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University research management models: a literature review

Modelos de gestión de investigación universitaria: una revisión de literatura

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Abstract

In the literatre, the lack of activities related to research management in Higher Education Institutions (HEIs) has been identified to promote the products derived from the research process towards transfer. This research work aims to identify university research management models and frameworks that have been developed since 2010 under the management approaches of research organizations, as well as project management in research groups. For this, an integrative review of the literature was carried out among different authors who have made contributions to the theoretical body of the subject using the search and evaluation methodology for inclusion. This research is important because it will provide valuable information for those responsible for the research areas in HEIs, since it will show them a range of options that have been developed to guide this management process and will allow them to decide on the convenience of adopting them or, adapt them to your institutional research strategy.

Management of university research, models and frameworks, review

Resumen

En la literatura se ha identificado la carencia de actividades relativas a la gestión de investigación en las Instituciones de Educación Superior (IES) para impulsar los productos derivados del proceso de investigación hacia la transferencia. Este trabajo de investigación tiene como objetivo identificar modelos y frameworks de gestión de investigación universitaria que han sido desarrollados a partir del año 2010 bajo los enfoques de administración de organizaciones de investigación, así como el de gestión de proyectos en grupos de investigación. Para ello se hizo una revisión integrativa de literatura entre diferentes autores que han realizado aportes al cuerpo teórico del tema utilizando la metodología de búsqueda y evaluación para inclusión. Esta investigación resulta importante porque proporcionará información de valor para los responsables de las áreas de investigación en las IES ya que les mostrará un abanico de opciones que han sido desarrolladas para guiar este proceso de gestión y les permitirá decidir sobre la conveniencia de adoptarlos o bien, adaptarlos a su estrategia de investigación institucional.

Gestión de investigación universitaria, modelos y marcos de trabajo, revisión

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Introduction

Innovation is one of the pillars of a country's competitiveness and progress, which is why technology transfer contributes to the development of regions through government-university-business synergies (De Moortel & Crispeels, 2018).

By transferring their scientific-technological advances to society, industries and markets, universities generate value and increase innovation-based productivity (Cruz Novoa, 2016). Globally, countries such as Sweden, Belgium, Singapore, Germany, the United Kingdom, Norway, Finland, Israel, the United States and Switzerland have positioned themselves over the years as leaders in promoting university collaboration with industry, and the result of this is reflected in their competitiveness and innovation indices (WEF, 2018).

However, in developing countries such as Mexico, this rapprochement between industry as an acquirer and universities as technology providers is a relatively new and therefore incipient phenomenon (Becerra, 2019; Calderón et al., 2016; Frías, 2019). Although several Mexican universities stand out nationally and internationally, it is not a phenomenon that is replicated in the majority of universities in the country (Pérez Cruz, 2019).

The literature points to shortcomings and weaknesses in the processes inherent to research management as the reasons why the transfer of technologies produced in Higher Education Institutions (HEIs) to the markets does not take off (Agramon & Lechuga, 2019; Alpizar et al., 2017; Álvarez et al., 2019; Benitez-Abarca & Rubio-Toledo, 2020; Bolívar-Cruz et al., 2017; Calderón-Martínez, 2014; García, 2017; Hernández et al, 2015; Jiménez & Castellanos, 2013; Martínez et al., 2018; Medellín Cabrera & Arellano Arellano, 2019; Meza & Delzo, 2017; Morales et al., 2014; Munari et al., 2017; Nuñez & Montalvo, 2015; Parakhina et al, 2017; Ponce Jaramillo & Güemes Castorena, 2016; Ramírez & Royero, 2019; Rocha & Romero, 2012; Solange & Silva, 2018; Soleimani et al., 2016; Solleiro & González, 2016; Soria et al., 2017; Velez et al., 2019; Yeverino & Álvarez, 2019; Sepúlveda, 2017).

It is of utmost importance to recognise that in order to achieve innovation, it is first necessary to go through research, which has undoubtedly been formally structured and organised in HEIs, although its management has not (Nguyen & Meek, 2016), therefore, it is important to focus on improving this function in order to make it efficient and improve its performance (Ramos et al., 2018).

Research management has not been a simple matter for universities at national and international level due to the academic community's deep-rooted focus on the fulfilment of research from a traditional point of view, which has not allowed them to generate a new system vision in university research and innovation processes (Pino et al., 2021).

In this respect, internal changes in management frameworks have been proposed to move HEIs from being "traditional" to "entrepreneurial" (Gür et al., 2017), 2017); however, this transition from research to innovation is not simple, it requires a strategy to develop it and make it happen, it requires a method, a "way", and that "way" includes planning actions, executing them, evaluating them and adjusting them in a systematic way (Garnica & Franco, 2020), this, without leaving out the establishment of rules and procedures to manage the life cycle of research projects (Nguyen & Meek, 2016).

