


# A New Step-by-Step Model for Implementing Open Innovation

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**Abstract:** Open innovation has been found to have many benefits and tangible results for those who partake in it. This study aims to showcase the importance of open innovation, and through a theoretical example present how an organization (university, research center, company, firm, etc.) can take action to implement open innovation guidelines. In this paper, firstly, a demonstration showing how open innovation can work with multiple partners is shown. Secondly, a model is presented that shows the steps an organization must follow to successfully implement open innovation. This model covers the introduction of an organization to open innovation from the initial interest to the implementation of the final product. Several success stories are also presented to demonstrate how these steps have been used by major organizations during several collaborations as well as the results produced from implementing open innovation.

**Keywords:** open innovation; SMEs; research centers; growth; sustainable development



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## 1. Introduction

Open innovation has attracted wide interest since it first appeared in the 2003 book by Chesbrough. It proposed that companies combining internal and external ideas when innovating would benefit more than by adhering to the traditional research and development model [1]. As many definitions have been proposed for this term since then, it appears that open innovation is not something stationary and is constantly evolving. At this time, the most prevalent definition seems to be that open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. This means that firms wanting to advance their technology can and should use both internal and external ideas [2].

Even though the term for open innovation appeared in 2003, the truth is that part of what is now considered open innovation existed prior to the term’s appearance. There is historic proof showing that the Roman Empire used what is now considered open innovation guidelines to expand [3].

Furthermore, collaborations always existed, especially between universities, but it was after 2003 that these partnerships became more specific. The term open innovation brought all of them under its umbrella and it is now easier to search for this topic, seek guidelines and see how it is beneficial for those involved.

Even though there are several definitions for open innovation [4–8], their common thread is the creation of relations and collaborations in order to create something new with the resources at hand. The differences in the definitions usually refer to different scopes concerning resources, the degree of openness, etc.

The current manuscript deals with several different aspects of open innovation. After addressing the importance of open innovation, a theoretical example is presented in order to better understand how open innovation can work between different collaborators

and to see how collaboration can have beneficial effects among the different participants. Afterwards, a model with the steps that an entity might follow to adopt open innovation principles is provided. The proposed model provides a step-by-step guide that begins with the mere interest of an organization to implement open innovation, continues throughout all the processes that might be needed, and ends with the final project outcome of the collaboration.

Finally, some stories of open innovation implementation are shared in order to see how it was applied and the effects its application has on real companies and institutions.

## 2. The Importance of Open Innovation

The traditional research and development model was beneficial to large companies that could afford an in-house R&D department that also gave them full control in whatever innovation it produced as well as all the profits that were turned out. In contrast, open innovation promotes collaboration between companies, research centers, universities and even individuals that can bring different ideas forward to help solve problems that would otherwise be very difficult to manage.

The research institutes participating in open innovation reaped many benefits as it was found that open innovation strengthened the position of the public research institute, increased internal networking and broadened and improved the capabilities and knowledge of the involved researchers [9]. Furthermore, research consistently shows that open innovation has been beneficial to firms that have used it [10].

As new technology appears to need multidisciplinary development, open innovation can help, as a single organization may find it hard to be able to provide what is needed, especially if it is a smaller one [11]. Small research institutes, that are usually dedicated to one discipline, even if they produce quality research, will have limited viewpoints on things concerning other parts of science. Similarly, an industry with in-house research and development department, even if it is well established and has produced valuable assets for its owner, will probably face troubles when trying to expand its research to subjects beyond its expertise, as the research teams usually prefer to focus on one specific area of expertise. As open innovation helps the collaborators to work in a complementary way, there is a significant reduction in the use of resources needed for a project. For example, if one of the collaborators has already the infrastructures needed for the project ready, the rest of the partners will have to simply use it instead of spending their resources. The resources that are saved by this approach can then be used for something else that is needed maybe even another project.

It has been found that in open innovation collaborations the diversity of the people working on the project has a positive effect as the different perspectives that everyone involved lead to the creation of better products, services, or research [12].

The fact that open innovation leads to less time needed for the project's actualization has many advantages for the company, such as finishing projects before the competition.

Furthermore, open innovation has also shown societal benefits. Open access, open source and open-source science, which are open innovation tools, can provide societal benefits. A wider pool of participants is established through open innovation. The results produced can be shared even with those that would have been excluded otherwise, as they are accessible to all. The risks of this endeavor are mitigated due to the number of participants [13].

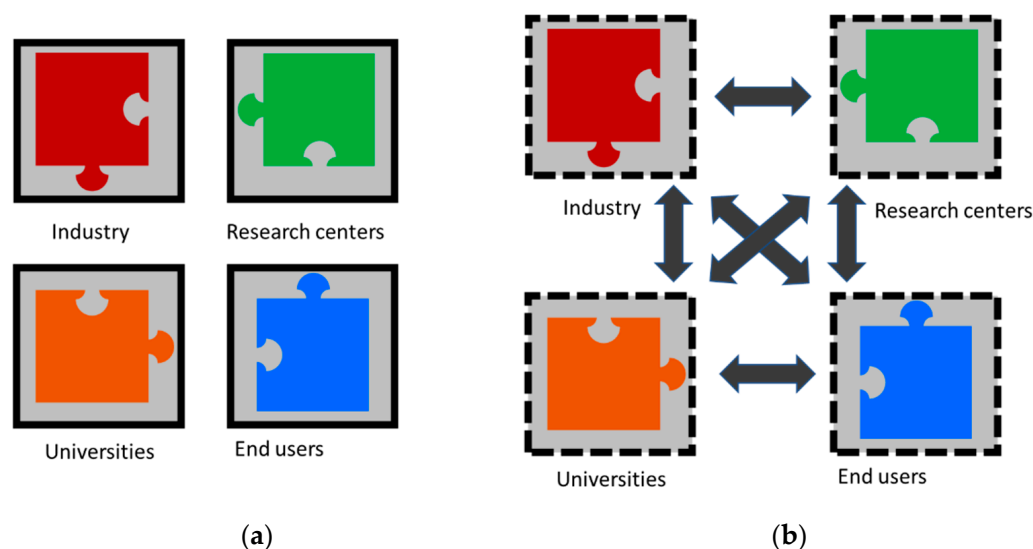
Moreover, there is evidence that innovation can promote economic as well as sustainability results at the same time [14,15], as open innovation has also been proven to have important connections with sustainability. A very large part of open innovation studies has been found to touch upon several sustainability issues [15].

Additionally, this connection has shown beneficial effects as new products and services produced through open innovation have been replacing older, costlier, and sometimes more environmentally unfriendly ones. The replacement of petrochemicals with other bio-based substances that were developed through open innovation is an example of this [16].

These beneficial effects have also been observed when firms are trying to focus more on sustainability. It has been found that during the new product development phase, better results are achieved, a fact that becomes even more evident if the consumers' concerns are taken into account by using open innovation practices [17]. Both the firms, as well as the consumers, can make an environmentally beneficial impact by using open innovation in order to minimize costs regarding pollution and manufacturing [18]. Sustainability combined with open innovation has also helped firms expand. Alibaba, for example, used a sustainable open innovation model which led to the rapid expansion of the company [19]. An offshoot of open innovation is open social innovation. Open social innovation is what takes place when open innovation and its principles are used for social issues and challenges. As of now, there are projects that use open social innovation in regions of Europe in order to promote innovation in these areas [20]. The use of IT solutions has been found to have a beneficial effect on open social innovation as it has the ability to bring together citizens and the issues they have with the rest of the collaborators [21]. Research has also shown that digitization can also have beneficial effects on innovation at a regional level [22].

