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Conceptualising Capabilities and Value Co-Creation in a Digital Business Ecosystem (DBE): A Systematic Literature Review

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ABSTRACT

Digital Business Ecosystem (DBE) is a topical concept for business organisations to collaborate in driving product or service innovation. DBE is supported by digital technologies which aim to create and co-create values among the participated business organisations. For achieving successful collaboration, business organisations need to understand their capabilities that lead to value creation. This approach is vital for a business organisation to benefit from the values co-created when collaborating with others. Failing to do so will cause inefficient collaboration. However, there is a lack of capability and value co-creation studies in the DBE context. Therefore, this paper aims to conceptualise capabilities and value co-creation through a systematic literature review. We analysed the findings by thematic analysis. The review results produced a set of research themes surrounding the capability and value co-creation concepts. The research themes contribute to informing future avenues in digital business ecosystem research.

Keywords: Digital Business Ecosystem, capabilities, value co-creation, Archimate, sharing economy

INTRODUCTION

Sir Arthur Tansley first articulated the terminology *ecosystem* as “abiotic community or assemblage and its associated physical environment in a specific place” (Pickett & Cadenasso, 2002). He emphasised abiotic and biotic components as complexes in an ecosystem, and a nested structure is required to manage the interaction between the two components. An ecosystem consists of a set of actors and interactions hence the actors’ capabilities and roles evolve dynamically in their own manner (Moore, 1996; Wallner & Menrad, 2010; Valkokari, 2015). Since then, the ecosystem terminology has been adopted in various research and practices such as in business (Moore, 1993), digital environment (Briscoe, Sadedin, & De Wilde, 2011) including the use of cloud computing (Suciu, Ularu, & Craciunescu, 2012), innovation (Gobble, 2014), and knowledge management (Thomson, Callan, & Dennis, 2007).

The concept of the digital business ecosystem (DBE) was first coined in an EU project back in 2002 to encourage collaboration between small and medium-sized enterprises (SMEs) in an efficient manner through the use of technology (Nachira, 2002). A DBE is seen as an integrated value chain where it consists of business organisations with different characteristics, interests, and capabilities (Kandiah & Gossain, 1998). DBE enables business organisations to work together for meeting customers’ rising expectation, as well as create or co-create values (Accenture, 2015; DigitalMckinsey, 2018). These business organisations work cooperatively and competitively for producing new products or services in a self-organised and self-evolved manner by using technology (Barua, Kriebel, & Mukhopadhyay, 1995; Dini *et al.*, 2005; Melville, Kraemer, & Gurbaxani, 2004; Nachira *et al.*, 2007).

Despite the benefits brought by DBE, uncertainties such as ineffective collaboration and capabilities alignment still occur among business organisations (Sun *et al.*, 2016). These uncertainties are the impediments to value creation and co-creation among the business organisations in a DBE. Moreover, the mismanagement of value co-creation in particular could lead to value co-destruction (Abedin & Bidar, 2019), which will jeopardise the collaboration among business organisations. Hence, business organisations need to understand and examine their existing capabilities, such as digital skills before establishing or joining a DBE (InnovateUK, 2015; TechCity, 2017). Although there is previous DBE research conducted such as Senyo, Liu and Effah (2019), there is a lack of literature in identifying organisations’ capabilities before embarking on a DBE journey (Battistella *et al.*, 2013; Molla *et al.*, 2008). Therefore, this paper aims to conceptualise capabilities and value co-creation in DBE by conducting a systematic review study. The research poses three research questions (RQ).

RQ1: What are the key concepts associated with DBE?

RQ2: What are the capabilities required by an organisation before forming or joining a DBE?

RQ3: What are the potential values co-created in a DBE?

This paper is structured as follows: the second section illustrates the review methods, and the third section discusses the review findings, which are a set of research themes for conceptualising capabilities and value co-creation in DBE. The last section discusses the contributions, limitations and further research avenues of DBE research.

REVIEW METHOD

A systematic review is a type of literature review that identifies, assesses and synthesises the most relevant evidence available to the specific research questions to provide evidence-based answers and information (Boland, Cherry, & Dickson, 2017). Unlike a traditional literature review which only provides a high-level summary on the research topic, SLR ensures the data collected are reliable and relevant to the study field (Ten Ham-Baloyi & Jordan, 2016). SLR avoids the inherent bias found in the traditional literature review. SLR begins with a predefined strategy that is used to identify, select, evaluate and synthesise relevant literature which later draws a conclusion or address the research questions with concrete evidence (Boland, Cherry, & Dickson, 2017). This paper adopts the SLR protocol suggested by Kitchenham and Charters (2007), and the following sub-sections explain the review details.

