An integrated understanding of open data entrepreneurship for start-ups in the digital economy

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Abstract

Purpose – This paper aims to develop an integrated understanding of open data as a source of digital entrepreneurship for start-up entrepreneurs in Malaysia.

Design/methodology/approach – The study adopted qualitative case study research design within the interpretivist research worldview. The author conducted 24 online semi-structured interviews with start-up Chief Executive Officers, founders and co-founders in Malaysia. Interview transcripts were coded inductively through thematic analysis by using NVivo 12 software. Then, the author developed a theoretical model based on research findings.

Findings – Three essential components of the proposed model include the dynamic relationship between data owners and start-up entrepreneurs, the critical importance of open data enablers for greater entrepreneurial effects and the roles of broader contexts such as policies and infrastructure readiness. Surprisingly, the research found two emerging open data enablers from the interviews: a sandbox program and a quadruple helix partnership. Joining a sandbox program allowed a HealthTech start-up to collaborate with regulatory partners. A quadruple helix partnership enabled this start-up to collaborate with industry, academia, government and civil society. Also, the study came across a local open data movement initiated by a start-up association. One of the agendas of this movement was to urge the government to prioritize the disclosure of open data API in the public sector.

Practical implications – Open data scholars can explore the proposed model further for future studies. Policymakers can integrate a sandbox program and quadruple helix collaboration to nurture open data innovation. Also, there is a need to strengthen laws and regulations to inspire confidence in the ethical use of open data for innovation and entrepreneurship.

Originality/value – Previous research has considered open data for entrepreneurial benefits. However, there is a lack of an integrated model on this subject. Hence, this study offers a novel integrated model to understand open data entrepreneurship for start-ups in the data economy.

Keywords Open data, Open government data, Digital entrepreneurship

Paper type Research paper

Introduction

In discovering the future of open data, Verhulst *et al.* (2021) published a report entitled *The emergence of a third wave of open data* based on the conversations of global open data institutions, leaders and experts. An integral part of that report is the historical evolution of

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open data, named "the three waves of open data". The first wave of open data is built on the premise of freedom of information. The value proposition in the first wave is to enhance government transparency. The second wave of open data revolves around the emerging interest in open government data worldwide. This is where governments share their data for transparency and value-creation purposes. On the contrary, the third wave emphasizes open data for innovation and entrepreneurship. The third wave focuses on impactful user-driven open data projects through strategic collaborations and partnerships. The approach of the third wave is *publish with purpose* to encourage open data innovation in both the public and private sectors (Verhulst *et al.*, 2021). The research sits on the emerging third wave of open data due to its prospects for start-up innovation and entrepreneurship. The study defines open data as nonproprietary and freely available data for its usage and distribution in the public and private sectors (Open Data Charter, 2015). Hence, "open data entrepreneurship" is a term coined to explain the use of open data as a strategic resource for innovation and entrepreneurial projects (Mohamad, 2024).

Malaysia aspires to generate economic and social benefits from open data implementations. The Minister of Communications and Multimedia identified open data as a significant area for development in 2014. The proposal for a national open data initiative was then tabled and agreed upon by the cabinet meeting in the same year. After that, the government initiated a centralized open data platform to enhance data-sharing services, innovation and participation in the digital economy (Prime Minister's Department, 2015; The World Bank, 2018). Since then, the government has included open data aspirations into national strategic plans for sustainable open data implementations. Three national plans that can be associated with open data are the Eleventh Malaysia Plan (2016–2020), the Twelfth Malaysia Plan (2021–2025) and the Malaysia Digital Economy Blueprint (MyDIGITAL). In brief, the Eleventh and Twelfth Malaysia Plans are medium-term plans to enhance open data infrastructure, governance and data-sharing culture in the public sector. MyDIGITAL serves as a long-term national plan to accelerate the digital economy in Malaysia. One of the visions of MyDIGITAL is to nurture open data as a catalyst for start-ups' innovation and entrepreneurship (Prime Minister's Department, 2021). Relatedly, the National Data Sharing Policy was developed at a later stage to encourage the use of open data for the digital economy (Ministry of Communications and Digital, 2022).

Past studies indicate the importance of open data as a source for innovation and entrepreneurship (Kassen, 2020). Open data initiatives could lead to the emergence of creative products and services by start-up entrepreneurs (Mohamad, 2025). Nonetheless, there is scarce empirical evidence to demonstrate the success of open data as a source for digital entrepreneurship (Huber *et al.*, 2022; Kraus *et al.*, 2023). Specific to Malaysia, there is a discrepancy between the government's aspirations and actual innovative outcomes from open data usage in the country (World Bank Group, 2017). Hence, an integrated comprehension of this area is vital because the government invests enormous funds and effort in open data infrastructure. By identifying the relevant stakeholders, policymakers may design specific programs to encourage open data usage for entrepreneurial benefits. Against this background, the study aims to answer the following research question:

RQ1. What are the key components of an ecosystem for open data entrepreneurship to emerge in the context of a developing economy?

This research is essential for Malaysia to recognize an ideal ecosystem to nurture open data innovation. To a greater audience, the research serves as a referential case on inculcating an ecosystem to nurture open data entrepreneurship.