### 3. A Demonstration of How Open Innovation Can Work

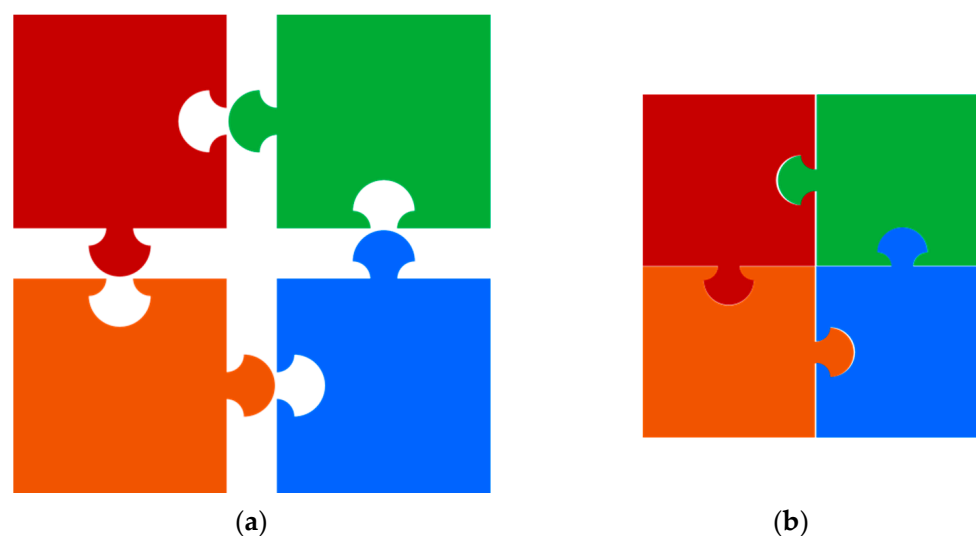
Firms and entities, such as research centers and universities, in terms of research can have huge gaps (evidence, knowledge, practical–knowledge conflict, methodological, empirical and theoretical and population gaps [23]) and overlaps. When working under closed innovation, all the research is in-house, closed-off and within the limits of each entity; therefore it will be very difficult for the industry to research something that can be readily available to the end- users on its own. Each entity can have a piece of the solution for a certain issue or can create it, but the other pieces are unavailable as the borders created by the actors are solid and impenetrable to others (Figure 1a).



**Figure 1.** (a) The four collaborators before adopting open innovation; (b) the four collaborators during their partnership using open innovation.

By adopting open innovation principles, the borders come down and all the actors can communicate with each other. Every collaborator can provide the piece of the solution that they have or have created and help each other with the project (Figure 1b).

In the end, all partners have come together, and a solution is created with the input of all collaborators. The solution created encompasses the parts provided by everyone and the final product is something that would be almost impossible to be created by each partner separately (Figure 2).



**Figure 2.** (a) The pieces of the solution from each partner coming together; (b) the final product produced using open innovation.

To see how this works more clearly, an example concerning a company that produces baked goods will be presented in detail. This company desires new products that are appealing to the end-users to keep up with the competition. The end-users want a healthier product that is tasty as well. The research center has produced a new sugar substitute that can be used in baking, but it has been used only in small scale operations and not in an industrial setting. The cost is prohibiting for them to try and to work in a scaled-up environment, as they do not have the infrastructures, so their research remains incomplete. The university has researched consumer trends for the last 5 years in various settings. The research is sound and provides many insights into what a consumer wants and how to market different products, but there is no funding to continue. When all these entities work together with their combined resources, through open innovation, a solution appears to each problem. The research center can try its new sugar substitute in the baking company's industrial plant, in order to see if it can work in a scaled-up environment and what it takes to make a good marketable product with it. The university shares its research with the other partners to make the product tailored to what the consumer wants and makes it more easily marketed. For this purpose, they also receive funding to conduct new research as to how the consumer reacts to the new product and if there are changes needed to be made before it is released into the market.

After this collaborative process, the company has a new product made to satisfy the consumers' needs and wants and the insight into how to market it. The research center completed the research for the sugar substitute in an industrial setting easily as everything took place in the baking factory and no other external output was needed. The university received funding for its research. The consumers got the product they wanted from the beginning.

If there was no collaboration between all participants, all of their problems would have remained unsolved, but through open innovation all of the pieces fell into place and a solution was formed.

#### 4. Methodology

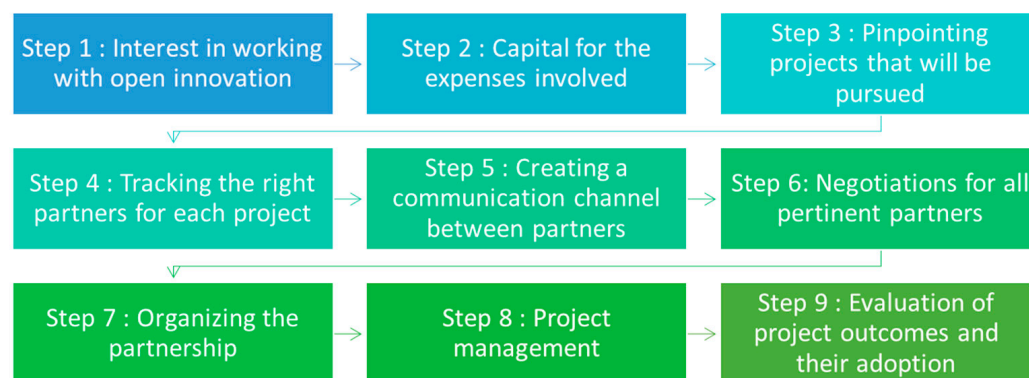
The model that is presented in this manuscript was generated by reading and analyzing several papers about open innovation, which explained how open innovation can be implemented in research facilities, companies, etc. When studying the literature, several patterns started to emerge as to how this was happening and what effects it had on the organization. Furthermore, it was observed that there was a research gap, as up until now, a similar model did not exist for this subject. By combining the information from the literature and the empiric knowledge of the research team, the following model was

created. The steps described below do not have to be taken in the sequence that they are presented for open innovation implementation. Depending on the conditions some steps can be taken simultaneously, out of the presented order, or not at all.

The proposed model is intended to show the actions that can take place during open innovation implementation in a comprehensive way.

### 5. How to Introduce Open Innovation to an Organization, Step by Step

In this part, a pathway of how an organization can implement open innovation is going to be presented. As it is shown in Figure 3 several steps must be taken in order to successfully adopt open innovation.



**Figure 3.** Steps taken during the adoption of open innovation.

#### 5.1. Step 1: Interest in Working with Open Innovation

Firstly, interest must be shown in order to adopt open innovation. As firms, research centers, etc., realize the benefits of open innovation, they want to be a part of it.

Research centers, by nature, were already connected to different partners in the innovation systems as they were acting as intermediaries. Nevertheless, there is pressure to make them even more interconnected in different ways with different partners in order to transfer knowledge [9].

Many questions arise about the implementation of open innovation in research institutes, mainly in the aspect of what open innovation offers to these institutes and what conditions have an impact on the success of open innovation. By analyzing the effects that open innovation had on different cases that pertained to public research institutes, it was found that open innovation had a beneficial effect on all examined [9,24].

