

Big Data Analytics to Open Innovation Strategies

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Dynamic business environment has pushed service-oriented firms such as banks to collaborate with external partners through open innovation (OI) to address issues of service differentiation, optimize customer experience, and create effective open innovation strategies (OIS).

Keywords: open innovation ; big data analytics ; strategic resources

1. Introduction

Innovation is a key to organizational success, growth, and the acquisition of strategic resources ([Allassaf et al. 2020](#)). Particularly, open innovation (OI) is essential to resolve complex organizational issues by suggesting the most relevant ideas, solutions, and people entirely from outside the organization ([Chesbrough 2004](#)). Through OI, organizations successfully acquire breakthrough ideas by connecting with a global pool of talented people, which allows them to develop innovative products and services, respond to dynamic workforce requirements, and find a solution to unresolved issues ([Bigliardi et al. 2021](#)). Progressive organizations have started to transcend their boundaries to improve their innovative activities through the conscious inflow and outflow of knowledge, which is helping them to embrace OI and optimize innovation performance ([Chesbrough 2003](#); [Naseer et al. 2021](#)). Alternatively, acquiring revolutionary ideas and knowledge through external sources help organizations in reducing costs and investment in R&D as well as sharing risk with external partners ([Elia et al. 2020](#); [Leckel et al. 2020](#)).

The concept of OI has received considerable attention from scholars and practitioners over the past two decades; however, a large cluster of studies have focused on investigating OI from a firm-level perspective ([Antons et al. 2016](#); [Bertello et al. 2022](#); [Greco et al. 2021](#); [Nestle et al. 2019](#); [Radziwon and Bogers 2019](#); [Sengupta and Sena 2020](#); [Shaikh and Randhawa 2022](#); [Teplov et al. 2018](#); [West and Bogers 2017](#)). The findings of these studies have established that the management of OI hinges on firms' openness ([Bogers et al. 2018a](#); [Laursen and Salter 2006](#)), the selection of external partners ([Sofka and Grimpe 2010](#)), OI methods ([Veugelers and Cassiman 1999](#)), formalizing collaboration processes ([Vlaar et al. 2007](#)), and internal practices ([Lakemond et al. 2016](#)). A few studies have also highlighted that firms in the past have used multiple OI models to successfully develop innovation strategies and accelerate innovation-based business activities which require external support, critical knowledge, and identifying innovative methods for acquiring and creating knowledge ([Bogers et al. 2017](#); [Gatzweiler et al. 2017](#); [West and Bogers 2017](#); [Zhu et al. 2019](#)). This represents a disagreement in the literature about the barriers and drivers of OI which can be classified into cultural, legal, financial, and economic ([Greco et al. 2019](#); [Vanhaverbeke et al. 2017](#)). The admitted complexities of the OI process and organizations' surge for innovative strategies demand logical, analytical, and technology-based solutions for the management of the OI process.

2. Background of OI

The invention of OI can be linked to the unconventional practices of large innovative firms deviating from traditional innovation methods ([Chesbrough 2003, 2006](#)). The pioneering study on OI defined it as "the flow of inbound or outbound ideas towards the organization and transferred to the market from inside or outside the organization" ([Chesbrough 2003](#)). The current definition of OI has been significantly modified by innovation scholars and Chesbrough to emphasize entities' surge for inflow and outflow of knowledge. [Chesbrough \(2006\)](#) re coined OI and asserted that organizations purposely use knowledge inflows and outflows for accelerating their internal innovation process and market expansion. Recent modifications in OI are associated with different business models practiced by progressive organizations and it can be defined as "purposive management of the inflows and outflows of knowledge across organizational boundaries to create a distributive innovation process using financial and non-financial methods in a way that it diverges with organizations existing business models" ([Chesbrough and Bogers 2014](#)). Precisely, OI can be described as a distributed innovation process resulting due to the deliberate flow of information across entire organizational hierarchies ([Naseer et al. 2021](#)).

A number of studies have explored multiple aspects of OI ranging from underlying issues to the requirement of experts and the nature of the project ([Ahn et al. 2017](#); [Du et al. 2014](#); [Kim et al. 2015](#)). A few studies have also focused on investigating the significance of organizational platforms, business ecosystems, and social issues in publicly administrated organizations ([Ahn et al. 2019](#); [Schmidhuber et al. 2019](#)). Scholars argued that the successful capitalization of OI relies on establishing a flexible culture essential to restructuring current business models in a way that fosters OIS ([Bogers et al. 2019](#)). This highlights entities' need to integrate strategic and smart assets coupled with technologically driven internal and external sources aligning with their business models to power OI. The current era characterized by unprecedented changes demands organizations to resolve issues by extracting value from existing knowledge through modern architectures and systems instead of developing an entirely new piece of knowledge ([Naqshbandi and Jasimuddin 2022](#)). Despite the significance of integrating systems and architectures to gain real value from knowledge ([Chesbrough 2006](#)), there is no evidence in the extant literature about the strategic assets required to manage OI in organizations.

