the "Macroprogramas" and representatives of administration and researchers. This group makes the final evaluation of each project, focusing on their corporate strategic merit and their alignment with Embrapa's goals.

#### 4.2. Project portfolio structuring

Regarding results related to integration criteria (table 4), involvement of organizational functions in the portfolio was evident, as recommended by Meskendahl (20), but it could be further improved through participation of other employees.

The institution seeks to transfer technologies from closing to new projects, but this practice is not regular and, therefore, it could also be improved. Projects have cross-functional teams, and the technical capacity of leaders is weighted, however their management skills are not formally assessed. Integration promotes technological innovation as pointed out by Jugend and Silva (17), who consider the physical proximity of staff as a relevant factor. This aspect is considered by the institution, but it still lacks mechanisms to be analyzed and monitored.

Researchers are increasingly closer to market demands and they participate in preparation of market research and position papers. A concern regarding monitoring external environment could be noticed. Aspects regarding internal and external interaction are appreciated, such as communication and inter-institutional relationships, which help to overcome integration barriers.

Results related to integration criteria of the model summarized in table 4.

**Table 4** - Project Portfolio Structuring - integration criteria.

<b>Integration criteria</b>	<b>Diagnostic</b>	<b>Practices suggested</b>
Involvement of organizational functions mainly affected by decisions when structuring project portfolio.	Some sectors are consulted during project preparation.	To increase involvement of sectors in project writing by organizing and disclosing administrative information. To promote participation of employees from different organizational roles in decisions about portfolio structure.
Ability to select, develop and transfer technologies from previous projects to new ones.	Forms for writing projects have a section about the state of the art on the project's subject. This section is reviewed by a multidisciplinary committee that may request information from previous projects to be added.	Technologies and expertise developed in previous projects can be better organized to facilitate their use.

Inter-functional teams.	Projects include inter-functional teams and greater involvement of affected roles is pursued.	To increase the involvement of functions affected by some R&D activities.
Participation of R&D personnel in market research.	Researchers are increasingly closer to market demands and they participate in preparation of market research and position papers.	To create regular processes for participation of researchers in market researches.
Physical proximity.	Researchers and technicians have their rooms and laboratories physically near to each other, although in multidisciplinary projects researchers might be located in different cities and sometimes even in other countries.	To develop mechanisms for analyzing if existing teams' physical proximity is suitable for activities carried out.
Project leaders with technical and management skills.	Technical abilities are judged for project leadership, but management skills need a better evaluation.	To evaluate management skills for project leaders. To promote training for improving management skills in the institution's research team.
Internal and external communication.	Communication is encouraged and there are channels for it, mainly through intensive use of Information and Communication Technologies (ICT).	To check if there are other communication channels that can be used.
Inter-institutional relationships.	The inter-institutional relationships are encouraged and implemented through technical cooperation projects and contracts.	Check for further inter-institutional relationships that can be pursued.
Knowledge transfer and senior	Senior researchers participate in the discussion of new research projects	To implement a knowledge management process to make



management support.	at research groups meetings and report their considerations and suggestions.	instruments available for knowledge transfer.
Consent for informal information flow.	The institution seeks to promote the flow of information in a free and informal way. Recently an internal open forum called " <u>R&amp;D.com</u> " has been created to encourage and facilitate free exchange of information among the over 2,500 Embrapa's scientists.	Communication channels can be strengthened by encouraging contributions from employees.

Source: Elaborated by the authors.

The studied institution follows formalized processes, as results shown on table 5 and applies the rules regularly to both, new and ongoing projects. Procedures, data, criteria and rules are available to all employees. Therefore, the Research Center studied fully meets this formal criteria, in accordance to what is proposed by Meskendahl (20).

This observation is rather important, since studies indicate a positive influence of formalization on efficient portfolio management (20).

**Table 5** – Project Portfolio Structuring - formalization criteria.

<b>Formalization criteria</b>	<b>Diagnostic</b>
Adequate and accurate data.	Data regarding the portfolio are appropriate and accurate.
Objective and explicit criteria.	Objective and explicit criteria are defined and publicly available on internal regulations.
Reasonable and clear rules.	Internal committees and work groups have well-defined operating rules and statutes.
Transparent and well-known procedures.	Procedures are transparent and acknowledged by all involved. Eventual changes are timely informed.