It was also found that, for several projects pursued using open innovation, the networks that were created using this approach helped the generation of more and better ideas for innovation. As there were many participants in these processes more and more diverse ideas were presented, which in turn made it easier to select the best ones for each project. Furthermore, the created networks provided resources that could complement shortages that appeared in other participants. Lastly, it was found that these networks helped create legitimacy and support for the project and its results [9].

Another thing to keep in mind is how open the collaboration will be in terms of breadth and depth. Innovation performances tend to be hindered when a plethora of outside sources are used (breadth), while at the same time when not using a source efficiently enough, the benefits of the collaboration are being minimized [25].

#### 5.2. Step 2: Capital for the Expenses Involved

Of course, for anything to begin, funding must be secured. Companies and industries have budgets specifically for research and development that can be spent for R&D either in-house or on collaborating projects with other organizations. However, some research institutes, universities, and other actors participating in an open innovation scheme might not have that luxury. In particular, universities can be notoriously underfunded and that



can lead to severe problems relevant to their operation as research facilities, leading them to be constantly on the lookout for funding. There can be intervals where no funding is provided leading to issues with personnel retainment and leaving research unfinished [26]. Other extra costs can be attributed due to the lack of funding, e.g., equipment that remains unused for long periods can break down and without funding it can be impossible to fix.

If the different partners are not interested in ensuring financial compensation for everyone involved in the project, some of the participants might not engage fully or even drop out [27].

If one of the entities is dependent on the resources that someone else in the collaboration is providing, the receiving partner might change focus to primarily aid the giving partner. This might help the collaboration up to a point, but it can also be detrimental [28].

When public funding is involved, more problems can arise. Firms usually have very clear goals for their research, they want a successful outcome that will bring value to the company. However, the fact that research created with public funds should benefit the whole society instead of a single organization, can create a conflict of interest. Furthermore, there is always a risk of privatizing the research created with public funds when industries are involved. The private sector benefiting from public research organization outcomes can lead to severe consequences in the future when affecting downstream research [29]. Nevertheless, it has been shown that public funding mostly has a promotional effect on innovational pursuits [14].

Moreover, companies that participate in open innovation might create a fund for these reasons in order to bankroll their collaborators so that the research process goes more smoothly, as Huawei did [30].

Another aspect of finding funds when open innovation is concerned is crowdfunding. During crowdfunding, besides the funds that are gathered for the projects, there is almost always a back and forth between the project originators and the funders leading to a further beneficial collaboration [31].

### 5.3. Step 3: Pinpointing Projects That Will Be Pursued

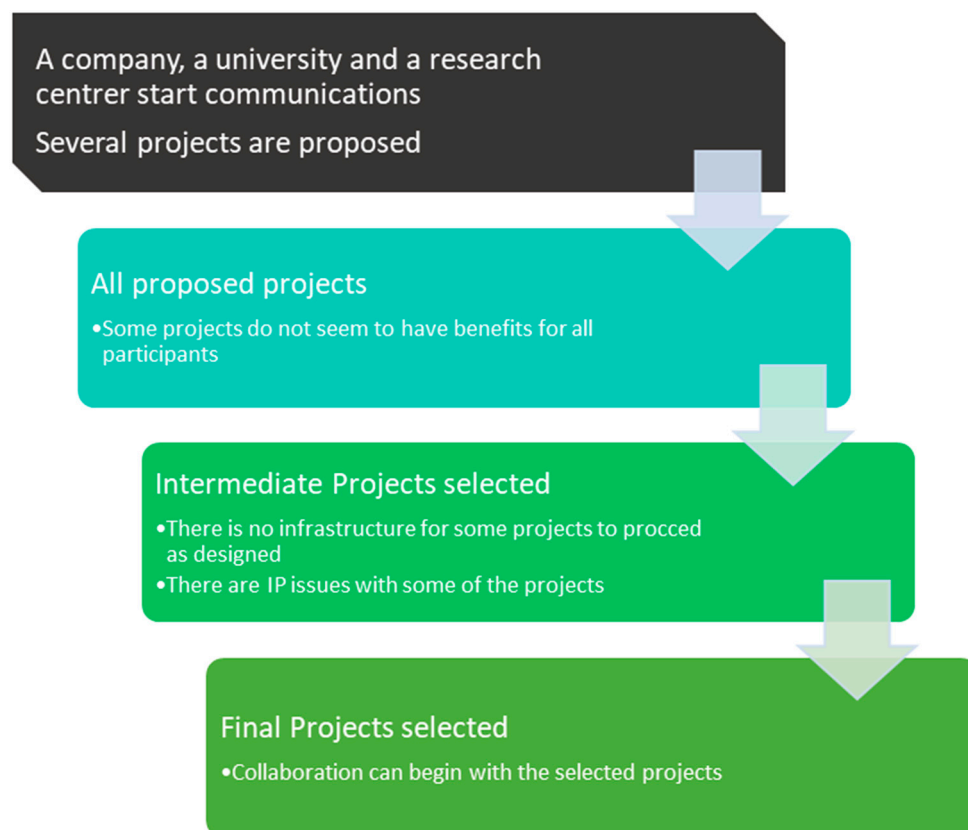
Choosing which projects will be pursued in any kind of research is a difficult task. When different partners are trying to collaborate, there has to be a common goal for attempted research. However, even if the partners are pursuing a common goal, their motives for the research might be misaligned, a fact that can threaten the partnership. Since the partners are of different natures, there probably can be different motives as to how the research will be used. An industry wants to gain profit from whatever outcome occurs, while a university or a research center might want to do research in order to pursue purely academic interests, as it has been found that profit organizations have different criteria in selecting projects [32]. In any case, the projects that will be selected must be compliant with the participating members' criteria, as well as be feasible with the resources available or be abandoned [33].

Research has shown that open innovation has usually a positive effect for all participants [24]. However, some research topics cannot be pursued while using open innovation. Companies that have been protective with their Intellectual Property (IP) might be unwilling to bring in outside help for fear of their internal secrets being leaked to the competition. All collaborations need an amount of trust between partners: if that does not exist it is impossible to have a positive outcome [34]. Even though the partners can have different motives for which to pursue collaborations and open innovation, there has to be a common ground especially when referencing the research that will go into the project.

For example, an industry desiring a partnership with a university would want the final product to be something from which can gain profit. A university might only want to further its research and might not be concerned if the result has a major practical use. Nevertheless, the partners must communicate their needs and wants, and find a project that can be followed through without threatening each other's success. When partners have overlapping interests, a project that might be just beneficial for one of the

partners, might be one of the partners' whole business model and pursuing it through open innovation will have devastating effects on them. Moreover, a situation such as this will cause the partners not to give their best selves, out of fear of destroying their own business or research [35].

For example, in Figure 4, some partners have decided to collaborate in order to pursue some common research interests. In the beginning, several projects are proposed. Out of these projects, some are only beneficial for some of the partners and are abandoned. Out of the rest of them, it is found that the infrastructure is not there for the project to proceed, while several others have IP issues that make them poor candidates for open innovation. These are also abandoned. The remained projects are the ones that will be pursued.



**Figure 4.** An example of project selection process.

#### 5.4. Step 4: Finding the Right Partners

The search for partners can go both ways. One of the future partners can have a project that they need support, therefore they search for others for help, or the future partners can have some similar interests and decide to pursue a common goal.

As in all collaborations, open innovation partnerships included, it is very important to find the right partners.

When different kinds of partners from different disciplines or different kinds of organizations are trying to cooperate, even more problems can arise. The clashing of different perspectives from different partners can lead to issues, such as who can provide the necessary solutions for each step of the collaboration [27]. Furthermore, research organizations and institutes might be unaware of the problems that are pertinent to industries and vice versa [27].