Search Strategy

DBE research gains popularity in various fields such as information systems, computer science, tourism and general management (Senyo, Liu, & Effah, 2019). Hence, we selected GoogleScholar as the key database for performing the search. This approach ensures the robustness of the research. GoogleScholar is one of the largest databases for academic resources such as journal and conference papers, and other scholarly literature (Komljenovic, 2019). **Table 1** describes the search strings for each research question by considering the relevant keywords. We applied Boolean operator such as: “AND”, “OR” & “NOT” for narrowing the results and improving the search precision. Inclusion and exclusion criteria are the selection element in the SLR protocol. We employed this element for validating the collected sources (see **Table 2**).

Table 1. Search strings of this review study

RQ1: What are the key concepts associated with DBE?	
Search string	“Ecosystem” OR “Digital Ecosystem” OR “Business Ecosystem” OR “Digital Business Ecosystem” OR “IT Ecosystem”
RQ2: What are the capabilities required by an organisation before forming or joining a DBE?	
Search string	(“IT capabilities” OR “IS capabilities” OR “Digital capabilities” OR “Business capabilities” OR “Dynamic capabilities”) AND (“Ecosystem” OR “Digital ecosystem” OR “Business ecosystem” OR “Digital Business Ecosystem” OR “IT ecosystem”)
RQ3: What are the potential values co-created in a DBE?	
Search string	(“Value Creation” OR “Value Co-creation” OR “Collaboration” OR “Coopetition” OR “Value Creation Logic” OR “Value Chain” OR “Value Shop” OR “Value Network” OR “Digital Business Strategy” OR “Business Value” OR “Co-production” OR “Value delivery” OR “Value Configuration” OR “Open innovation” OR “Strategic alignment”) AND (“Ecosystem” OR “Digital ecosystem” OR “Business ecosystem” OR “Digital Business Ecosystem” OR “IT ecosystem”)

Table 2. Inclusion and exclusion criteria of this study

Inclusion criteria	Exclusion criteria
Refereed academic journal articles that fulfil the following criteria:	Refereed academic journals that discuss biological, natural or social ecosystem.
Closely related to DBE such as business ecosystem or digital ecosystem that can be applied as a lens to explain the notion of DBE	Sources do not contain books, extended abstracts, conferences papers, presentations, presentation notes, or keynotes speech
Cover the key concepts of the DBE such as its definition and characteristics	Papers written in other languages
Cover the capabilities study, value creation, and co-creation in the context of DBE from the business or digital ecosystem perspective	
Published from 2013 (to capture the latest development of the study)	
Should be written in English	

Figure 1 illustrates the SLR process of this research. We employed Zotero, a reference management software to manage the collected literature, and exported a CSV file for further analysis and documentation (Zotero, 2019).

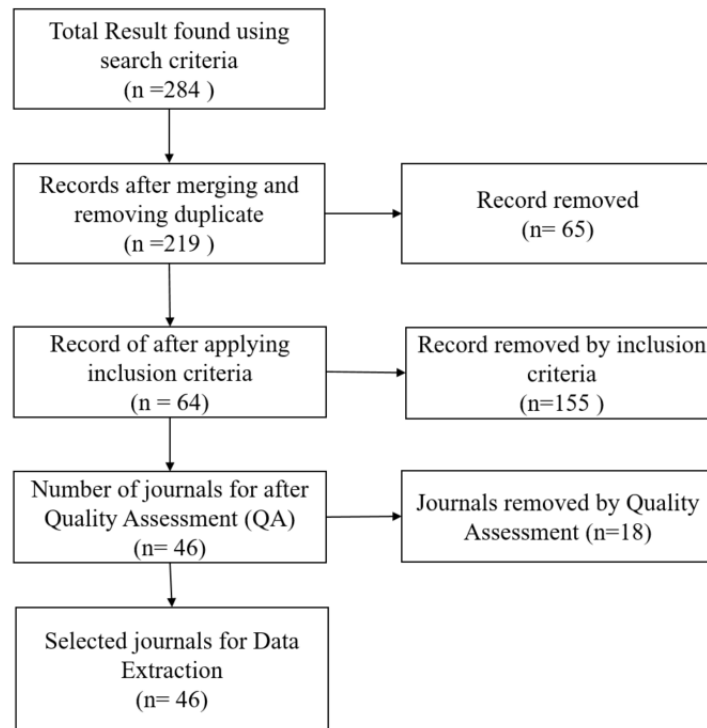


Figure 1. SLR process in this study

Quality Assessment

Quality assessment (QA) is a process of assessing the quality of the selected sources based on the inclusion and exclusion criteria (Al-Emran, Mezhuyev, & Kamaludin, 2018), and it is created as supporting evidence for the SLR (Zhou *et al.*, 2015). **Table 3** describes the QA checklist in this paper adapted from Zhou *et al.* (2015).