Formal process applied regularly to both, ongoing and new projects.	The formal process is applied regularly to all projects.
---	--

Source: Elaborated by the authors.

The institution showed rather good performance on criteria regarding consistency as shown on table 6, proving proximity of institutional strategy with project portfolio planning. Goals are well defined in the strategic planning and projects are developed aiming outcomes relevant for the beef value chain, which is the research concentration area of the studied investigation center.

This result shows that the institution's strategy was defined and transferred to the portfolio and consequently to research projects, what should allow resources allocation according to corporate strategies. Strategic planning shows to be an effective way to implement strategy through the research center's project portfolio.

**Table 6** – Project Portfolio Structuring - Consistency criteria.

<b>Consistency criteria</b>	<b>Diagnostic</b>
Portfolio targets set before project selection.	Strategic objectives are defined in the Research Center's Agenda of Priorities (strategic plan).
Proximity of strategy with portfolio planning.	Projects are designed according to strategies from the local Agenda of Priorities. A formal, inter-functional committee, called Internal Technical Committee evaluates strategic alignment.
Specific strategies for projects aiming new products.	Strategic planning is geared towards new products (outcomes) linked to the value chain demands, which influence project preparation.
Strategy for technology development related to organizational strategy.	There are institutional efforts for acquisition, adaptation, management and integration of technologies with systems and people. These, however, in some cases are limited by bureaucratic and legal constraints.
Resources allocated in the portfolio are aligned to strategy.	Resources are allocated according to activities planned in projects.

Source: Elaborated by the authors.

Regarding the diligence attribute, results are shown on table 7. Improvement practices are recommended for defining a target portfolio. Results point out the need to implement long-term innovative projects, as suggested by Meskendahl (20). In the other hand, positive aspects were observed, mainly the existence of clear criteria to select the "right projects", use of scenarios, project interdependence and institutional culture aimed at prioritization with sharp focus in the institution's practices.

**Table 7** – Project Portfolio Structuring - Diligence criteria.

<b>Diligence criteria</b>	<b>Diagnostic</b>
Picture of a target portfolio to be achieved.	There is no existing picture of a target portfolio to be achieved.
Appropriate structuring process to select the "right" projects.	Project preparation involves discussions in local research groups, involving also other local or external researchers. Projects are evaluated by internal reviewers and thereafter by the inter-functional committee (CTI). After adjustments and approval, the project is rated by a central technical corporate committee as well as by the central managing committee of the broad research program.
Using scenarios.	Creating scenarios for analysis of project portfolio is used, even though it was started recently.
Interdependencies between projects are considered.	Projects are evaluated by committees before being approved, who necessarily check for interdependence among projects and suggest adjustments when necessary.
Mix of long-term and innovative projects.	Although long-term programs exist in the portfolio, projects are limited to short and medium terms.
Organizational culture focused on priorities with well-defined focus.	Organizational culture is oriented in such a manner that research teams take into account institutional priorities and their focus is oriented by the strategic plan.

Source: Elaborated by the authors.

### 4.3. Project portfolio success

Results of the analysis on project portfolio success in relation to criteria of average single project success, are shown on table 8. It could be noticed that the institution seeks to expand its vision to meet consumer and market needs as proposed by Lee and Om (18), Meskendahl (20), Haverila (16) and Mendes and Ganga (19).

**Table 8** – Project portfolio success - average single project success criteria.

<b>Average single project success criteria</b>	<b>Diagnostic</b>	<b>Practices suggested</b>
Considers market and consumer needs.	Projects are written to meet market and beef supply chain needs. Society demands are monitored by the local Beef Intelligence Center.	Criterion fulfilled.
Budget, schedule, and quality management.	Projects are monitored via corporate systems. There are limitations on how to use financial resources. Cuts on budget are common. Some projects follow quality requirements, although it is a practice under implementation.	To promote corrective actions based on project monitoring. To improve budget management to allow use of resources as planned. To expand quality assurance actions in order to introduce quality criteria in all projects.
Uses modern project management techniques.	Projects are developed according to modern project management techniques.	To expand project management practices using modern techniques during project duration.
Promotes cooperation with the industry transferring and strengthening technological advances.	Cooperation with industry is promoted through technical cooperation agreements and technology licensing.	Criterion fulfilled.
Facilitates technology transfer and trade of research results.	Technology transfer is carried out by specific sectors dedicated to that.	Criterion fulfilled.