This research work aimed to identify models and frameworks for university research management that have been developed since 2010 under two specific approaches.

To achieve this, in accordance with Torraco (2005), an integrative literature review was conducted among different authors who have made contributions to the theoretical body of the subject, using the search and evaluation methodology for inclusion of Xiao and Watson (2019).

This research is important because it will provide valuable information for those responsible for research areas in HEIs as it will show them a range of options that have been developed to guide this management process and allow them to decide whether to adopt or adapt them to their institutional research strategy.

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The content of this document has been divided into four sections: the first section provides the context of research management; the second describes the methodology used for this research; the third shows the results obtained; and finally, the conclusions drawn from this research are drawn.

The context of scientific research management

Scientific research management has a significant influence on improving the level of research in universities (Yao, 2019). It is recognised as a systematic process that aims to strengthen and articulate research, development and innovation activities in different contexts, as well as foster cooperation between researchers, research groups and institutional networks (Ramos et al., 2018). This is achieved through the determination of an organisation's priorities in terms of scientific and technological needs, providing the necessary guidelines to develop research projects, proposing the appropriate means to expand the knowledge market in order to generate greater resources and strengthen alliances between the State-Business-University-Society that contribute to the development of the scientific, business and social community (Becerra et al., 2015).

The need for research management arises from at least three interconnected issues (Schuetzenmeister, 2010):

1. An increasing number of research organisations compete for scarce resources provided by governments or the private sector.

2. The complexity of many scientific problems requires interdisciplinary or transdisciplinary collaborations within or between research institutes and often non-scientific organisations.

3. Many fields rely on expensive infrastructure, facilities and instrumentation, such as particle accelerators, genome sequencers, aircraft, supercomputers or even satellites that require government support as well as collaboration between organisations.

Nguyen & Meek (2016), identify ten generic parameters for organising and structuring research management in universities in order to develop research capacity and improve research outputs, but also in the hope of ensuring that all organisational elements point in that direction. They are shown in Table 1. They also state, that five are more visible, and that the less visible tasks refer to the so-called "formalisation of behaviour" which is the design parameter by which the work processes of the research-oriented organisation are standardised.

	Tasks
More visible	Create research posts.
	Create research management positions.
	Decide on the main organisational units for research delivery.
	Create a research office.
	Create research oversight committees.
Less visible	Develop rules for research integrity.
	Develop rules and procedures for managing the life cycle of a research project.
	Develop a mechanism for assessing the quality of research results.
	Prepare researchers and research managers for the necessary skills and knowledge.
	Decide on vertical and horizontal decentralisation.

Table 1 Generic tasks for organising and structuring Research Management in universities
Source: (Nguyen & Meek, 2016)

Research management can be viewed through four approaches:

1. 1One aimed at the management of national Research and Development systems.

2. A level of funding organisations.

3. The management of research organisations, e.g., universities or research centres.

4. Project management in research groups, centres or departments where decisions are made with reference to the social environment of research as well as the cognitive dynamics of a scientific field. Working conditions, opportunity structure and constraints are shaped at this level (Schuetzenmeister, 2010).

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The Research Management approach to the administration of research organisations arises because university administrations have tended to promote managerial control similar to commercial organisations, i.e. they have had to establish formalised control and evaluation routines to improve productivity and increase the accountability of researchers for the use of resources and the outcome of research activities. On the other hand, project management in research groups, research centres and the department represents how research work is carried out, on the basis of which decisions are made related to the social environment of research as well as to the cognitive dynamics of a scientific field (Schuetzenmeister, 2010).

Methodology

For this research, according to Torraco (2005), an integrative literature review was conducted among different authors who have made contributions to the theoretical body of the topic, using the search and evaluation methodology for inclusion of (Xiao & Watson, 2019).

Based on the search criteria, 187 articles were initially identified. The inclusion and exclusion criteria used was to identify studies referring to conceptual frameworks, models, methodologies or approaches related to research and innovation management in universities, also referred to in the literature as Higher Education Institutions.

First, duplicates were removed (N=30) and articles were excluded because they were not relevant, were reviews, were not in English or Spanish, or the full text was not found (N=51). The abstracts of 106 articles were reviewed to ensure that the focus sought was correct. Forty-nine were excluded and 57 were selected based on the inclusion criteria.

In the next stage, the 57 studies were classified according to the four approaches outlined by Schuetzenmeister (2010) mentioned above. Given that this research is oriented towards two of them, specifically: approach 3, which refers to the administration of research organisations, and approach 4, which relates to project management in research groups, centres or departments, only 11 were finally chosen.