Table 3. QA checklist adapted from Zhou *et al.* (2015)

Type	No	Question
Research Questions Examine the relevance of the source with the research	1	Does the selected source define or state the concept of Digital Business Ecosystem?
	2	Does the selected source explain the concept of capabilities and describe the capabilities required by an organisation prior to setting up or joining a Digital Business Ecosystem OR Ecosystems OR Collaboration OR networking?
	3	Does the selected source explain the concept of value creation and co-creation in the context of Digital Business Ecosystem OR Ecosystems OR Collaboration OR networking?
Reporting Examine if the source has a clear motivation, aim, and context	4	Does the selected source have well-defined the aim, purposes, objective, goals, and motivations?
	5	Does the selected source have an adequate description of the method applied for data collection?
	6	Does the selected source have consistent and clear reporting?
Rigorous Examine the validity of data collection methods and tools	7	Does the selected source have well-defined metrics such as research method, research design, and measures applied in the study?
	8	Does the selected source use an appropriate method to validate the study and justify the data analysis approaches?
	9	Does the selected source's research methodology address the research questions and the study's aim?
	10	Does the selected source provide suitable approaches to address the research issue?
Credibility Examine if the finding is valid and meaningful to the study	11	Does the selected source provide an explicit finding that relates to the aim of the research?
	12	Does the selected source provide sufficient data or evidence to support the finding of the journals?
	13	Does the selected source discuss any problem, limitations, and threats with the validity of the result?
Relevance Examine the relevance of the findings to the study	14	Are the selected journals valuable and appropriate to be used in this research?
	15	Does the selected source report the conclusion and implication for future research work or practices accurately?

Table 4 illustrates the QA metrics for scoring the quality of the collected sources based on the QA checklist (see **Table 3**) in this research. The QA metric was developed by applying a checklist approach suggested by Zhou *et al.* (2015). The QA metrics analyse the sources and re-assess the inclusion and exclusion criteria to ensure the selection process is accurate, and to remove sources that do not meet the requirements.

Table 4. QA Matrices

Quality	Good quality	Average quality	Poor quality	Bad quality
Points	13-15	8-12	5-7	0-4

Each selected source was assessed by using the questions demonstrated in **Table 3**. For each question, scoring 1 refers as the source exactly match the condition of the question, the score of 0.5 indicated the source partially match the criteria, whereas the

score of 0 applies when the source does not meet the requirement. After the scoring process, we then summed up the total score for each source. This process was to assess the suitability of the source for this research. By employing heuristics principle proposed by Arazy, Kopak and Hadar (2017), we classified the total score of each source into four categories as shown in **Table 4**. The source would be removed if its total score was less than 8 (the *poor quality* and *bad quality* category). As a result, we found that all 46 selected sources were suitable for this research. **Table 5** details the scoring for the selected sources.

Table 5. QA scoring

Source ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Quality Total Score
S-1	1.0	1.0	1.0	0.5	1.0	1.0	1.0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	13.5
S-2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	14.5
S-3	0.5	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	13.0
S-4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	14.5
S-5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	14.5
S-6	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	0.5	1.0	12.5
S-7	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	0.0	1.0	13.5
S-8	1.0	1.0	1.0	0.5	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	0.5	1.0	13.5
S-9	0.5	0.5	0.5	1.0	1.0	1.0	0.5	1.0	0.5	0.0	1.0	1.0	0.5	1.0	0.0	10.0
S-10	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	14.0
S-11	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	0.5	13.0
S-12	0.0	0.0	1.0	1.0	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	0.5	0.5	0.0	9.0
S-13	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	14.5
S-14	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	14.5
S-15	1.0	1.0	1.0	0.5	1.0	1.0	0.5	0.5	0.5	1.0	1.0	0.5	1.0	0.5	0.5	11.5
S-16	1.0	1.0	0.5	0.5	0.5	1.0	1.0	1.0	0.5	0.5	1.0	1.0	1.0	1.0	0.5	12.0
S-17	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	1.0	1.0	1.0	0.5	0.5	13.0
S-18	1.0	1.0	1.0	0.5	0.5	1.0	1.0	0.5	0.5	1.0	1.0	0.5	1.0	1.0	1.0	12.5
S-19	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	14.0
S-20	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5	1.0	0.5	1.0	1.0	1.0	0.5	1.0	12.5
S-21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	14.5
S-22	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	14.0
S-23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	15.0
S-24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	14.5
S-25	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	14.0
S-26	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	15.0
S-27	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	15.0
S-28	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	14.5
S-29	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	0.5	0.5	1.0	1.0	1.0	1.0	1.0	13.5
S-30	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	15.0
S-31	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	13.5
S-32	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	14.5
S-33	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	14.5
S-34	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	13.5
S-35	1.0	1.0	0.5	0.5	0.5	1.0	1.0	0.5	1.0	0.5	1.0	1.0	1.0	1.0	1.0	12.5
S-36	1.0	1.0	0.0	0.5	0.5	1.0	0.5	1.0	1.0	1.0	1.0	1.0	0.5	0.5	1.0	11.5
S-37	0.5	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	14.0
S-38	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	14.5
S-39	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	15.0
S-40	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	14.0
S-41	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	15.0
S-42	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	13.0
S-43	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	14.5
S-44	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	0.5	1.0	1.0	1.0	1.0	1.0	14.0
S-45	0.5	1.0	1.0	1.0	0.5	0.5	0.5	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	12.5
S-46	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	1.0	1.0	12.5

