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Open and Crowd-Based Platforms: Impact on Organizational and Market Performance

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Abstract: The aim of the research was to present the state of the art on the use of open and crowd-based platforms and the advantages in terms of business performance that emerging practices employing such technologies are able to provide. The analysis was performed by extracting information on emerging practices from the repository Business Process Framework for Emerging Technologies developed by the Department of Industrial Engineering of the University of Salerno (Italy). Contingency tables allowed analysis of the association of such practices with industry, business function, business process, and impact on performance. From the analysis of the results, many implementation opportunities emerge, mainly in manufacturing, healthcare, and transportation industries, providing benefits not only in terms of efficiency and productivity, cost reduction, and information management but also in product/service differentiation. Therefore, the research provides an overview of opportunities for organizations employing open and crowd-based platforms in order to improve market and organizational performance. Moreover, the article highlights in what specific business contexts these technologies can be mainly useful.

Keywords: open-source; crowdsourcing; crowdfunding; open data; open science; crowd science; open access; open innovation; platforms; emerging technologies

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1. Introduction

In the last decade, the term "open" has been widely used in literature on business and innovation management. Enlarging the original open innovation paradigm [1], scholars have focused on the opportunities of inbound and outbound knowledge flows to improve the performance of business activities, with a particular focus on processes such as R&D and operations. The initial idea of exploiting knowledge exchanges among companies and organizations—both private and public—has been extended by considering the engagement of citizens [2], people [3], individuals [4], crowds [5], and communities [6]. Therefore, scholars have focused on these new opportunities by coining terms such as open-source [7], crowdsourcing [8], crowdfunding [9], open data [10], open science [11], crowd science [12], and open access [13]. These terminologies are strictly connected with technological instruments and tools that allow external actors to cooperate, interact, and collaborate with companies. In particular, platforms and networks are fundamental to allow organizations, people, and stakeholders to communicate and exchange knowledge and perform transactions [7]. With the technological development of such tools being a key driver for the diffusion of these new practices, this paper aims at describing the state of the art of open and crowd-based platforms (OCBP). Indeed, OCBP enclose all platforms and collaborative tools, networks, and technologies that support the new paradigm. In particular, with this work the following technologies are considered: open-source, crowdsourcing platforms, crowdfunding platforms, open data platforms, open and crowd science platforms, open access, and open innovation platforms.

The literature has widely explored these phenomena by proposing case studies and suggesting opportunities of implementation. Despite many contributions that suggest

benefits deriving from the use of OCBP, research is still limited and fragmented, lacking a wide and formal investigation of the conditions under which they provide advantages in terms of business performance. Therefore, this work presents the results of the analysis of the repository Business Process Framework for Emerging Technologies developed by the Department of Industrial Engineering of the University of Salerno (Italy). The repository collects thousands of business practices employing emerging technologies that enhance companies' performance. The development of the framework is based on a consolidated project that started in January 2021 and will continue over the next few years. The aim of the observatory is to analyze emerging technologies in order to study their evolution over time. Practices were collected from the analysis of case studies and applications reported in scientific papers, performed by a group of experts. The repository includes 96 emerging technologies grouped into: 3D printing, artificial intelligence, big data and data analytics, blockchain, computing, digital applications, geo-spatial technologies, human-computer interaction, immersive environments, Internet of Things, open and crowd-based platforms, proximity technologies, and robotics. In order to carry out this exhaustive analysis of these emerging technologies over time in a standardized way and with high quality of information, international journals have been selected as data sources. Information captured from papers was standardized by recording the practices within predefined fields in the repository. By accessing the repository and specifically selecting practices employing OCBP, the work provides an overview of the state of the art of such technologies. Indeed, the repository associates each business practice with one of the technologies under investigation, also clarifying the industry in which it is possible to employ it, the business functions and processes where the practice can be implemented, and the impact on market and organizational performance. This allows a detailed study of the context where OCBP are likely to provide benefits for companies. In particular, the paper contributes to the identification of opportunities for organizations to engage citizens, individuals, crowds, and communities to improve their market and organizational performance. Specifically, the research analyzes in which contexts the OCBP can generate benefits for the companies, such as the sector, business functions, and business processes. Furthermore, the paper aims to investigate which specific impacts, i.e., market or organizational, these technologies can carry out on business performance.

The paper is organized as follows. After a literature review that provides a brief description of the specific typologies of OCBP considered in this manuscript, the methodology is presented, describing how practices were collected and showing the variables associated with each emerging practice. Thereafter, results are presented, letting emerge many opportunities of implementation available in different industries, to support activities of various business functions and improve the performance of different processes. Finally, discussion and conclusions will clarify theoretical implications, methodological issues, managerial and practical considerations, the relationship with sustainability, limitations of the work, and future developments.

2. Theoretical Background

2.1. Open Innovation Platforms

In the years following the publication of Chesbrough's work [1], the concept of open innovation generated several theoretical and managerial insights. In spite of the traditional mechanism of generating innovative ideas based on internal resources, the open innovation paradigm highlights the importance of external sources, such as other companies, universities, and suppliers [14]. The benefits of involving external actors in the development of new knowledge are based on the possibility of having different types of external skills and competencies that allow generating new ideas [15], improving R&D performance of companies, and [16–18] generating sales growth [19].

With increasing digitalization, the concept of open innovation has moved into the digital world using open innovation platforms, i.e., platforms based on online software [20]. These platforms connect organizations and external resources and provide access to a set of

ideas and capabilities that facilitate innovation needs [21,22]. In this context, open innovation intermediaries play a key role since their work is supported by these technologies. In particular, open innovation intermediaries seek and select external knowledge and identify appropriate markets [23–25].

The actors involved in open innovations platforms are innovators, open innovation adopters, and open innovation intermediaries. Innovators play the role of innovation partners, sharing ideas and collaborating in innovation initiatives. Open innovation adopters are organizations embracing the open innovation paradigm and opening their innovation processes towards new solutions. Intermediaries help innovators to connect with open innovation adopters and to define their ideas [20].

2.2. Crowdsourcing Platforms

Recently, the crowdsourcing phenomenon has been spreading more and more among organizations that outsource the development of solutions for internal innovation problems to external individuals [4,8,26]. In particular, crowdsourcing allows the diversified knowledge of different participants to be exploited, the so-called "crowd wisdom", overcoming the social, geographical, and cultural barriers of the participants [27]. In this way, companies can benefit from external sources of knowledge, linking them with their internal resources in order to promote the generation of innovative ideas [15]. Thanks to developments in IT, the involvement of external individuals connecting through the Internet is increasing [28]. The benefits for people participating in crowdsourcing activities can be social as well as of a monetary nature [3,8].

We can define three forms of crowdsourcing, respectively related to "inventive activities", "routine activities", and "contents" [29]. The first exploits the crowd to find solutions for complex problems that companies are not able to solve using only their internal resources [30]. The second exploits the crowd for the outsourcing of repetitive activities for which specific skills are not required. The third exploits the dispersed crowd to gather large amounts of data when the heterogeneity of individuals is crucial [8].

The main and common features of crowdsourcing initiatives are: the identification of a task to be performed by an organization, the crowd that performs this task, an online platform that connects the crowd with the organization, and finally, the collection of benefits for both actors [31]. However, different from traditional open innovation practices, the companies interact with a crowd based on thousands of dispersed participants [5]. Therefore, crowdsourcing involves costs related to the administration of the online campaign [3]. Furthermore, individuals in the crowd lose any right to the innovation outcomes developed, which could generate legal disputes over intellectual property rights. Finally, the results from an unknown crowd are more uncertain [32].

2.3. Open and Crowd Science Platforms

The phenomenon of open science did not emerge recently: sharing new ideas on a local scale has always been a way to survive, and with the emergence of academies and scientific publications, it was also made on a large scale. Already in medieval and industrial times, the adoption of organizational practices such as industrial exhibitions [33], the invention of prizes [34], and the granting of licenses for external innovations [35], questioned the idea of companies and individuals as separate entities from their environment. In recent decades, organizational openness was widely debated in the academic literature, highlighting the importance of using external resources and entities. In particular, open science refers to "transparent and accessible knowledge that is shared and developed through open collaborative networks" [11] (p. 434).

