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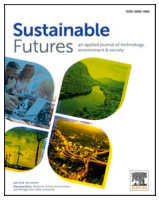

Overcoming the Valley of Death: A New Model for High Technology Startups

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ABSTRACT

The Valley of Death (VoD) reflects a series of challenges facing technology-based companies during their early development stages. Extant literature highlights the need for startups to equip themselves with the tools and resources to manage this turbulent transition. However, the existing frameworks propounded by fellow scholars and practitioners regarding VoD are fragmented, each covering only a few issues in the chasm. Thus, the current article proposes a new and comprehensive model for high technology-based startups. The new model emerged from an in-depth review of 128 scholarly materials and empirical data collected from 30 startups (from artificial intelligence, virtual and augmented realities, internet of things, medical, and cleantech industrial sectors). The model was piloted in three pre-startups. The model adds on the existing VoD frameworks to provide a holistic baseline for future research in this field by presenting different challenges underlying the pre-establishment years of a company while addressing courses of action needed to overcome this perilous transition.

1. Introduction

Valley of Death (VoD) is a situation when new businesses cannot breakeven [37,84]. It is also described as the inability of a startup to have a breakthrough [15,96]. Other scholars characterized VoD as a funding gap (e.g., [13,92,119,147]), a failed technology commercialization (e.g., [48,58,76]), or a lack of startups' governmental support (e.g., [14,39,105,151]). Considering these explanations, VoD can be regarded as an unfavorable business condition that any new enterprise can witness during their early life cycle.

Thus, VoD is not a new phenomenon to scholars, practitioners or policy makers [22,81,91]. In fact, existing literature sheds light on a palette of scholarly works, practitioner reports, recommendations, and government policies unveiling different aspects of VoD. Most of these works identified VoD causes, while some even suggested recommendations on how to overcome them. All of these research works affirmed that VoD is a serious challenge that startups, be it small businesses or large companies, are facing during their commercialization projects [76,92]. Recent studies covering high technology-based companies, especially life sciences and digitalized businesses, revealed that VoD appears to affect startups the most [51].

That being said, it is now imperative to revisit VoD, especially with the bourgeoning deployment and development of new technologies (e.g., [51,53,60]) and the necessity to make startups and small businesses sustainable [55,56,88]. This article examines the relevance of existing models of VoD, specifically in the context of high technologies and digitalized startups. This aim is based on lessons learned from previous studies on the commercialization of high technologies, including commercialization challenges (e.g., Al [6,23,113]), processes (e.g., [4,52,94,114]) and models (e.g., [50,133]; Al 5]). In this article, the term high technology refers to an innovative technology with a new added value (incremental innovations) or disrupting an existing ecosystem (disruptive or radical innovations) [31,51]. Similarly, digitalized startups refer to the business enterprises that engage in artificial intelligence, internet of things, data analytics, big data and other information and communication technologies (ICT), as discussed by Gbadegeshin [52].

To achieve the above-mentioned objectives, this article will be answering the following questions: (i) What is the Valley of Death (VoD)? (ii) What causes VoD? (iii) and How can it be managed or overcome in startups? In addressing these sub-topics, the article employs

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Table 1
Background information of the participating startups.

Line of business	Spin-off	Regular	Total
Augmented Reality /Virtual Reality (AR/VR)	4	2	6
Artificial Intelligence (AI)	1	7	8
Internet of Things (IoT)	3	6	9
Medical devices (Meditech)	1	2	3
Cleantech (Cleantech)	2	2	4
Total	**11**	**19**	**30**

The Table shows that all the participating startups engage in the high technology sectors. They were selected because they satisfied the characteristics of high technology, as described in the work of Gbadegeshin [52]. The interviewees were asked about their background, history of the startup and the research question: '*What activities have you done in order to reduce the VOD stage as a company*?'.

a systematic literature review and qualitative research methods. The rest of the article is structured as follows: methodology, findings, "Buztech" startup model and conclusion.

2. Methodology

A mixed-research method was employed in this article. Johnson and Onwuegbuzie [73] argued that the mixed-research methodology is relevant for new knowledge discovery about a specific phenomenon, which is asserted in the works of Creswell [30] and Erickson and Kovalainen [40]. Palinkas et al. [112] added that the use of the mixed-research method facilitates new knowledge convergence, as well as complements, develops and expands existing knowledge. The mixed research uses both qualitative and quantitative research methods. Some scholars note that this methodology could blend a plethora of approaches, methods, instruments, and even concepts in a single study (e.g., [73]). Therefore, this article uses a systematic literature review and qualitative research approaches for an in-depth understanding and interpretation of the collected data.

A systematic literature review (SLR) is suitable for multi-disciplinary studies, especially to ascertain focus, trends, and points of view of scholarly works on a specific issue. SLR enables scholars to understand what is known and what is yet to be unveiled about a phenomenon [34]. It is a method where different literature on a topic is consolidated [139]. In fact, SLR helps in identifying research gaps and research concentration areas [115]. In a nutshell, SLR is a method for searching and synthesizing different existing published works, such as articles, dissertations, conference proceedings, and reports on a specific topic. The main goal of the method is to detect key themes, debates and discussions around a specific topic [135]. This method can also be described as an integrative literature review; it combines related works and provides key knowledge on a topic [140]. The method requires pre-determined criteria [135] and its process consists of formulating the research question, locating literature, selecting and evaluating literature, analyzing the selected literature, and reporting findings [34].

Similarly, a qualitative research method is suitable for a study where the real subjects of the research are examined [30,154]. The method also examines how a phenomenon can be better understood [40]. It helps researchers to collect and analyze data and interpret findings [154] so that a new knowledge can be developed. This method needs to define and follow specific procedure to ensure its credibility [40,100,132]. Interviews are one of the research instruments of this method [154] and it is employed in this article.

2.1. Systematic literature review process

As with the works of Denyer and Tranfield [34] and Petticrew and Roberts [115], the SLR activities of this article were performed sequentially. The activities consisted of defining the search terms, deciding on databases, searching of literature, pre-reading, selecting relevant literature, analyzing literature materials and presenting findings. When defining search terms, VoD was selected first. The associated terms such as innovation, commercialization, business development and business model were also considered as important aspects. In addition, these terms were defined in accordance to Gulbrandsen [58], who stated that VoD is used in different contexts and it denotes different meanings. Furthermore, it affirmed that VoD in business contexts is commonly used in the scholarly works. Consequently, several researchers, such as Budi and Aldianto [22], Earle et al. [37] and Lenzer [80], stated that VoD is highly associated with the commercialization of new technologies. Some scholars also linked VoD to entrepreneurship (e.g., [89,98,126]), innovation (e.g., [15,44,53,81]), business development (e.g. [84,127,138]) and business models (e.g., [36]). Similarly, Barr et al. [13] argued that VoD is associated with financial, institutional and skill gaps. Additionally, the scholar recommended that VoD should be examined in relation to these contents. Therefore, VoD and these terms were selected for search words.

Subsequently, different databases were defined. Accessibility was the main factor that was considered while selecting the databases. Hence, ABI (Proquest), EBSCOHost, Scopus, ScienceDirect and Google scholar databases were selected. After that, the aforementioned terms were searched on the databases. For instance, VoD and commercialization, entrepreneurship and innovation were searched. Meanwhile, the search was limited to between June 2000 and June 2020. For each search, prereading was conducted, in order to reduce the number of search results. Prereading focused on the abstract to select the relevant articles. At this stage, about 600 literature materials were selected. Afterwards, the selected literature materials were read thoroughly to determine their relevance. The selection was based on the research questions and goals of this article. The selection criteria consisted the definition of VoD, perspective of VoD, causes of VoD, proposed solutions for VoD, context and industry. Then, 128 literature materials were found to be relevant to the study. They consisted of scholarly articles, conference papers and doctoral dissertations.

The selected literature was analyzed using thematic analysis method. This method was recommended by Torraco [140] and Steward [135] who stated that the SLR data needs to be categorized. The analysis was done by first summarizing each article according to each criterion. Then, the summary of each criterion was codified. The codes were later re-summarized to themes and further grouped and named accordingly. The renamed themes are presented as findings of this article. These processes were concluded according to the work of Eriksson and Kovalainen [40] and Braun and Clarke [20].

2.2. Qualitative research method process

As Silverman [132], Creswell [30] and Yin [154] recommended, couple of the authors of the current article compiled knowledge learned from previous empirical studies and startup models. This information was used to define interview questions and study participant selection criteria. The interview questions contained background information, current technology commercialization or startup activities and VoD questions (specifically, how the startup or entrepreneur experienced and overcame VoD). The selection criteria for the study participants were that the startup or company must have been active for more than 3 years, and its products, services and solutions must target international markets, and it must be registered and have its head office in Finland. With these criteria, 50 startups were contacted, with 30 able to participate.