3. Operationalizing BDA in Banks

Data scientists defined BDA as “a unified approach rendered for the management, processing, and analysis of unstructured data to extract a meaningful insight for creating sustained value, optimizing performance, and achieving competitive advantage” ([Wamba et al. 2017](#)). Earlier studies on BDA described it as a 3Vs (volume, velocity, and variety) concept ([Duan and Xiong 2015](#)); later on, [Wamba et al. \(2015\)](#) re coined the term and characterized it as a 5Vs (volume, velocity, verity, veracity, and value) phenomenon. A categorical interpretation of the 5Vs highlighted that volume represents the daily creation of voluminous data from multiple sources at an exponential rate, velocity determines the prompt response to capture BD, variety represents multiple data sources (including new ones), veracity determines the reliability of data, and value means the extraction of economic benefits from available BD. Recently, a few studies ([Mishra et al. 2017](#); [Seddon and Currie 2017](#); [Wamba and Mishra 2017](#)) extended BD's dimensions and established that it should be described as a 7Vs (volume, velocity, verity, veracity, value, variability, and visualization) concept due to variations in the flow and sources of data (variability) and the importance of visualizing data by experts to prepare it for analysis (visualization).

BDA has become a top trend in academia and research in recent years and its analytical capabilities have convinced academicians and practitioners to position it at the forefront of future research agendas in the fields of business management and information systems ([De Mauro et al. 2016](#); [Gandomi and Haider 2015](#); [Del Vecchio et al. 2018](#)). The research in academia on BDA gained significant momentum after the hallmark study of [McAfee et al. \(2012\)](#), who regarded it as a major frontier of science, innovation, and the industrial revolution of the new millennium. BDA is categorized as large datasets originating from multiple sources at a high speed. BDA trends, applications, and growth started to take off in 2015, and a number of studies were conducted to analyze its impact on business, organizations, and many other domains of life ([Del Vecchio et al. 2018](#)).

A few recent studies have described BDA as a strategic component used for managing customer relations, operational risks, and overall operations of firms to maximize their financial performance ([Bresciani et al. 2018](#); [Germann et al. 2014](#); [Kiron et al. 2013](#); [Mikalef et al. 2019](#); [Wamba et al. 2017](#)). From a managerial perspective, BDA offers infinite data to streamline business processes, supply chains, and workforce performance, as well as to improve organizations' internal collaboration and analyze consumers' behavioral patterns ([Bresciani et al. 2018](#); [Dubey et al. 2019](#)). Additionally, reports have argued that BDA helps in gaining a deeper insight into customers' preferences extending beyond the traditional methods of information collection, especially related to the latent needs of customers ([Mora Cortez and Johnston 2017](#); [Watson et al. 2018](#)). Furthermore, organizations in the past have successfully implemented complex and voluminous data for strategic decision making, as well as scientifically supported and logically explained actions ([Bertello et al. 2021](#); [George et al. 2016](#); [Mazzei and Noble 2017](#)). Nonetheless, organizations concerned with developing new customer management strategies; creating innovative products, services, and business models; and enhancing customer experience, satisfaction, and loyalty are required to carefully manage millions of data sources ([Levine et al. 2017](#); [Mahmoud et al. 2018](#); [Shipilov et al. 2017](#)).

BDA and its significance in the financial industry are also widely debated in the literature as it is a frontier of future innovations ([Hasan et al. 2020](#)). Innovative financial services create large datasets daily through online peer-to-peer lending, crowdfunding, SME financing, assets, wealth, and trading, as well as mobile-payment-managing platforms, cryptocurrencies, and remittance administration channels. These datasets are used by financial analysts for strategic investment decisions to investigate consumers' spending behaviors for products and service customization ([Hale and Lopez 2019](#)). BDA has also contributed to improving different stakeholders' understanding of financial market trends, strategic decision making to enhance the quality and security of services, transparency, risk analysis, algorithm trading, and transformational culture ([Ali et al. 2021](#); [Diebold et al. 2019](#); [Shen and Chen 2018](#)).

4. Operationalizing BDA in Banks

Almost all the features of BDA (7Vs) exceptionally fit into the fundamental requirements of OI outlined by [Chesbrough \(2003\)](#). Particularly, OI assumptions such as the wide distribution of innovative ideas, the lack of monopolistic ideas, the lack of timely discovery of innovative ideas to gain a competitive advantage, the selection of relevant business models based on their technological performance, and the perishability of intellectual property and services in the context of banks can be supported and discussed through the lens of BDA. The multi-dimensional context of BDA, with its ability to integrate into various organizational perspectives (external R&D, range of methods to create and advance intellectual properties, etc.), can explain diverging forms of OI ([Barlatier et al. 2020](#)).