However, for several centuries scientists have not applied the academic transparency practices that are used today. In the past, scientists sought ways to protect their knowledge in order to make their inventions profitable and avoid religious, political, and social problems [7]. Recognized scientists or inventors such as Galileo Galilei or Leonardo da Vinci were jealous of their writings and protected them with secret codes [36].

Since the mid-1990s, the rise of the Internet has created new opportunities for collaboration and knowledge exchange between people and organizations. Accessing, sharing, and collaborating via the Internet allows for cheaper and less demanding coordination when compared with face-to-face meetings [7]. Therefore, there has been a push to adopt IT tools for various open science practices based on the principle of mass participation—for example, using crowd science platforms [12]. In these platforms, participants dedicate their time and effort for scientific purposes and innovations such as collecting or analyzing data for social goals—for example, cleaning up a polluted canal [37,38]. A subset of crowd science is citizen science, where everyone, including those without any specific knowledge, can participate in the innovation process for companies by carrying out specific, well-defined, and typically simple tasks. For example, citizen science can monitor, through these platforms, insects that are potential carriers of infectious diseases, with consequences for food, and can implement new strategies for the control of agricultural pests [39]. Recently, citizen science initiatives have engaged the crowd for museum management, making visitors proactive and satisfied and encouraging visits to the museum. Specifically, museum managers leverage these platforms to collect visitor ideas, preferences, and feedback in order to improve the route design and organization of artworks in exhibits and to ensure a more satisfying museum experience for visitors. [2].

2.4. Open Access Platforms

In addition to collaborative open and crowd science platforms, there is a growing enthusiasm in open access platforms aimed at spreading knowledge. Open access activities have grown with the introduction of the Internet, making it a model of public service for providing and guaranteeing the wellness of society [13]. Open access allows the removal of knowledge barriers and the enrichment of education in an egalitarian way [40].

One of the biggest advantages of open access is the ease of accessing knowledge using multiple sources without having to collect data before carrying out experiments. Moreover, open access sources allow knowledge to spread pervasively, ensuring greater achievements for organizations [41]. Researchers involved in the open access process, including those lacking adequate financial resources, can also take advantage of open access and become aware of certain findings and innovations. In the education context, students can benefit from using information through open access platforms and deepening their studies [42]. Experts and professional figures can profit from open access platforms by being able to analyze issues more easily and further strengthening the relationship with science [43]. In particular, open access redirects the interests of the scientific community and business companies towards the interests of the society and thus lays the foundations for putting science and innovation in the service of society [44]. Finally, open access allows time reduction for validation and verification of research ideas and proposals—as was, for instance, demonstrated by the speed with which COVID-19 vaccines could be developed after the virus genome was published by scientists.

2.5. Crowdfunding Platforms

In 2012, President Barack Obama signed the JOBS Act, which revolutionized the way in which companies can raise capital. In Title III, better known as Crowdfund Act [9], the law allows entrepreneurs to sell limited quantities of their company's shares to a wide range of investors via social networks and Internet platforms [45].

This new perspective has made crowdfunding very popular for film, music, and photography projects via websites such as Kickstarter and IndieGoGo. Through these sites, companies post a call for funds and typically offer a token reward to those who contribute [9]. Crowdfunding supports both entrepreneurs looking to turn their ideas into profitable businesses and small business owners looking to keep their businesses. Indeed, the potential of crowdfunding can greatly help companies with limited access to capital. However, crowdfunding is not only limited to financing only business projects but also applies to cultural or social ones [46].

Internet-based platforms allow worldwide fundraising activities, making it possible also for very distant players to contribute [47]. In this sense, crowdfunding supports a global access to finance and a democratization of entrepreneurial activities [48].

The actors involved in this process are the project creator, the crowdfunding platform, and the money lenders. The project creators establish the target in terms of money they intend to raise. The project creators must submit the idea to potential funders, describing the expected results [49]. This is critical to the success of the campaign [50]. From the money lenders point of view, financing a project featured by technical and market uncertainty involves a risk [46]. Therefore, project creators should set up a benefit scheme to repay money lenders. For example, in rewards-based crowdfunding projects creators establish different rewards, which can be the delivery of a customized release of the product/service developed.

2.6. Open Data Platforms

In recent years, the amount of data released on public platforms around the world has exploded, and many projects are based on these platforms. Open data platforms aim to ensure visibility: data are published to contribute to new product development [51,52].

For example, the availability and accessibility of open data can provide information that disaster management can use to develop awareness of pre-, during, and post-disaster events. The use of open data in hazard modelling and risk assessment in data-scarce regions can provide important information for strengthening disaster resilience for communities [53]. In addition, open data can allow the calculation of parameter analyses regarding the sewage system for further efficiency improvements [54]. In the healthcare sector, using open data, it is possible to have clinical details available, reducing the time for prognosis and diagnosis of diseases, improving the medical service offered to patients, and providing doctors with quick diagnoses and the selection of adequate disease treatment plans [55]. Open data platforms can be used to estimate the private electricity demand needed to supply private electric vehicles [56]. Moreover, the use of these technologies could allow the analysis of turnover and dismissal by CEOs on employees in order to analyze the precursors and effects of the dismissal and the impact on performance indicators in view of the future results of companies [57].

2.7. Open-Source

One of the open practices for the IT community is the development of open-source software that has dramatically modified the features of the software industry. Specifically, the software aims to provide instructions for the proper functioning of the computer and programs. By granting free products, open-source software has hindered traditional ones [7]. Open-source communities are Internet-based groups where several participants voluntarily collaborate on software development. Within companies, closed source software can be limited by internal knowledge, while open-source players can freely modify, model, and remodel software in terms of use, design, and development [6]. Indeed, regardless of the utility and computing power of proprietary software, open-source software allows time and costs to be reduced by accessing codes already implemented by previous programmers. Bollinger [58] (p. 2) argues that open-source software is free software which "grants users the right to run, copy, distribute, study, modify and improve it as they see fit, without having to seek permission from or pay tax to any group or external person".

However, the term open-source software is not necessarily a synonym of "free" from a payment point of view: it means "free speech" [59]. Therefore, open-source software is considered as an enabler that allows collaboration in designing and exchanging software codes without a direct monetary profit [60]. Hence, open-source technology is considered as a community where everyone can improve, modify, and remodel codes, but no one can boast their ownership [61].

Open-source can be seen as an open innovation practice, allowing different actors to improve and share software quickly and at low cost. From a business perspective,

open-source technology can be considered as a business model capable of creating new value [62].

3. Materials and Methods

The purpose of the research was to collect the state of the art on phenomena related to the inclusion of crowd, external individuals, and communities coming from outside the boundaries of organizations to favor knowledge advancement and innovation development for companies. The data collection, coming from scientific journals, allows identification of the benefits and advantages that the inclusion of crowd and open innovation practices bring to organizational performance by providing a complete and general analysis of the importance of OCBP. The work aimed to analyze the technologies that allow external individuals to cooperate, interact, and collaborate with companies. Therefore, the collection of practices focused on specific technologies that support the open paradigm—specifically, open-source, crowdsourcing platforms, crowdfunding platforms, open data platforms, open and crowd science platforms, open access, and open innovation platforms. The paper aims to show the potential of these collaborative technologies, clarifying the context in which they can be implemented and their impact on business performance. This section clarifies how the structure was built, while in the following sections the variables used will be identified.