The key management team members, such as founders, co-founders, chief executive officers and chief operation officers, were interviewed. Interviews were recorded and transcribed. On average each interview took an hour. Transcriptions were analyzed with content and thematic analysis. The content analysis was performed to reduce lengths of transcriptions. Summarized transcriptions were later codified for theme development. The themes were later grouped and presented as the

Table 2
The scholars' perspective on VoD and their industrial sectors.

Perspective on VoD	Industrial Sectors	Scholars
Finance or funding	General (no specific industry)	Maulina et al. [91], Lenzer [80], González et al. [57], Wilson et al. [148], Nemet et al. [104], Dobrenkov et al. [35], Amonarriz et al. [7], Nalivaychenk & Kirilchuk [102], Huang-Saad & Sheridan [64], Lee et al. [79], Samford et al. [128], Salamzadeh & Kirby [127], Ojeaga [107], Lukason et al. [83], Bandera et al. [11], Jung et al. [75], Otter & Weber [110], Wonglimpiyara [150], Martin [89], McIntyre [92], Vonmont [144], Gicheva & Link [54], Cooper [29], Gobble [56], Ionescu [67], Beard et al. [14], Saridakis et al. [130] and Wessner [146] Upadhyayula et al. [141]
	Military	Belz et al. [15], Ford & Dillard [48],
	Medical /Life sciences	Saarela et al. [129], Cummings et al. [32], Boltze et al. [17], Prasad et al. [118], Barrable et al. [12], Ballantyne [10], Ackerly et al. [2], Moran [99],
	Manufacturing	Nnakwe et al. [106],
	Finance	Gechbaia, et al. (2018)
	Cleantech	Hartley & Medlock III [60], Ferroukhi et al. [45], Jackson & Boxx [71], Weyant [147]
	University/ research institute	Herber et al. [61], Lackéus & Middleton [77], Maia & Claro [86], Ponomariov [116], Meyer et al. [95],
	Marine technology	van den Burg et al. [143]
	ICT	Witjara [149], D'Amico, et al. [33]
	Nanotechnology	Isaacs et al. [68]
Process	General (no specific industry)	Budi & Aldianto. [22], Earle et al. [37], Kogure et al. [84], Islam [69], Jucevicius et al. [74], Sanga [129], Elmansori [38], Hudson & Khazragui [65], Rencher [124], Bowonder et al. [18], Foster [47], Gulbrandsen [58], Stam et al. [134], Faravelli & Dovleac [43], Osawa & Miyazaki [109], Markham [87].
	Medical/Life sciences	Lettner et al. [81], Arciénaga et al. [8], Weggeman et al. [145], Byrd et al. [24], Collins et al. [28], Pusateri et al. [119], Wong [151], Youssoufian & Lewis [153] , Valverde et al. [142], Roberts et. al. [125] , Newey et al. [103], Finkbeiner [46], Reis et al. [123]
	ICT	Chi-Han & Hung-Che [27], Maughan et al. [90], Ouchi & Watanabe [111]
	Cleantech	Mossberg et al. [101], LaBelle & Goldthau [76], Brooks [21]
	University/ research institute	Rowlinson et al. [126], Farritor [44], Abereijo [1]
	Nanotechnology	Aithal & Aithal [3]
Period or situation	General	Islam [70],
	Medical/Life sciences	Thompson [138], Popp et al. [117], Fujiwara [49]
	ICT	Morales-Alonso et al. [98]
	Cleantech	Raven & Geels [121],
Barrier	General	Ford & Dillard [48], Jaksić et al. [72], Leahy & Lane [78], Markham et al. [88], Assink [9]
	Medical/Life sciences	Ray et al. [122], SeOpriş & Ionescu [108], Rai et al. [120]
	ICT	
	Cleantech	Earle et al. [37], Yadav et al. [152]
	Transportation	Midler [96], Zhou et al. [156]
	Semiconductor	Faccin et al. [42]
Risk/ Uncertainties	General	Magruk [85], Cheah [26], Tassey [136]
	Cleantech	Thies et al. [137]
Resources & competence	General	Girdauskiene et al. [55], Ibata-Arens [66], Björk [16]
	Medical/Life sciences	Liotta & Painter [82]
	University/ research institute	Barr et al. [13]
Policy	General	Carayannis & Dubina, [25], Hage et al. [59], Zhu et al. [155], Niosi [105],
	Medical/Life sciences	Saarela et al. [129], Emmert-Buck [39]

findings of the current article. The processes of content and thematic analyses were conducted as proposed by Creswell [30], Braun and Clarke [20] and Miles and Huberman [97]. The following Table 1 shows the information about the study participants.

3. Findings

3.1. Theoretical findings

3.1.1. Definition of VoD

Firstly, VoD is interchangeably used in the literature with other words to denote the same meaning. The SLR showed that "chasm" is the most common substitute term that scholars used in their works. VoD was initially used in the work of Moore (1991) and some scholars used it in their recent works, such as Earle et al. [37], Midler [96], Ford and Dillard [48], Opris and Ionescu (2016), Rencher [124], D'Amico et al. [33], Ouchi and Watanabe [111] and Yadav et al. [152]. Other substitute terms for VoD are innovation drought, innovation deficit, or innovation curve (e.g., [56]), a vacuum that exists between research and commercialization resources (e.g. [13]), market failure of new technologies (e.g., [77]), gulf (e.g., [108,118]), innovation crisis (e.g., [59]), and funding or financial gap (e.g., [53,64,129,143]; [127]). VoD is also described as an opportunity according to Merceret et al. [93], who defined it as a "Valley of Opportunity".

Secondly, it is learned that there are several definitions of VoD. The majority of scholars defined it as a financial or capital gap that exists between initial and later availability of funds for a company. Some scholars defined it as a profit-related issue, such as Nalivaychenk and Kirilchuk [102], who described it as no profit point for an entrepreneur and McIntyre [92], who described it as a point where a business, often a technology based business, has a working prototype for a product or service that has not yet been developed enough to earn money through commercial sales. Other specific definitions are: a stage between Proof of Concept (PoC) and profitability for a startup business (e.g., [44]), a vacuum that blocks adoption of new technologies [108], uncertainties opportunities, and potential responses of new technologies or innovations [85], a systematic problem caused by high uncertainties of technological and economical changes [156], a time of lack of structure, resources, and expertise that exists between discovery and commercialization of new technologies [131], a difference between government-funded research and operational use [33], a transition of innovations from the lab to the market [124], a period when new companies failed [18] and a separation world of research from world of trade and industry [16].

Thirdly, the scholars described the VoD gap as a situation where activities are not completed, are partially completed, or are delayed. The scholars also described the VoD gap from different points of view. For examples, VoD is an innovation gap where certain geography or industry is lagging behind in innovativeness (e.g., [8]; Arocena & Sutz, 2010), VoD is a discipline demarcation that occurs when a new idea is born and when it starts generating revenue. This demarcation happens to different

disciplines, such as finance, when R&D funding does generate sales (e.g., [29]; Saxton, et al., 2010; Wessner, 2008; Murphy & Edwards, 2003), and to business organizations when innovation could not turn into efficiency (e.g., Frese & Gielnik, 2014, Flamholtz & Randle, 2012). VoD is an academic or education gap that exists between the research laboratory (or invention) and the marketplace (e.g.,[1,46,116]), when there is limited funding between academic grants and private investments [61] or it exists between academic research and the commercialization of a new product [28]. Additionally, VoD is a technology gap when Technology Readiness Level (TRL) is between the stages of 5 and 6. This implies that an invention of the technology is validated but not yet demonstrated (e.g., [141]). Similarly, in technology, the VoD gap also lies between the initial innovation phase and prototype/proof of concept [137].

Fourthly, the SLR revealed that there are several perspectives in defining VoD by the scholars. These perspectives influenced their models and their recommendations. Mostly, the scholars described VoD from a financial perspective. From this point of view, the scholars defined and examined VoD as lack of funding to either commercialize new technologies or to make them profitable. The scholars from this perspective proposed different models on how new businesses or existing companies could overcome their financial bottleneck (e.g., [77,89, 148,149]). Another perspective is process. Some scholars described VoD as a process, in which a new technology or innovation needs to pass through. Their explanation contained financial problems as one of critical features of the VoD process. Examples of these scholars are Arciénaga et al. [8], Weggeman et al. [145], Islam [69] and Aithal and Aithal [3]. Some scholars also described VoD from a period or situational point of view. These scholars viewed VoD as a certain time when the commercialization of new technologies is not progressing (e.g., [49, 70,117,121,138]). Furthermore, some scholars explained VoD from a barrier perspective. They considered different problems that are associated with VoD (e.g., [42,122,156]). Similarly, some investigated VoD from the angle of risk and uncertainty (e.g., [131,136,137]) and some researched it from resources and competence (skill) point of view (e.g., [13,55,66,82]). Saarela et al. [129], Hage et al. [59], Zhu et al. [155], Emmert-Buck [39], among others, discussed VoD from a policy outlook. However, only s few scholars discussed it from a regional or geographical perspective (e.g., [63]).