Data Extraction and Analysis

We conducted the thematic analysis for data extraction by using Nvivo 11 Pro software. Thematic analysis is a data analysis method for identifying, analysing and reporting implicit and explicit information and present patterns (themes) within the selected sources (Alhojailan, 2012; Boyatzis, 1998). In this research, we adopted the six steps of thematic analysis from Braun and Clarke (2006). The six steps include: 1) familiarise with the collected sources, 2) generate initial codes, 3) search for the themes, 4) review themes, 5) define themes, and 6) reporting the outcome. We extracted the themes for addressing the three research questions, which contribute to the findings reported in the third section.

RESEARCH THEMES FOR CONCEPTUALISING CAPABILITIES AND VALUE CO-CREATION

RQ1: What are the Key Concepts Associated with DBE?

Based on the literature collected, 18 articles are discussing the key concepts associated with DBE (see **Table 6**). The key concepts are *definition* (n=9), *characteristics* (n=10), *benefits* (n=8), and *actors* (n=7). In terms of the *definition* of DBE, most sources such as Benghozi and Salvador (2014), Korpela, Ritala, Vilko, and Hallikas (2013), Baggio and Chiappa (2013), Pan, Foo, and Tan (2014), Baggio and Del Chiappa (2014), and Koch and Windsperger (2017) inherit the DBE definition from scholars Nachira et al. (2007) and Corallo, Passiante, and Prencipe (2007).

Table 6. Key concepts of DBE

Source ID	Sources	Research Themes			
		Definition	Characteristic	Benefits	Actors
S-39	(Baggio & Chiappa, 2013)	x	x	x	
S-5	(Baggio & Del Chiappa, 2014)	x	x	x	x
S-38	(Benghozi & Salvador, 2014)	x			
S-41	(Djatna & Luthfiyanti, 2015)	x	x	x	
S-37	(Graça & Camarinha-Matos, 2017)	x	x	x	x
S-4	(Immonen <i>et al.</i> , 2016)			x	
S-3	(Järvi & Kortelainen, 2017)				x
S-43	(Kinnunen <i>et al.</i> , 2013)				x
S-28	(Koch & Windsperger, 2017)	x	x	x	
S-30	(Korpela, Ritala, <i>et al.</i> , 2013)	x	x	x	
S-20	(Lusch, Vargo, & Gustafsson, 2016)				x
S-40	(Moiescu & Sacala, 2016)	x			
S-31	(Nagrath <i>et al.</i> , 2015)		x		
S-28	(Pan, Foo, & Tan, 2014)	x	x	x	
S-42	(Pattinson & Johnston, 2015)		x		
S-7	(Valkokari, 2015)				x
S-45	(Vargas <i>et al.</i> , 2016)		x		
S-6	(Weber & Hine, 2015)				x

Nachira *et al.* (2007) define DBE as a business ecosystem catalysed by ICT, whereas Corallo, Passiante, and Prencipe (2007) propounds that DBE enhances traditional collaborative ventures such as centralised (client-server), distributed (peer-to-peer models) and hybrid (such as web services) models, to form a separate holistic model. Scholars such as Djatna and Luthfiyanti (2015), Graça and Camarinha-Matos (2017), Moiescu and Sacala (2016) suggest significant definitions for DBE. Djatna and Luthfiyanti (2015) claim that DBE applies digital technologies in centralising data and information to facilitate business activities. Graça and Camarinha-Matos (2017) suggest that DBE consists of interactions of digital species such as software applications, services, agents, business models, knowledge and law. Hence, DBE can be seen as an open social-technical system. Similarly, Moiescu and Sacala (2016) describe DBE as a new form of dynamic business interactions and global co-operation among business organisations enabled by digital technologies. Hence, we concluded that DBE is a social-technical system consisting of business and technical components, where technical components are employed to facilitate the business activities and interactions.

Korpela, Ritala, Vilko, and Hallikas (2013), Graça and Camarinha-Matos (2017), Pattinson and Johnston (2015), and Baggio and Chiappa (2013) describe the *characteristics* of DBE from the metaphor of a biological ecosystem, where digital species have their independent behaviour and evolve overtime. A DBE possesses the business and technical perspective (Baggio & Del Chiappa, 2014; Djatna & Luthfiyanti, 2015; Koch & Windsperger, 2017). The business perspective studies the economy of society and how the business agents or stakeholders influence the formation of DBE or how the environment influences DBE (Graça & Camarinha-Matos, 2017). The technology perspective elicits the technical infrastructure required in enabling a DBE (Baggio & Del Chiappa, 2014; Koch & Windsperger, 2017). The business and technology components are strongly coupled and co-evolve from time to time (Baggio & Chiappa, 2013). Collectively, DBE enables information and knowledge sharing (Vargas *et al.*, 2016). Moreover, DBE enables business organisations to source relevant capabilities for growing the organisation, fosters collaborations and open innovation in developing new products or services, and eventually lead to value creation and co-creation between various parties (Nagrath *et al.*, 2015; Pan, Foo, & Tan, 2014).