Past research on firms practicing OI using BDA has highlighted that proactive participation in OI powered by BDA allows firms to interact with various organizations and professionals ([Sun et al. 2020](#)). From a banking perspective, this will help banks to create and monetize digital services, reduce costs, improve user experience, enhance business value, accelerate digital transformation, and place banks in an innovation position ([Bogers et al. 2018b](#)). Particularly, banks may follow the mechanisms of large firms to use BDA as an innovation fuel for strategic decision making for creating Fintech(ization), establishing state-of-the-art technology, and strengthening their mutual networks ([Barlatier et al. 2020](#)). There are several data-driven organizations such as Tesla, AT&T, Cisco, and Linux that have benefited in the past from BDA to foster OI for building new products and services and offering a unique customer experience ([Bogers et al. 2019](#)). Contextualizing this to the banks (primarily described as data-driven entities) should consider leveraging BDA to accelerate OI for forecasting sales, planning and designing data-driven operations, creating new and innovative business models, and rectifying governance issues.

The integration of BDA into the OI process renders several benefits and challenges to organizations as well as banks. Generally, banks are criticized for their lack of transparency, which can be resolved by their participation in the OI process through BDA, ensuring that information is available across multiple platforms accessible to different stakeholders ([Manyika et al. 2011](#)). During the preliminary stages of OI, banks may benefit from BDA to pretest products' efficiency, which will help in overcoming performance issues ([Yang et al. 2017](#)). Moreover, market segmentation is a complex issue as it is directly related to customer satisfaction and profitability ([Eriksson and Mattsson 1996](#)), which can be addressed by implementing automated algorithms while banks embark on the OI process for customizing their products to fulfill the varying needs of different segments ([Barlatier et al. 2020](#)).

5. Theoretical Background and Hypotheses Development

This employed a dynamic capability view (DCV) to empirically investigate the influence of BDA on creating and managing OIS in banks. DCV is an extension of [Barney's \(1991\)](#) resource-based view (RBV) theory, which is operationalized to explain the strategic progress of banks while contemplating a competitive advantage in a dynamic environment ([Hitt et al. 2016](#); [Teece et al. 1997](#)). Based on the underpinning of DCV, the acquisition of strategic resources and the management of these resources are critical for the banks concerned to gain a competitive advantage while operating in a frequently changing environment. Past studies have used the fundamentals of DCV to outline BDA as a source of competitive advantage for organizations operating in a dynamic environment and requiring transparency ([Akter et al. 2016](#); [Dubey et al. 2019](#)).

Subsequently, DCV logic is used to conceptualize BDA as a reflective construct and establish that the acquisition of strategic resources is essential in developing strategies pertaining to OI in banks ([Barney 1991](#)). Earlier studies have confirmed that firms concerned with designing OIS are required to manage their dynamic resources such as openness ([Bogers et al. 2018a](#); [Laursen and Salter 2006](#)), selection of external partners ([Sofka and Grimpe 2010](#)), OI methods ([Veugelers and Cassiman 1999](#)), formalizing collaboration processes ([Vlaar et al. 2007](#)), and internal practices ([Lakemond et al. 2016](#)). Following this argument, BDA is used as a higher-order construct for linking the creation of OIS in the banks by managing these underlying factors and investigating their role in supporting the OI process.

Despite an established fact about the opportunities created by BDA in managing OI firms ([Del Vecchio et al. 2018](#)), the extant literature lacks empirical evidence about the potential and methods of harnessing BDA to promote OIS in the banks ([Barlatier et al. 2020](#); [Fasnacht 2018](#)). A few recent studies in the banking sector have focused on highlighting the management of information and digital technologies at the organizational level to manage OI in banks and improve financial performance ([Gianiodis et al. 2014](#); [Martovoy et al. 2015](#); [Naseer et al. 2021](#)). Factors such as banks' openness (BOP), selection of external partners (SEP), open innovation methods (OIM), formalizing collaboration processes (FCP), and banks' internal practices (BIP) need to be investigated prior to discussing the actual impact of information and digital technologies acquired by the banks as a source of competitive advantage to support OIS.

The studies on banks' openness (BOP) have linked it with the stability of the banking sector, financial development, reduction in bank risk, and stimulation of domestic competition allowing banks to produce a range of products and services ([Bayraktar and Wang 2006](#); [Bekaert et al. 2011](#); [Luo et al. 2016](#); [Ma and Yao 2022](#)). Following the argument of banks' surge for the creation of openness, banks may strategically enhance their openness through OIS, as suggested by [Bogers et al. \(2018a\)](#) and [Laursen and Salter \(2006\)](#). However, enhancing BOP through OI requires information sharing among collaborating partners of banks' internal data, such as financial portfolios, products and services, and customers. Simultaneously, BDA, through its dynamic capabilities, may allow banks to enhance BOP, resulting in better banking stability, deep financial development, lower risk, and better domestic competition ([Ali et al. 2021](#); [Diebold et al. 2019](#); [Shen and Chen 2018](#)).