Another issue is that the different partners can contribute to the project in varying degrees meaning that some partners might complete the bulk of the work while other partners do the bare minimum [27]. This can lead to even more problems during the project

implementation, especially when the partners are trying to benefit from whatever the partnership has produced.

Some of these issues have been solved with the use of intermediaries that can create broad networks, improve the conditions for a successful interaction, making it easier for compatible collaborators to find each other [36].

#### *5.5. Step 5: Creating a Communication Channel between Partners*

Proper communication channels must be established and maintained throughout the partnership from the initial steps to the final result. Communication is key in open innovation as it brings the collaborators closer to their cooperation. The partners can discuss the issues of the projects so they proceed on a timely manner and produce good grade results [30].

However, managing and organizing cooperation, especially when different disciplines are involved, has been proven to be difficult and complex, which in turn shows the need for new and improved procedures for collaborations [37]. It appears that knowledge sharing, and the collaborations needed for open innovation are becoming more and more complicated as time goes by [37].

#### *5.6. Step 6: Negotiations for All Pertinent Partners*

Every collaboration of this kind needs negotiations every step of the way. As there can be many partners from different backgrounds, several managerial, cultural, and other differences can be present, a fact that can hinder any kind of relationship [38,39].

Negotiations are vital for subjects concerning the collaboration, such as the division of labor among the partners, as it is very important to determine the responsibilities of everyone concerned to avoid overlaps and delays [40].

The subject of the utmost importance concerning these negotiations is how the intellectual property of everyone involved will be protected. During the collaboration process, the sharing of knowledge is essential for its smooth continuation. The openness of the collaborators, as well as internal managerial factors, can determine how the intellectual property can be protected [41], as many companies adhere to secrecy in order to protect their innovations [42]. Where open innovation is concerned, there is a paradox as the partners are trying to protect their knowledge that have to share at the same time, which shows a need for a specific knowledge exchange strategy [43]. Negotiations are critical in terms of what will be shared with whom, how the end results will be deployed and who will have the rights of the product. To this end, tools such as NDAs (Non-disclosure agreements) are usually signed. Other tools can be MOUs (memorandums of understanding) that can also define other aspects of the collaboration, copyright, licensing, patents, etc. [40,43]. All of this makes negotiations complex and long lasting and, in many cases, the negotiations take place from the beginning to the end of the collaboration [38].

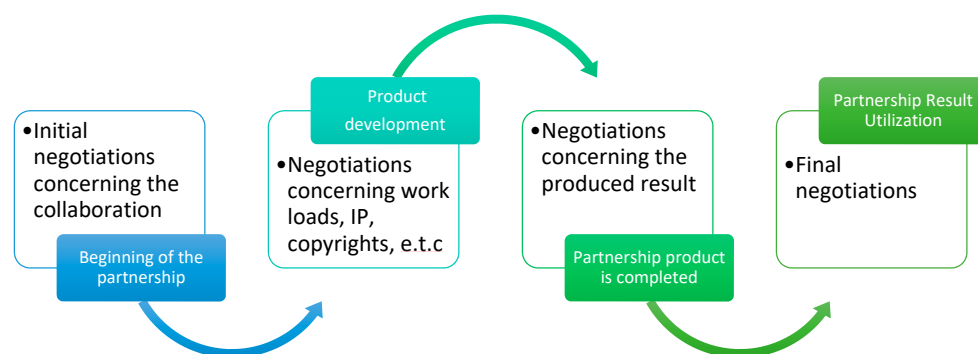
In Figure 5, the different stages of the negotiation process taking place during a collaboration are presented to better demonstrate what happens. As mentioned before, negotiations start at the beginning of the partnership and continue throughout the partnership. All matters pertaining to the collaboration are explored and communicated to the partners (workloads, patents, etc.) every step of the way.

#### *5.7. Step 7: Organizing the Partnership*

As for organizing the partnership, there is not any typical procedure to follow. How the collaboration will be organized is affected by who the partners are and what they are trying to accomplish. A platform must be established, based on which the partners will work together. It would also be prudent to estimate the capabilities of the concerned partners in terms of open innovation in order to see how and with what this collaboration can be beneficial [44]. Decisions will have to be made depending on the project as to how the collaboration will proceed. The delegation of staff in the corresponding aspects of the project and how the communication among partners will be established are issues that will

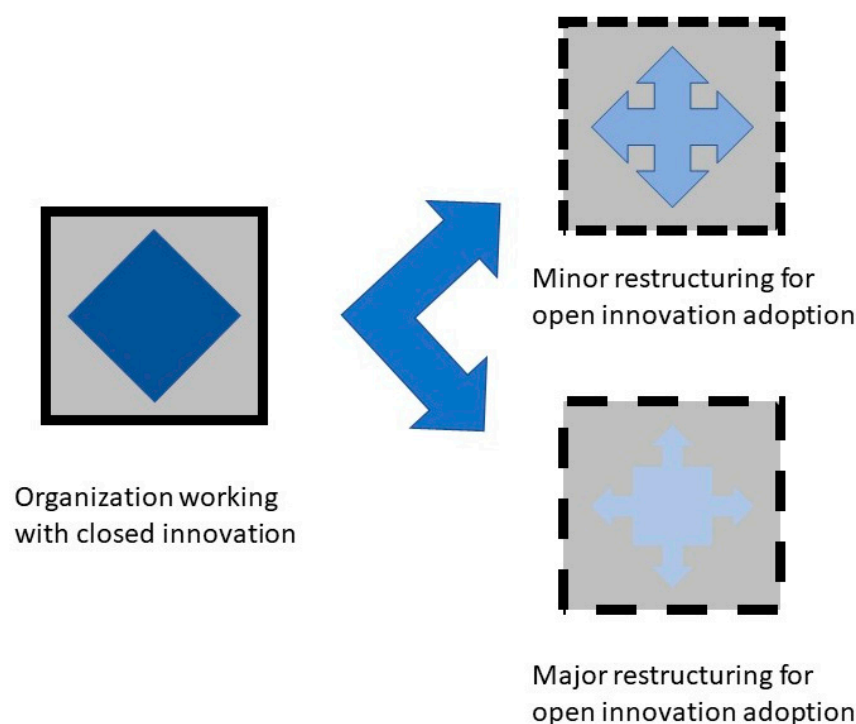


have to be solved in this stage of the collaboration so that the project will be concluded on time with the desired results. Outside factors, which could even be localized, must also be considered as they can affect the project considerably [45]. Changes must be made depending on the characteristics of each actor and the nature of the project [46]. This can mean anything from changing a few policies to a complete restructuring if needed. In any case, opening a previously closed-off section requires much more than just eliminating a few boundaries. When all the above issues have been resolved, the partners can apply themselves to the collaboration and move forward with the research needed for the project.