Related literature

There is ongoing interest in open data for start-up entrepreneurs. Magalhaes and Roseira (2020) examined the commercial values of open data by 178 business firms in the USA. They introduced 12 "atomic models" to demonstrate how business firms exploit open data. These include using open data as a strategic source for advocacy, consultancy, process optimization and business intelligence. Comparatively, Mohamad (2024) investigated the actualization of open data affordances for Malaysian start-up entrepreneurs through a qualitative approach. He found that start-up entrepreneurs actualized open data for product building, optimizing products and services and developing business research and strategies. More interestingly, he discovered that start-up entrepreneurs might have a misconception that open data must be "opened" or "shared" when requested from open data providers. The abovementioned studies are some of the very few research that shed some light on the commercialization prospect of open data for businesses. It is also important to note that open data for entrepreneurial usage is not a straightforward process. The success of open data innovation for start-up entrepreneurs depends on numerous factors, such as business model suitability (Kazantsev *et al.*, 2023), collaboration and networking for business opportunity (Kitsios and Kamariotou, 2023), as well as institutional and technological readiness for open data utilization (Kraus *et al.*, 2023; Rodriguez, 2019).

Countries with open data initiatives have diverse levels of progress in harnessing entrepreneurship from open data. For instance, Huber *et al.* (2022) explored the effects of open data on digital entrepreneurship across nations and regions. They obtained longitudinal data sets from six global reports representing 90 countries. They asserted a positive connection between open data disclosure and digital entrepreneurship. The researchers found that developed countries such as the USA, the UK, Australia and Canada are associated with higher open data disclosure and greater entrepreneurial activities. Developing countries such as Brazil, China, Saudi Arabia and Turkey have moderate entrepreneurial outcomes associated with open data. Nations such as Nigeria, Myanmar and Botswana have less entrepreneurial impact generated from open data. Ekundayo *et al.* (2023) posited that the lack of entrepreneurial impacts of open data can be linked with inadequate open data implementations at a national level. In other studies, scholars reported that Gulf countries such as Bahrain, Kuwait and Oman could exploit open data for innovation and economic diversification (Saxena, 2017). Disclosing open data alone does not warrant greater innovation and entrepreneurial effects in a particular country. In this sense, Huber *et al.* (2022) argued that a supportive ecosystem, institutional readiness and governance enable greater economic outcomes from open data utilization. In some regions, such as South East Asia, there have been calls for a regional collaboration to develop greater digital infrastructure through the ASEAN Digital Economy Framework Agreement (DEFA) (Mahusin and Prilliadi, 2025). This will allow greater, safer data-sharing opportunities to accommodate regional open data developments.

Ecosystem design has become an integral part of open data literature. An ecosystem is a science that studies the processes, patterns and dynamic interactions between actors in achieving a common goal within a given environment (Fang *et al.*, 2024). Ecosystem-focused research in open data literature involves studies that compare ecosystems across cities and countries (Bonina and Eaton, 2020; Lnenicka *et al.*, 2024), the relationship of actors (Mo *et al.*, 2024; Reggi and Dawes, 2022; Runeson *et al.*, 2021) and mechanisms to nurture an ideal ecosystem (Kraus *et al.*, 2023). It is apparent from these studies that open data ecosystems and infrastructure are unique between nations. Also, ecosystem research in open data focuses on how best to provide a conducive environment for open data

implementations. This is when these studies identified the interrelationship between stakeholders with certain mechanisms to stimulate success in open data innovation.

Two essential actors in an open data ecosystem are providers and users who cultivate open data values. Open data actors are public personnel across government agencies that supply data from their respective institutions. In this respect, the disclosure of open data from the public sector is guided by certain open data policies and guidelines to reduce data-sharing risks. On the contrary, heterogeneous users utilize open data to build data-driven apps and websites. Collaboration and interaction between data providers and users are required to generate open data values (Ruijer and Meijer, 2020). Equally important are open data enablers such as hackathons (Kitsios and Kamariotou, 2023) and open data movements (Kassen, 2020). Also, scholars suggest the importance of national vision (Altayar, 2018), open data policy (Zhou *et al.*, 2023), institutional readiness (Cho and Lee, 2022), data demands and interest (Fang *et al.*, 2024) within an open data ecosystem.

The extant literature suggests that creating open data values can be challenging. One of the challenges is the commitment of public personnel to supply high-quality data for sustainable open data implementations (Wang *et al.*, 2022). Another challenge is to fulfill the needs of heterogeneous open data users such as entrepreneurs, citizens and researchers. Other challenges are data quality and low open data usage (Quarati, 2021). In response, scholars propose certain strategies to address these challenges, such as having clear guidelines and policies (Zhou *et al.*, 2023), engaging open data users (Susha *et al.*, 2015b), strengthening governance (Bonina and Eaton, 2020) and incentives to nurture data sharing culture in public and private sectors (Wang *et al.*, 2022).

The literature reviewed in this study draws upon a range of theoretical frameworks as a basis of understanding. Several notable theories include the Technology Acceptance Model, the Unified Theory of Acceptance and Use of Technology and the Theory of Planned Behavior. Studies employing these theories focus on explaining and predicting user behaviors when it comes to using open data systems (Lněnička *et al.*, 2022; Rizun *et al.*, 2024). Other popular theories include Institutional Theory (Altayar, 2018), Social Cognitive Theory (Chen *et al.*, 2023), Affordance Theory (Mohamad, 2025) and Resource-based Theory (Zhao and Fan, 2021). It is also important to note that some studies integrated various concepts and theories as a lens of understanding (Kazantsev *et al.*, 2023; Kitsios and Kamariotou, 2023; Kraus *et al.*, 2023). Scholars may adopt such a strategy to enrich the main theory used in their research. In doing so, scholars may be able to explore an open data phenomenon from new perspectives.