This study is part of a broader research project named Business Process Framework for Emerging Technologies. The repository consists of thousands of practices, captured by the analysis of worldwide scientific papers, which describe how emerging technologies improve business aspects. This worldwide repository is continuously updated by a team of experts in the field of organization, engineering, and technology management. Specifically, a cloud-based PHP web application was implemented to allow experts to carry out this activity and record the information. The activity consists in the reading and analysis of scientific articles in search of practices based on the business application of new technologies. Each practice is recorded by assigning one or more labels for each level (e.g., technology, sector, business function, business process, and impact). The procedure requires a certain experience in the technical knowledge of the analyzed practice. The presence of predefined variables allows data standardization and comparability. Each article is searched by an expert, with three possible outcomes: (a) article not found, (b) not useful article, or (c) useful article. The first refers to documents that were not downloadable from the web, while the second concerns scientific contributions where no practice was detected. The article is labeled as useful only when at least one practice is found. Practices are recorded only if it is clear how they work, what data they use, why they are used, what the goal of their implementation is, how they support the company in achieving its purposes, and positive impact. At the end of the process, an expert has the task of validating the articles recorded within the repository. The labeling process is manual and is based on the selection of standardized tags to facilitate data comparability. For the labeling activity, the ability to interpret and synthesize by an expert is required in order to convert the information present in the scientific article into standardized tags. Within this web application there is an analytics section that allows the extraction of information to carry out experiments and extract descriptive statistics. The purpose of this project is to publish this tool in the future so that, after selecting the variables of interest (technology, sector, business function, business process, and impact), it is possible to identify useful practices for implementation within companies.

The starting list of scientific articles consisted of contributions published from January 2019 to November 2021 in the most relevant journals (Q1 and Q2 quartiles) in the fields of economics, finance, management, public administration, operations research, management science, and accounting, according to ISI Web of Science and Scimago Journal Ranking. The list of scientific articles was searched on SCOPUS, creating a specific search query for collaborative platforms. For each open and crowd-based platform, specific contents were searched within the title and keyword fields, which referred to the specific category.

The following query was used to search such documents: TITLE ("open science") OR KEY ("open science") OR TITLE ("open source") OR KEY ("open source") OR TITLE ("crowdsourcing") OR KEY ("crowdsourcing") OR TITLE ("open data") OR KEY ("open data") OR TITLE ("crowd science") OR KEY ("crowd science") OR TITLE ("open access") OR KEY ("open access") OR TITLE ("crowdfunding platform") OR KEY ("crowdfunding platform") OR TITLE ("open innovation platform") OR KEY ("open innovation platform").

At the end of November 2021, the number of documents searched was 1005. In particular, 53 documents were not found, while 952 were downloaded and analyzed. Among them, 298 reported at least one practice. The distinct number of emerging practices employing OCBP was 570. The number of different academic journals from which the practices were collected was 133.

Classification Levels: Industry, Business Function, Business Process, and Impact

The classification of the practices collected by scientific articles was based on the evaluation of four variables: industry, business function, business process, and impact. The framework distinguishes 39 industries in the primary, manufacturing, and tertiary sectors (Table 1), also adding a general category when the suggested practice is potentially usable in all sectors. In addition, two general categories were added within the manufacturing and tertiary sectors—manufacturing industry (general) and services (general)—when the suggested practice was considered potentially usable in all industries of those sectors. To check comprehensiveness and quality of the suggested classification, industries were associated with the Standard Industrial Classification Codes (https://www.gov.uk/government/publications/standard-industrial-classification-of-economic-activities-sic (accessed on 23 December 2021)).

Table 1. List of industries by sector reported within the framework.

Sector	Industry	SIC Codes
General	General	
Primary	Agriculture	01110; 01120; 01130; 01140; 01150; 01160; 01190; 01210; 01220; 01230; 01240; 01250; 01260; 01270; 01280; 01290; 01300; 01410; 01420; 01430; 01440; 01450; 01460; 01470; 01490; 01500; 01610; 01621; 01629; 01630; 01640.
	Fishing	03110, 03120; 03210; 03220.
	Mining	05101; 05102; 05200; 06100; 06200; 07100; 07210; 07290; 08110; 08120, 08910; 08920; 08930; 08990; 09100; 09900.
	Wood	01700; 02100; 02200; 02300; 02400.
Manufacturing	Manufacturing (general)	
	Aerospace and aeronautics	30300; 33160.
	Automotive	29100; 29201; 29202; 29203; 29310; 29320.
	Biomedical	26600; 32500; 32910.
	Chemical	20110; 20120; 20130; 20140; 20150; 20160; 20170; 20200; 20301; 20302; 20411; 20412; 20420; 20510; 20520; 20530; 20590; 20600.
	Construction	16100; 16210; 16220; 16230; 16240; 16290; 23510; 23520; 23610; 23620; 23630; 23640; 23650; 23690; 23700; 23910; 23990; 41100; 41201; 41202; 42110; 42120; 42130; 42210; 42220; 42910; 42990; 43110; 43120; 43130; 43210; 43220; 43290; 43310; 43320; 43330; 43341; 43342; 43390; 43910; 43991; 43999.
	Electric power	27110; 27120; 27200; 27310; 27320; 27330; 27400; 27510; 27520; 27900.
	Electronics	26110; 26120; 26200; 26301; 26309; 26400; 26511; 26512; 26513; 26514; 26520; 26701; 26702; 26800; 33130; 33140; 95110; 95120; 95210.
	Energy	35110; 35120; 35130; 35140; 35210; 35220; 35230; 35300.
	Food and beverage	10110; 10120; 10130; 10200; 10310; 10320; 10390; 10410; 10420; 10511; 10512; 10519; 10520; 10611; 10612; 10620; 10710; 10720; 10730; 10810; 10821; 10822; 10831; 10832; 10840; 10850; 10860; 10890; 10910; 10920; 11010; 11020; 11030; 11040; 11050; 11060; 11070; 12000.
	Machinery production	28110; 28120; 28131; 28132; 28140; 28150; 28210; 28220; 28230; 28240; 28250; 28290; 28301; 28302; 28410; 28490; 28910; 28921; 28922; 28923; 28930; 28940; 28950; 28960; 28990; 33120; 33200.
	Paper and pulp	17110; 17120; 17211; 17219; 17220; 17230; 17240; 17290; 18110; 18121; 18129; 18130; 18140.
	Petroleum	19100; 19201; 19209.
	Pharmaceutical	21100; 21200.
	Textile	13100; 13200; 13300; 13910; 13921; 13922; 13923; 13931; 13939; 13940; 13950; 13960; 13990; 14110; 14120; 14131; 14132; 14141; 14142; 14190; 14200; 14310; 14390; 15110; 15120; 15200.