**Figure 5.** Different stages of negotiations during collaborations.

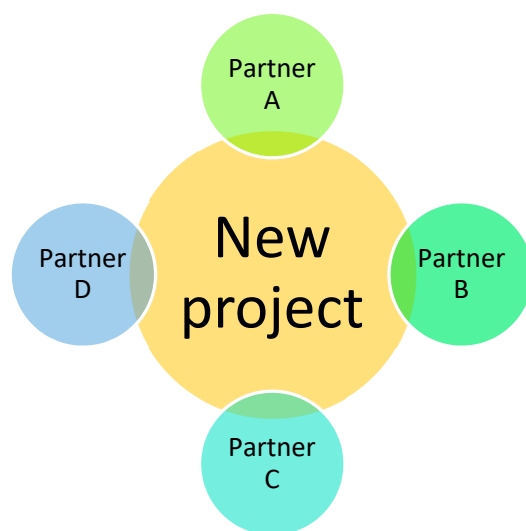
In Figure 6, a visual representation is illustrated, so that a better grasp of the impact that these changes can have on organizational level can be obtained. The organization before the changes, when working with closed innovation, had closed borders in order to protect its assets. When the decision to adopt open innovation is taken, some restructuring is deemed to happen. To adopt open innovation practices, the closed borders must be eliminated. If only a minor restructuring is needed, the borders will open up to a point so that the collaboration will proceed. The restructuring needed will not be as pervasive and the internal configuration of the company will remain similar, but with the adequate changes integrated. If major restructuring is needed for the adoption of open innovation, the internal configuration will be much more altered and the borders more open.



**Figure 6.** Schematic demonstrating the changes needed when implementing open innovation.

### 5.8. Step 8: Researching Projects Using Open Innovation—Project Management

When all the above issues have been clarified, it is time for the partners to start working towards the completion of the project. All the partners begin to provide input towards the completion of the project. Depending on the circumstances, it can be either a completely new project or the continuation of an existing one that now has the assistance of all the other partners. By combining everyone's resources, hopefully, a result can be produced. According to Figure 7, the four partners are providing parts of their available resources so that the project can be realized.



**Figure 7.** Schematic representing a collaboration.

### 5.9. Step 9: Evaluation of Project Outcomes and Their Adoption

In the end of the collaboration, hopefully, there is a final product. Each project must be evaluated to be adopted or released. All research has the potential to give false positives or false negatives. A false positive is a project that seemed successful but did not have the value that it was initially assessed as having. An example of this can be the creation of a consumer good that seemed promising, but the consumers rejected it for unforeseen reasons.

Additionally, false negatives are projects that seem to be a failure at first glance, have minor success or appear not to have great value, while the opposite is true. The collaboration must have a proper management division that will be able to correctly assess the value of all projects and decide the next steps needed. This can mean, depending on the project and the outcome, to use the result as it is, continue the research in order to improve it, send it to an entity that it will be better suited for it, or abandon it completely [47].

Thanks to the negotiations that took place in the previous steps, there is a structure in place as to how this product will be used and by whom. If the collaboration is successful, the outcome is evaluated and then, depending on what it is, it is either adopted by the partners or sent out to the market [30]. A positive outcome in these collaborations makes the partners more open to engage in future collaborations [48].

## 6. Discussion

### *Open Innovation and Problems*

Open innovation has been found to have a positive effect on all the partners involved [9]. However, the process of transforming a firm that has a closed R&D to an open innovation concept can be a long and arduous multistep process, as many things must be considered in order to have a successful result.

A firm that has been working with a closed R&D process can have some issues when trying to switch to a more open one.

It has been registered that bias inside the company can slow down or even stop the transfer to open innovation. For example, firms with founders that were exposed to trust-reducing local contexts are less likely to engage in inter-firm R&D cooperation (Santa Clara, CA 95054, USA), where the role of trust is critical [49]. Imprinted biases can stall open innovation in ventures and make them ignore strategic options offered especially in old and established institutions. Moreover, firm characteristics can be a huge issue if the decision is made to implement principles of open innovation. Established firms and systems that operated with closed innovation put huge value on knowledge management and storage to protect their IP and profit from it in the future. Concerns about the IP can slow down or even derail collaborations. Negotiations are usually undertaken by specialized lawyers [50] from the beginning to the end of the project, in order the partners to agree on how it will be managed. This is because IP is the most valuable asset that can be created from these collaborations and its management will determine who will profit from it and how much [38].

Open innovation, in contrast, promotes collaborations and knowledge sharing. This means that changes are essential for the firm in order to adopt open innovation. These changes depending on the firm and the level of adoption for open innovation that the firm desires, can be the simple adoption of some of the practices of open innovation to the restructuring of the entire firm [46].

Distrust among the participants can also create issues as there is an initial level of distrust in collaborations even though research shows that after a successful collaboration the participants tend to be more open for the next projects [50].

Moreover, it has been found that for a successful cooperation, constant negotiation is necessary. Inter-organizational interactions can be very complex by nature as many actors, with often different interests, are participating, especially if cultural and managerial differences exist. Communication issues can also arise for these same reasons [38].

Furthermore, issues can also rise from a managerial standpoint concerning open innovation. Even though, in the long run, open innovation can save money and time, is a process that takes time, its implementation can require much effort, and many factors must be taken into account for it to be successful. The managerial staff must be competent enough and have the organizational skills needed so that issues and problems arising from the open innovation implementation are effectively handled, making the organization stronger without disrupting it [9,51]. Furthermore, changes might be needed to the managerial staff in order for the changes to be managed successfully [52]. Since the open innovation implementation can be such a huge project for an organization, managerial concerns can arise regarding whether the effort and resources spent and the risks associated with it are worth it. To this end, solutions are being proposed that take into account the relevant aspects of the organization in order to mitigate these risks and create value [53].

The importance of having a competent managerial staff that can accept changes and use this to their advantage has become even clearer in recent years. For example, digital transformation, which is connected to open innovation, took place in several companies, and competent managerial staff was needed for the changes to be successfully adopted, especially by employees [54] and even more so since the COVID-19 pandemic forced many companies and institutions to accelerate this transformation [55].

Besides the above problems, several other complications can and will derail open innovation. The failure of a step, as described above, will possibly lead to the failure of open innovation implementation and the subsequent collaboration.

## 7. Success Stories

The use of open innovation has already shown tangible results when used on multiple occasions. Many organizations and companies have applied open innovation initiatives and the results have confirmed the beneficial effects that were discussed above. To better perceive this significance, some examples of successful open innovation are presented below, and the steps presented in Figure 3 have been used by these organizations.

NASA (Washington, DC, USA) [56], Huawei (Shenzhen, China) [30], Amazon (Seattle, WA, USA) [57], Coca Cola (Atlanta, GA, USA) [58], and General Electric (Boston, MA, USA) [59] are some of the major corporations that have established open innovation programs and have seen many benefits considering research and new products. In these examples besides the monetary gains that were made, research was also promoted through open innovation.

### 7.1. NASA

An organization that has adhered to and implemented open innovation is NASA (Step 1, as seen in Figure 3). The National Aeronautics and Space Administration (NASA) has many projects concerning space exploration that are vital, as they determine if crew, supplies, and equipment will arrive at the programmed destination. To this end, NASA has successfully used open innovation practices to find solutions to many problems with the use of competitions with prizes, as well as crowdsourcing. The use of open innovation in NASA was cost saving and in addition helped NASA to be more interdisciplinary as it was in contact with partners that conduct research in sectors besides space exploration. This fact led also to new business opportunities as well as new jobs [60].

An example of resources that were utilized for open innovation is the use of the InnoCentive (Waltham, MA, USA), yet2.com (Needham, MA, USA) and TopCoder (Glastonbury, CT, USA) platforms. Several previously determined challenges were posted on the platforms, and it was found that all of the procured results were notable during the pilot phase (Steps 3–5) [56]. In later years, all of the results procured from these platforms were found to be substantial (Steps 8 and 9) [61].