DBE with its very distinct nature possesses many anticipated *benefits*. Baggio and Chiappa (2013), Djatna and Luthfiyanti (2015), Graça and Camarinha-Matos (2017), Koch and Windsperger (2017), and Korpela, Ritala, et al. (2013) claim that by forming or joining a DBE enables businesses to gain a competitive advantage in the market. Information created and shared in a DBE is the key to achieving the competitive advantages by responding to the market demand in a timely and cost-efficient manner. DBE promotes business to business (B2B) interaction and content sharing among businesses. This phenomenon helps businesses to form or be a part of an effective, dynamic and self-organising network which produces business opportunities and foster innovation beyond the organisation's boundaries which in return, enhancing the overall competitiveness.

Additionally, DBE serves as an open innovation platform through the use of digital technologies, enables businesses co-create values where businesses share ideas (Baggio & Del Chiappa, 2014; Immonen *et al.*, 2016). The value co-creation activities happen through the coordination and cooperation by the trust and legitimacy that exist within a whole ecosystem. Since DBE functions as a single entity, businesses can exchange and enhance their capabilities, access to the communal resources and cost-effective value creation activities (Korpela, Ritala, *et al.*, 2013; Pan, Foo, & Tan, 2014).

The *actors* in any ecosystem are very crucial since they are the ones who make up the ecosystem, and they are essential for the survival of the ecosystem. Similar to the concept of digital species suggested by Graça and Camarinha-Matos (2017), Baggio and Del Chiappa (2014), Järvi and Kortelainen (2017), Weber and Hine (2015), Lusch, Vargo, and Gustafsson (2016), Kinnunen, Sahlman, Harkonen, and Haapasalo (2013), and Valkokari (2015) postulate that DBE actors are human and non-human actors. The human actors are business actors such as commercial organisations, suppliers, buyers, producers, customers, sellers, delivery channels, non-governmental organisations (NGOs), governmental organisations, distributors, advertiser, policymaker, funders (e.g., banks, venture capitalist, angel, and corporate investors), marketers. The non-human actors refer to the digital actors such as computers, software, business models, frameworks and applications. Additionally, there is an individual actor (typically a firm), the relationship between the actors (inter-firm relationship) and the ecosystem when analysing a DBE (Weber & Hine, 2015). The relationship between the actors is moving from the firm-centric relationship to more networked-based and collaboration-based relationship, which aims for fostering coopetition (competition and cooperation at the same time), value creation and co-creation.

RQ2: What are the Capabilities required by an Organisation before Forming or Joining a DBE?

There are 17 articles discussing the capabilities required by organisations before forming or joining a DBE (see **Table 7**). Organisations should first understand the concept of capabilities or *purpose of capability* (n=6), followed by equipping themselves with *dynamic capability* (n=4), *networking capability* (n=1), *collaboration capability* (n=2), *strategy capability* (n=2), and *digital capability* (n=2). In terms of the *purpose of capability*, Immonen et al. (2016) highlight that capabilities study contributes to understanding the objective of a DBE formation or participation, and its governance. The governance activities include directing, monitoring, and managing the interactions among actors in a DBE. Moreover, it is vital for DBE actors to understand that capabilities will co-evolve from time to time (Graça & Camarinha-Matos, 2017; Kinnunen et al., 2013; Liu & Rong, 2015). This phenomenon happens when a diverse set of capabilities are required for meeting customer demand that is beyond the capability of an organisation. These interactions create values among business actors (Li et al., 2016). As a result, business actors in a DBE develop the ecosystem-based capabilities which are self-renewal to adapt to the dynamic business environment or known as dynamic capabilities (Rehm, Goel, & Junglas, 2017).

Table 7. Capabilities required by organisations in DBE

Source ID	Sources	Research Themes					
		Purpose of capability	Dynamics capability	Networking Capability	Collaboration capability	Strategy capability	Digital Capability
S-38	(Benghozi & Salvador, 2014)		x				
S-46	(Camarinha-Matos & Afsarmanesh, 2018)				x		
S-37	(Graça & Camarinha-Matos, 2017)	x			x		
S-4	(Immonen et al., 2016)	x					
S-3	(Järvi & Kortelainen, 2017)					x	
S-43	(Kinnunen et al., 2013)	x					
S-2	(Koch & Windsperger, 2017)		x				x
S-44	(Li et al., 2016)	x					x
S-45	(Liu & Rong, 2015)	x	x			x	
S-36	(Rehm, Goel, & Junglas, 2017)	x	x	x			

Benghozi and Salvador (2014), Koch and Windsperger (2017), Liu and Rong (2015) and Rehm, Goel, and Junglas (2017) acknowledge the importance of *dynamic capability* of business actors in a DBE. Referring to Teece, Pisano, and Shuen (1997), Koch and Windsperger (2017) posit dynamic capabilities as the agility, fluidity, or adaptability level of an organisation in a DBE. Benghozi and Salvador (2014) suggest that dynamic capabilities help business actors to gain and sustain their competitive advantage.