To summarize, this section covered the innovative potential of open data for start-up entrepreneurs across countries and regions. Also, the section explored ecosystem-focused research in open data literature. The study observed a lack of focus on comprehending an open data ecosystem specific to start-ups and entrepreneurship. Hence, the research is crucial for a collective understanding of this topic. This study might help Malaysia achieve its national aspirations through the commercial use of open data, as stated in some of its strategic plans. The study might help policymakers in other countries to optimize their ecosystems for greater entrepreneurial outcomes. Table 1 shows related literature regarding the research topic. The relevance of these scholarly articles is based on the experimentation of keywords searched through Scopus, such as “open data entrepreneurship”, “open data innovation” and “open data and start-up entrepreneurs”. No range of years was predetermined to discover more literature surrounding the research topic. The author selected “journal article” as the type of source for literature searching through Scopus.

Table 1. Related literature surrounding the research topic

Topics	Ecosystem comparisons	Relationship of actors	Enabling mechanisms	Open data providers	Open data users	Governments	Usage and impacts
Bonina and Eaton (2020)	/	/	/	/	/	/	
Lnenicka *et al.* (2024)	/	/		/	/	/	
Magalhaes and Roseira (2020)							/
Mohamad (2024)							/
Kazantsev *et al.* (2023)		/	/				
Reggi and Dawes (2022)		/					
Runeson *et al.* (2021)		/					
Kraus *et al.* (2023)			/				
Fang *et al.* (2024)	/		/	/	/		
Huber *et al.* (2022)							/
Kitsios and Kamariotou (2023)		/	/				
Ruijer and Meijer (2020)		/	/				
Corrales-Garay *et al.*, (2022)							/
Ruijer and Meijer (2020)		/	/	/	/		
Altayar (2018)			/				
Zhou *et al.* (2023)							
Yoon and Copeland (2020)		/	/	/	/		/

Note(s): The topics are based on the author's own interpretation. These references are a sample of articles retrieved from Scopus database as of October 4th, 2024

(*continued*)

Table 1. Continued

Topics	Hackathons	Policy and laws	Culture	National visions	Governance	Business models	Issues
Bonina and Eaton (2020)		/			/		/
Lnenicka *et al.* (2024)		/					/
Magalhaes and Roseira (2020)						/	
Mohamad (2024)							
Kazantsev *et al.* (2023)						/	
Reggi and Dawes (2022)							/
Runeson *et al.* (2021)			/				/
Kraus *et al.* (2023)							
Fang *et al.* (2024)							
Huber *et al.* (2022)		/					
Kitsios and Kamariotou (2023)	/		/			/	
Ruijer and Meijer (2020)							
Corrales-Garay *et al.*, (2022)						/	
Ruijer and Meijer (2020)			/				
Altayar (2018)		/		/	/		/
Zhou *et al.* (2023)		/					
Yoon and Copeland (2020)							/

Method

This section explains the research method, data collection and analysis used in the study. In general, the Malaysian Administrative Modernization and Management Planning Unit (MAMPU) is a public agency that leads open data implementations in Malaysia. Hence, the author consulted MAMPU to recognize start-up entrepreneurs who might be relevant to the study. Four well-known start-up accelerators were also consulted to recruit informants. MAMPU and these accelerator programs provide access toward the recruitment of start-up entrepreneurs for the study. The study considered start-up entrepreneurs with at least one year of experience in using open data for innovation and entrepreneurship. The researcher compiled a list of potential informants together with their company backgrounds. After that, purposive snowball sampling was carried out throughout the data collection stage within five months. In doing so, the interviewed informants recommended other start-up entrepreneurs that might be relevant to the research topic. Informants were recruited through an email invitation and supplied with the research information sheet. Twenty-four online semi-structured interviews were conducted with start-up Chief Executive Officers (CEO), founders and co-founders. Table 2 shows samples of informants' backgrounds and their characteristics.

Data collection and analysis

Online semi-structured interviews were conducted through Zoom due to the COVID-19 restrictions. At the start of each interview, the information sheet and informed consent form were summarized verbally. An interview guide was developed based on the literature review to capture informant experiences regarding the research topic. The context for the interviews revolved around an ideal ecosystem to inculcate open data entrepreneurship in Malaysia. This is when the informants suggested crucial components or enablers of such an ecosystem based on their experiences. Follow-up questions were asked whenever required to comprehend the informants' views. The medium of language for the interviews was English, and each interview lasted around 30–45 min. The interviews were audio-recorded and self-transcribed. Transcribed interviews were sent to informants by email for validation.

The study adopted thematic analysis by Braun and Clarke (2006) to analyze the interview transcripts. This thematic analysis consists of six stages: familiarization with the interview transcripts; generation of initial codes; development of themes; reviewing themes; defining and naming themes and producing the report. In the first stage, interview transcripts were read multiple times for familiarization. Interesting notes were taken and recorded through Memos in NVivo 12 software, which were referred to in the subsequent process. In the second stage, initial coding was conducted by labeling a few lines of text or paragraphs in the interview transcripts. This coding exercise was carried out reiteratively to capture themes that emerged from the interview transcripts. For example, some initial codes captured during the second stage were related to *resource availability*, *business model dependency*, *practical benefits in solving a problem and data requirements* (Figure 1). In total, 65 initial codes were generated in the second phase.