Fifthly, the scholars discussed VoD in relation to different technologies. In all cases, varied technologies are high technology. Examples of the technologies are drone technologies, eHealth applications, new drug development, biorefinery, translational medicine, bio-photonics, marine technology, electrical vehicles, nanotechnology, weather satellite systems, shale gas, cybersecurity, and different medical devices. Similarly, the scholars discussed VoD mostly from these industries: medical/life sciences, university/ research institutes, cleantech, ICT, meteorological, transportation, semi-conductors and military.

To sum up, VoD is defined as a challenge that entrepreneurs, business owners, technology experts, as well as innovators or inventors, need to consider. The scholars concluded that VoD is a part of new business development and each business passes through it whether their owners like it or not. Thus, it is essential for people to know and have a better understanding of the causes of VoD. This is further described in the next subsection. The following table outlines the different perspectives on VoD and industries in the studied material.

In Table 2, the term 'general' was used when a specific industry was not mentioned in the literature. In many of the works, scholars approached VoD as general problem that reaches across industries and tried to explain and provide new knowledge on the phenomena. Similarly, the table shows that medical or life science are more focused on VoD than other industries. A possible reason for this was noted in the work of Gbadegeshin [52], who stated that life sciences entailed huge R&D investments and its commercialization takes between 6 to 10 years. The scholars also noted that this industry is highly regulated. Thus, the impact of VoD is more visible in the life sciences sector.

3.1.2. Causes of VoD

As put forth by the scholars in extant literature, limited funding or financial related problems appeared to be the main cause driving startups down the VoD curve. Many scholars covering VoD viewed it as a financial challenge affecting all business entities. In a similar line of thought, some scholars, such as Budi and Aldianto [22]; Midler [96], Aithal and Aithal [3], Belz et al. [15], Kogure et al. [84], Lenzer [80], Nalivaychenk and Kirilchuk [102], Herber et al. [61], Popp et al. [117] and Weyant [147] discussed the financial gap as a lack of governmental funds to support either technology development or commercialization activities. Other scholars, Wilson et al. [148], Huang-Saad and Sheridan [64], Lee et al. [79], Wonglimpivara [150] and Gicheva and Link [54], viewed the limited funding as a capital or equity problem. They emphasized insufficient or declining seed investments as the key drivers for capital failure in startups. On the other hand, Nnakwe et al. [106], Cummings et al. [32], Hartley and Medlock III [60], Salamzadeh and Kirby [127], Hage et al. [59] and [29]) argued that VoD's financial problem can be justified by a mismanagement of funds. These scholars cited misdirected funds, budget reduction, misallocation of funds, and wrongful handling of portfolio management as common financial pitfalls leading firms down the VoD trap. With a similar monetary viewpoint, Saarela et al. [129], Wilson et al. [148], Otter and Weber [110], and Girdauskiene et al. [55] related VoD's financial issues with liquidity problems at the startup level. They pointed to specific drivers, such as a lack of cashflows, continuously poor sales and/or low level of assets to acquire further investment. Other financial problems included poor funding policy (e.g., [75,129]), limited private financing (e.g., [57,98, 144]), lack of technology reimbursement (e.g., [91]) and sales stagnation (e.g., [103]).

Another line of thought on the causes of VoD considers the startup or organization's existing resources. The scholars from this thought argued that VoD may be fueled by a lack of resources, such as skill sets, competences and/or human resources and infrastructure needed in the pre-commercialization phases. Similarly, Thompson [138], Cummings et al. [32], Markham et al. [88], and Barr et al. [13] argued that the lack of skills or relevant competences drove many new businesses down the VoD lane. Meanwhile, Girdauskiene et al. [55] points out the need for entrepreneurship and leadership skills to bridge VoD. Thompson [138] also added that field experts are the most needed for any startups to pass through VoD. This scholar suggested that skillful staff, funds, appropriate facilities and quality materials would enable startups to pass through the pre-clinical phases in the medical sector. Likewise, Budi and Aldianto [22], Aithal and Aithal [3] and Assink [9], asserted that the unavailability of the needed infrastructure would lead some startups to fall down VoD. These scholars pointed out that availability of facilities would always assist new companies to conduct their piloting activities. The scholars added that successful piloting often helps startups to acquire the necessary funds and attract experts with the proper experience and competences for companies to bridge over the VoD phase. Additionally, Liotta & Painter [82], Dobrenkov et al. [35], Byrd et al. [24], Barrable et al. [12], Schoonmaker et al. [131], Brooks [21], Maughan et al. [90], Zhu et al. [155], Björk [16], Yadav et al. [152] and others noted that the lack of skillful personnel and facilities led to VoD.

The data analysis also revealed another key driver of VoD is the lack of collaboration. Several scholars, including Weggeman et al. [145], Amonarriz et al. [7], Byrd et al. [24], Jucevicius et al. [74], Chi-Han & Hung-Che [27], and Abereijo [1], claimed that new businesses experience VoD due to a poor collaboration with other organizations, specifically research institutes. This finding was interesting, especially when some scholars, such as Al Natsheh et al. [5], Bradley et al. [19] and Hindle and Yenchen [62] that there are always cooperation mechanisms between high-tech companies and universities (including research institutes). Pusateri et al. [119], Wong [151], Merceret et al. [93], Hudson & Khazragui [65], and Zhu et al. [155] took a step further in saying that the collaboration might be problematic due to conflicting logic between academia and business. For instance, while researchers are more

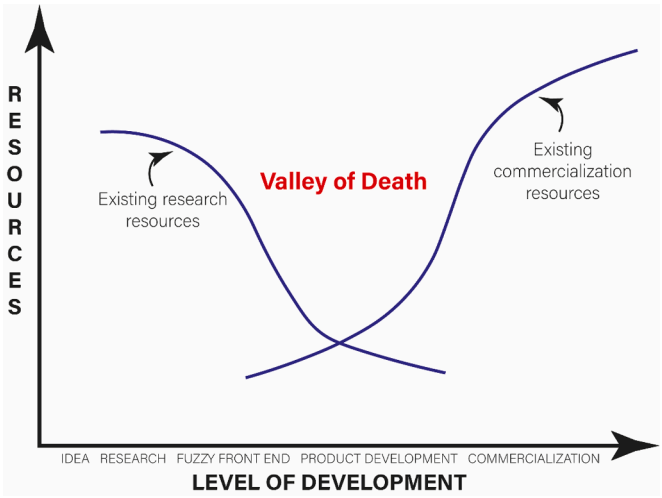

Fig. 1. Valley of Death.

oriented to new technology development, patents filing and publications, the businesspeople focus on sales and profit making for their company's survival. This difference makes their cooperation difficult. A similar perspective on collaboration was also asserted by D'Amico et al. [33], Rencher [124], Finkbeiner [46], Gulbrandsen [58], Stam et al. [134], Reis et al. [123], and Rai et al. [120].

Another cause of VoD put forth by many scholars lies in the poor understanding of the business environment, or limited business knowledge. The research revealed that most technology innovators face difficulties in grasping how a business operates, usually undermining the external factors driving market resistance and assuming an instant acceptance of the technology or product, This perspective was also briefly mentioned in the works of Nalivaychenk & Kirilchuk [102], Magruk [85], Cheah [26], Jung et al. [75], Isaacs et al. [68], Merceret et al. [93], Youssoufian and Lewis [153], Roberts et al. [125], Leahy and Lane [78], and Raven and Geels [121].

Faccin et al. [42], Byrd et al. [24], Popp et al. [117], and van den Burg et al. [143] claimed that high estimation of risks or a lack of risk estimation could cause VoD. The scholars explained that there is always high risk with new high technologies, and undermining the risks would lead startups down VoD. Magruk [85], Cheah [26], Collins et al. [28], Bandera et al. [11], Isaacs et al. [68], and Thies et al. [137] echoed this cause that the fear of high risks would lead to VoD. These scholars, Gicheva and Link [54], Valverde et al. [142], Gobble [56], Newey et al. [103], Foster [47], Beard et al. [14], and Fujiwara [49], mentioned this cause before the above scholars. Thus, it was agreed that an overestimation or lack of estimation of risks is a cause of VoD.

The data analysis showed several other causes for VoD, including insufficient time for commercialization and business development (e.g., [78,90,108]), bureaucratic delays (e.g., [21,25,28,68,111,124,156]), poor technology development (e.g., [77,109,129,156]), institutional pressures (e.g., [37,74,86,151]), high initial costs (e.g., [38,45,54]), social resistance and cultural challenge (e.g., [29,56,59,87]), poor application of the new technology (e.g., [77,121]), undermining of commercialization aspects ([36]a; [67,90,93,95,103]), a lack of successful demonstrations or testing (e.g., [75,101,122]), et al., poor innovation system (e.g., [18,72,104]), lack of government support (e.g., [39,65,105,155]) and economic crisis (e.g., [10,25,56]).