Subsequently, a grounded theory research design was used, the main feature of which is that the data is categorised with open coding, and then the resulting categories representing the emerging theory are organised (Hernández et al., 2014).

Results

Under the research organisation management approach, 5 models and frameworks were found and are briefly described below.

a. Viable university research framework.

This model suggests the need for a more holistic approach to research management and its maintenance from a systemic and self-sustaining approach through the use of the Viable System Model (VSM). The concept of cohesion in VSM addresses the need for coherence between its functions, coherence between the higher level system and its subsystems, as well as between its subsystems. These cohesive relationships match the operations of the whole system with the requirements of its internal and external situations to ensure the viability of the system. This model is intended to help university leaders and administrators understand the interrelationship of functions within the university to develop functions derived from the third mission (Adham et al., 2015). This model is shown in Figure 1.

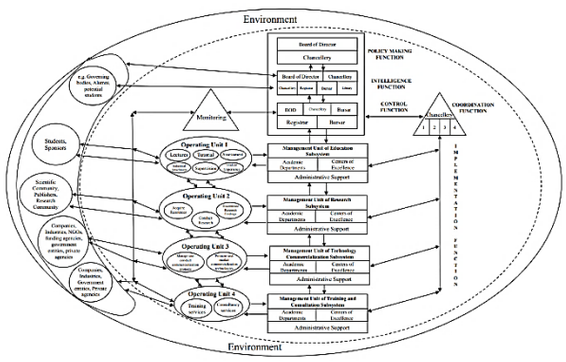

Figure 1 Viable university research framework
Source: Adapted from (Adham et al., 2015)

b. Innovation and performance management framework for university research

The framework is based on a concept in which innovation management contextual factors have a direct effect on innovation performance. The conceptual framework of innovation management contextual factors consists of 17 attributes that are grouped into 5 innovation management success factors as independent variables: a) innovation strategy; b) leadership; c) organisational structure; d) organisational culture; e) innovation resources.

Meanwhile, the dependent variables in the conceptual framework focus on innovation performance in terms of: a) efficiency and effectiveness of the innovation process; b) number of new projects, services or products completed, c) amount of research fund awarded; d) number of external linkages; e) duration to complete a research project (Kowang et al., 2015). The framework is shown in Figure 2.

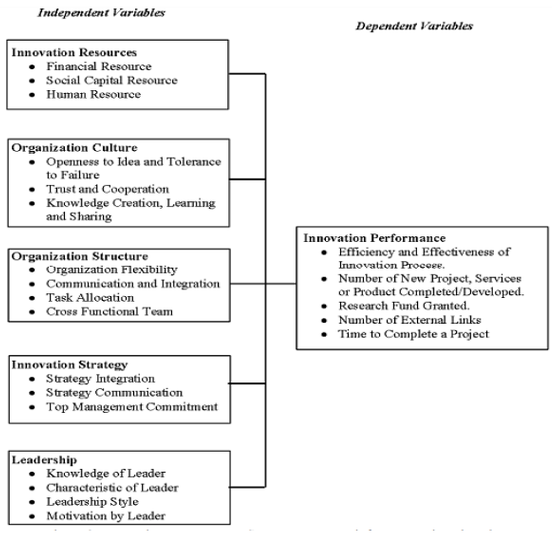

Figure 2 Innovation and performance management framework for university research
Source: Adapted from (Kowang et al., 2015)

c. Framework for structuring interdisciplinary research management.

With project-based research becoming an important form of research organisation, its coordination and management has become an important task in interdisciplinary research collaborations and a key determinant of their success.

This framework is based on three types of analysis that form the methodological basis for its development: 1) content analysis of working documents and contracts; 2) team-reflected experience and documented action analysis; and 3) literature review on interdisciplinary and transdisciplinary management and organisational management. Furthermore, through a case study of a European Integrated Project, the authors developed four essential management domains and related them to the existing literature on inter- and transdisciplinary research project management. The resulting model includes 4 quadrants referring to interdisciplinary culture, integrative product development. Open systems and internal processes (König et al., 2013). This framework is shown in figure 3.

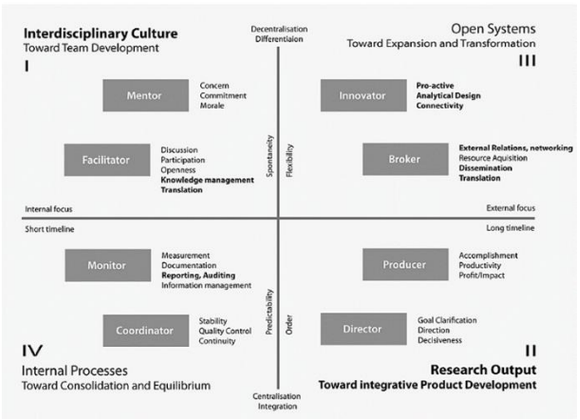

Figure 3 Framework for interdisciplinary research management
Source: Adapted from (König et al., 2013)

d. University business research framework

For the development of the framework a constructionist grounded theory was used to collect multiple but highly focused data to identify and develop the concepts shown in Figure 4.