Carry out studies on market and technical feasibility for new projects.	Studies are carried out for some areas or technologies.	To expand studies for market and technical feasibility for new projects.
Considers attributes that increase new technologies acceptance.	Some attributes that increase new technologies acceptance are considered.	To carry out project evaluation regarding attributes that increase acceptance of new technologies.

Source: Elaborated by the authors.

The studied research center perceives and uses traditional and modern techniques for project management, although some actions are limited by restrictions on public purchases and procurement, as well as constant cuts on budget initially assigned. Quality management is also being incorporated into local processes.

Cooperation with industry and technology transfer as pointed out by Lee and Om (18) are practiced in the institution, having a specific department for such. Market and technical feasibility studies for new projects are also being incorporated into the routine, though it needs to be expanded.

Some attributes that increase acceptance of new technologies as mentioned by Rogers (28) are considered, though not being part of project evaluation routine yet.

Actions directed to use of synergies are summarized on table 9. They are visibly fostered in the institution, as for example the coordinated management of all projects in the portfolio and the efforts to reduce double work (20), but it can be suggested better organization of projects into portfolio for easy visualization of opportunities to share technologies, market insights, knowledge and resources. This kind of setting will bring benefits beyond the sum of single results, generating synergy.

**Table 9** – Project portfolio success – use of synergies criteria.

Use of synergies criteria	Diagnostic
Shares technologies, market insights, knowledge and resources.	There is no formal procedure to check for synergies, although there are projects that share knowledge and resources.

Manages coordinately all projects in the portfolio.	Individuals responsible for R&D management are increasingly integrated and coordinated. Through automated systems, portfolio information is easily available to those involved.
Considers reducing double work.	Projects are evaluated by committees before being approved. These committees check for double work and might suggest adjustments on the proposal, integration with other projects or its non-approval.

Source: Elaborated by the authors.

The strategic fit criteria associated with this attribute as proposed by Meskendahl (20) were fully met by the studied institution (table 10). The research center makes sure that projects reflect its strategy and its objectives are aligned.

**Table 10** – Project portfolio success - strategic fit criteria.

<b>Strategic fit criteria</b>	<b>Diagnostic</b>
The sum of the projects reflects the strategy of the institution.	The set of projects reflects the overall strategy, being well integrated with institutional planning.
Project objectives fit the strategy.	Project objectives and its outcomes are aligned with institution's strategy and can be checked through an online platform called INTEGRO which keeps organized and updated the whole Agenda of Priorities for all Embrapa's Research Centers.

Source: Elaborated by the authors.

The analysis results of the criteria regarding portfolio balance, shown on table 11, let to the following recommendations from the model: to promote balance of short and long-term projects, to perform risk analysis and analysis of balance between generation of incremental and radical innovation. It is important to remark that Vigoda-Gadot et al. (31) emphasize that risk should also be considered in innovative public institutions.

**Table 11** – Project portfolio success - portfolio balance criteria.

<b>Portfolio balance criteria</b>	<b>Diagnostic</b>
-----------------------------------	-------------------

Balance between short and long term benefits.	Definition of results exists to meet short, medium and long-term demands, although this balance still needs to be improved.
Project risk analysis.	In the institution's forms for project writing there is a mandatory section to list and discuss potential project risks. However, a thorough risk analysis for each case is not carried out.
Balance in generating incremental and radical innovation.	Analysis regarding balance of incremental and radical innovation is not performed.

Source: Elaborated by the authors.

#### 4.4. Public research institution success

Regarding success of public research institutions, results on table 12 show that all criteria are met by the studied Research Center. It is recommended, though, that in the strategic planning, stated institutional goals stress the concern with social and psychological well-being of citizens. It is also advisable to foster discussion on how to facilitate public research institutions to work with the private sector.