In the third stage, coded data were categorized into seven themes labeled as *open data considerations*, *open data providers*, *collaborators*, *enabling mechanisms*, *national contexts*, *impediments for data providers and impediments for start-up communities*. Codes were arranged and combined by experimentation to form overarching themes. Also, the mind map feature through NVivo software was utilized to provide a rough graphical representation of codes and themes. The developed themes were reviewed in the fourth and fifth stages, and some themes were combined. To do this, Braun and Clarke (2006) suggested that data within themes should be coherent, and there should be identifiable differences between themes. For

Table 2. Informants' backgrounds

No.	Pseudonym	Age	Gender	Position	Years of experience	Industry	Focus
1	Nikau	40–45	M	Co-founder	3–5	Transportation	Monitors the arrival times for public and express buses
2	Akahata	40–45	M	Co-founder	4–5	Automotive	Offers centralized car maintenance and breakdown services
3	Anewa	35–40	M	Founder	5–6	Automotive	Focuses on car maintenance and breakdown services
4	Mikaere	25–30	M	Co-founder	3–5	Mobility	Mobility as a service start-up (MaaS) for stage buses
5	Ari	35–40	M	Co-founder	7–8	Mobility	A leading technology-driven logistics service provider in Southeast Asia
6	Manaaki	35–40	M	Founder	7–8	Marketplace	Connects creative artists with freelance jobs
7	Jack	40–45	M	Founder	8–10	Consultation	Provides digital transformation services for the corporate sector
8	Rawiri	40–45	M	CEO	13–14	Consultation	A digital charity provider that connects philanthropies with COVID-19 victims via crowd sourced locational data
9	Mateo	40–45	M	Founder	2–3	Real estate analytics	Provides real estate analytics
10	Manaia	50–55	F	CEO	5–7	Healthcare	Provides sharing of personalized digital healthcare records between hospitals and medical practitioners on an app
11	Etera	35–40	M	CEO	2–3	Education	Offers a popular gamified learning app for school students
12	Mia	25–30	F	Founder	3–4	Education	Connects university students with internship placements
13	Hahona	35–40	M	Co-founder	2–3	Agriculture	Focuses on providing a digital bookkeeping solution for farmers in rural areas

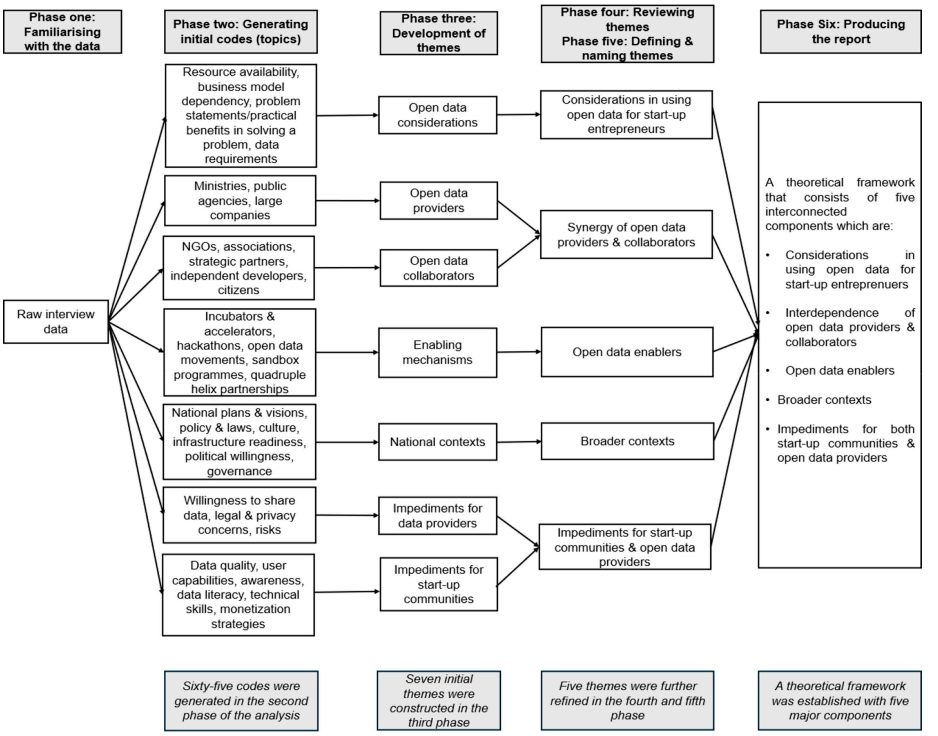

Figure 1. Data analysis for the study
Source: Author's own figure

instance, *open data providers* and *open data collaborators* were two themes combined into a single theme called *open data providers and collaborators.* In the sixth phase, the researcher constructed a theoretical framework comprising five overarching themes observed during the data analysis phase. Figure 1 shows the stages of data analysis conducted in the study.

Findings

The five main themes of the study are *considerations in using open data for start-up entrepreneurs, the synergy of open data providers and collaborators, open data enablers, broader contexts and impediments for start-up communities and open data providers.* This section unveiled interview excerpts of five themes that emerged in the study.