Table 1. *Cont.*

Sector	Industry	SIC Codes
Tertiary	Services (general)	69101; 69102; 69109; 69201; 69202; 69203; 70100; 70210; 70221; 70229; 71111; 71112; 71121; 71122; 71129; 71200; 72110; 72190; 72200; 73110; 73120; 73200; 74100; 74201; 74202; 74203; 74209; 74300; 74901; 74902; 74909; 74990; 78109; 78200; 78300; 80100; 80200; 80300; 81100; 81300; 82110; 82190; 82200; 82301; 82302; 82911; 82912; 82920; 82990; 84110; 84120; 84130; 84210.
	Consulting and professional services	
	Digital	18201; 18202; 18203.
	E-commerce	47910.
	Education	85100; 85200; 85310; 85320; 85410; 85421; 85422; 85510; 85520; 85530; 85590; 85600; 91011.
	Entertainment	59111; 59112; 59113; 59120; 59131; 59132; 59133; 59140; 59200; 60100; 60200; 78101; 90010; 90020; 90030; 90040.
	Fashion	46160; 46420; 47710; 47820.
	Financial services	64110; 64191; 64192; 64201; 64202; 64203; 64204; 64205; 64209; 64301; 64302; 64303; 64304, 64305; 64306; 64910; 64921; 64922; 64929; 64991; 64992; 64999; 65110; 65120; 65201; 65202; 65300; 66110; 66120; 66190; 66210; 66220; 66290; 66300.
	Healthcare	75000; 86101; 86102; 86210; 86220; 86230; 86900; 87100; 87200; 87300; 87900; 88100; 88910; 88990.
	Hotels and accommodation	55100; 55201; 55202; 55209; 55300; 55900.
	News media	58110; 58120; 58130; 58141; 58142; 58190.
	Passenger transport	49100; 49311; 49319; 49320; 49390; 50100; 50300; 51101; 51102; 51220; 52213.
	Real estate	68100; 68201; 68100; 68201; 68202; 68209; 68310; 68320; 68202; 68209; 68310; 68320.
	Restaurants and cafés	56101; 56102; 56103; 56210; 56290; 56301; 56302.
	Retail	45111; 45112; 45190; 45200; 45310; 45320; 45400; 46110; 46120; 46130; 46140; 46150; 46170; 46180; 46190; 46210; 46220; 46230; 46240; 46310; 46320; 46330; 46341; 46342; 46350; 46360; 46370; 46380; 46390; 46410; 46431; 46439; 46440; 46450; 46460; 46470; 46480; 46491; 46499; 46510; 46520; 46610; 46620; 46630; 46640; 46650; 46660; 46690; 46711; 46719; 46720; 46730; 46740; 46750; 46760; 46770; 46900; 47110; 47190; 47210; 47220; 47230; 47240; 47250; 47260; 47290; 47300; 47410; 47421; 47429; 47430; 47510; 47520; 47530; 47540; 47591; 47599; 47610; 47620; 47630; 47640; 47650; 47721; 47722; 47730; 47741; 47749; 47750; 47760; 47770; 47781; 47782; 47789; 47791; 47799; 47810; 47890; 47990; 77110; 77120; 77210; 77220; 77291; 77299; 77310; 77320; 77330; 77341; 77342; 77351; 77352; 77390.
	Software	58290; 62011; 62012; 62020; 62030; 62090; 63110; 63120; 63910; 63990.
	Sport, fitness, and wellness	93110; 93120; 93130; 93191; 93199; 96040.
	Telecommunication	61100; 61200; 61300; 61900.
	Tourism	79110; 79120; 79901; 79909; 91012; 91020; 91030; 91040; 93210; 93290.
	Transportation and logistics	49200; 49410; 49420; 49500; 50200; 50400; 51210; 52101; 52102; 52103; 52211; 52212; 52219; 52220; 52230; 52241; 52242; 52243; 52290; 53100; 53201; 53202.
	Videogames	58210.
	Waste	38110; 38120; 38210; 38220; 38310; 38320; 39000.
	Water	36000; 37000.

A further objective of this work was to investigate business functions and business processes, in order to understand whether there are different opportunities of implementation of the technologies under investigation depending on the specific context. In Table 2 the nine business functions with their respective business processes are analyzed for OCBP.

As a last step of analysis, the classification of scientific articles provided a specific impact for each practice. In this way it was possible to detail and deepen the organizational and market impact using the OCBP. In Table 3, the impact can be divided into market or organizational effects. The first refers to the improvement in the external relations performance with customers, investors, and stakeholders in general, while the second concerns the organizational positive effects of OCBP implementation. Such a variable is important for underscoring the real effect determined by the implementation of practices using OCBP. Tables 2 and 3 show some examples of bibliographic references from which OCBP practices were collected.

Table 2. List of business functions and business processes considered within the framework.

Business Functions	Business Processes	Reference
Accounting and finance (A&F)	Accounting and auditing	[63]
	Credit risk and financial monitoring	[64]
	Financial transactions	[65]
	Investments evaluation	[66]
Distribution	3PL 4PL couriers—outsourcing	[67]
	Delivery	[68]
	Reverse logistics	[69]
	Transportation	[70]
	Warehouses	[71]
Governance and administration (G&A)	Business monitoring	[72]
	Decision making	[73]
	Strategic planning	[74]
Human resources (HR)	Human resources management	[75]
	Recruitment and selection	[76]
	Training—education—organizational culture	[70]
	Work health and safety	[77]
Information and communications technology (ICT)	Database and data management	[78]
	Software and information systems	[79]
	Telecommunication and network services	[80]
Marketing	Advertising, communication, and promotion	[81]
	Customer service	[82]
	Market analysis	[83]
	Sales and sales channels	[84]
Operations	Maintenance and diagnostics	[85]
	Operations control	[86]
	Operations planning	[71]
	Plant services	[54]
	Production of goods	[87]
	Provision of services	[88]
	Quality management	[89]
Procurement	Buyer–supplier relationships	[67]
	Order management—purchasing	[90]
Research and development (R&D)	Product design and development	[91]
	Product innovation	[92]
	Prototyping	[93]

Table 3. List of effects by impact area reported within the framework.

Area of Impact	Specific Impact	Reference
Market	Attracting investors	[94]
	Brand reputation	[95]
	Competitive advantage	[84]
	Customer satisfaction	[96]
	Product/service quality/value/differentiation	[88]
	Revenues	[90]
Organizational	Cost reduction	[97]
	Efficiency and productivity	[70]
	Employees engagement	[98]
	Energy efficiency	[54]
	Flexibility	[97]
	Information management	[99]
	Innovation, knowledge, and technology management	[75]
	Risk reduction	[75]
	Supply chain relationship management	[71]
	Time reduction	[100]

4. Results

This section first presents a global exploratory study on the 570 practices employing OCBP. Subsequently, a two-dimensional analysis is reported in which the single type of OCBP is combined with the specific context. Each practice of OCBP can have different implementation opportunities in terms of impact on business performance, industry, business function, and business processes. Therefore, from the analysis of the practices, it is possible to outline an overall applications framework based on OCBP.

4.1. Descriptive Statistics

A first univariate analysis is performed on each variable in order to show the distribution of the overall practices related to the OCBP. Figure 1 shows the number of practices used in the specific OCBP. The most frequent practices are related to open-source software and crowdsourcing platforms, covering over 70% of the total.

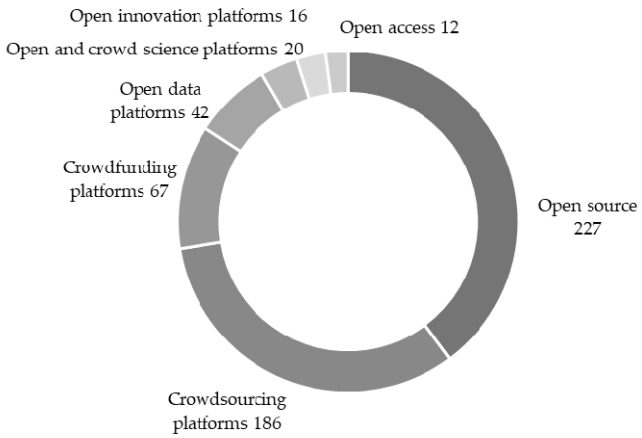

Figure 1. Count of practices associated with OCBP.

Figure 2 groups the practices by sector, underscoring that the manufacturing and tertiary sectors are featured by a greater number of practices than the primary sector.

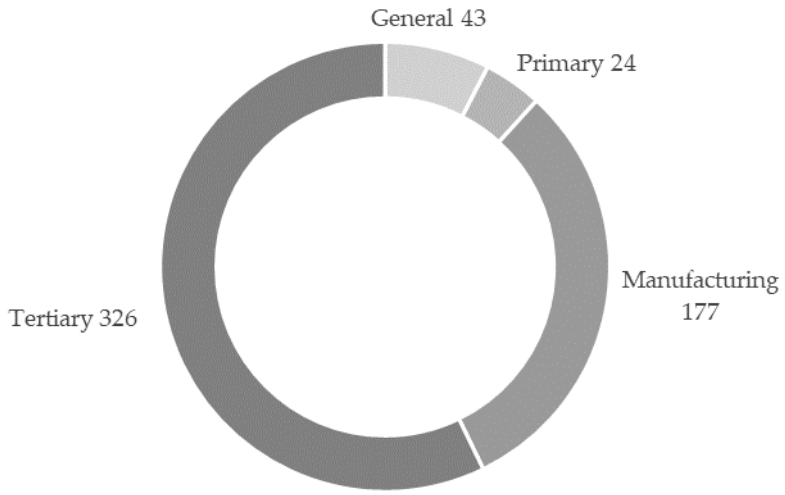

Figure 2. Count of OCBP practices by sector.