3.1.3. *Proffered solutions to VoD*

According to a majority of the scholars, acquiring sufficient funds for operations and/or commercialization remains the most important course of action for startups to accelerate the transition over VoD. Most of the scholars stated that business enterprises need to get more funds to finance their activities. Meanwhile, some scholars proposed specific sources of funds for the business. For instance, Lukason et al. [83], Zhou et al. [156], Lackéus and Middleton [77], Hossain et al. [63], and Cooper [29] recommended that startups need to appeal to business angel, venture capitalists, and government grants for alleviating their financial hurdles during pre-commercialization stages. This idea was supported by Lettner et al. [81], Morales-Alonso et al. [98], Saarela et al. [129], Islam [70], Arciénaga et al. [8], Lee et al. [79] and Ojeaga [107]. Some scholars, such as Collins et al. [28], Ibata-Arens [66] and Ackerly et al. [2] also suggested the use of government subsidies to sail through VoD.

On the other hand, scholars that include Budi and Aldianto [22], Maulina et al. [91], Lettner et al. [81], González et al. [57], Ford and Dillard [48], Arciénaga et al. [8], and Faccin et al. [42] suggested early commercialization of technologies to limit VoD's impact on the startups. These scholars argued that the commercial values of any new innovation should be identified and discussed earlier, especially during the preliminary research of the innovation process. These scholars also asserted that academia should consider embracing a business logic in their philosophy to reap benefits from innovations, especially for a society betterment. As such, new innovations should be problem solvers in order to be beneficial for society.

Another line of thought considered engaging relevant stakeholders to manage VoD problems and help businesses thrive during this perilous transition. Accordingly, scholars such as Lettner et al. [81], González et al. [57], Weggeman et al. [145], Boltze et al. [17], and Prasad et al. [118] pointed out that all important stakeholders need to be identified and engaged in new business activities. The latter should, according to Wong [151] Hudson and Khazragui [65], Roberts et al. [125], Carayannis and Dubina [25], and Maughan et al. [90], include market opinion leaders, government agents, new technology users or beneficiaries, and technology experts. Similarly, Nemet et al. [104], Hartley and Medlock III [60], Van den Burg et al. [143], Magruk [85], and Jung et al. [75] recommended that startups need to collaborate with their stakeholders. They suggested that collaboration with academic and research institutes is important. A similar viewpoint was supported by Gicheva and Link [54], Weyant [147], Emmert-Buck [39], and Beard et al. [14].

Another VoD solution is for the startup to have a qualified team to enable a smooth management of the VoD transition [8,85,87,152,155]. Accordingly, these scholars advised that having people with relevant know-how and business skills is essential. The scholar reinforced that a diversified team, where individuals from different backgrounds and with varying competences that complement one another, brings strength in the business.

Arciénaga et al. [8], Magruk [85], Jaksić et al. [72], Merceret et al. [93], Maia and Claro [86], D'Amico, et al. [33], Raven and Geels [121], and Fujiwara [49] pointed out different management strategies for companies to alleviate the VoD transition, including but not limited to: agile learning and decision making, intrusive management, strategic niche management and technology management.

Having internal and external knowledge was also proposed as a possible solution to VoD. Kogure et al. [84], Midler [96], Chi-Han, & Hung-Che [27], Bandera et al. [11], Lackéus and Middleton [77] and Newey et al. [103] called on startup teams to seek knowledge on specific technology supply chains. As such, startups ought to cautiously consider both industrial and market information that might interfere with different aspects of a product's supply chain. In this sense, factors like competition, suppliers, and customers information are of essence for the successful commercialization of a new technology onto markets.

Finally, the scholars also called on governments to provide a better business environment or infrastructure. Particularly emphasis was on the need to allocate more funds for commercialization of innovations, construct facilities for entrepreneurial use, offer tax breaks for new and striving businesses, and provide subsidies for these organizations. In line with the governmental support perspective, Lenzer, [80], Nnakwe et al. [106], Liotta and Painter [82], Amonarriz et al. [7], Bandera et al. [11], Magruk [85], and Abereijo [1] pointed to the need for governments to

establish entrepreneurially specific policies that enable companies to overcome the perilous VoD transition. Further details of the aforementioned solutions are presented Table 4 below.

3.1.4. The existing VoD models

The literature review shows an aggregate of 33 different VoD models. However, the most commonly cited model is that of Markham [87], which shows the gap between resources' availability for R&D and commercialization activities, as presented in Fig. 1 below. Most of the existing models added on Markham's [87] framework, emphasizing different gaps, such funding and skill gaps.

The existing models used different yardsticks for their y-axis and x axis. On the y-axis, some used revenue or income (e.g., [35,67,128]), valuation (e.g. [79]), influence (e.g., [88]), sources of finance (e.g., [98]), money flow (e.g., [53]), commercial value (e.g., [24]), cumulative profit/loss (e.g., [80]), visibility (e.g., [108]), net cashflows (e.g., [98]) and funds (e.g., [84]). All these terms refer to the availability of monetary resources. As for the x-axis, some used time (e.g., [80,108]), company's life [98], and stage of production (e.g. [128]). The latter terms reflect the startup's development level. That being said, some scholars did not specify neither the y- nor the x-axis (e.g., [129]; Beard et al., 2013), but rather used different visuals to show how resources are available in the y-axis and how the resources are reduced in x-axis. Thus, all the models affirmed that there is a resource availability on one side and there is reduction of the resource on the other side; the gap that causes the difference is termed as VoD.

Some models showed that VoD could occur more than once (e.g., [93,123,129,138]). These models revealed that if a startup survived a first VoD, it might have another one in the future. In fact, the model of Markham et al. [88] depicts that VoD could occur at different commercialization phases.

Although the existing models explained how VoD looks and its impact on the startup, they did not yet explain how VoD could be managed. The models did not show how this perilous transition could be prevented or flattened. Similarly, some existing models focused on the "financial" aspect of VoD, but other aforementioned gaps seemed to be missed. Nevertheless, the models illustrated that VoD is a serious challenge that startups are facing. Therefore, the current article considers these weaknesses in its new model.

3.2. Empirical findings

3.2.1. Differences in startups

The empirical data analysis shows that there are differences among startups. The first difference is that spinoff startups are supported by parent organizations (most commonly universities) and government financial agents. The spinoffs have more possibilities to participate in government financial programs than non-spinoffs (termed here as "regular startups"). The second difference is that spinoffs have strategic cooperation with their parent organizations, which regular startups strive to achieve. The third difference is that the spinoffs have a long history with their innovation (that may have been developed through various projects); meanwhile, regular startups might not have such a history. The last difference is that of their ecosystems. For instance, the spinoff might have issues with IP ownership or right to use with the parent organization, whereas the regular startups might face crises because they are not accountable to any large organizations.

However, the above-mentioned differences do not impact how the startups manage their VoD. It was learned that all the participating startups experienced VoD. Based on public business information (collected from the Finder.fi database), the participating startups were at different stages of VoD. Some of them passed, while others struggled. It was learned from public data that a couple of them appeared still to be trapped at the time of writing this article. This trapping means that they have not yet breakeven, but they get more funds, employees, and sales, while incurring more costs. These trapped startups appeared to have promising solutions, which needed further developments for additional industrial applications. The trapped startups studied in this article are engaging in the medical field and IoT. The following Table 5 shows their details.

3.2.2. Managing VoD

Participating startups were invited to answer the following question concerning our research study: "What activities have you undertook, at the organizational level, to alleviate the VoD transition?" Responses show that these companies employed different strategies to cope with the Valley of Death, as detailed below.

3.2.2.1. Business creation and development. The Empirical data showed that startups emerged by capitalizing on a need for a real world solution. Their technologies aimed to solve real life problems. One of the founders from ***AI8*** said: *three other co-founders came along after they saw how deep understanding of the problem from the technological and domain standpoint, we (2 founders) have.* Similarly, most of the startups' technologies were protected with patent rights and a couple of them were protected before the actual development. The analysis also shows that the startups had a good team. For instance, interviewees from ***AI6*** pointed that the *first thing where the company fails is in a bad team selection*. The startups tried to avoid this problem. They also tried to recruit and retain experienced team members asserted by an interviewee from ***CT2***: an *experienced team knew what kind of risks could come, and then avoid or minimizes them*. The startups' team was well equipped with the relevant technology skills, business skills, working experience, persona (entrepreneurial mindset) and a good network. The founder of ***AR/VR4*** shared that the key aspects he specifically looked for when building the team were: experience, technical skills and persona (entrepreneurial mindset). Furthermore, the startups' main founders had a clear understanding of the requirements of committing to entrepreneurship. This was emphasized by an interviewee from ***MD1*** who mentioned that *without one of the founder's entrepreneurial experience the company would not exist, founding a company brings a lot of surprises*.