Theme one: considerations in using open data for start-up entrepreneurs

All start-ups in the interview have a specific problem statement. This problem statement entails the market gap that start-ups would like to fill through their product offering. Open data usage for start-ups depends on its practical benefits in solving a problem. Also, it depends on how open data fits well with start-up resources and business models:

> The problem statement needs to be created, right? Why do I need open data? How do I justify all the resources to enable this? How does it fit into my business model? That is the reasoning (Nikau, Co-founder of a transportation start-up).

One informant reported that using open data is about understanding pain points in a market. Start-ups will approach open data providers if open data is required to solve a particular problem:

> Companies that want to provide solutions around open data must first understand the industry or their clients' needs. What are the useful data to solve a 'pain point' using the least resources, cost-effective and quick too? (Ari, Co-founder of a mobility start-up).

One informant emphasized areas where open data is fundamental:

> Things like marketing, I don't think so. However, telematics, smart city, and smart farming, those areas would benefit a lot (Nikau, Co-founder of a transportation start-up).

The same informant informed that the role of open data depends on the start-up business model and its practicality to solve a problem quickly for monetization:

> We had a roadmap for what to develop. We had the algorithm, hardware and software - we covered everything, but in the end, you have to understand that start-ups have to solve a problem quickly to make money (Nikau, Co-founder of a transportation start-up).

Another interesting aspect is the start-up nature of being a passionate problem solver:

> Start-up founders are always passionate about solving problems. I think it is a bit naive, but, in a way, that is the gist of the nature of start-ups, you know. Having to find a problem we are passionate about that might overwhelm you (Rawiri, CEO of a consultation start-up).

Analysis of the interviews suggests that each start-up has a specific problem they are eager to solve. The decision to use open data depends on the start-up business model, problem statement and resources. There must be a clear understanding of the market and a specific problem to be solved. After that, start-ups might use open data as part of their innovative solution.

Theme two: synergy of open data providers and collaborators

Evidence from the interviews indicates that open data requires the collaboration of stakeholders. For example, one informant showed the importance of government involvement in an open data ecosystem:

> Government contributions to the open data ecosystem are significant for us to build more open data applications (Ari, Co-founder of a mobility start-up).

Another informant acknowledged the need for collaboration between the government and the private sector for open data:

> The open data platform needs consolidation or collaboration between the government and the private sector instead of working in silos (Jack, Founder of a consultation start-up).

Mikaere leads mobility as a service start-up (MaaS) for stage buses. He believed that open data in the transportation industry exists through collaborations with infrastructure providers such as transportation companies or related public agencies:

> Open data for public transport is always by invitation. If you are appointed vendors, you can work with the infrastructure providers. Then over there, I think [an agency] is doing a good job sharing data with start-ups (Mikaere, Co-founder of a mobility start-up).

In summing up his interview, Jack made a statement that refers to the progress of open data connectivity between public and private agencies:

> The ecosystem has been maturing in the past five years. We are seeing big players in the private sector trying to offer data connectivity to different companies. Companies that were before this "data blind" started to talk about data. That is a huge step up compared to how companies were run a decade ago (Jack, Founder of a consultation start-up).

Analysis of this section affirms that open data entrepreneurship depends on collaboration between stakeholders. The study documented examples of open data collaborators such as government agencies, ministries, associations, non-governmental organizations (NGOs) and other strategic partners. Data sharing between sectors varies, and open data awareness has improved in the country.

Theme three: open data enablers

The findings uncovered three open data enablers: hackathons, start-up accelerators and open data movements. Interestingly, the study documented two emerging open data enablers, a sandbox and a quadruple helix partnership program. The following section explains open data enablers discovered in the study.

Hackathon

One interesting finding is regarding a national hackathon program organized by a ministry. During this hackathon, government departments generate their problem statements or issues to be resolved by start-ups. This hackathon helps start-ups understand rather than assume the problems faced by public agencies:

> This hackathon is unique in the sense that problem statements come from public agencies. Sometimes, start-up entrepreneurs would assume that public agencies have some problems. Then, they prepare some proposals, but government agencies do not really need those solutions (Etera, CEO of EduTech start-up).

Accelerator program

The study found an accelerator program organized by the Open Data Institute (ODI) with a government-linked company to encourage open data innovation:

> This accelerator program is connected to a big data mandate from the government. So, from there on, they started having all the roadmaps and strategic plans for start-ups and the digital economy (Hahona, Co-founder of AgriTech start-up).

Open data movement

One informant was a council member of a prominent start-up association in Malaysia. The informant noted the importance of open data for start-up development within that association. He cited a case where a start-up founder expressed disappointment as he could not retrieve small and medium enterprise (SME) data for his project. Later, the council members had an opportunity to discuss the critical need of Application Programming Interface (API) for open data with the Minister of Science and Technology:

> Amongst the council members, we discussed what we wanted to bring up beforehand because it is not that frequent that we meet him [the minister]. We listed a few points, and one of the points was specifically on open data API. I remember explaining to him examples of alert apps with climate data, disasters or even floods (Etera, CEO of EduTech start-up).