Figure 3 shows the top 20 industries in terms of the number of available practices. OCBP are mostly used in all the manufacturing industries and in the healthcare, but most open and crowd practices can potentially be used in all sectors. The implementation of OCBP is also useful for the passenger transport and transportation and logistics.

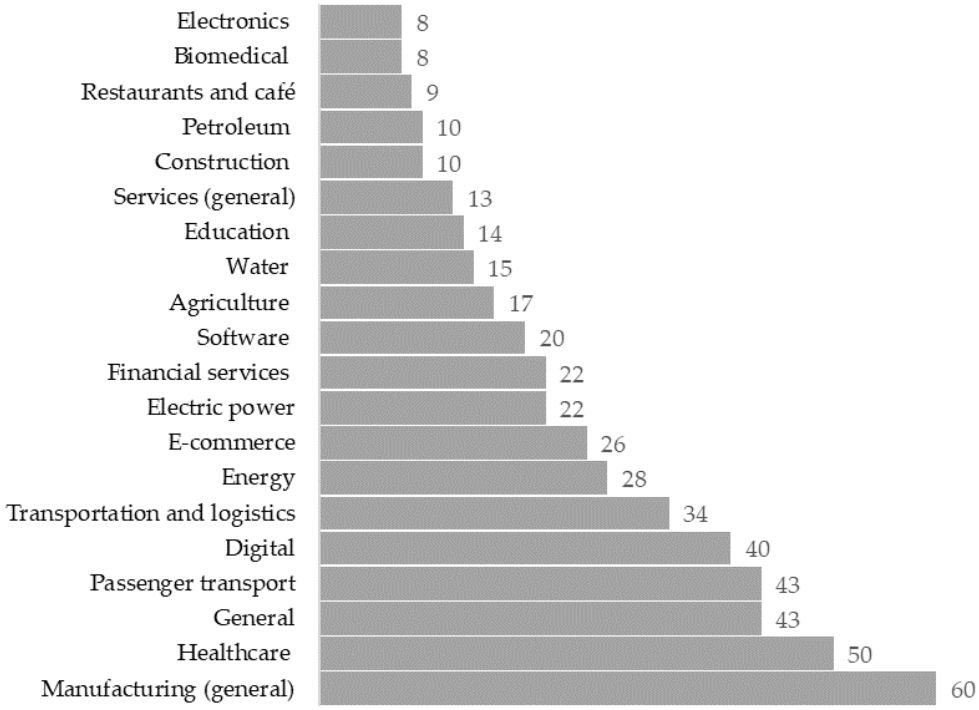

Figure 3. Top 20 industries for OCBP practices.

In addition, Table 4 reports the number of applications per business function and the corresponding business processes. Most of the practices are associated with operations. However, the highest number of business process practices concerns the product design and development process in R&D. The OCBP are less used in the area of procurement and human resources.

Table 4. Count of OCBP practices by business function and business processes.

Business Functions	No. of Practices	Business Processes	No. of Practices
Operations	214	Provision of services	69
		Operations control	63
		Production of goods	37
		Operations planning	24
		Quality management	9
		Plant services	8
		Maintenance and diagnostics	4
Research and development (R&D)	107	Product design and development	86
		Product innovation	12
		Prototyping	9
Marketing	62	Market analysis	29
		Advertising, communication, and promotion	25
		Customer service	5
		Sales and sales channels	3
Information and communications technology (ICT)	49	Database and data management	35
		Software and information systems	8
		Telecommunication and network services	6
Distribution	46	Delivery	19
		Transportation	19
		3PL 4PL Couriers—Outsourcing	4
		Reverse logistics	2
		Warehouses	2
Governance and administration (G&A)	36	Decision making	21
		Strategic planning	11
		Business monitoring	4

Table 4. *Cont.*

Business Functions	No. of Practices	Business Processes	No. of Practices
Accounting and finance (A&F)	35	Investments evaluation	12
		Accounting and auditing	8
		Credit risk and financial monitoring	8
		Financial transactions	7
Human resources (HR)	15	Recruitment and selection	6
		Training—education—organizational culture	4
		Human resources management	3
		Work health and safety	2
Procurement	6	Order management—purchasing	4
		Buyer-supplier relationships	2
Total	570		570

As for the effects on business performance, about 20% of the practices allow improvements in terms of efficiency and productivity, followed by cost reduction and information management. However, OCBP improve customer satisfaction and the quality/value/differentiation of products/services (Figure 4). Finally, grouping the practices by areas of impact, the results show that improvements in terms of organizational performance characterize more than 70% of the practices.

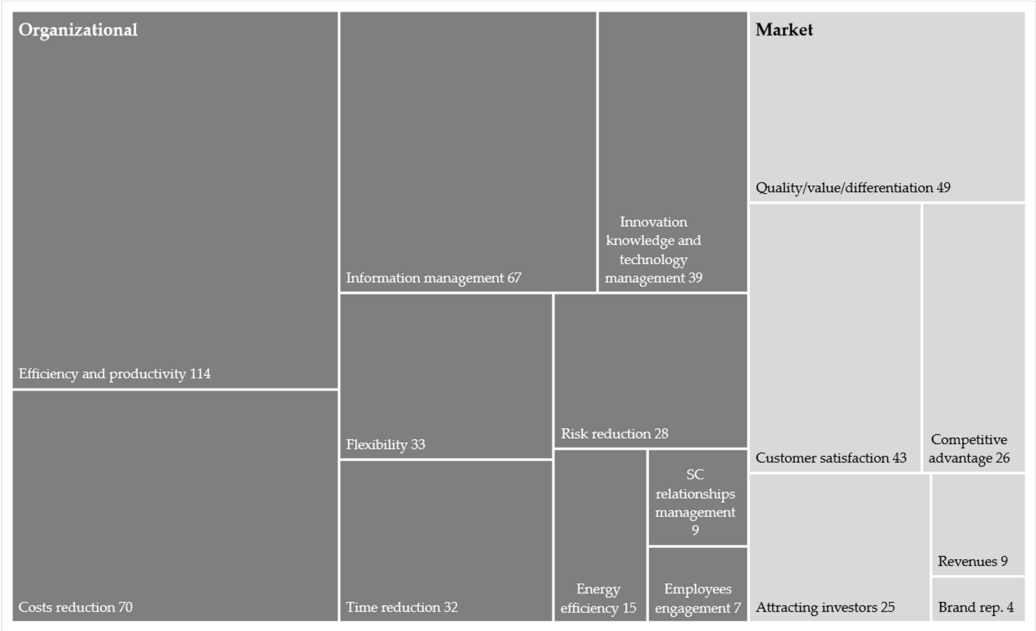

Figure 4. Count of OCBP practices by impact.

4.2. Analysis of Open and Crowd-Based Platforms

In order to find an association between applications on OCBP and (a) industry, (b) business function, (c) business processes, and (d) impact, contingency tables were implemented, showing the frequency distribution of variables. This frequency corresponds to the number of practices present in a specific context and with a specific impact.

The relationship between OCBP and the sector is useful for highlighting the differentimplementation opportunities in different areas. Table 5 shows the relative frequency of distribution (total by columns), showing in which **sector** and **industry** these platforms are mainly used. As to the **sectors**, most of the applications are present in the tertiary sector, except for open innovation platform. Moreover, open access, open data, and open innovation platforms are not used in the primary sector, whereas crowdsourcing platforms and open-source software are widely applied in the tertiary sector.

Table 5. Distribution of OCBP practices by industry and sector.