The analysis revealed that there was a clear agreement among the team members. One of the agreement documents was the shareholder's agreement. The startups had well-crafted shareholder's agreement that contained ownership, positions (roles) and their responsibilities, exit strategy, IPR, dispute resolution and other important issues. Some of the startups outsourced the preparation of their agreement to professional experts. The analysis delineated that the startups appeared to have stories or learned (from their past experiences) how unwritten agreements were problematic. It also delineated how the startup team made assurances to avoid these problems. A couple of interviews shared how sub-standard agreements doomed some startups to failure.

The interviewees also emphasized the importance of board members. They stated that the board must have an expert in the company who understands customers' pains, their purchasing power, and their willingness to pay. The interviewee from the company ***AI6*** supported this point by adding that:

…would be good to have a person within the team or as a board member that has been dealing with those key problems in that specific industry (customers') the startup is trying to solve or even made his work career in that industry. If you can convince him about your idea, then you can convince others too, namely customers.

They also stated that the board must have a member with good established networks because that person can open access to some vital gatekeepers. They noted that someone in the board must have industry expertise. They explained that such person usually gives credibility and validation in the customers' eyes. They illustrated that when a startup is developing a medical device, having a medical doctor or scholar in the board would send messages to the target industry and customers that their products is of value. They affirmed that a good profile of board members conveys a message to the potential customer. They also added

that having a legal practitioner in the board helped to negotiate with big companies. Interviewee from the company ***AI3*** said: *legal practitioner in a board usually offers knowledge for a startup to negotiate with big industrial companies*.

The data analysis revealed that startups defined the needed skills and competences for their potential employees. They hired staff with specific skills and did not focus only on the technological knowledge or background. In fact, an interviewee from the company ***AI7*** mentioned that *we try to hire top people who are better than any of us existing people in some aspect*. They employed people with sales competence (as their in-house marketers). They also tried to entice new employees with other incentives that went beyond monetary one. The interviewee from ***AI1*** said: *if tech people is acquired only with money, they leave immediately when salaries are one week late (inevitable situation)*.

3.2.2.2. Technology and IPR management. The startups considered the relevance of timing for their technology transfer or commercialization process. The study interviewees shared that they allocated sufficient time to their commercialization process because they were aware of possible challenges associated with IPR. One of the interviewees shared an experience when a company had bad experiences with *public-private-partnership* research projects. He narrated that a public-owned organization demanded 500 000€ for an IP that the company created itself. He ended that the new company went into bankruptcy due to the low demand. Another interviewee shared that the *university technology transfer policies and terms may even create "showstoppers" for later investors*.

The startups also paid attention to the importance of IP. The interviewees emphasized that an IP is important, but its importance needs to be weighed. One of the interviewees said: *a company made a licensing deal with the university about IPRs. Soon it was obvious that the patent, software and market research data were completely worthless*. This could be a reason why the interviewee from ***AI5***said: *in the best case, patents are key thing for success, but it requires they are strong enough and you have the resources to defend them*. Another interviewee shared that, at first, their university wanted to own their IPR for the software, which was seen as impossible from their company's viewpoint. He narrated further that later his team and the university settled the issue with an agreement that the university had the right to use the software, while their company also had the right to use it for business purposes.

In addition, the startups focused on how IPs could be used effectively. The startups also showed that the IPR should not be use only as a competitive advantage. The interviewee from ***CT3*** said: *despite the large number of patent, highly skilled people were seen most important in the company*. The interviewee from ***AI3*** added that: *If IPRs were the main company's crucial competitive edge, the company's story could be short if suddenly these founders would leave*.

3.2.2.3. Networking and ecosystem. The data analysis showed that the startups used their networks to recruit team members, employees, advisors, and board members. The interviewee from ***IoT7*** attested to this by mentioning that: *recruiting has been successful via personal networks. Easier to get in talks with customers when industry contacts are starting to form*. The startups used the personal networks of their founders, employees, and board members to get suppliers, customers, collaborators and investors. The interviewee from ***CT1*** said: *personal networks to critical component suppliers have helped the company by giving access to components not available to all startups*. The interviewee from ***AR/VR3***added that: *our founding partner knows personally a large part of company leaders, and who he does not know, knows him; so it is very easy for us to get in touch with potential clients*. The interviewee from ***AI8*** supported this argument by adding that one of their founders owned a professional network which helped their company secure R&D agreements with 7 customers from their main target group and gain access to data enabling the firm to develop algorithms.

The startups also used their networks to raise funds. The company ***AI3*** mentioned that their founders employed their existing connection with listed industry giants (on stock exchange market) to get their early sales from big industrial clients. The company ***MD2*** also mentioned that their first customers and funding came from the personal networks of their team members. Additionally, the startups tried to broaden the existing network for further progress and sustainability in the long run. The interviewees shared that they engaged in different activities, such as trade fairs and exhibitions, mainly to build solid network ecosystems.

On the ecosystem level, the empirical data revealed that the spinoff startups made use of their university and their networks. These startups were safeguarded in having good relationships with public organizations. One of the interviewees from ***IoT2*** shared that a business development manager from a public-owned organization helped their company to spin-off and to find investors.

3.2.2.4. Sales and revenue model. Interview analysis reveals that the startups tried to make early sales. They focused on making sales as soon as they were established (and even prior to their commencement). Early sales efforts caused the startups to engage in piloting. For instance, the company ***IoT6*** got its first customer projects before it was established. Similarly, the company ***CT4*** got involved in a public commercialization project with a public organization that subsequently made a big purchase within one month of the startup being founded. The interviewee from ***IoT6*** said: *we see pilots as a way to get foot in the door and proof of concepts offering a low threshold way to test solution's business benefits;* another respondent from ***AI7*** added: *piloting bring in revenues, but we have tried to price them in a way that the makes the main emphasis on learning; I see the pilot's biggest value in offering us market information and requirements*. The interviewee from ***IoT3*** shared their experience as follows:

This is a so new technology and question mark to the customer that pilots need to be sold separately. Pilots should be between 3-6 months to get enough data for the basis of purchase decision-making. We don't benefit from rushing the pilot because it may decrease the buying arguments (lack of data).

Similarly, some startups engaged in pre-study services to generate sales. The interviewee from ***AR/VR3*** shared their experience on the pre-study service by saying:

We offer and bill customers early with pre-study and design sprint services in order to i) teach them about this issue, ii) scope problems to solve and iii) better select the best cases which we then sell to the customer.

The startups used their early sales to determine their demand and test their customers' commitment. *Sell first … then, committing potential customers to pay verifies the true demand*, as mentioned by an interviewee from ***MD3***. The company ***IoT4*** also affirmed that giving products or services for free does not guarantee clients' commitment. The company added that free gifts may send a wrong signal. The interviewee from ***IoT4*** said that they started to send monthly payments to clients that wanted to test their products as a compromise and a message that their solution works and satisfies their need. This interviewee shared that their clients paid their setup costs and their company received valuable feedback. The interviewee from the ***AR/VR3*** discusses:

… product-oriented companies, many times, fail in this, when you have a product, customers want to have a taste of it. You always have to make a little NRE-work and if you don't bill it, you're in trouble. It takes courage to say to customer, you need to pay if you want to try.

Meanwhile, the participating startups realized that they needed in-house salespeople with a particular emphasis on the marketing and technology know-how or expertise. The ***AI4*** company found that getting new salespersons in high technology businesses is difficult and these enterprises should try to raise, develop, and retain their internal salespeople. This company and several others emphasized that in-house salespeople often understand core solutions of the company and have the ability to explain these solutions to customers. In addition, the startups realized that they needed to prepare for possible "mass production". The startups appeared to be aware of the need for urgency and

the unexpected demands of their products; thus, they planned for it. The interviewee from ***CT4*** explained that getting an order from a large corporation often followed with some layers of questioning regarding supply reliability, financial status, quality systems and soon. The interviewee added that these questions should be envisaged and well-planned for a good startup.

Concerning the revenue model, the participating startups used different frameworks. Their revenue model depends on their solution and industries. For example, the interviewee from ***AR/VR4*** argued that the medical industry is complex and hierarchical. He explained that the complexity of the industry could be noticed from its sales process by saying: "*from…letter of intent to memorandum of understanding to the evaluation agreement to the conditional distribution contract (e.g. when certifications are ready, buyer is obliged to buy a certain amount in certain price etc.)*. However, startups employed different models to achieve a profitable level for their business. The interviewee from ***AI1*** attested that when their investors suggested a pricing model change. The stakeholders first agreed and tested it, but soon returned to the old model as it was proven to be more lucrative.