Sandbox program

Sandbox is a testbed set up by regulators that allows start-ups to experiment with their proposed products without regulatory laws. The vision of sandbox programs is to evaluate a provisional product offering in a live and controlled environment. The study captured responses to indicate that a sandbox concept is highly applicable to open data. Theoretically, start-ups will be supported with data sharing through the sandbox environment. For instance, the Ministry of Science and Technology introduced the National Technology and Innovation Sandbox (NTIS). One informant who participated in the NTIS program shared her insights:

> From a commercial point of view, what happens now is that we can work with hospitals for our pilot project because we need to prove that our idea works. We have proven it works, and people or patients can indeed own their healthcare records. However, we do not see a clear regulatory pathway from this sandbox because another ministry is the principal actor of this policy (Manaia, CEO of HealthTech start-up).

This start-up focuses on leveraging access to personalized healthcare records via an app. This service allows the public to share personalized healthcare records between hospitals and medical practitioners. The issue is that healthcare records belong to medical healthcare providers. Hence, a revision is required under the existing law to allow this start-up access to healthcare records. The informant acknowledged that participating in the sandbox program helped them initiate a pilot project with regulators, hospitals and patients. Another interesting viewpoint is the need for a clear pathway and guidance across ministries. This is because the Ministry of Science and Technology organizes the sandbox while the sole permission to access healthcare data is under the purview of the Ministry of Health. Interestingly, one of the future upgrades for their service is the option for app subscribers to share their de-identified data anonymously for medical research. In return, research participants will be rewarded with points to purchase discounted items with the start-up partners.

Quadruple helix partnership

A quadruple helix partnership drives active collaboration from industry, academia, government and civil society. One informant explained the collaboration between four stakeholders in the healthcare industry with the following statement:

> It is supposed to form a quadruple helix partnership. So, it is an initiative involving the public sector, private, academia, and civil society. Data sharing from the government side will come from [name of a hospital]. We are getting participants from [name of a hospital]. From the civil society, we are collaborating with [name of an association] and [name of an NGO]. When it comes to academia, we collaborate with a medical faculty from [name of a university] (Manaia, CEO of HealthTech start-up).

Manaia averred that her start-up project on medical healthcare records applied the quadruple helix partnership concept. They work with collaborators from a hospital, a university, a healthcare association and an NGO. They build trust and interest in solving the problem of accessing medical healthcare records through such a partnership. In general, Manaia advocated that a quadruple helix collaboration could lead to positive outcomes in open data innovation. She is currently working with her strategic partners to enhance and commercialize her start-up product.

Theme four: broader contexts

The informants postulated that the success of open data entrepreneurship depends on broader contexts. For example, a clear open data policy helps to encourage public agencies to share their data:

> Government departments should have a common way to share a lot of this data via API. To achieve that, you need to have some form of policy (Ari, Co-founder of mobility start-up).

Other informants suggested that governance is a principal factor in open data success:

> My concern is more about how and who is to implement it. We are good at designing policies and blueprints, but implementation and governance must be equally good (Mateo, Founder of real estate start-up).

The informants also mentioned that open data usage is conditional to existing laws:

> The Personal Data Protection Act [PDPA] rules whether we can use the data or are against the law (Manaaki, Founder of marketplace start-up).

Mikaere leads a start-up providing software for stage buses. He approached a state assembly member in the city council about his interest in enhancing public bus routes. Coincidentally, one of the interests of the state assembly member was to improve bus services in the local area. There is a political will to solve a community issue, leading to further discussions on adopting a start-up solution:

> I have no political connections, but I managed to work with a politician. She was back then an assemblywoman of [a city council]. I sent an email saying we have technology that can help citizens have more confidence in taking buses, particularly the urban poor community. She invited me to her office to collaborate with her (Mikaere, co-founder of a mobility start-up).

Analysis in this section verifies the role of broader contexts that affect open data usage. Several informants suggested that a policy is required to guide the release of open data. Another essential element is the governance of open data implementations. Equally important is the political will to share data to solve societal issues.

Theme five: open data impediments

Evidence from the interviews shows that impediments exist for data owners and users. Impediments for data owners revolve around the challenges of disclosing high-value data. For example, one informant specified that willingness to share data is the most significant barrier to open data implementation:

> The biggest barrier is the willingness to share data openly (Nikau, Co-founder of a transportation start-up).

An informant acknowledged that there might be governance issues in open data implementations:

> I think the government must have their act together rather than having multiple agencies doing the same thing (Manaia, CEO of HealthTech start-up).

Nikau suggested that data quality is one of the common impediments to the meaningful use of open data:

> Start-ups benefit from having open data of good quality that is readily available, accessible, and useable (Nikau, co-founder of a transportation start-up).

Jack commented that start-ups might be unaware of the existence of open data platforms. Equally important are experience and skills to integrate open data into businesses:

> They need to be aware of open data platforms. They need to understand how to “slice” and “dice” those data. Raw data has no meaning unless you have the knowledge and experience to use it (Jack, Founder of a consultation start-up).

Equally important are data literacy skills and monetization strategies in integrating open data for start-up businesses:

> Data literacy, if we don't know how or where to find the data, it does not make sense, right? (Anewa, Founder of AutoTech start-up).

> How can you make money out of open data? You need proper planning for monetization (Manaaki, Founder of marketplace start-up).

Analysis in this section demonstrates the impediments for data owners and start-up communities. The informants asserted that unwillingness to share data is one of the main barriers. Another impediment is the lack of consistency in open data implementations. Also, the informants perceived that data providers have legal and privacy concerns and risks in open data implementations. Start-up founders believed that open data has enormous potential for the start-up industry. However, they acknowledged obstacles to the meaningful use of open data, such as data quality, monetization strategies, and data literacy skills.