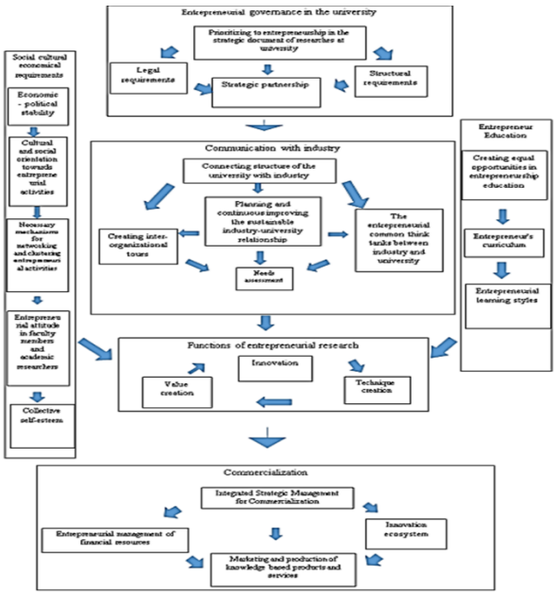

Figure 4 University business research framework
Source: Adapted from (Naderibeni & Radovic, 2020).

The model concentrates on 6 substantial categories that operate within the organisation under a systemic approach: 1) entrepreneurial governance in the university; 2) communication with industry; 3) entrepreneurial research functions; 4) social, cultural and economic requirements that drive entrepreneurial research; 5) entrepreneurial education as an organisational culture and, 6) commercialisation (Naderibeni & Radovic, 2020).

d. Institutional model of an entrepreneurial university

The model shows that top-level management is the driving power that plays a dominant role in determining the direction of the university to become entrepreneurial. Top management is generally able to shape organisational strategies in terms of facilitating, initiating and implementing, so their commitment is required when executing a management system that drives research quality. The elements used to form the institutional model are actors who play a role in fostering entrepreneurial universities. After a selection and validation process, the authors identify 7 that are fundamental: 1) top-level management; 2) faculty and staff, 3) students, 4) alumni, 5) parents, 6) local government, 7) regulator, 8) industry, 9) community, 10) research institute and; 11) media, which they integrate into a hierarchical model through which they map the positions and roles of each of them in the entrepreneurial ecosystem. This model is shown in Figure 5 (Novela et al., 2021)

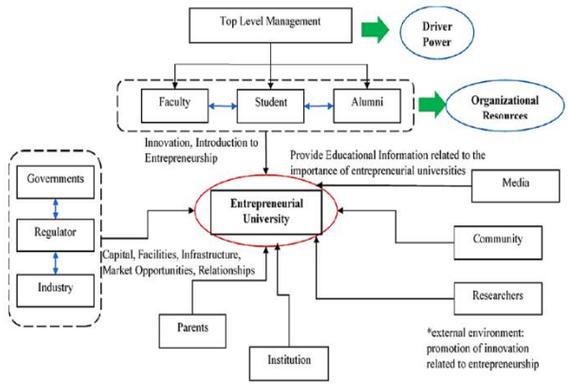

Figure 5 Institutional model of an entrepreneurial university
Source: Adapted from (Novela et al., 2021)

On the other hand, under the approach of management oriented to research groups, centres and departments, 6 models and frameworks were found, which are described as follows.

d. Action Research and Innovation Management Framework (AIM-R).

Action research is a practice-oriented research method applied in collaboration with practitioners, which focuses simultaneously on solving practical problems and expanding scientific knowledge. It therefore helps to generate rigorous and relevant research knowledge.

This model is based on the Design Research Methodology which is action-oriented in a high-level iterative process of four phases: 1) clarification of vision; 2) articulation of theories; 3) implementation of actions and data collection; and, 4) reflection and informed action planning. Design Research Methodology focuses on improving product development at various levels, from single design methods through processes to broader organisational changes, including smaller changes in techniques and methods.

The AIM-R model, shown in Figure 6, provides a structured research process for systematically applying action research as a way of fostering rigorous research processes while stimulating relevant practical outcomes. AIM-R specifically considers different levels of change (individual, team, organisational) and objects, e.g. outcome, process or capability, all critical to the multifaceted character of innovation management.