3.2.2.5. Value proposition and customer creation. The main key value propositions of the participating startups are added value and cost saving. The startups employed different strategies to ensure that their customers see the values in their solutions and understand the inherent cost benefits. The interviewee from ***AI1*** pinpointed that: *we have cost savings excel to support the sales process, but the added value aspect is more interesting in our case. If we can help the company to bring a product earlier to market, it could mean closer to billion euros*.

One of the most interesting findings is the way startups created, developed and retained their customers. Results from the data analysis show that startups exerted great effort and made use of varying methods to attract and convince potential customers. The first method is having an industrial expert that can guide the startup team on how the industry looks, provide customers' information (characteristics), advise on regulations and outline different market segments. One of the interviewees adds that:

Customers are not going to start to calculate how much your service creates savings. When you have an industry expert, he knows the pain points of customers which can be cost savings, added value, security, increase of working comfort or anything.

The second method lies in contacting potential customers. The startups showed that they immediately identified their customers and started to contact them. The interviewees emphasized that reaching out to the customer is one of the most critical activities of any high technology-based businesses. The interviewee from ***AR/VR5*** said: the *customer contact is important already during the development project that you know you are doing the right thing*. The startups required that their team members went outside to visit, meet and discuss with their customers. One of the interviewees shared that *if I would setup a company now first thing, I would do now would be to buy flight tickets and go travel the world and discuss with accelerators of specific verticals*. The third method lies in the proper communication with customers. In this sense, the startups obliged that they talk and make their customers understanding their solutions. When discussing with customers, the startups focused on how their solution could impact or improve their clients' business. In this regard, the interviewee from ***CT4*** said: *we try to communicate to customer that we are not trying to replace their existing solution but more like offering a new business opportunity*. Some startups considered communication with the customers paramount to the business' survival, as mentioned by ***AR/VR3*** that:

One key aspect in our business is that we need to teach a customer to buy because what we try to sell is so new. We try to benchmark other businesses in the same (or close) market and see what kind of business models successful companies use.

The last method resides in a deep understanding of customers' needs. They used the understanding to tailor their solutions to the needs of the customer, as well as to specify key areas where their solutions could be of add value. The interviewee from ***AR/VR3*** confirmed that although they knew little about customers' core business, they were able to find paths to help customers find the right things concerning their technology due to their understanding of the customers. The interviewee from ***AI1*** added: *deeper vertical (market) thinking is important and not just stating that this technology is applicable to everything*.

3.2.2.6. Marketing and communication. The empirical data showed that the startups focused on ways to gain visibility in the customers' specific industries. As such, companies engaged on different events organized for various industries. They also used different personal networks to access to industrial networks and tried to avoid niche market events. The interviewees shared that a greater visibility enabled them to reach out to unknown customers. Similarly, the startups did not only use local advertisements, but also promoted their solutions internationally. Finally, the startups considered starting their marketing and promotion activities at an early stage. The interviewee from ***AI1*** denotes: *never underestimate the power and importance of being present in new markets*.

3.2.2.7. Strategic focus. There was a common strategic focus among the startups. The startups were aware that everything they do should increase their valuation. They were aware that a better valuation of their business would compensate their efforts. Similarly, the startups tried to secure sufficient funding so that they could focus on the essential activities that would lead their business to success. The startups tried to avoid the "solution is seeking a problem" mindset, and instead focused on the "solution solves this problem". Additionally, the startups tried to avoid "home-market-trap". They were aware that their niche market is not only available in their home countries, but also all over of the world.

3.2.2.8. Finances and funding. The startups used various sources of funding to establish and develop themselves. Most of the startups used public funding programs, both locally and internationally. They also used private finances to kick off their operations. The startups used their early sales as a good financing source. They also borrowed from public and private organizations and used equity to raise funds. Furthermore, the data analysis showed that these startups considered all different funding programs that were available, and wisely deduced on how to they apply for them. They considered local government programs (such as Business Finland and ELY programs which are locally available in Finland), as well as international programs (mostly through the European Commission). In addition, startups tried to utilize professionals when applying for more demanding public instruments (namely EU) in order to compensate their insufficient skills and time for company's activities.

Startups were also aware that investors invest in entrepreneurs, and therefore, acquired additional help when needed in finding funding contacts and preparation of the investment cases. They analyzed which issues raise leverage in funding negotiation specific to the industry at hand (e.g. patents, distribution contracts, research and development partnerships etc.). Startups also ensured a proper preparation for stakeholder meetings and negotiations, after a careful research and screening of international venture capitalists, accelerators and incubators. Whenever they got an offer from an investors, they considered their need and urgency for accepting or rejecting. They focused on "decent" investment offers instead of waiting for a perfect deal.

With regards to financial management, the startups avoid providing exorbitant salaries for their executives to optimize on existing resources needed for running daily operations. They ensured that there is always available money for urgencies, and did not blindly rely on "promising" sales to sustain operations. these startups rather focused on existing funds received. They constantly check revenue models and their subsequent impacts the company's financial needs. Overall, their main

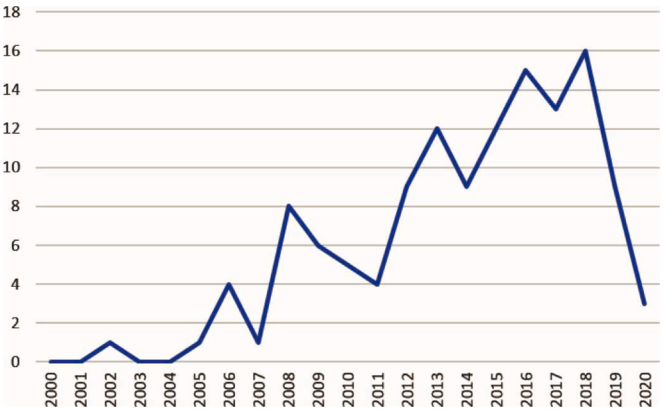

Fig. 2. Numbers of scholarly materials published per year.

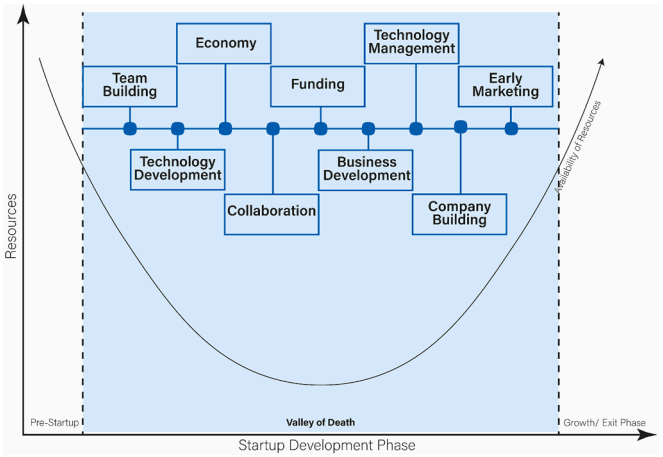

Fig. 3. Buztech startup model.

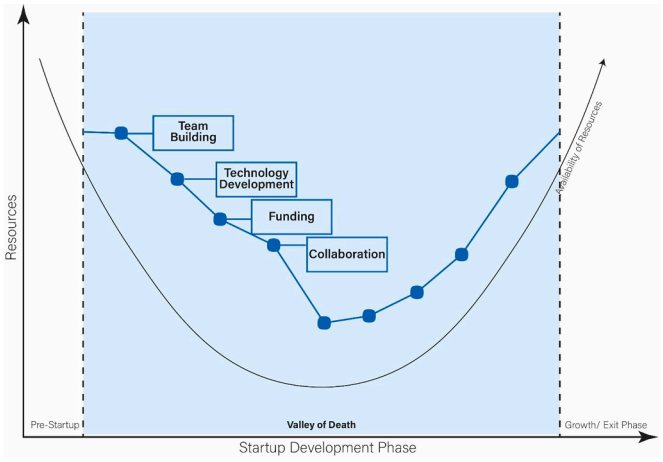

Fig. 4. The impact of some BSM blocks on Pilot B startup.

financial strategy is geared towards a "lower costs, increased income" logic.

3.2.2.9. Technology readiness level. The common TRL level among the startups, using European standard, is between 5 and 7. According to the European Commission [41], TRL 5 denotes that a technology is validated in a relevant industrial environment, while TRL 6 means that a technology has been demonstrated in a relevant industrial environment.