Furthermore, InnoCentive created the Nasa@work internal crowdsourcing platform for sharing knowledge and to advance projects internally. This cumulated in the staff being able to upload problems through posting to the platform and other staff exploring the problem and crowdsourcing the solutions (steps 3–5 as seen in Figure 3) [61]. Another initiative that gave many promising results is the eXploration Systems and Habitation (X-Hab) Academic Innovation Challenge. This challenge helped link NASA with universities (Step 4) in order to find solutions for different issues concerning habitation in space at first before expanding to topics such as space manufacturing, life support, and plant growth. These projects that were outside of the purview of the initial challenge were pursued with this initiative with very promising results (Steps 7–9) [62]. Another open innovation initiative by NASA is the CubeSat Launch Initiative. Most participants were universities, schools, and not-for-profits (Step 4). The knowledge created from this program is being used in many other programs of NASA, as several knowledge gaps were bridged because of it (Steps 8 and 9) [63]. Furthermore, Hackathons, such as the International Space apps Challenge event that were also organized by NASA, promoted innovation performance through competitive intensity (Step 9) [64].

### 7.2. HUAWEI

Another example for demonstrating the positive effects of open innovation is Huawei. Huawei turned to open innovation to improve its R&D capabilities in a very efficient and cost-effective way (Steps 3–5 as seen in Figure 3). This turned Huawei from a company that, when established in 1987 was a seller of telephone switches, to be ranked #61 among the Fortune Global 500 companies in 2019 and was the first Chinese company in the Top 100 Best Global Brands by Interbrand® in 2014.

For Huawei to bring open innovation to the company, several actions were taken which, in the end, culminated in the establishment of the Huawei Innovation Research Program (HIRP) (Step 2). This program has shown great results since its initiation, as it produced a successful way to pursue collaborative projects from start to finish. The result was that, in only a few years, through open innovation, the research pursued by the collaborators lead to major achievements in developing new technologies. In return,

the utilization of the technologies created led to the rapid development of the company (Steps 3–9) [30].

### 7.3. Amazon

Amazon is a company that has put much attention into its R&D since its conception and has increased its expenses for this purpose over the years. Since the primary concern is customer satisfaction to the end that they will be return customers, Amazon harnessed users' imputes through the internet using open innovation practices in order to create a better service so that they will keep coming back. Using user-driven innovation in conjunction with Amazon's substantial R&D via open innovation principles led to the further development of the company, even during the COVID-19 pandemic [57,65] (Steps 1–9 as seen in Figure 3).

### 7.4. Coca Cola

Food companies, even though they are considered traditional and mature, have had very good outcomes when working with open innovation (Step 1 as seen in Figure 3) [66].

The Coca-Cola Company for example, one of the most prominent food companies, has used open innovation initiative for the 'freestyle dispenser machine'. This machine had the ability to let customers everywhere mix their own flavors and suggest a new taste for Coca-Cola products (Steps 3 to 8). Moreover, a mobile application was made that could record, share, and replicate the customers' new flavors. These flavors could also be evaluated by other customers (Steps 5–8). These evaluations could then be used for market research leading to insights for new product lines (Step 9) [58].

### 7.5. General Electric

General Electric (GE) is another example where open innovation was very lucrative. GE launched the 'ecomagination' initiative in 2005 (Step 1 as seen in Figure 3) [67] an initiative that was created for pursuing more environmentally friendly technologies. In the beginning, in conjunction with venture capital, funds were raised for investing in many startup ventures before the launch of the project (Steps 2 and 4). When the project was launched, submissions started pouring in from many different companies and institutions, and out of them the best were selected for funding, leading to the creation of several startups (Steps 4–8) [68]. Years later, Ecomagination has been proven to be a great success for GE. As well as environmental benefits, it has garnered more than USD 200 billion since its inception (Step 9) [59].

### 7.6. Failed Open Innovation: The Case of Boeing's Dreamliner

Boeing's Dreamliner was supposed to be one of the most advanced aircrafts ever made; however, several problems made the whole project a failure, even despite its promising beginning. Failures pertaining to the design of the airplane led to delays. In response, Boeing outsourced a huge portion of the airplane production workload (Step 3) to 700 local and foreign suppliers (Step 4) and gave them a share from the future revenues instead of paying them for the produced work (Step 2). This included design, manufacturing, etc., as Boeing would only do the assembly of the airplane. However, the fact that this collaboration had so many partners made coordination impossible (Step 7 failed) which led to delays from the suppliers (Step 4 failed) which in turn led to even further delays in the delivery of the airplane and Boeing had to pay penalties for failing to provide the airplanes in time [69]. By the time the supply chain issues were solved, the project was already 3 years overdue [70].

## 8. Conclusions

As has been demonstrated, open innovation can be very beneficial to firms, universities, research centers, and end-users. Collaborations between these partners have provided

otherwise unattainable results at a small cost. Open innovation is ever expanding and now, with the use of digital tools, partners can be reached easily no matter where they are.

Nevertheless, several problems have come to light regarding open innovation. Differences between partners regarding issues such as, e.g., how the final product will be deployed, or how the workload will be shared, can put a damper to any collaboration. If these issues are solved successfully, the collaboration can proceed. However, if these differences prove to be insurmountable, the collaboration will simply not happen.

The model presented here is a comprehensive guide that analyzes, step-by-step, how an organization can adopt open innovation. The steps presented in this paper can be followed one-by-one for the implementation of open innovation by a research center, a corporation, or some other organization if needed. These steps can serve as an introductory guide for implementing open innovation that also showcases how complex and multi-faceted this process can be. The proposed pathway can be used as a frame of reference for open innovation implementation for students and managers alike, as there is a lack of research in this subject.

Furthermore, in the good examples of open innovation practice that were presented above, it was addressed how the model has worked in real-life environments. The implementation of some or all the steps was quite helpful for adopting open innovation. Moreover, it is also obvious from these examples that open innovation led these organizations in creating research and products that otherwise would be either unattainable or very difficult to obtain. These success stories also demonstrated the high monetary gains that open innovation brought to these organizations. In contrast, the example of failed open innovation showed some of the issues that can appear during implementation, as well as the effects that it can have on the organization.

The real-life examples provided here show that open innovation, when used properly, can give results that promote knowledge and have monetary benefits.

As previously mentioned, this research can be used as a starting point for someone who wants to be informed about open innovation and its implementation. However, this study has several limitations, some of which can be used for further research. Even though an effort was made for the proposed model to be as inclusive and detailed as possible, it was not feasible to include all the possible aspects of open innovation, its implementation, or all the factors that could affect it. Furthermore, this model has not been used in its current form for open innovation implementation in real cases. Future research can include these topics in a more substantial manner.