In the Research Center are highlighted practices towards the criteria: long-term thinking; tackling social challenges and elimination of inequalities; improving science and technology levels; improving efficiency, quality and availability of services to society.

**Table 12** – Criteria regarding public research institutions success.

<b>Public research institutions success criteria</b>	<b>Diagnostic</b>
Concern for the social and psychological well-being of citizens.	Mission of Embrapa is: "Provide solutions for research, development and innovation for sustainability of agriculture for the benefit of Brazilian society". Actions to achieve this goal are present in the project portfolio of the Research Center as well as in the results made available to society.



Long-term thinking	There is a document of vision targeting the year 2034 as well as there are studies and scenarios developed by the Embrapa's Strategic Intelligence System (Agropensa), that guide institutional initiatives. Locally, there is an initiative called Beef Intelligence Center focused on the beef value chain.
Tackling social challenges and elimination of inequalities.	There are axes of impact in strategic planning that guide R&D initiatives. Axis IV promotes integrated actions for inclusive farming and reduction of rural poverty.
Advance of science and technology level.	Similarly, to the previous item, impact axis II promotes research and innovation for strategic and competitive insertion of Brazil in the emerging bioeconomy.
Expanding competitiveness of industries.	Initiatives are being carried out in this area, although bureaucratic and legal limitations of public institutions hamper this action.
Improving efficiency, quality and availability of services to society.	The Research Center voluntarily strives for compliance with the Brazilian Framework for Excellence in Public Administration as well as it has implemented an integrated management system, which encompasses quality, health&safety and environmental soundness.

Source: Elaborated by the authors.

## 5. Conclusions

As a direct implication for management of the public sector, this study concludes that the proposed model is suitable as a tool for diagnostic of project portfolio management for public research institutions. Results have shown that strengths of the studied Research Center, as well as aspects that need attention have been raised by the proposed method. Based on the structured assessment model proposed, it is possible to design an improvement plan for local project portfolio management.

The importance given to strategic orientation by the studied research center became evident throughout the work. Under public research institutions, this practice is not much common, especially under universities. This need to integrate project portfolio with institutional strategy influences the three dimensions of the model and especially the attributes: consistency, diligence

and strategic fit. From the results obtained it becomes evident that putting into practice an effective strategic planning for public research institutions is paramount for project portfolio success.

Also from the case studied, it can be concluded that it is still difficult to incorporate a vision of long-term goals and radical innovation involving higher risks. Since it is a public institution, aversion to risk is even higher. However, in order to promote radical innovation in benefit of the society, public institutions need also integrate risks, which are an intrinsic part of the process.

Regarding the model itself, dimensions adopted were based on the work from Meskendahl (20) with an expansion of criteria associated to the dimensions of project portfolio structuring and project portfolio success. The dimension public research institutions success was incorporated to the model by the authors. Taking these items into consideration showed to be relevant in the context of the case study used for model's validation.

Further investigation using this model for other areas of research and other countries would contribute to sediment this methodology. It is important to notice that this tool is expandable and from the work performed, possibilities to enhance the model in the future were realized, especially through incorporation of new criteria and dimensions as they become more important for public institutions, especially if they succeed in establishing research partnerships with private companies. Future studies could also quantitatively test relationships among criteria (variables) and dimensions (constructs) of the proposed model involving several institutions.

## 6. References

- (1) Abbasi, G. Y., and Al-Mharmah, H. A. "Project management practice by the public sector in a developing country", *International Journal of Project Management*, Vol. 18, 2000, pp. 105-109.
- (2) Aguado, Y. Y. "Portfolio Management of Research Projects in the Public and Private Sector" (doctoral thesis). Norwegian University of Science and Technology, Department of Industrial Economics and Technology Management, Trondheim, 2011.
- (3) Barzelay, M. "The New Public Management: improving research and policy dialogue", University of California Press, Berkeley, 2001.
- (4) Bassi, N. S. S., and Silva, C. L. "Processo de gestão de projetos de pesquisa, desenvolvimento e inovação na Empresa Brasileira de Pesquisa Agropecuária – Embrapa", in *Anais do XIV Congresso Latino-Iberoamericano de Gestão Tecnológica – ALTEC - 2011*, Lima, Peru, 2011.
- (5) Bloch, C., and Bugge, M. M. "Public sector innovation-from theory to measurement", *Structural Change and Economic Dynamics*, Vol. 27, 2013, pp. 133-145.