While creating OIS, 21st-century organizations actively collaborate with numerous partners to build cooperative relationships with research and development (R&D) and their potential stakeholders, including customers, suppliers, competitors, and public institutions ([Enkel et al. 2009](#)). The selection of external partners (SEP) has been recognized as the most crucial aspect of creating OIS due to the complexities of knowledge required by the organizations and the fact that SEP significantly influences OIS capabilities and overall innovation ([Lassen and Laugen 2017](#); [Marina and Gulbrandsen 2013](#)). Banks are known as multidisciplinary technology-implementing service entities producing a range of products and services having a short life cycle to fulfill dynamic market needs. Currently, banks do not possess the required capabilities to produce sophisticated products and services, which forces them to collaborate with external partners by creating effective OIS. However, the underlying complexities in the process of SEP based on the existing capabilities require leveraging smart and strategic resources enabled by BDA, as it allows the pretesting of products and overcoming performance issues, which may positively influence the creation of OIS ([Yoon and Song 2014](#); [Yang et al. 2017](#)). Past studies have rendered different methods and approaches to SEP, such as morphology analysis (MA), generative topology maps (GTMs), effectuation, and causation, for creating effective OIS ([Marina and Gulbrandsen 2013](#); [Yoon and Song 2014](#)).

Open innovation methods (OIMs) are considered another key area to creating effective OIS and rely on organizations' internal capabilities and access to external sources and knowledge ([Yildirim et al. 2022](#)). Generally, organizations use three widely practiced OIMs (inbound, outbound, and a combination of both) to create OIS, and selecting an accurate OIM is critical due to the benefits associated with the identification of required capabilities, time, and overall innovation performance ([Chesbrough and Bogers 2014](#); [West and Bogers 2017](#)). Past studies are yet to fully categorize the essential factors of an accurate OIM relevant to creating OIS. A few studies have attempted to highlight the issue by proposing organizational awareness and the nature of the project as the main criteria to consider during the selection of an OIM ([Oztaysi et al. 2017](#); [Yildirim et al. 2022](#)). Practically, it is difficult to generalize and export these criteria to banks due to the differences in access and availability of the resources essential to select relevant OIM for authenticating OIS ([León et al. 2020](#)). Following the dynamic capabilities of BDA and banks' broad access to voluminous data from multiple platforms, it is predicted that BDA may act as a substantial tool to identify, select, test, evaluate, and correct relevant OIMs for creating effective OIS.

Formalizing the collaboration process (FCP) is central to OIS as it ensures the success of OI processes and facilitates organizations in designing the right innovation structure ([Bagherzadeh et al. 2021](#); [Obradović et al. 2021](#)). Recent studies have associated the identification of collaborating partners, shortage of experts, ambiguity of goals, organizational decision making, and governance structure with FCP ([Brown et al. 2021](#)). Alternatively, these factors can be described as organizational, legal, and regulatory barriers to FCP and can be managed by organizations' strategic resources such as information and knowledge. Banks are the most regulated entities as they follow various stringent internal and external formal regulations. Therefore, FCP in banks for creating effective OIS demand extra attention to overcome the heterogeneity issues, ensure effective portfolio and innovation management, and resolve governance issues. BDA offers a strategic solution to the organizations in the form of the availability of information and knowledge to be used as a tool for formalizing FCP for the identification of collaborating partners, people, goals, decision-making process, and governance structure, which will contribute to creating effective OIS.

The permeability of organizational boundaries has pushed organizations to consider multiple operational approaches to achieve a competitive advantage ([Lu and Chesbrough 2022](#)). This has resulted in a variety of business practices and models to manage the multidimensional operations of organizations. Particularly, service-oriented organizations (banks) operating in a dynamic business environment often face the critical issue of customer satisfaction, which drives them to design various OIS ([Bogers et al. 2018b](#)). In this regard, banks' internal practices (BIP) such as strategic resources, internal knowledge and skill, internal processes related to operations and governance, and manpower development to enhance skill may positively contribute to creating effective OIS ([Barlatier et al. 2020](#)). Additionally, banks operating in saturated markets are expected to park support for Fintech by integrating resources in a way that conforms to the

emerging requirements of global competitive markets (Barlatier et al. 2020). Banks may achieve these goals by integrating the strategic resources available in the form of BDA to streamline BIP for creating effective OIS, which will help them to fulfill customers and market needs (Ali et al. 2021).

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