Koch and Windsperger (2017) claim that dynamic capabilities help business actors to create value as a result of collaborations in DBE, only if business actors open their value creation structure and processes. Rehm, Goel, and Junglas (2017) suggest *networking capability* is vital for business actors as they have to understand who they are partnering with, what are the contributions from each partner, and how exactly each partner can cooperate with others across the network. Business actors should take networking activities as a learning process where they can integrate knowledge and pooling available resources in the DBE when exploring or pursuing new opportunities. However, business actors should consider aspects such as the business needs and the terms when managing the relationship with other partners (e.g., adding, reconfiguring and ending a relationship) to ensure the *network capability* is functioning to its best. Similarly, business actors should equip with the *collaboration capability* from the information exchange and process integration perspectives (Graça & Camarinha-Matos, 2017). The key *collaboration capability* areas include sharing cost and risk, reducing the level of dependence concerning third parties, enhancing innovative capacity, defending or increasing a position in the market, increasing flexibility and agility, improving knowledge sharing or increasing specialisation, establishing appropriate rules, and sharing corporate responsibility. Camarinha-Matos and Afsarmanesh (2018) propose to study this capability by examining the collaboration building blocks such as identifying the presence of other business actors, distinguishing between collaborators and cheaters or freeloaders, establishing the social bonding, assessing the social environment, adjusting behaviour according to past behaviours of partners, maintaining future benefits, and selecting suitable partners. Regarding *strategy capability*, business actors should align their innovation strategy when forming or joining a DBE (Järvi & Kortelainen, 2017). Most business actors do not typically rely on a single DBE but benefit from joining multiple DBE.

Additionally, business actors can examine the *strategy capability* from the process viewpoint. Liu and Rong (2015) suggest the core properties of studying the *strategy capability*: 1) co-vision (processes for formalising interaction methods and collaboration

assessment), 2) co-design (processes for developing new product or services, platform strategy, and organising efforts of generating solutions), and 3) co-create (processes for promoting the platform and optimising the operational processes). Lastly, business actors should also prepare themselves with *digital capability*. This capability is vital for business actors for combining resources when creating new products or services via the digital actors (Koch & Windsperger, 2017; Li *et al.*, 2016). Li *et al.* (2016) suggest the four dimensions of strategic alignment model from Henderson and Venkatraman (1993) in studying *digital capability*: 1) strategy execution, 2) technology transformation, 3) competitive potential, and 4) service-level management. Strategy execution refers to the skills of articulate, design and implements business strategy in the digital environment. Technology transformation relates to the skills of using technology in achieving business strategy. Competitive potential describes the abilities to apply technology in exploring new service or product provision, and service-level management explains the skills of employing technology for improving the current service provision. Moreover, Koch, and Windsperger (2017) propose business actors should assess *digital capability* in four perspectives: 1) devices (e.g., hardware and operating systems), 2) network facilities (e.g., physical requirements such as cable and transmitters, and logical requirements such as network protocol like TCP/IP or P2P), 3) service (e.g., application programs where business actors can create and consume content), and 4) content (e.g., information in various formats such as texts, sounds, images, and videos).

RQ3: What are the Potential Values Co-created in a DBE?

Based on the collected literature, there are 23 articles explaining value co-creation in a DBE (see **Table 8**). The relevant themes are *business model* (n=9), *value creation* (n=8), and *value co-creation* (n=7). A *business model* is vital for organisations to understand the *value creation* and *value co-creation* process. In a DBE, a *business model* enables organisations to understand how they can go beyond the boundaries for creating values through complementarities and interdependencies between an organisation and other third parties or business partners (Zott & Amit, 2013). There are three main elements when designing a business model: 1) content (the activities performed in the focal organisation and its business partners), 2) structure (how the performed activities link to each other), and 3) governance (who should perform the activities at where) (Carayannis, Sindakis, & Walter, 2015; Kohler, 2015; Muzellec, Ronteau, & Lambkin, 2015; Novikova & Vuori, 2013; Wei *et al.*, 2014).