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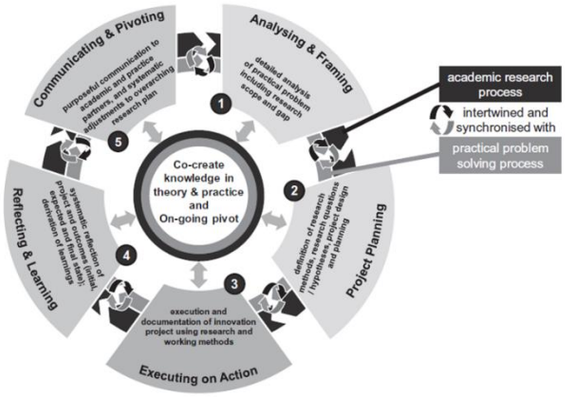

Figure 6 Action research and innovation management (AIM-R) framework
Source: Adapted from (Guertler et al., 2020).

The model includes five circular phases: 1) analysis and elaboration; 2) project planning; 3) action implementation; 4) reflection and learning; and 5) communication and pivoting. It is worth mentioning that it has already been tested in a project that took two years to develop. This project focused on open innovation management with three industrial partners and was funded by a German industrial cluster agency (Guertler et al., 2020).

e. Reference model for academic research management based on PMBOK.

In the research process there is a need for a project management system that meets the requirements of adaptability and flexibility, as well as efficiency in resource allocation for successful management. Project Management Book Of Knowledge (PMBOK) issued by PMI (Project Management Institute) is widely used in successful project management and several studies show that with the use of PMBOK, good practices in software project management help organisations to achieve their goals.

This model aligns the project life cycle with the PMBOK phases, dividing it into five phases: initiation, planning, execution, monitoring and control, and closure.

The model is shown in figure 7.

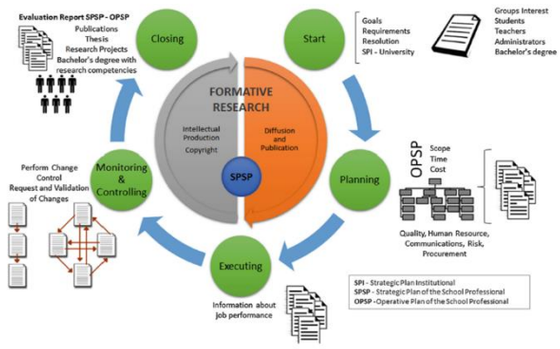

Figure 7 Reference model for academic research management based on PMBOK
Source: (Bayona et al., 2018)

It is important to mention that the model was adapted for each area of knowledge by reducing in some cases the processes and activities, as well as establishing the processes involved in each of them. It is also worth mentioning that this model has already been implemented to manage research management projects in two universities in Peru and that the results obtained corroborate its efficiency in meeting stakeholder expectations (Bayona et al., 2018).

f. Technology and Innovation Management Model for Higher Education Institutions.

This model attempts to solve the common bottlenecks in the innovation and development process known as the "European Paradox" or the "Latin American Innovation Gap" also known as the "valley of death"; it is also intended to be the solution to the innovation gap regarding the learning model for effective practices and design tools in technology and innovation management. Conceptually, the model focuses on competencies, tools, skills and behaviours.

It arises from a case study analysis from Europe and Latin America to which they also added as complementary sources, cases from the literature and their own experiences. From this, they derived a learning model based on the organisational framework.

The model includes the following knowledge areas: (a) research information skills; (b) knowledge of technological trends; (c) knowledge about financial markets and new schemes (e.g. crowdfunding); (d) knowledge about market requirements and skills to identify potential customers; (e) knowledge and skills related to managing innovation processes and projects; f) skills to make decisions under conditions of risk and uncertainty; g) skills to stimulate entrepreneurship in many different organisational situations; h) ability to interact with many different actors to innovate; i) knowledge and information of environmental regulations; j) new approaches to product design in the framework of the circular economy. Figure 8 shows the model, which in the outer circle shows the basic conditions or contexts needed to manage or implement successful technology and innovation management. Some of these are external to the organisation, some internal, such as systems thinking, and some both internal and external, e.g. complexity, uncertainty and risk. The inner circle includes the specific tools and competences for technology and innovation management (Arciénaga et al., 2018).