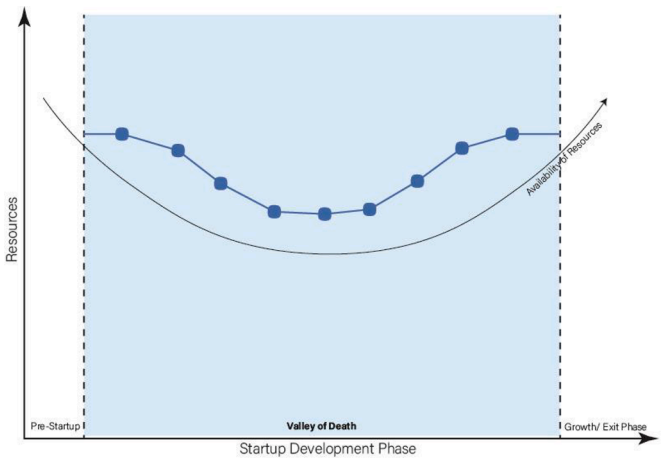

Fig. 5. The impact of BSM on a startup.

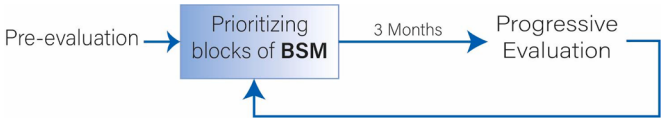

Fig. 6. The application of BSM.

The Commission states that TRL 7 exists when a technology prototype is demonstrated in an operational environment. As such, startups that quickly passed through VoD had a TRL 7 during their establishment and made use of public funds to reach the level.

4. Discussion and emerging of Buztech startup model

Some previous works centered around startups, such as Gbadegeshin (2017), Al Natsheh et al. [5] Bradley et al. [19] and Hindle and Yenchen [62], presented that there are three development stages for any startup: pre-startup, startup and growth/exit. According to these scholars, amongst others, at the pre-startup stage, innovation is confirmed, and its technology is under development. At this stage, there is sufficient resources. The available resources are mostly in the form of adequate finances and an access to several networks. These resources depend on the nature of the technology, its application areas, and its relevance to the needs and wants of the customers. Meanwhile, there may be no formal business discussion among the team members. At the startup phase, there are formal business discussions and sometimes there may be business transactions. Hence, the business reality IoT3s in at this stage. The resources at the startup's disposal are reducing, just as the need for more increases. This phase represents VoD and startups usually find themselves in a difficult situation. It takes about three years for the startups to sail through VoD. Once they passed through VoD, they start to experience growth. This stage is known as the growth or exit stage. At this stage, sales revenue is enough to sustain the startups' development and the debt a company had accrued is shrinking. In some cases, the investors are seeing returns on their investment. Also, at this stage, some founders prefer to sell their business, while others merge their business with large corporations, hence it is one of reasons the phase is also referred to as the exit stage.

Considering the theoretical and empirical findings of this article, it is well established that VoD occurs at the startup phase. Likewise, the findings and lessons learned from the previous studies (such as, Al Natsheh et al. [4,5] & [6] established that VoD needs a new framework. Similarly, in consideration of the boom of digitalization and its impact on new business boom, the need for a new model is compounded. Additionally, the trends of the scholarly materials analyzed for this current article shows that there is an increase on the papers published on

Table 3
The causes of VoD.

Factors	Scholars
Limited funding	Budi & Aldianto. [22], Kogure et al. [84], Earle et al. [37], Lenzer [80], Midler [96], Belz et al. [15], González et al. [57], Saarela et al. [129], Thompson [138], Wilson et al. [148], Cummings et al. [32], Arciénaga et al. [8], Gechbaia et al. [53], Upadhyayula et al. [141], Ray et al. [122], Dobrenkov et al. [35], Amonarriz et al. [7], Herber et al. [61], Lee et al. [79], Popp et al. [117], Samford et al. [128], Witjara [149], Ojeaga [107], Boltze et al. [17], Lukason et al. [83], Prasad et al. [118], Zhou et al. [156], Jaksić et al. [72], Martin [89], Jung et al. [75], Isaacs et al. [68], Wonglimpiyara [150], Pusateri et al. [119], Girdauskiene et al. [55], McIntyre [92], Vonmont [144], Barrable et al. [12], Hage et al. [59], Gicheva & Link [54], Merceret et al. [93], Ponomariov [116], Brooks [21], Maughan et al. [90], Zhu et al. [155], Jackson & Boxx [71], Valverde et al. [142], Roberts et. al. [125], D'Amico et al. [33], l.Rencher [124], Leahy & Lane [78], Weyant [147], Meyer et al. [95], Barr et al. [13], Gulbrandsen [58], Ibata-Arens [66], Saridakis et al. [130], Stam et al. [134], Fujiwara [49], Reis et al. [123], Ackerly et al. [2], Moran [99], Yadav et al. [152], and Wessner [146]
Lack of relevant skills/ competences / human resources	Thompson [138], Cummings et al. [32], Liotta & Painter [82], Upadhyayula et al. [141], Dobrenkov et al. [35], Byrd et al. [24], Aithal & Aithal [3], Jung et al. [75], Girdauskiene et al. [55], Barrable et al. [12], Schoonmaker et al. [131], Brooks [21], Maughan et al. [90], Zhu et al. [155], Roberts et. al. [125], Leahy & Lane [78], Markham et al. [88], Barr et al. [13], Stam et al. [134], Reis et al. [123], Björk [16], Yadav et al. [152]
Lack of cooperation	Kogure et al. [84], Islam [70], Arciénaga et al. [8], Weggeman et al. [145], Amonarriz et al. [7], Byrd et al. [24], Jucevicius et al. [74], Chi-Han & Hung-Che [27], Abereijo [1], Pusateri et al. [119], Wong [151], Merceret et al. [93], Hudson & Khazragui [65], Zhu et al. [155], D'Amico et al. [33], Rencher [124], Finkbeiner [46], Gulbrandsen [58], Stam et al. [134], Reis et al. [123], Rai et al. [120]
Poor understanding of business environment	Islam [70], Arciénaga et al. [8], Hartley & Medlock III [60], Nalivaychenk & Kirilchuk [102], Magruk [85], Cheah [26], Jung et al. [75], Isaacs et al. [68], Merceret et al. [93], Youssoufian & Lewis [153], Roberts et al. [125], Leahy & Lane [78], Raven & Geels [121]
High risks	Faccin et al. [42], Thompson [138], Hartley & Medlock III [60], Byrd et al. [24], Popp et al. [117], van den Burg et al. [143], Magruk [85], Cheah [26], Collins et al. [28], Bandera et al. [11], Isaacs et al. [68], Thies et al. [137], Tassey [136], Gicheva & Link [54], Valverde et al. [142], Gobble [56], Newey et al. [103], Foster [47], Beard et al. [14], Fujiwara [49],
Insufficient time	Budi & Aldianto. [22], Aithal & Aithal [3], Opriş & Ionescu [108], Maughan et al. [90], Leahy & Lane [78].
Bureaucratic delays	Budi & Aldianto. [22], Arciénaga et al. [8], Amonarriz et al. [7], Aithal & Aithal [3], Collins et al. [28], Zhou et al. [156], Isaacs et al. [68], Carayannis & Dubina, [25], LaBelle & Goldthau [76], Brooks [21], Zhu et al. [155], Roberts et. al. [125], D'Amico et al. [33], Rencher [124], Ouchi & Watanabe [111], Reis et al. [123]
Poor technology development	Ford & Dillard [48], Popp et al. [117], Islam [69], Sanga [129], Zhou et al. [156], Lackéus & Middleton [77], D'Amico et al. [33], Raven & Geels [121], Björk [16], Yadav et al. [152], Osawa & Miyazaki [109]
Institutional pressures	Earle et al. [37], Amonarriz et al. [7], Jucevicius et al. [74], Zhou et al. [156], Wong [151], Maia & Claro [86], Rencher [124], Reis et al. [123]
High initial costs	Faccin et al. [42], Thompson [138], Hartley & Medlock III [60], Nalivaychenk & Kirilchuk [102], Byrd et al. [24], Girdauskiene et al. [55], Elmansori, [38], Gicheva & Link [54], Ferroukhi et al. [45]
Social resistance and cultural challenge	Ford & Dillard [48], Arciénaga et al. [8], Liotta & Painter [82], Dobrenkov et al. [35], Carayannis & Dubina, [25], LaBelle & Goldthau [76], Hage et al. [59], Cooper [29], Gobble [56], Markham et al. [88], Reis et al. [123], Markham, S. K. [87]
Poor application of technology	Ford & Dillard [48], Sanga [129], Lackéus & Middleton [77], Raven & Geels [121]
Ignoring of commercialization aspects	Earle et al. [37], Earle et al. [37] Merceret et al. [93], Maughan et al. [90], Newey et al. [103], Ionescu [67], Meyer et al. [95], Beard et al. [14].
Lack of successful demonstration	Upadhyayula et al. [141], Mossberg et al. [101], Ray et al. [122], Byrd et al. [24], Jung et al. [75], Brooks [21]
Inactive actors	Mossberg et al. [101], Opriş & Ionescu [108]
Poor innovation system	Nemet et al. [104], Jaksić et al. [72], Hage et al. [59], Cooper [29], Ionescu [67], Bowonder et al. [18]
Lack of government support	Hartley & Medlock III [60], Popp et al. [117], Aithal & Aithal [3], Jaksić et al. [72], Wong [151], Hudson & Khazragui [65], Zhu et al. [155], Emmert-Buck [39], Beard et al. [14], Niosi [105]
Low entrepreneurial acumen	Kogure et al. [84], Rowlinson et al. [126], Upadhyayula et al. [141], Popp et al. [117], Prasad et al. [118], Abereijo [1], Lackéus & Middleton [77], Girdauskiene et al. [55], Hage et al. [59], Gicheva & Link [54], Merceret et al. [93], Foster [47]
Poor brand image	Budi & Aldianto. [22]
Selling and marketing challenge	Maulina et al. [91], Nemet et al. [104], Jung et al. [75], Newey et al. [103], Raven & Geels [121], Faravelli & Dovleac [43], Yadav et al. [152], Osawa & Miyazaki [109]
More focus on technological development	Earle et al. [37], Opriş & Ionescu [108]
Poor application of technology	Ford & Dillard [48], Sanga [129], Lackéus & Middleton [77], Raven & Geels [121]
Lack of cashflows	Saarela et al. [129], Wilson et al. [148], Otter & Weber [110]
Need for safety and efficacy of new technology	Thompson [138], Popp et al. [117], Opriş & Ionescu [108], Isaacs et al. [68], Thies et al. [137],
Lack of operation and production history	Islam [70], Popp et al. [117], Jung et al. [75], Newey et al. [103]
Poor techniques or process	Islam [70], Brooks [21], Maughan et al. [90], Markham et al. [88], Finkbeiner [46], Yadav et al. [152], Markham, S. K. [87].
Complex customer base	Wilson et al. [148], Nalivaychenk & Kirilchuk [102], Magruk [85], Merceret et al. [93], Faravelli & Dovleac [43]
Lack of successful demonstration	Upadhyayula et al. [141], Mossberg et al. [101], Ray et al. [122], Byrd et al. [24], Jung et al. [75], Brooks [21]
Inactive actors	Mossberg et al. [101], Opriş & Ionescu [108]
Poor innovation system	Nemet et al. [104], Jaksić et al. [72], Hage et al. [59], Cooper [29], Ionescu [67], Bowonder et al. [18]
Lack of government support	