Table 8. Values co-created in DBE

Source ID	Sources	Research Themes		
		Business model	Value creation	Value co-creation
S-19	(Ammar & Ouakouak, 2015)	x		
S-10	(Carayannis, Sindakis, & Walter, 2015)	x		
S-32	(Clarysse <i>et al.</i> , 2014)		x	
S-18	(Frow <i>et al.</i> , 2014)	x	x	x
S-33	(Golnam, Ritala, & Wegmann, 2014)			x
S-2	(Koch & Windsperger, 2017)		x	x
S-22	(Kohler, 2015)	x		
S-14	(Letaifa, 2014)		x	x
S-20	(Lusch, Vargo, & Gustafsson, 2016)			x
S-9	(Morgan, Feller, & Finnegan, 2013)	x	x	
S-34	(Muzellec, Ronteau, & Lambkin, 2015)	x		
S-24	(Novikova & Vuori, 2013)	x		
S-21	(Pagani, 2013)		x	
S-11	(Pera, Occhiocupo, & Clarke, 2016)			x
S-12	(Ritala & Tidström, 2014)		x	
S-17	(Ritala <i>et al.</i> , 2013)			x
S-23	(Wei <i>et al.</i> , 2014)	x		
S-16	(Zott & Amit, 2013)	x	x	

Similarly, Ammar and Ouakouak (2015) suggest five dimensions in representing a business model: 1) value proposition, 2) value architecture, 3) value network, 4) value engaged, 5) value generation. Value proposition contains value creation, capture and delivery activities. Value creation activities include identifying the key drivers, resources, partners and required processes for the daily business operations. Value delivery activities reflect the distribution channels to deliver values and customer relationship segment, and the value capture activities ensure that the costs are kept under control and focus on generating revenues (Carayannis, Sindakis, & Walter, 2015; Muzellec, Ronteau, & Lambkin, 2015).

The notion of the value proposition in a DBE should include multiple stakeholders or business actors in emphasising the idea of co-creating value through interactions (Frow *et al.*, 2014). Value architecture refers to an organisational structure that addresses its key activities, resources and processes, similar to the concept of the value chain where it includes activities such as manufacturing, designing, producing, marketing, sourcing to the after-sale services (Ammar & Ouakouak, 2015). Value network relates to the relationship an organisation has with its external stakeholders such as customers, supplier, competitors, partners, subcontractors and distributors in delivering value for the customers (Ammar & Ouakouak, 2015; Morgan, Feller, & Finnegan, 2013). Value engaged describes the resources invested in the value creating activities of an organisation. Value generation refers to the revenue stream of an organisation through its value creating activities (e.g., transforming value to profit) (Ammar & Ouakouak, 2015). Hence, there is no one single business model in a DBE as there are many business actors or organisations sharing the same ecosystem (Zott & Amit, 2013). However, each organisation should delineate a unique business model for achieving the desired outcome from the DBE.

Value creation refers to the contribution or the effectiveness of the final goods or services to the end users (Pagani, 2013). **Table 9** explains various perspectives on value creation. Therefore, values are created from product or service enhancements, process

integration or sharing, knowledge and information exchange activities in a DBE. This phenomenon, in turn, promotes innovation, enhances the capabilities and skills of each business actor and further leads to value co-creation (Clarysse *et al.*, 2014; Letaifa, 2014).

Table 9. Value creation perspectives in DBE

Perspective	Values created	Source
Traditional product architecture	Adding product features and enhance the product's quality	(Koch & Windsperger, 2017)
Transaction Cost Economics (TCE)	Reducing transaction cost through a hierarchical control or intermediate governance modes such as strategic alliance or joint ventures to reduce the cost	(Morgan, Feller, & Finnegan, 2013)
Knowledge-based View (KBV)	Leveraging the employee's knowledge to foster innovation and offer superior and new customer value	(Ritala & Tidström, 2014)
Value chain	Adopting Porter (1985) idea of how to turn raw materials to consumptions by considering the primary and secondary activities	(Zott & Amit, 2013)
Value network	Offering companies the potential to share capabilities, risks, objectives, generate economies of scale and share knowledge which facilitates collaborative learning, innovative ideas and integrate resources to co-produce values that a single firm cannot create on its own	(Frow <i>et al.</i> , 2014)

Value co-creation in a DBE refers to values created not only by a single organisation, but with the help of the business actors such as business networks, allies, suppliers, and customers (Pera, Occhiocupo & Clarke, 2016; Ritala *et al.*, 2013). *Value co-creation* happens when the business actors interact and collaborate in providing product or service to their customers (Koch & Windsperger, 2017). The concept of *value co-creation* particularly encourages the interactions between the provider (an organisation or a group of organisations in the DBE) and their consumers (Frow *et al.*, 2014; Letaifa, 2014). The technological infrastructure in a DBE allows consumers to determine the value of the product or service they received. The consumers do so by sharing their experience in DBE. They can also interact with the network of other business actors in this collaborative environment. Examples of value co-created in a DBE are like sharing cost-sharing (where organisations enter a new market with a lower cost), sharing risks and responsibilities, enhancing innovation capabilities, increasing flexibility, sharing resources and skills, increasing customer satisfaction, increasing efficient production, increasing productivity and optimising business performances (Golnam, Ritala, & Wegmann, 2014; Lusch, Vargo, & Gustafsson, 2016).