Discussion

The main research question is, *What are the key components of an ecosystem for open data entrepreneurship to emerge in the context of a developing economy?* The researcher conducted semi-structured interviews with start-up entrepreneurs in Malaysia to answer this research question. Based on the findings, the researcher developed a theoretical framework to represent an ecosystem of open data entrepreneurship (Figure 2). This framework consists of five major components, which are:

(1) considerations in using open data for start-up entrepreneurs;

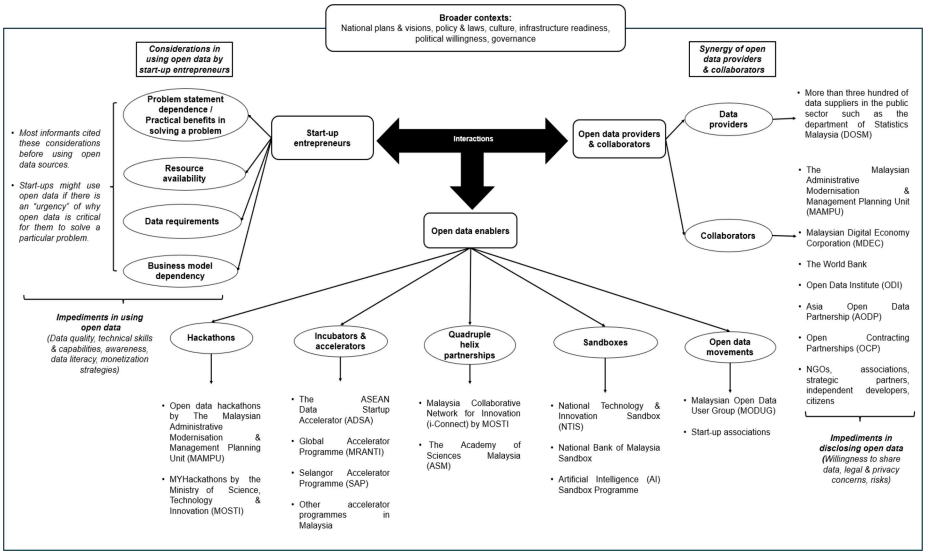

Figure 2. Theoretical framework
Source: Figure by author

(2) the synergy of open data providers and collaborators;
(3) open data enablers;
(4) broader contexts; and
(5) impediments for start-up communities and open data providers.

This section discusses the findings and the main components of the theoretical model against the surrounding literature. The first component is related to the purpose of using open data for start-up entrepreneurs. Most informants associated open data relevance with the nature of their "problem statements". The term "problem statement" refers to a particular problem that a start-up wants to solve through innovation. Also, the informants indicated that the purpose of using open data for start-up entrepreneurs depends on its practical benefits in solving a problem. In fact, the informants asserted that open data usage relies on certain organizational circumstances, such as business models, resource availability and specific data requirements for their operations. In general, the literature revealed the practical use of open data for start-up entrepreneurs (Mohamad, 2025; Huber *et al.*, 2022; Magalhaes and Roseira, 2020). Still, there is a lack of empirical evidence to indicate the considerations taken by start-up entrepreneurs before they utilize open data. The finding enriches the literature by highlighting these considerations specific to start-up entrepreneurs, such as organizational circumstances and open data practicality to solve a particular problem.

The second component is about the synergy between open data providers and stakeholders. The study discovered several start-ups collaborating with government agencies and businesses to innovate from open data. For instance, the study discovered a telematics start-up that shared data between road drivers, insurance companies and a research institute to score the driving behaviors of road drivers. In another example, a property start-up shared data between property agencies and a national property institution to build rental estimates for the property market. The research came across numerous collaborations between data owners and stakeholders, such as professional associations, government ministries and NGOs. Specific collaborators are shown in Figure 2. The study affirms the importance of strategic collaborations for open data innovation in the literature (Feyzbakhsh *et al.*, 2022; Mo *et al.*, 2024; Ofe and Sandberg, 2022).

The third component is regarding open data enablers. The current research found five enablers: accelerator, hackathon, open data movement, sandbox program and quadruple helix partnership. The first three enablers often appear in open data literature and are reflected in the findings (Dall-Orsoletta *et al.*, 2022; Herala *et al.*, 2019; Kitsios and Kamariotou, 2023; Mo *et al.*, 2024). For instance, the research discovered an open data movement initiated by a start-up association. A meeting was held between the start-up representatives and the Minister of Science and Technology regarding open data APIs in the public sector. Such an event signifies the critical importance of accessing open data in the public sector for start-up entrepreneurs. Also, the research came across a regional open data accelerator program to encourage start-ups to innovate from open data. These findings affirm the importance of hackathons, accelerators and open data movements to encourage innovation.

Two unexpected findings on open data enablers were the emerging roles of sandbox and quadruple helix partnership. In the literature, scholars explored regulatory sandboxes to assess the suitability of disruptive innovation, particularly in the FinTech sector (Fahy, 2022; Quatrochi *et al.*, 2022). Also, researchers investigate the role of quadruple helix partnerships in creating innovative products (Bellandi *et al.*, 2021; Cai and Lattu, 2022; Kitsios *et al.*, 2021). However, limited empirical studies explore or integrate both enablers in an open data

environment. Unlike other studies, the findings advocate that sandbox and quadruple helix programs could facilitate open data innovation.