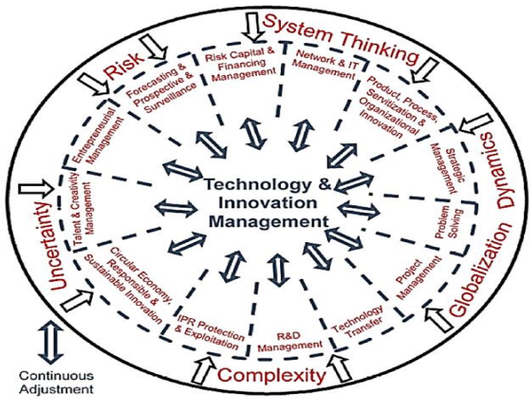

Figure 8 Technology and Innovation Management Model for Higher Education Institutions
Source: Adapted from (Arciénaga et al., 2018)

g. The business model of the Cambridge innovation process

The Cambridge Business Model Innovation Process (CBMIP) framework addresses the different stages of an organisation's business model generation, from initial conceptualisation to implementation. It aims to provide better guidance through the business model innovation process with its different phases and activities and to map the potential challenges of the gap between design and implementation for companies.

The model shown in Figure 9 consists of eight sequential but iterative phases or steps: 1) Ideation: in this phase the purpose of the business model innovation and the key stakeholders are defined; both the value proposition and the first conceptual ideas are devised; 2) Conceptual design: a first rough conceptualisation of the key elements of the business model is developed and documented; 3) Virtual prototyping: a variety of prototypes are generated and reviewed to refine and communicate the business model concept; 4) Experimentation: key assumptions and concept variables are tested in simulations and field experiments, ideally through randomised controlled trials; 5) Detailed design: An in-depth and detailed analysis of all elements of the business model and the interactions between these elements is performed; 6) Pilot testing: the entire concept is tested by running a first limited version of the business model in a subsection of the target market; 7) Launch: the business model is implemented in all responsible organisational units and in the target market; 8) Adjustment and diversification: the business model is reviewed according to the initial plans, expectations and strategic fit, based on this assessment adjustments are made depending on the changes needed. Based on this assessment, adjustments are made depending on the necessary changes. Based on this assessment, the entire business model innovation process can be repeated (Geissdoerfer et al., 2017).

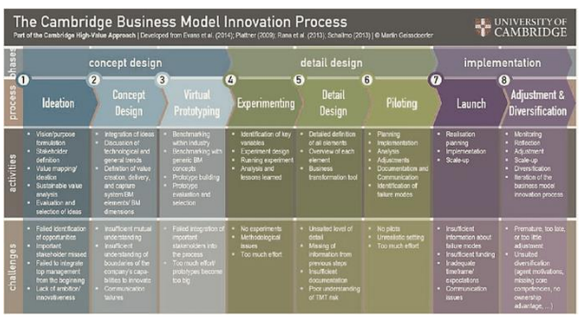

Figure 9 The business model of the Cambridge innovation process
Source: Adapted from (Geissdoerfer et al., 2017)

h. Translational research and development framework for linking university research in science and engineering with commercial outcomes

Over the past few decades, translational research has emerged as a new means of trying to speed up the time it takes to turn basic scientific discoveries into practical applications. The concept started in the medical industry, but its use has been migrating to other areas of knowledge. Through this translational research and development (R&D) framework, the aim is to create a smoother transition from research to business (R2B).

The translational R&D methodology proposed in this model incorporates best practices from two interrelated fields of expertise: project management (PM) and new product development (NPD). PM is the use of management skills, tools and processes to successfully carry out a project, while NPD is the overall process of strategy, organisation, concept generation, product creation, marketing plans, evaluation and commercialisation of new or improved products.

The NPD framework in the translational R&D methodology proposed in this model is a variant recommended in the New Product Development Manual (PDMA®), i.e. the Stage-Gate® model by Cooper, (2013) which is a business process and risk model that creates value through the rapid and cost-effective transformation of good ideas into successful new products.

As shown in Figure 10, the model comprises four phases: initiation, planning, execution and closure.

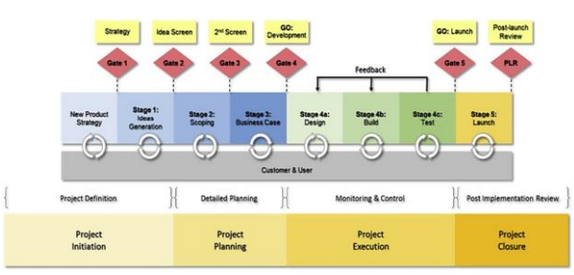

Figure 10 Project life cycle diagram representing the four project phases and the five-stage Stage-Gate® system
Source: Adapted from (Bazan, 2019)

Critical success factors such as front-loading, sharp product definition, spiral development and voice of the customer approach are intrinsically integrated into the model that seeks to help researchers initiate, plan, execute and close a university-based translational R&D project with the intention of bringing products to market (Bazan, 2019).

i. Proposed model for University-Industry Technology Transfer (UITT) in India.