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## References

- Chesbrough, H.W. The era of open innovation. *MIT Sloan Manag. Rev.* **2003**, *44*, 35–41.
- Chesbrough, H. *Open Innovation-Open Innovation*; Harvard Business School: Boston, MA, USA, 2006; pp. 1–9.
- Jeon, J.-H.; Kim, S.-K.; Koh, J.-H. Historical review on the patterns of open innovation at the national level: The case of the roman period. *J. Open Innov. Technol. Mark. Complex.* **2015**, *1*, 20. [[CrossRef](#)]
- Gassmann, O.; Enkel, E. *Towards a Theory of Open Innovation: Three Core Process Archetypes*; Radma: Chester, UK, 2007.
- Perkmann, M.; Walsh, K. University-industry relationships and open innovation: Towards a research agenda. *Int. J. Manag. Rev.* **2007**, *9*, 259–280. [[CrossRef](#)]
- Lichtenthaler, U. Open innovation in practice: An analysis of strategic approaches to technology transactions. *IEEE Trans. Eng. Manag.* **2008**, *55*, 148–157. [[CrossRef](#)]
- Dittrich, K.; Duysters, G. Networking as a means to strategy change: The case of open innovation in mobile telephony. *J. Prod. Innov. Manag.* **2007**, *24*, 510–521. [[CrossRef](#)]
- West, J.; Vanhaverbeke, W.; Chesbrough, H. Open Innovation: A Research Agenda. *Open Innov. Res. A New Paradigm.* **2006**, *17*, 285–308.
- Van Lancker, J.; Wauters, E.; Van Huylenbroeck, G. Open innovation in public research institutes -success and influencing factors. *Int. J. Innov. Manag.* **2019**, *23*, 1950064. [[CrossRef](#)]
- Lu, Q.; Chesbrough, H. Measuring open innovation practices through topic modelling: Revisiting their impact on firm financial performance. *Technovation* **2021**, 102434. [[CrossRef](#)]
- Uribe-Echeberria, R.; Igartua, J.I.; Lizarralde, R. Implementing open innovation in research and technology organisations: Approaches and impact. *J. Open Innov. Technol. Mark. Complex.* **2019**, *5*, 91. [[CrossRef](#)]
- Tang, T.; Fisher, G.J.; Qualls, W.J. The effects of inbound open innovation, outbound open innovation, and team role diversity on open source software project performance. *Ind. Mark. Manag.* **2021**, *94*, 216–228. [[CrossRef](#)]
- Eppinger, E. How open innovation practices deliver societal benefits. *Sustainability* **2021**, *13*, 1431. [[CrossRef](#)]
- Costa, J.; Matias, J.C.O. Open innovation 4.0 as an enhancer of sustainable innovation ecosystems. *Sustainability* **2020**, *12*, 8112. [[CrossRef](#)]
- Payán-Sánchez, B.; Belmonte-Ureña, L.J.; Plaza-úbeda, J.A.; Vazquez-Brust, D.; Yakovleva, N.; Pérez-Valls, M. Open innovation for sustainability or not: Literature reviews of global research trends. *Sustainability* **2021**, *13*, 1136. [[CrossRef](#)]
- Kennedy, S.; Whiteman, G.; van den Ende, J. Radical Innovation for Sustainability: The Power of Strategy and Open Innovation. *Long Range Plan.* **2017**, *50*, 712–725. [[CrossRef](#)]
- Du, S.; Yalcinkaya, G.; Bstieler, L. Sustainability, Social Media Driven Open Innovation, and New Product Development Performance. *J. Prod. Innov. Manag.* **2016**, *33*, 55–71. [[CrossRef](#)]
- Yang, J.Y.; Roh, T. Open for green innovation: From the perspective of green process and green consumer innovation. *Sustainability* **2019**, *11*, 3234. [[CrossRef](#)]
- Yun, J.J.; Zhao, X.; Park, K.B.; Shi, L. Sustainability condition of open innovation: Dynamic growth of alibaba from SME to large enterprise. *Sustainability* **2020**, *12*, 4379. [[CrossRef](#)]
- Arvaniti, E.N.; Stylios, C.D.; Papadakis, V.G. Open Social Innovation: Challenges and Opportunities. *Int. Conf. Entrep. Innov. Reg. Dev.* **2017**, *36*, 17–25.
- Arvaniti, E.N.; Stylios, C.D.; Papadakis, V.G. Methods To Enhance Local Communities Contribution Towards Open Social Innovation. In Proceedings of the International Conference Fifty Years of Local Governance 1980–2030 Institute of Geography and Spatial Planning, Lisbon, Portugal, 4–5 September 2018.
- Samara, E.; Andronikidis, A.; Komninos, N.; Bakouros, Y.; Katsoras, E. The Role of Digital Technologies for Regional Development: A System Dynamics Analysis. *J. Knowl. Econ.* **2022**, 1–23. [[CrossRef](#)]
- Miles, D.A. A taxonomy of research gaps: Identifying and defining the seven research gaps. *J. Res. Methods Strateg.* **2017**, *1*, 1–15.
- Zhang, Y.; Chen, K.; Fu, X. Scientific effects of Triple Helix interactions among research institutes, industries and universities. *Technovation* **2019**, *86–87*, 33–47. [[CrossRef](#)]
- Bernal, P.; Salazar, I.; Vargas, P. Understanding the open innovation trends: An exploratory analysis of breadth and depth decisions. *Adm. Sci.* **2019**, *9*, 73. [[CrossRef](#)]
- Glied, S.; Bakken, S. Institutional Challenges of Interdisciplinary Research Centers. *J. Res. Adm.* **2007**, *38*, 28–36.
- Şendoğdu, A.A.; Diken, A. A Research on the Problems Encountered in the Collaboration between University and Industry. *Procedia-Soc. Behav. Sci.* **2013**, *99*, 966–975. [[CrossRef](#)]
- Hoppmann, J. Hand in hand to Nowhereland? How the resource dependence of research institutes influences their co-evolution with industry. *Res. Policy* **2021**, *50*, 104145. [[CrossRef](#)]
- Arza, V.; Vazquez, C. Interactions between public research organisations and industry in Argentina. *Sci. Public Policy* **2010**, *37*, 499–511. [[CrossRef](#)]
- Yan, X.; Huang, M. Leveraging university research within the context of open innovation: The case of Huawei. *Telecomm. Policy* **2020**, *46*, 101956. [[CrossRef](#)]
- Chu, C.C.; Cheng, Y.F.; Tsai, F.S.; Tsai, S.B.; Lu, K.H. Open innovation in crowdfunding context: Diversity, knowledge, and networks. *Sustainability* **2019**, *11*, 180. [[CrossRef](#)]
- Jeng, D.J.F.; Huang, K.H. Strategic project portfolio selection for national research institutes. *J. Bus. Res.* **2015**, *68*, 2305–2311. [[CrossRef](#)]