DISCUSSIONS AND CONCLUSION

DBE is a concept that promotes collaboration that contributes to a win-win scenario for organisations involved which is enabled by technology. In this paper, we have conducted a systematic literature review for conceptualising capabilities and value co-creation in a DBE. Capabilities and value co-creation studies are imperative for generating successful collaborations in a DBE. And in this paper, we addressed the gap of lack of research in these two aspects by conducting the systematic literature review. We analysed the results via thematic analysis and produced relevant research themes of DBE.

The results of the three research questions contribute to understanding the capabilities and value co-creation in a DBE. The results in RQ1 suggests that a DBE consists of a business and digital layer, business actors (identify relevant stakeholders) and digital actors (software, hardware). The DBE actors evolve, co-evolve and share information and knowledge for increasing their competitiveness and the competitiveness of the network of organisations. Hence, an organisation needs to understand the context of DBE before joining or establishing one. The findings in RQ2 posit business actor (e.g., an organisation) should understand and examine their current capabilities (e.g., dynamic, network, collaboration, strategy and digital) before embarking a DBE journey. Dynamic capabilities include agility, fluidity and adaptability. Network and collaboration capabilities are aspects such as information sharing and process integration. Strategy capabilities refer to aligning innovation strategy, establishing a process for co-vision, co-design and co-create. And, digital capabilities relate to the ability to use existing technology to achieve the four alignments in strategic alignment model: devices, network, service and content. On the other hand, the outcomes in RQ3 postulate that business actors should always understand their business model as it leads to value creation and later value co-creation. The business model is imperative for every single organisation as it helps to identify and achieve the desired outcomes from the DBE.

Therefore, the contributions of this paper are in twofold. From the academic perspective, this paper identifies the key research themes of capabilities and value co-creation in DBE. The research themes could be linked ontologically for developing a skeleton of a DBE model, which could be extended for future DBE research. From a practical perspective, this research delivers useful research themes for organisations to undertake the DBE journey. Organisations can employ the research themes to profile their capabilities status (e.g., business and digital capabilities), and to understand how these capabilities enable the current value creation. The DBE research themes also inform organisations of the importance of value co-created through collaborations with other organisations and how it impacts on the existing capabilities. These elements are vital for organisations to make an informed decision before making any strategic moves or interactions in a DBE.

The main limitation of this paper is that the review results disclose the capability types associated in a DBE, but not into how to measure each capability in the DBE. For instance, the literature synthesis for RQ2 describes the capabilities study in a DBE context. However, literature is scarce in examining capability from the methodological perspective. Similarly, the literature analysis in RQ3 shows the key themes related to value co-creation. And, there is a lack of literature in quantifying value co-creation in DBE.

As for future research avenues, this paper offers an opportunity for further developing each research theme in DBE into individual assessment technique. This paper delivers the research themes that guide the activities or events before establishing or joining a DBE. Moreover, the outcome of this research could be extended by employing enterprise architecture for modelling the DBE with Archimate (adapted from Aldea *et al.*, 2018; Korpela, Kuusiholma, *et al.*, 2013; Tan, Sun, & Liu, 2015). Archimate offers rich semantics for modelling concepts and their relationship. Archimate could be applied to make sense of the research themes discovered via the systematic literature review and develop a practical DBE model that consists of business, application and technology services. Future research can focus on delineating each service with quantifiable data, which eventually affect the value creation and co-creation.

Moreover, the research themes produced in this paper can serve as a foundation for a technical prototype such as a digital platform. This platform will allow business actors (such as business organisations or producers, and consumers) to interact, exchange information, and collaboration based on a set of agreed principles. Furthermore, this research is closely related to topical studies such as crowdsourcing, sharing economy and platform-based business. These concepts are rooted in one theme - "collaboration", and they could benefit from the DBE research themes. The outcome will achieve an immense impact, especially in contributing to a more sustainable economy and society.

Furthermore, digital leadership is essential for actualising or increasing the DBE capabilities proposed in this research. Digital leadership in the DBE context refers to the ability of a leader of an organisation for making decisions by aligning the business and digital factors (adapted from Li *et al.*, 2016). Moreover, effective management is vital for producing a successful DBE, and the project management practice could be employed in this perspective. Therefore, future research could also focus on instilling digital leadership skills in organisations who are planning to embark on a DBE journey by adapting the relevant leadership or management frameworks, for instance, the project management framework proposed by Wenu and Tan (2019).

Lastly, this research offers a set of quality assessment criteria for SLR in DBE. Hence, along the same line, scholars could further expand the quality assessment criteria by including elements such as indexation and impact factor when scrutinising the collected source. This approach will contribute to enriching the academic rigour of the SLR related study in DBE.

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