This model was designed based on a comparative study of technology transfer policies and models practiced in some universities in the US, Japan and Israel and then analysing current practices in India. The model is based on empirical evidence concerning policies and models implemented in the aforementioned countries. The criteria for choosing these nations was based on the diversity of geographic locations and proven success stories in technology commercialisation by universities.

Information was obtained from published literature sources, country reports and government websites. Public information was also obtained from the World Intellectual Property Organisation (WIPO) relating to public universities in the US, Japan, and Israel. Subsequently, we qualitatively compared: 1) the innovation and technology transfer policies; 2) the strategies undertaken at a leading university in the countries on university research; and, 3) the organisation of the technology transfer office for the successful commercialisation of university research.

The resulting model shown in Figure 11 includes four stages: 1) research results; 2) technology assessment; 3) market assessment; 4) commercial viability. If the new technology meets all the above criteria, it can be licensed if the patent is granted or can be transferred to the potential licensee according to agreed terms (Ravi & Janodia, 2022).

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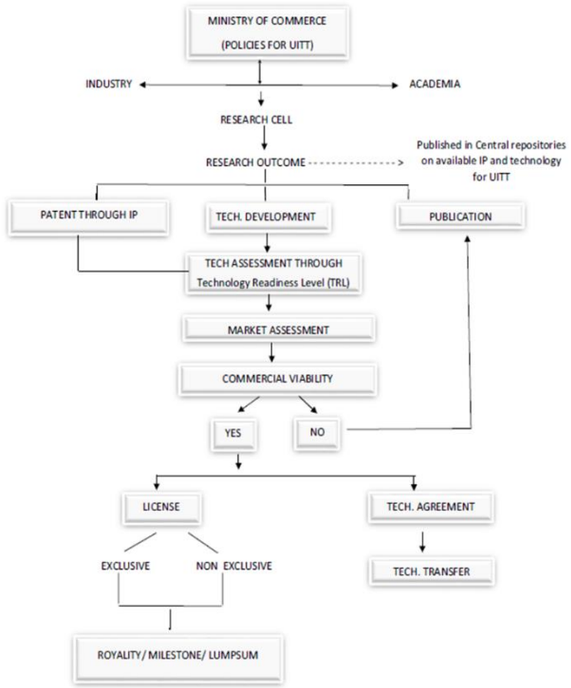

Figure 11 Proposed model for University-Industry Technology Transfer in India
Source: Adapted from (Ravi & Janodia, 2022)

Once the models found had been presented in a very general way, various analyses were carried out, which are presented below. Table 2 summarises the analysis carried out on the elements that make up each of the models and frameworks for research management that refer to the administration of research organisations.

Framework	General elements
A viable university research framework *(Adham et al., 2015).*	1. Policy-making function. 2. Intelligence function. 3. Control function. 4. Coordination function. 5. Implementation Subsystem.
Innovation and performance management framework for university research *(Kowang et al., 2015).*	1. Innovation strategy. 2. Innovation leadership. 3. Organisational structure. 4. Organisational culture. 5. Innovation resources.
Framework for structuring interdisciplinary research management *(König et al., 2013).*	1. Internal communication management and collaboration. 2. Integrative development of trans- and interdisciplinary research products. 3. Managing the external environment, the interface between science and policy. 4. Internal organisation and administration of a project.
University business research framework *(Naderibeni & Radovic, 2020).*	1. Corporate governance at the university. 2. Communication with industry 3. Entrepreneurial research functions. 4. Consider the social, cultural and economic requirements that will drive the university towards entrepreneurial research. . 5. Integrating entrepreneurial education as an organisational culture. 6. Marketing.
Institutional model of an entrepreneurial university *(Novela et al., 2021).*	1. First level management. 2. Faculty and staff. 3. Student. 4. Alumni. 5. Parents . 6. Local government 7. Regulator 8. Industry 9. Community 10. Researchers 11. Media

Table 2 Constituent elements of Models and Frameworks for research management that refer to the administration of research organisations
Source: own elaboration based on the cited authors

Similarly, table 3 summarises the analysis of the constituent elements of the models and frameworks developed for research management with respect to project management in research groups, centres or departments.