33. Bai, L.; Bai, J.; An, M. A methodology for strategy-oriented project portfolio selection taking dynamic synergy into considerations. *Alex. Eng. J.* **2021**, *61*, 6357–6369. [\[CrossRef\]](#)
34. Kuo, T.H. How expected benefit and trust influence knowledge sharing. *Ind. Manag. Data Syst.* **2013**, *113*, 506–522. [\[CrossRef\]](#)
35. Ollila, S.; Elmquist, M. Managing Open Innovation: Exploring Challenges at the Interfaces of an Open Innovation arena. *Creat. Innov. Manag.* **2011**, *20*, 273–283. [\[CrossRef\]](#)
36. Schepis, D.; Purchase, S.; Butler, B. Facilitating open innovation processes through network orchestration mechanisms. *Ind. Mark. Manag.* **2021**, *93*, 270–280. [\[CrossRef\]](#)
37. Shmeleva, N.; Gamidullaeva, L.; Tolstykh, T.; Lazarenko, D. Challenges and opportunities for technology transfer networks in the context of open innovation: Russian experience. *J. Open Innov. Technol. Mark. Complex.* **2021**, *7*, 197. [\[CrossRef\]](#)
38. Barchi, M.; Greco, M. Negotiation in Open Innovation: A Literature Review. *Gr. Decis. Negot.* **2018**, *27*, 343–374. [\[CrossRef\]](#)
39. Hofstede, G.J.; Jonker, C.M.; Verwaart, T. Cultural Differentiation of Negotiating Agents. *Gr. Decis. Negot.* **2012**, *21*, 79–98. [\[CrossRef\]](#)
40. Manzini, R.; Lazzarotti, V. Intellectual property protection mechanisms in collaborative new product development. *R D Manag.* **2016**, *46*, 579–595. [\[CrossRef\]](#)
41. Hagedoorn, J.; Zobel, A.K. The role of contracts and intellectual property rights in open innovation. *Technol. Anal. Strateg. Manag.* **2015**, *27*, 1050–1067. [\[CrossRef\]](#)
42. Bos, B.; Broekhuizen, T.L.J.; de Faria, P. A dynamic view on secrecy management. *J. Bus. Res.* **2015**, *68*, 2619–2627. [\[CrossRef\]](#)
43. Bogers, M. The open innovation paradox: Knowledge sharing and protection in R&D collaborations. *Eur. J. Innov. Manag.* **2011**, *14*, 93–117. [\[CrossRef\]](#)
44. Jun, Y.; Kim, K. Developing an Open Innovation Attitude Assessment Framework for Organizations: Focusing on Open Innovation Role Perspective and Locus of Activity. *Behav. Sci.* **2022**, *12*, 46. [\[CrossRef\]](#) [\[PubMed\]](#)
45. de Melo, J.C.F.; Salerno, M.S.; Freitas, J.S.; Bagnó, R.B.; Brasil, V.C. From open innovation projects to open innovation project management capabilities: A process-based approach. *Int. J. Proj. Manag.* **2020**, *38*, 278–290. [\[CrossRef\]](#)
46. Gianiodis, P.T.; Ellis, S.C.; Secchi, E. Advancing a typology of open innovation. *Int. J. Innov. Manag.* **2010**, *14*, 531–572. [\[CrossRef\]](#)
47. Chesbrough, H. Managing open innovation. *Res. Technol. Manag.* **2004**, *47*, 23–26. [\[CrossRef\]](#)
48. De Silva, M.; Rossi, F.; Yip, N.K.T.; Rosli, A. Does affective evaluation matter for the success of university-industry collaborations? A sentiment analysis of university-industry collaborative project reports. *Technol. Forecast. Soc. Chang.* **2021**, *163*, 120473. [\[CrossRef\]](#)
49. Wyrwich, M.; Steinberg, P.J.; Noseleit, F.; de Faria, P. Is open innovation imprinted on new ventures? The cooperation-inhibiting legacy of authoritarian regimes. *Res. Policy* **2022**, *51*, 104409. [\[CrossRef\]](#)
50. McPhillips, M. Trouble in paradise? Barriers to open innovation in regional clusters in the era of the 4th industrial revolution. *J. Open Innov. Technol. Mark. Complex.* **2020**, *6*, 84. [\[CrossRef\]](#)
51. Lam, L.; Nguyen, P.; Le, N.; Tran, K. The relation among organizational culture, knowledge management, and innovation capability: Its implication for open innovation. *J. Open Innov. Technol. Mark. Complex.* **2021**, *7*, 66. [\[CrossRef\]](#)
52. Mignon, S.; Ayerbe, C.; Dubouloz, S.; Robert, M.; West, J. FOCUS managerial innovation and management of open innovation. *J. Innov. Econ. Manag.* **2020**, *32*, 3–12. [\[CrossRef\]](#)
53. Shaikh, I.; Randhawa, K. Managing the risks and motivations of technology managers in open innovation: Bringing stakeholder-centric corporate governance into focus. *Technovation* **2022**, *114*, 102437. [\[CrossRef\]](#)
54. Solberg, E.; Traavik, L.E.M.; Wong, S.I. Digital Mindsets: Recognizing and Leveraging Individual Beliefs for Digital Transformation. *Calif. Manage. Rev.* **2020**, *62*, 105–124. [\[CrossRef\]](#)
55. Neumeier, X.; Liu, M. Managerial Competencies and Development in the Digital Age. *IEEE Eng. Manag. Rev.* **2021**, *49*, 49–55. [\[CrossRef\]](#)
56. Richard, E.E.; Davis, J.R. NASA Human Health and Performance Center: Open innovation successes and collaborative projects. *Acta Astronaut.* **2014**, *104*, 383–387. [\[CrossRef\]](#)
57. Tou, Y.; Watanabe, C.; Moriya, K.; Naveed, N.; Vurpillat, V.; Neittaanmäki, P. The transformation of R&D into neo open innovation—a new concept in R&D endeavor triggered by amazon. *Technol. Soc.* **2019**, *58*, 101141. [\[CrossRef\]](#)
58. Miglietta, N.; Battisti, E.; Campanella, F. Value maximization and open innovation in food and beverage industry: Evidence from US market. *Br. Food J.* **2017**, *119*, 2477–2492. [\[CrossRef\]](#)
59. Ki, H.; Kim, J.Y. Sell green and buy green: A signaling theory of green products. *Resour. Energy Econ.* **2022**, *67*, 101266. [\[CrossRef\]](#)
60. Gustetic, J.L.; Crusan, J.; Rader, S.; Ortega, S. Outcome-driven open innovation at NASA. *Space Policy* **2015**, *34*, 11–17. [\[CrossRef\]](#)
61. Richard, E.E.; Davis, J.R.; Paik, J.H.; Lakhani, K.R. Sustaining open innovation through a “center of excellence”. *Strateg. Leadersh.* **2019**, *47*, 19–26. [\[CrossRef\]](#)
62. Crusan, J.; Galica, C.; Gill, T. NASA’s eXploration Systems and Habitation (X-Hab) Academic Innovation Challenge. *Acta Astronaut.* **2018**, *151*, 412–419. [\[CrossRef\]](#)
63. Crusan, J.; Galica, C. NASA’s CubeSat Launch Initiative: Enabling broad access to space. *Acta Astronaut.* **2019**, *157*, 51–60. [\[CrossRef\]](#)
64. Senghore, F.; Campos-Nanez, E.; Fomin, P.; Wasek, J.S. Applying social network analysis to validate mass collaboration innovation drivers: An empirical study of NASA’s International Space Apps Challenge. *J. Eng. Technol. Manag.* **2015**, *37*, 21–31. [\[CrossRef\]](#)
65. Watanabe, C.; Akhtar, W.; Tou, Y.; Neittaanmäki, P. A new perspective of innovation toward a non-contact society—Amazon’s initiative in pioneering growing seamless switching. *Technol. Soc.* **2022**, *69*, 101953. [\[CrossRef\]](#)

- 
66. Arcese, G.; Flammini, S.; Lucchetti, M.C.; Martucci, O. Evidence and experience of open sustainability innovation practices in the food sector. *Sustainability* **2015**, *7*, 8067–8090. [[CrossRef](#)]
  67. GE launches 'ecomagination' initiative. *Filtr. Sep.* **2005**, *42*, 4. [[CrossRef](#)]
  68. Chesbrough, H. Open innovation: Where we've been and where we're going. *Res. Technol. Manag.* **2012**, *55*, 20–27. [[CrossRef](#)]
  69. Shenhar, A.J.; Holzmann, V.; Melamed, B.; Yao, Z. The Challenge of Innovation in Highly Complex Projects: What Can We Learn from Boeing's Dreamliner Experience? *Proj. Manag. J.* **2016**, *47*, 62–78. [[CrossRef](#)]
  70. Schmuck, R. Global supply chain quality integration strategies and the case of the Boeing 787 Dreamliner development. *Procedia Manuf.* **2020**, *54*, 88–94. [[CrossRef](#)]