The research discovered a unique case about MedTech start-up efforts in accessing medical record data from healthcare providers. To do so, this start-up joined a sandbox program to collaborate with regulatory partners. Furthermore, this MedTech start-up enhances its product with strategic partners through a quadruple partnership between the public, private, academia and civil society. These sandbox and quadruple partnership programs serve as a force multiplier to enhance the success rate of open data innovation for this MedTech start-up. In fact, other informants cited these two programs to inculcate a favorable environment for open data entrepreneurship. Collectively, studies in open data literature highlight the prominence of open data enablers such as hackathons and accelerator programs in inculcating innovation. Nonetheless, the study acknowledged the emerging roles of sandbox and quadruple partnerships in enhancing the success rate of open data entrepreneurship.

The fourth component is the relevance of broader contexts to drive open data entrepreneurship. The informants acknowledged the importance of national plans and vision to drive entrepreneurial usage of open data. Also, the findings indicate that open data policy and laws, culture, infrastructure readiness, political willingness and governance are required to nurture open data for entrepreneurial usage. Overall, the findings are consistent with the literature on designing a better ecosystem for open data innovation. For instance, Zhou *et al.* (2023) emphasized the importance of designing policies to govern open data implementations. Also, Cho and Lee (2022) acknowledged that technological readiness, institutional culture and competencies affect open data implementations. It is important to note that most informants were aware of open data development in the country. Nonetheless, they asserted that close engagement with start-up founders and associations would help the government to design a conducive environment for open data innovation.

In the fifth component, the study documented the impediments for data owners and start-up communities. Consistent with the literature, the impediments for data owners revolve around the willingness to share data, privacy concerns and legal risks in data disclosure (Cho and Lee, 2022; Kleiman *et al.*, 2023; Ruijer and Meijer, 2020). Impediments for start-up entrepreneurs revolve around data quality issues, technical capabilities and awareness (Susha *et al.*, 2015a).

Overall, this study developed an integrated understanding of the research topic. Open data entrepreneurship requires multi-stakeholder collaboration in an ecosystem. Open data enablers stimulate collaboration between stakeholders. Broader contexts encourage the sharing of high-quality data in the public sector. This study discovered an unanticipated case of a HealthTech start-up that works in a multi-stakeholder collaboration through a quadruple helix partnership and a sandbox program. Hence, the study advocates that both enablers might be able to increase the success of open data innovation. Also, the study found a unique open data movement that expressed the need for open data APIs in the public sector. This finding suggests that publishing APIs in the public sector might be able to stimulate open data entrepreneurship.

In terms of limitations, the snowball sampling technique used may introduce bias, as the researchers specifically sought informants with rich information and contextual knowledge relevant to the study. Another limitation is that the research lacks data triangulation with start-up experts, government officials, open data providers and other intermediaries to enrich the integrated model. Therefore, future studies can extend the research by employing data triangulation to extend the integrated model. In addition, future studies can use a quantitative approach to generalize the research outcomes. Future studies can also explore one of the

components in the integrated model in-depth to understand mechanisms that might promote entrepreneurship from open data.

Theoretical and practical implications

The main theoretical contribution is an integrated perspective of open data entrepreneurship for start-up entrepreneurs. This theoretical contribution is essential because the literature on this topic is fragmented. Scholars explore individual open data enablers such as hackathons (Kitsios and Kamariotou, 2023) and accelerators (Priestley *et al.*, 2022). In contrast, this study investigates the topic from a broader perspective to recognize essential components in open data entrepreneurship. In doing so, this study has practical implications for policymakers and practitioners.

First, policymakers can include a sandbox program in an ecosystem to inculcate open data collaborations. Sandbox programs allow start-ups to collaborate with regulatory agencies to assess their provisional products and services. MAMPU can lead in organizing an open data sandbox with its domestic and regional partners. One possible international partner is the Open Data Institute (ODI), which has extensive experience in open data innovation. MAMPU can collaborate with local partners, such as the Malaysian Digital Economy Corporation (MDEC). The Malaysian Open Data User Group (MODUG) and start-up associations might be able to recognize suitable start-up projects for the sandbox program. Given these circumstances, having a sandbox program is a feasible idea that requires commitment from MAMPU and its strategic stakeholders. One possible model MAMPU can adopt is from the National Technology and Innovation Sandbox Malaysia (NTIS) by the Ministry of Science, Technology and Innovation Malaysia (MOSTI).

In addition, the government can initiate a quadruple helix partnership in promising industries such as property, healthcare and agricultural sectors. Specific attention to certain industries might help to encourage open data innovation and entrepreneurship. One example of a model that MAMPU can adopt is "I-Connect" which is a program to inculcate innovation from MOSTI and the Academy of Sciences Malaysia (ASM). In general, I-Connect is a quadruple helix program focusing on specific health and wellness areas. Their primary focus is to drive disruptive innovation that involves actors from the government, academia, civil society and related industries. Hence, MAMPU can adopt such a model to nurture open data innovation and entrepreneurship. Clearly, both the sandbox program and the quadruple helix partnership require substantial strengthening of the existing laws and regulations concerning open data. Ultimately, this will promote ethical usage and safeguard the rights of data owners and users in the commercial use of open data in Malaysia.

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