Framework	Stages	Elements, sub-elements, attributes and/or functions
Framework for Action Research and Innovation Management (AIM-R) *(Guertler et al., 2020).*	Analysing and framing	Detailed analysis of practical problems, including research scopes and research gaps .
	Project planning	Defining research methods and questions, hypotheses, project design and planning .
	Implementation of the action	Execution and documentation of the innovation project using working and research methods .
	Reflection and learning	Systematic reflection of the project and its results (initial, expected and final states), lessons learnt.
	Communication and pivot	Useful communication to academic and practice partners and systematic adjustments to the overall research plan. .
	Home	Objectives, requirements, resolution, Institutional strategic plan, administrative, faculty and student stakeholders, academic degrees.
	Planning	Scope, time, cost, quality, human resources, human resources, communications, risk, procurement.
Reference model for academic research management based on PMBOK (Bayona et al., 2018).	Execution	Information on work performance.
	Monitoring and control	Perform change control, request and validation of changes.
	Closing	Evaluation reports, publications and theses, research projects, academic degrees with research competences.
Technology and Innovation	Systems thinking	• Talent and creativity management.
	Globalisation dynamics	

Framework	Stages	Elements, sub-elements, attributes and/or functions
Management Model for Higher Education Institutions *(Arciénaga et al., 2018).*	Complexity	• Entrepreneurship management, forecasting, foresight and vigilance. • Management of venture capital and financing. • Network and information technology management • Product, process, service and organisational innovation. • Strategic management • Problem solving • Project management • Technology transfer • Research and development management • IP protection and exploitation • Circular economy and responsible and sustainable innovation
	Uncertainty	
	Risk	
Translational research and development framework for linking university research in science and engineering to commercial outcomes *(Bazan (2019).*	start of the project-definition	• - New product strategy
	Detailed project planning	• - Idea generation
	Project implementation (Monitoring and control)	• Design • Construction • Testing • Continuous feedback
	Project closure	• Design • Construction • Testing • Continuous feedback
The business model of the Cambridge innovation process *(Geissdoerfer et al., 2017).*	Ideation	• Vision formulation • Identify stakeholders • Sustainable value analysis • Evaluation and selection of ideas
	Conceptual design	• Integration of ideas. • Discussion on technological and general trends. • Definition of the system of value creation, delivery, capture/elements of business management / dimensions of business management.
	Virtual prototypes	• Benchmarking within the industry. • Comparison with generic BM concepts. • Prototype construction. • Evaluation and selection of prototypes.
	Experimentation	• Identification of key variables. • Design of the experiment. • Running experiment • Analysis and lessons learned
	Design of details	• Detailed definition of all elements • Summary of each element. • Business transformation tool
	Piloting	• Planning. • Implementation. • Analysis • Adjustments • Documentation and communication • Identification of failure modes
	Launch	• Implementation planning. • Implementation • Expansion
	Adjustment and diversification	• Supervision • Reflection • Adjustment • Scaling up • Diversification • Iteration of the business model innovation process
Proposed University-Industry Technology Transfer (UITT) model in India	Ministry of Trade	• Policy areas.
	Research Cell	• Academia • Industry (IP) - Value of technologies.
	Research results	• Publication in central IP repositories only for the university.
	Technological Development	• Publications • Patents through Intellectual Property.
(Ravi & Janodia, 2022).	Technology assessment	• TRL
	Commercial viability	• Economic valuation • Licensing • Income from technology transfer

Table 3 Constituent elements of the Models and Frameworks for research management that refer to project management in research groups, centres or departments
Source: own elaboration based on the authors cited above

Conclusions

Describing and analysing the models developed for research management under two of the approaches identified by Schuetzenmeister (2010) has led to the following conclusions:

a. Through this research it has been possible to corroborate what Pino et al. (2021) mentioned, regarding the fact that management models for research and innovation in HEIs at an international level are still under construction, since few examples can be found in the literature on the implementation of this type of models in HEIs. In this research only 11 studies could be found under the selected approaches.

b. As can be seen from the analysis conducted, the models under the approaches referred to adhere to what is mentioned by Nguyen & Meek, (2016), regarding some of the tasks of research management being more visible than others.

c. This has also confirmed that research management should be approached from various perspectives (Schuetzenmeister, 2010), in order to cover each of the levels involved in the process, i.e. from the macro to the micro level, in order to create the necessary conditions according to each context, and to promote the research process and its subsequent transfer.

d. The authors of the models reviewed under the research organisation management approach agree that structuring the activities surrounding the research process from a systemic perspective would improve research results, but that the key factor for success is undoubtedly management and promotion from the highest level of the organisation.

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e. On the other hand, the models and frameworks developed under a project management approach in research groups, centres or departments refer to integrated activities in knowledge areas such as technology management, project management, technology assessment and its corresponding valorisation, all of which represent the "forms" mentioned by Garnica & Franco (2020), to manage to drive research towards transfer.

f. Derived from the above, it can also be affirmed that in order to move from a "traditional" university to an "entrepreneurial" one, it is necessary to make substantial changes in the processes involved in research, since otherwise the results will simply not be different.

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