Industry and Sector	Crowdfunding Platforms	Crowdsourcing Platforms	Open Access	Open Data Platforms	Open Innovation Platforms	Open and Crowd Science Platforms	Open Source
General	11	18		1	6	1	6
Agriculture	2	1				1	13
Other primary industries		1					6
Total primary sector	2	2				1	19
Biomedical				2			6
Chemical			2				5
Construction				3			7
Electric power	1			4		1	16
Energy	1			4		2	21
Manufacturing (general)	11	13		4	6	3	23
Petroleum							10
Textile		5					1
Other manufacturing industries	7	10			1		8
Total manufacturing sector	20	28	2	17	7	6	97
Digital	5	20	1	1	1	4	8
E-commerce		23		1		1	1
Education	1		2	2		5	4
Financial services	18	2				1	1
Healthcare	1	15	4	4			26
News media		6	1				1
Passenger transport		19	1	10		1	12
Restaurants and cafés	2	7					
Services (general)	6	2					5
Software		6		3	2		9
Tourism		5		1			
Transportation and logistics		17	1	1			15
Water		3		1			11
Other tertiary industries	1	13					12
Total tertiary sector	34	138	10	24	3	12	105
Total	67	186	12	42	16	20	227

For example, in the primary sector, using open-source software and open data it is possible to apply machine learning techniques in aquaculture to limit the damage from invasive aquatic species that devastate the farming of marine species [101]. The agricultural sector contributes significantly to global greenhouse gas emissions, and entrepreneurs can take advantage of crowdfunding campaigns in order to finance climate change mitigation practices. In this way, farmers can reduce the cost of the campaign by reducing the time needed to manage investors [102].

From the results of Table 5, open data could be used in the wind energy sector to make more informed business decisions on the need for future investments or on the choices of dispatching in production processes. Specifically, the study of open satellite data sources on wind energy production available in countries and regions allows for greater accuracy and acceptable quality standards [103].

Finally, in the tertiary sector, crowdsourcing finds application in freight delivery and travel sharing systems: semi-empty means of passengers and freight transport can be saturated [70]. In the education industry, open science can be used to create a system for sharing unrestricted intellectual property in order to create knowledge growth and achieve social benefit—for example, a system that generates revolutionary innovations in order to produce new goods and services that open up new markets such as the treatment of previously incurable diseases [104].

Looking in more detail at the different **industries in** Table 5, all OCBP offer the greatest number of opportunities in the digital industry; high values are also obtained for the manufacturing industry and for the general category.

Crowdfunding platforms are mostly implemented in the financial services industries, but they are also common in the manufacturing industry. Crowdfunding platforms, integrated with machine learning algorithms, can help venture capital companies to evaluate the proposals received, indicating the strengths and weaknesses of each company for granting investments [105].

There are many opportunities to implement crowdsourcing platforms in different industries, including e-commerce, digital industries, healthcare, manufacturing, passenger transport, and transportation and logistics. For example, in the e-commerce sector, crowdsourcing platforms collect huge volumes of online consumer reviews, and through advanced machine learning techniques it is possible to forecast demand for online stores [106]. For the passenger transport and transportation and logistics industries, crowdsourcing platforms are an opportunity to earn money that does not require a huge effort since people usually have to follow a specific path for family and work reasons, and they can store a package coming from other individuals or ride a passenger and deliver them in specific place already present on the established route [107].

Open access platforms are particularly promising in the construction and healthcare industries. For example, in the healthcare industry, the use of open access facial image data on patients with specific syndromes can help clinicians render appropriate clinical diagnoses [108].

As shown in Table 5, open data platforms can be used for passenger transport and in the electric power industry. Open data can help to develop applications for passenger transportation with information on stops, timetables, and routes of passenger transport [109]. Indeed, open data platforms can be employed to evaluate the energy demand of private electricity. Open data could support players in locating overloads in the grid [56].

Open innovation platforms find applications in the manufacturing industry. These platforms act as intermediaries in value creation and enable entrepreneurs to share risks and reduce prototyping costs [110]. Open and crowd science applications are significant in the education, digital, and manufacturing industries. For example, university groups can use these platforms to enhance companies' product innovation [98].

From the results of Table 5, no emerging open-source practices were found within the repository for restaurant and café and tourism industry. As highlighted in Table 5, open-source software can be useful for the energy, electric power, healthcare, and manufacturing industries. In the healthcare industry, there are user-friendly open-source software that facilitate whole slide scans and have algorithms for tissue quantification that employ machine learning techniques [88]. For the energy industry, open-source technologies create georeferenced maps of the spatial distribution of biogas production used to produce energy obtained from urban and agricultural organic waste. Seasonal and spatial mapping can be used for biogas production planning, risk management, and warehouse capacity evaluation [71].

The link between OCBP and business functions is investigated through Table 6, reporting the relative distribution frequency (total by columns), highlighting the business **functions** and **processes** where there are greater opportunities for implementation of the OCBP. As regards the **functions**, operations is present in all OCBP (Table 6). Crowdsourcing platforms, open access, open data platforms, and open-source software show a peculiar value in the operations function.

Table 6. Distribution of OCBP practices by business function and process.

Business Function and Process	Crowdfunding Platforms	Crowdsourcing Platforms	Open Access	Open Data Platforms	Open Innovation Platforms	Open and Crowd Science Platforms	Open Source
Accounting and auditing	7	1					
Credit risk and financial monitoring	5	2					1
Financial transactions	6						1
Investments evaluation	10	1		1			
Total A&F	28	4		1			2
Delivery		17				1	1
Transportation		2					17
Other distribution processes		4					4
Total distribution		23				1	22
Decision making		4		1		1	15
Strategic planning		3	1	2			5
Other G&A processes		3		1			
Total G&A		10	1	4		1	20
Recruitment and selection		4			2		
Other HR processes		5				1	3
Total HR		9			2	1	3
Database and data management		13	1	2		3	16
Software and information systems		3					5
Other ICT processes		4		1			1
Total ICT		20	1	3		3	22
Advertising, communication, and promotion	15	6	1	3			
Market analysis	8	11		2			8
Other marketing processes	3			1		1	3
Total marketing	26	17	1	6		1	11
Operations control		14		6		2	41
Operations planning		6	1	2			15
Plant services				3			5
Production of goods	4	6	2	6	2	1	16
Provision of services	4	28	5	10	1	3	18
Quality management		2					7
Other operations processes							4
Total operations	8	56	8	27	3	6	106
Order management—purchasing							4
Other procurement processes		2					
Total procurement		2					4

Table 6. *Cont.*

Business Function and Process	Crowdfunding Platforms	Crowdsourcing Platforms	Open Access	Open Data Platforms	Open Innovation Platforms	Open and Crowd Science Platforms	Open Source
Product design and development	3	39	1		8	5	30
Other R&D processes	2	6		1	3	2	7
Total R&D	5	45	1	1	11	7	37
Total	67	186	12	42	16	20	227

Crowdfunding platforms are mainly implemented within the marketing and accounting and finance functions. Through reward-based crowdfunding platforms, it is possible to infer the aggregate demand starting from new product pre-orders of few customers. Learning from the crowdfunding sample allows companies to invest only if the expectations are high [64]. Investment-based crowdfunding can allow fundraising for environment-oriented initiatives that can attract a large audience of moneylenders [111].

Open innovation and open and crowd science platforms are mostly used in research and development. For example, open innovation platforms for drug discovery are very interesting. In particular, pharmaceutical companies are using open science models in healthcare innovation to generate shared knowledge for drug discovery [112].

Finally, open-source software is useful for all business functions considered, especially for operations, research and development, distribution, governance and administration, and information and communications technology. Open-source technology is applied for water supply management. In practice, it enhances management decisions of water industries in response to drought or water scarcity. This open-source technology provides methods to help decision makers identify the main uncertainties and vulnerabilities of the water management control system [113].