- (6) Bryman, A. "Integrating quantitative and qualitative research: how is it done?", *Qualitative Research*, Vol. 6(1), 2006, pp. 97-113.
- (7) Brühl, R., Horsch, N., and Osann, M. "Improving integration capabilities with management control", *European Journal of Innovation Management*, Vol. 13(4), 2010, pp. 385-408.
- (8) Cats-Baril, W and Thompson, R. "Managing information technology projects in the public sector", *Public Administration Review*, Vol. 55(6), 1995, pp. 559-566.
- (9) Chapman, C. B.; Ward, S. C.; and Klein, J. H. "An optimised multiple test framework for project selection in the public sector, with a nuclear waste disposal case-based example", *International Journal of Project Management*, Vol. 24(5), 2006, pp. 373-384.
- (10) Cohen, W. M.; Nelson, R. R.; and Walsh, J. P. "Links and impacts: the influence of public research on industrial R&D", *Management Science*, Vol. 48(1), 2002, pp. 1-23.
- (11) Cooper, R. G., Edgett, S. J., and Kleinschmidt, E. J. "Portfolio management for new product development: results of an industry practices study", *R&D Management*, Vol. 31(4), 2001, pp. 361-380.
- (12) Debackere, K. "Managing academic R&D as a business at K.U. Leuven: context, structure and process", *R&D Management*, Vol. 30(4), 2000, pp. 323-328.
- (13) Empresa Brasileira de Pesquisa Agropecuária. A Embrapa, 2015. Access in: 28 feb. 2015. Available from: [www.embrapa.br](http://www.embrapa.br).
- (14) Felekoglu, B., Maier, A. M., and Moultrie, J. "Interactions in new product development: how the nature of the NPD process influences interaction between teams and management", *Journal of Engineering and Technology Management*, Vol. 30(4), 2013, pp. 384-401.
- (15) Fernandes, L. P. "Práticas de mensuração do desempenho em institutos públicos de pesquisa e desenvolvimento tecnológico" (Dissertação de mestrado), Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2006.
- (16) Haverila, M. "The marketplace variables in successful NPD projects in technology intensive companies", *Journal of Technology Management & Innovation*, Vol. 5(4), 2010, pp. 121-136.
- (17) Jugend, D.; and Silva, S. L. "Integration in New Product Development: Case Study in a Large Brazilian High-Technology Company", *Journal of Technology Management & Innovation*, Vol. 7(1), 2012, pp. 52-63.
- (18) Lee, M. and Om, K. "Different factors considered in project selection at public and private R&D institutes", *Technovation*, Vol. 16(6), 1996, pp. 271-275.