By expanding the analysis on business **processes**, it is possible to clarify and deepen the associations that the different platforms have on single business processes. For all business processes in which the number of applications was less than five, they have been grouped under the specific label "other" and the related business function (Table 6). In particular, crowdfunding platforms are mostly useful for advertising, communication and promotion, and investments evaluation. Analyzing data from equity crowdfunding platforms, investors are more aware of investing in dubious or underperforming companies, thus improving investment efficiency and making more informed decisions about where to invest [114].

Crowdsourcing platforms offer the greatest number of opportunities in different business processes; for example, the relevance of applications is related to delivery, operations control, product design and development, and provision of services. For example, crowdsourcing platforms could provide users with real-time bus arrival information—users can track their journeys to contribute real-time arrival estimates via apps. Specifically, passengers could select which bus to get on, choose the destination, and start tracking or sharing location information [115].

Open access and open data platforms mainly support production of goods and provision of services processes; furthermore, open data platforms are also useful for operations control. For instance, through open data platforms, it is possible to analyze energy consumption for space heating and urban and industrial water, identifying the best method of space and water heating [54].

Open innovation and open and crowd science platforms are implemented for product design and development processes; specifically, the latter have more applications than open innovation platforms. These platforms allow the procurement of external knowledge based on shared open data (databases, documents) coming from different actors. These shared platforms can reduce high costs for internal R&D and transactions, enhancing rapid

development, reducing risks, and advancing the innovation process even when there is no R&D internal knowledge [116].

Finally, open-source software is used almost on all business processes. The business processes in which this technology is most applied regard database and data management, decision making, operations control, product design and development, production of goods, provision of services, and transportation. The use of open-source software, based on multispectral image data of vegetation, can help farmers to optimize operations in the precision agriculture industry, starting from valuable information calculated by these tools [87].

Table 7 shows the link between OCBP and the **impact** on business performance. For all the impacts in which the number of applications was less than five, they were grouped under the specific labels "other market impacts" or "other organizational impacts". Efficiency and productivity impact is the most recurring for crowdsourcing platform, open and crowd science platform, and open-source software. Crowdfunding platforms are known for attracting investors by providing additional information and identifying the countries where their product carries the most interest and meets the needs of local customers [117].

Table 7. Distribution of OCBP practices by impact.

Impacts	Crowdfunding Platforms	Crowdsourcing Platforms	Open Access	Open Data Platforms	Open Innovation Platforms	Open and Crowd Science Platforms	Open Source
Attracting investors	21			2		1	1
Competitive advantage	5	8		2	1	1	9
Customer satisfaction	1	30	1	4			7
Product/service quality/value/differentiation	11	13	1	5	1	1	17
Other market impacts	2	6		1	2		2
Total market impacts	40	57	2	14	4	3	36
Cost reduction	3	23	3	1	2	4	34
Efficiency and productivity	9	31	2	6	3	7	56
Energy efficiency	1	1	1	4			8
Flexibility	1	13		1			18
Information management	8	12	2	9	2	1	33
Innovation, knowledge, and technology management		21		3	3	3	9
Risk reduction	3	10	1	1	1		12
Supply chain relationship management	1	2		1			5
Time reduction	1	12	1	1	1	1	15
Other organizational impacts		4		1		1	1
Total organizational impacts	27	129	10	28	12	17	191
Total	67	186	12	42	16	20	227

Cost reduction is achieved by implementing crowdsourcing platforms and using open-source software and open data. Crowdsourcing can be used by companies to reduce or eliminate internal R&D expenses. Based on the crowd wisdom, better decisions could be made than experts' decisions [118].

Crowdsourcing platforms contribute to various impacts, such as customer satisfaction, flexibility information management, innovation, knowledge and technology management, product/service quality/value/differentiation, risk reduction, supply chain relationship management, and time reduction, while open data platforms and open-source software contribute to an improvement in energy efficiency. Through these technologies, it is

possible to calculate the waste heat of industrial processes and energy production and reduce primary energy consumption for heating [54].

By exploiting open access platforms there are advantages in terms of cost reduction, efficiency and productivity, and information management. Using open data in the education industry can improve decision-making and teaching-learning processes. Open access platforms can facilitate the definition and standardization of information management processes and, at the same time, can allow the import, storage, data analysis, privacy guarantee, and identity and security of the students. In this way, it is possible to obtain representative results for analyzing the achievement of learning processes [119].

In addition, open data platforms improve efficiency and productivity, energy efficiency, information management, and product/service quality/value/differentiation. In the healthcare sector, open data can be used and analyzed to develop contingency plans in response to opioid overdose in order to improve efficiency and productivity [120]. Finally, open innovation platforms improve aspects regarding efficiency and productivity and innovation, knowledge, and technology management. These platforms allow the sharing and further development of digital file designs such as 3D printing files. In this way, participants can exchange comments on the work of others and share their ideas [91].

5. Discussion

5.1. Theoretical Implications

The research contributes to the understanding of the opportunities for organizations of engaging citizens, people, individuals, crowds, and communities to enhance their market and organizational performance. Indeed, results from the analysis of the repository confirm that these tools are useful for companies and can determine advantages for their business. In particular, the research analyzed a wide variety of contexts where OCBP can determine benefit for firms, suggesting that firms' peculiarities, such as the belongingness industry, impact on the opportunities of implementation. Moreover, depending on the expected impact on business performance, specific technologies and practices can be employed, also considering which are the business functions and processes that better fit with the technology. Indeed, the research focuses its attention on the differences among the various typologies of OCBP, providing a classification that avoids terminological misunderstanding. Considering the growing interest towards such technologies, the research suggests working on the analysis of the specific and different benefits provided by open innovation platforms, crowdsourcing platforms, open and crowd science platforms, open access, crowdfunding platforms, open data platforms, and open-source. For instance, crowdfunding platforms are useful for attracting investors, whereas crowdsourcing platforms support efficiency and productivity but also customer satisfaction. Moreover, open-source impact on cost savings, efficiency and productivity, and information management.

From the analysis of business functions and processes where these emerging practices can be implemented, it is evident that they have a significant breadth of application, even though the most promising areas are R&D and operations. Nonetheless, an important number of practices were uncovered within marketing, distribution, ICT, G&A, and A&F functions, as well as for supporting often neglected processes such as database and data management, decision making, and strategic planning.

However, these platforms could hide implementation risks within companies. In fact, the practices presented in the framework, which use OCPB, are considered emerging. Therefore, compared with best practices, they are not easily repeatable and are associated with high implementation risks. Managers and entrepreneurs should have the right awareness, knowledge, and tools to check whether these specific platforms could be useful to their company.

5.2. Methodological Issues

After the methodological point of view, the research required a significant effort in searching, analyzing, labelling, and standardizing the practices described in the scientific

literature. Emerging practices collected through the selection of international journals were needed to standardize analyses and results. In particular, the gray literature (such as trade magazines and social media) was excluded, as it is complex to select and standardize sources disseminated on the web and not based on peer review processes. The activity is time consuming and requires experience in business and technology management; therefore, a team of experts was engaged. Anyway, the repository has various strengths. First, data and information are standardized by the use of predefined tags. Practices are assigned to categorical variables based on predefined labels to allow comparability. Second, practices are retrieved from the scientific literature, which is source of high-level information, with the validation provided by peer review processes. Third, with the scientific literature being continuously updated, it is possible to record new and emerging practices by constantly accessing and studying papers. This will allow the analysis of the evolution of OCBP in future. Fourth, the labels within each variable of the repository can be simply and flexibly updated, so if new categories of OCBP emerge, they will be rapidly integrated within the database. Fifth, the methodology and the labels suggested with this work can be employed to study other emerging technologies and business trends.

However, some limitations need to be discussed. First, as already clarified, the process of updating the repository is time consuming and requires the engagement of experts. Second, the process of labelling is based on the personal interpretation of the expert who reads and classifies the practice captured from the paper. However, each practice is subjected to a subsequent review by a second expert who performs a second check on the correct association with each variable. Third, it is not possible to affirm that the repository records all available practices that employ OCBP, the analysis being limited to the study of scientific papers. Many practices may already be used by companies, and scholars may not have already captured and discussed some applications. Fourth, the repository suggests that by implementing an emerging practice within the "average company" operating in the suggested industry, it is likely that the practice will provide the suggested positive impact on business performance. However, the real outcome will depend on many business, organizational, and market issues that are not considered within the methodology. Therefore, the repository only aims at signaling an opportunity on the basis of a case study found in literature, but the real implementation depends on the company's ability of correctly exploiting the suggested business opportunity. Specifically, the company should understand and deepen the technology by evaluating its risks and disadvantages before considering its implementation useful. The repository aims to signal the advantage of these technologies; however, it is advisable to check the risk of their implementation.

5.3. Practical and Managerial Implications

This framework is a practical tool that companies could use to search, find, and select emerging practices from OCBP to implement market and organizational strategies useful for companies wishing to employ new technologies. By formally defining industry, business function, business process, and impact on business performance, it is possible to contribute to advancements in the understanding of the growing and emerging opportunities of implementation of OCBP. This will limit the risk of implementation of practices employing OCBP since companies can understand the usefulness of the specific practice and the expected results ex ante, also selecting the tools that better fit with their industry and with business functions and processes where they intend to improve performance. For example, a company in the biomedical sector could access the repository, select the industry, and identify which OCBP could be used to improve certain organizational impacts, such as information management, efficiency, and productivity for specific business processes, such as prototyping, product design and development, operations planning, or quality management. Another way to query the repository is to select an additional filter indicating the business processes and business functions of interest and to evaluate which technology is most suitable. For example, a company in the financial sector could select the industry and be mainly interested in the accounting and finance function and in particular the

business processes, such as credit risk and financial monitoring or financial transactions. From this selection, the company could identify which technologies could potentially improve these business processes. From the variables selection, the desired final impact can be assessed. Furthermore, the repository can be considered as a source for investigating emerging industries or technologies, so that it can be used as a technology roadmap or tool for technology forecasting. For research purposes, the research group intends to analyze all the technologies present in the repository and their potential combinations. In addition, the research group aims at publishing the repository in order to allow companies to access it and find emerging practices using OCBP. In particular, a web application will enable companies to search for emerging practices employing OCBP and other emerging technologies. The repository reports technology, industry, function, practice, and impact and also records a brief description of the emerging practice that summarizes its peculiarities, allowing firms to understand how it works. Moreover, references to the scientific papers are available, so that firms could study in depth the manuscript by accessing it from a journal's website. Companies can further investigate and consult the paper to understand how to implement the emerging practice. The repository will be available by the end of the year 2022. At first, access to the repository will be allowed to a limited number of companies requesting the service. The collection of feedback from these companies is foreseen as a way to evaluate the framework as a tool for consultation. In addition, a user manual for companies will be available to facilitate explorations within the repository.

5.4. Sustainability Implications for Companies

Collaborative, open, and crowd-based technologies improve several aspects of environmental, social, and economic sustainability [81,121,122]. Starting from the collection of practices, interesting reflections emerged.

Open innovation platforms facilitate knowledge exchange among the actors, which speeds up the process of generating ideas and increases the R&D companies' performance and subsequent growth in sales [15,123,124]. Therefore, the time and cost reduction on the processes of identifying and designing ideas could have an impact on economic sustainability [19,125].

Recently, crowdsourcing platforms that contribute to global environmental, economic, and social sustainability have been growing. Through these platforms, society contributes to innovation, and companies can take advantage by exploiting these innovations to satisfy those who have generated these innovative ideas [8]. Specifically, companies are pushed to innovate on aspects that society pays more attention to. These user-driven innovations could have an impact on social and economic aspects [3]. In addition, several last-mile delivery solutions are spreading across society that increase flexibility and reduce traffic with the use of social networking [97]. Crowdsourcing delivery is an emerging "shared economy" initiative that reduces the problems related to urban logistics. Logistic crowdsourcing allows communication among all those who need to deliver a package with people who are already driving and who can immediately store and deliver [68]. Therefore, these platforms allow a fleet of dedicated vehicles to be managed to carry out activities that cannot be performed by professional drivers at that specific moment. Crowdsourcing platforms enable people to better manage resources by sharing and reusing excess capacity in goods and services. The technology can reduce the negative environmental impact of using dedicated delivery vehicles, such as emissions, and to make the last-mile delivery less expensive [126].

Open and crowd science and open access platforms have a decisive impact on social sustainability aspects for the dissemination of knowledge on a large scale [37]. These platforms involve citizens who take part in science projects and who feel part of the community [127]. Moreover, open access platforms remove knowledge barriers and support education and social well-being [42]. Therefore, these technologies strengthen the relationship between the scientific community and society [44].

Environment- and society-oriented crowdfunding initiatives have great potential to contribute to sustainable development [128,129]. Several studies highlighted how environmentally oriented projects appear to be potentially attractive for many money lenders [81]. For example, in the agricultural sector, crowdfunding campaigns could fund climate change mitigation practices [102]. In recent years, environmental sustainability has become a very important issue in society and business [130]. Business awareness of "green" innovations has increased significantly, with several companies playing a proactive role through greater investments in energy efficiency on waste reduction and using materials or processes with a lower polluting impact [131,132].

Open data platforms have a highly innovative impact, allowing the re-processing of information and the creation of innovative services. The presence of open data platforms allows mapping, evaluations, and modeling to measure the theoretical waste heat in sewage systems, which could reduce environmental impact [54]. Additionally, the water industry uses open data platforms accessing altimetry databases around the world [133]. Professionals and scientists can foresee global water level trends by accessing such data [134]. This technology is critical for supporting sustainable development policies and activities that address water security [133]. Finally, open data applied to rail transport allows experts to explore how environmental factors affect metropolitan traffic. In this way the railway companies can guarantee a more efficient service [135].

Thanks to their features of being flexible and free of charge, open-source technologies are applicable in several contexts, producing different sustainable social, environmental, and economic impact. For example, there are open-source software that improve the efficiency of air transport by analyzing the frequency of travel and travel times of passengers. By defining specific parameters such as aircraft movements and delays, it is possible to determine emissions and effects on the global climate [136]. In the construction sector, through open-source technology it is possible to control energy consumption by reducing the risks of invisible events for monitoring building operations [137]. Open-source software allows chemical industries to monitor plastic pollution in order to offer increasingly environmentally products to the market, identifying in real time the location of accumulation areas of plastic pollution in the water system [138]. In addition, open-source technology can help farmers manage water resources in a sustainable way, reducing water consumption at the farm and regional level. Finally, farmers could simulate grain and herbaceous crop yields with suitable water levels [134].

6. Conclusions

The aim of the research was to present the state of the art of OCBP and their impact on companies' business performance. To perform the analysis, a repository of emerging practices provided by the Department of Industrial Engineering of the University of Salerno (Italy) was used. Each practice is associated with an industry, business function, business process, and impact on performance, so that it is possible to perform a study of the benefits that OCBP provide to companies. From the analysis of results, it emerged that many opportunities for implementation are available in different industries to support activities of various business functions and improve the performance of different processes. Peculiarities of each typology of OCBP in terms of impact on organizational and market performance emerged from the findings. Various implications after the theoretical, methodological, practical, and business perspective were reported, with a particular focus on the relationship with sustainability, considering all three dimensions, i.e., environmental, social, and economic.

Future research will be addressed to the enlargement of the repository, by extending the analysis to other scientific documents and ensuring continuous update. Moreover, a more formal focus will be made on the relationship between emerging practices and sustainability, adding a new variable to the repository to also report the dimension of sustainability associated with the emerging practice. Finally, the research group aims at finding the relationship between OCBP and other emerging technologies—such as big data,

artificial intelligence, blockchain, and cloud technologies—to study the conjunct impact on business performance derived from the combination of multiple emerging technologies.

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