- (19) Mendes, G. H. S; and Ganga, G. M. D. “Predicting success in product development: the application of principal component analysis to categorical data and binomial logistic regression”, *Journal of Technology Management & Innovation*, Vol. 8(3), 2013, pp. 83–94.
- (20) Meskendahl, S. “The influence of business strategy on project portfolio management and its success: a conceptual framework”, *International Journal of Project Management*, Vol. 28(8), 2010, pp. 807-817.
- (21) Mohan, S. R. and Rao, A. R. “R&D Project Priorization Model for Public Research Institutes”, *Journal of Scientific & Industrial Research*, Vol. 61(12), 2002, pp. 1033-1038.
- (22) Nagano, M. S., Stefanovitz, J. P. and Vick, T. E. “Innovation management process, their internal organizational elements and contextual factors: An investigation in Brazil”, *Journal of Engineering and Technology Management*, Vol. 33, 2014, pp. 63-92.
- (23) Oliveira, L. H.; Del`Arco Junior, A. P. and Brandão Neto, N. “Gestão sistêmica de projetos em uma instituição pública de pesquisa e desenvolvimento”, *Journal of Aerospace Technology and Management*, Vol. 2(1), 2010, pp. 83-104.
- (24) Park, M. H., Lim, J. W. and Birnbaum-More, P. H. “The effect of multiknowledge individuals on performance in cross-functional new product development teams”, *IEEE Engineering Management Review*, Vol. 40(4), 2012, pp. 42-54.
- (25) Pinheiro, A. A.; Siani, A. C.; Guilhermino, J. F.; Henriques, M. G. M. O.; Quental, C. M. and Pizarro, A. P. B. “Metodologia para gerenciar projetos de pesquisa e desenvolvimento com foco em produtos: uma proposta”, *Revista de Administração Pública*, Vol. 40(3), 2006, pp. 457-478.
- (26) Project Management Institute. “Government Extensions to the PMBOK Guide”. (ed. 3). Project Management Institute, Newtown Square, PA, 2006.
- (27) Rosacker, K. M. and Rosacker, R. E. “Information technology project management within public sector organizations”, *Journal of Enterprise Information Management*, Vol. 23(5), pp. 587-594, 2010.
- (28) Rogers, E.M. “Diffusion of innovations” (ed. 3). The Free Press, New York, 1983.
- (29) Song, L. Z. and Song, M. “The role of information technologies in enhancing R&D-Marketing integration: an empirical investigation”, *Journal of Product Innovation Management*, Vol. 27( 3), 2010, pp. 382-401.
- (30) Staub, E. “Desafios estratégicos em ciência, tecnologia e inovação”, *Revista Parcerias Estratégicas*, Vol. 13, 2001, pp. 5-22. [http://www.cgee.org.br/arquivos/pe\\_13.pdf](http://www.cgee.org.br/arquivos/pe_13.pdf).
- (31) Vigoda-Gadot, E., Shoham, A., Schwabsky, N. and Ruvio, A. “Public sector innovation for the managerial and the post-managerial era: promises and realities in a globalizing public administration”, *International Public Management Journal*, Vol. 8(1), 2005, pp. 57-81.

- (32) Vigoda-Gadot, E. and Meiri, S. “New public management values and person-organization fit: a socio-psychological approach and empirical examination among public sector personnel”, *Public Administration*, Vol. 86(1), 2008, pp. 111-131.
- (33) Weerd-Nederhof, P. and Fisscher, O. “Alignment and Alliances for Research Institutes Engaged in Product Innovation. Two Case Studies”, *Creativity and Innovation Management*, Vol. 12(2), 2003, pp. 65-75.
- (34) Yin, Robert K. “Estudo de caso: planejamento e métodos” (ed. 2). Bookman, Porto Alegre, 2001.
- (35) Zapata, A. R. P. and Cantú, S. O. “Gestión estratégica de la tecnología en el predesarrollo de nuevos productos”, *Journal of Technology Management & Innovation*, Vol. 3(3), 2008, pp. 112-122.

## 7. Acknowledgment

This paper was funded by Embrapa project entitled “INFOPEC: Information and knowledge management for technologies, products and services generated by Embrapa and other national and international research institutions to meet beef cattle chain demands.” under SEG Number 05.13.14.001.00.00.

## 8. Correspondence

Paulo Henrique Nogueira Biscola, Embrapa Gado de Corte, Av. Rádio Maia, 830, Zona Rural - 79106-550 - Campo Grande – MS – Brazil, email: paulo.biscola@embrapa.br.

Davi José Bungenstab – Embrapa Gado de Corte, Av. Rádio Maia, 830, Zona Rural - 79106-550 - Campo Grande – MS – Brazil, email: davi.bungenstab@embrapa.br.

Gabriel Lopes Alves – Universidade Federal de Mato Grosso do Sul, Av. Costa e Silva, s/nº, Universitário - 79070-900 - Campo Grande – MS – Brazil, email: glalves1287@gmail.com.

Nibia Queiroz de Paula – Embrapa Gado de Corte, Av. Rádio Maia, 830, Zona Rural - 79106-550 - Campo Grande – MS – Brazil, email: nibia.paula@embrapa.br.

José Roberto de Souza Freire – Embrapa Gado de Corte, Av. Rádio Maia, 830, Zona Rural - 79106-550 - Campo Grande – MS – Brazil, email: jose.freire@embrapa.br.