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Table 3 (*continued*)

Factors	*Scholars*
	Hartley & Medlock III [60], Popp et al. [117], Aithal & Aithal [3], Jaksić et al. [72], Wong [151], Hudson & Khazragui [65], Zhu et al. [155], Emmert-Buck [39], Beard et al. [14], Niosi [105]
Conflicting interests	Nalivaychenk & Kirilchuk [102], Prasad et al. [118], Abereijo [1], Lackéus & Middleton [77], Hossain et al. [63], Maia & Claro [86], Markham, S. K. [87]
Mismanagement	Salamzadeh & Kirby [127], Collins et al. [28]
Unclear ROI process	Jucevicius et al. [74], Beard et al. [14]
Communication problem	Magruk [85], Chi-Han & Hung-Che [27], Hossain et al. [63], Leahy & Lane [78], Markham et al. [88]
Less attention on sustainability	Martin [89]
IP problem	Lackéus & Middleton [77], Roberts et. al. [125], Leahy & Lane [78]
Availability and maintainability challenge	Thies et al. [137], Girdauskiene et al. [55]
Lack of quality assurance	Girdauskiene et al. [55], Barrable et al. [12]
Economic crisis	Carayannis & Dubina [25], LaBelle & Goldthau [76], Gobble [56], Ballantyne [10],
Earlier publication of discovery	Wong [151]
Unsupportive ecosystem	Wong [151]
Use of wrong metrics	Cooper [29]
Lack of flexibility	Maughan et al. [90]
Lack of faith	Jackson & Boxx [71]
asymmetry of information	Maia & Claro [86], Gicheva & Link [54], Foster [47], Wessner [146]
Concentration on specific industry	Saridakis et al. [130]

the topic from year 2015 (shown in the Fig. 2). Thus, a new framework of VoD would pave the way for further discussion.

Therefore, a new model termed the "Buztech Starup Model" (BSM) is proposed. The model is based on the aforementioned findings and lessons. BSM focuses on the startup phase. This phase is called VoD and metaphorically refers to a ***gap***, according to the scholars. To build a ***bridge*** and cross over VoD, some support materials are needed as argued by Ford and Dillard [48], LaBelle and Goldthau [76], and McIntyre [92]. That being said, this new BSM contains a set of "blocks" that can be used by startups to build their own bridge. The blocks consist of ***team building, technology development, ecosystem, collaboration, funding, business development, technology management, company building*** and ***early marketing***. The Fig. 3 below is a visual representation of the BSM. In turn, each block contains a set of activities that the startup team needs to consider. These activities are a combination of commonly cited recommendations from fellow scholars, interviewed entrepreneurs, startup team members, business advisors and the startup government agents. Table 6 presents suggested activities for each BSM blocks.

Furthermore, the blocks of BSM need to be arranged or prioritized according to the needs and present situation of the startup. To implement this, a proper ***evaluation*** of the current situation (and mission) of the startup must be conducted. The evaluation is expected to have a set of questions that examine each activity of each block. For instances, the questions may contain: what specific problem does the new technology solve? what is its industrial application area? and how many possible products or services can be developed from the technology? (for the technology development)? what skills do team members need? what are the criteria for selecting new members and how should responsibilities be shared among the team members? (for team building).

Answers to the evaluation questions will show the current situation of the startup and give directions on how the startup should proceed. The answers determine how the blocks are prioritized. For example, when BSM was piloted, each piloting startup was asked to answer a set of question for each block. Altogether, there were 50 questions. The team leaders of the startups were also invited for a joint discussion to clarify their responses. After the discussion, their answers were arranged in relation to each activity and block. The following Table shows the

Table 4
The proffered solutions for VoD.

Suggested solution	*General description*	*Scholars*
Providing funds	Providing support to investor on funding application; using of business angels and venture capitalists; engaging in crowdfunding; using of government grants and financial programs; applying for subsidies; using of public facilities and tax breaks	Lettner et al. [81], Morales-Alonso et al. [98], Saarela et al. [129], Islam [70], Arciénaga et al. [8], Hartley & Medlock III [60], Byrd et al. [24], Lee et al. [79], Ojeaga [107], Collins et al. [28], [83], Zhou et al. [156], Lackéus & Middleton, [77], Hossain et al. [63], Cooper [29], Ibata-Arens, [66], Ackerly et al. [2]
Early commercialization	Considering commercial values of an innovation from the research phase; focusing on market needs or specific problems, engaging users or beneficiaries early; focusing on solution development	Budi & Aldianto [22], Maulina et al. [91], Lettner et al. [81], González et al. [57], Ford, & Dillard [48], Arciénaga et al. [8], Faccin et al. [42], Dobrenkov et al. [35], Sanga [129], Aithal & Aithal [3], Zhou et al. [156], Zhou et al. [156], Jaksić et al. [72], Carayannis & Dubina, [25], Brooks [21], Maughan et al. [90], Markham et. al [88], Finkbeiner [46], Yadav et al. [152], Markham [87]
Engaging relevant stakeholders	Identification of and cooperation with relevant stakeholders to the business	Lettner et al. [81], González et al. [57], Weggeman et al. [145], Boltze et al. [17], Prasad et al. [118], Wong, T.Y. [151], Hudson & Khazragui [65], Roberts et. al. [125], Carayannis & Dubina [25], Maughan et al. [90]
Collaboration	Engaging in collaboration activities, especially with relevant stakeholders	Nemet et al. [104], Hartley & Medlock III [60], Van den Burg et al. [143], Magruk [85], Jung et al. [75], Gicheva & Link [54], Weyant [147], Emmert-Buck [39], Beard et al. [14]
Having a qualified team	Selecting team members with different important competences	Arciénaga et al. [8], Magruk [85], Zhu et al. [155], Yadav et al. [152], Markham [87]
Applying different management strategies	Using of different management strategies, such as agile learning and decision making, heavyweight project management, intrusive management, strategic niche management and technology management	Arciénaga et al. [8], Magruk [85], Jaksić et al. [72], Merceret et al. [93], Maia & Claro [86], D'Amico, et al. [33], Raven & Geels [121], Fujiwara [49]
Having internal and external knowledge	Having knowledge about targeting industrial and their inter-organization relations as well as market knowledge.	Kogure et al. [84], Midler [96], Chi-Han, & Hung-Che [27], Bandera et al. [11], Lackéus & Middleton [77], Newey, et al. [103]
Better policy	Government should set up conducive business policies, such as sufficient funds for innovation commercialization, general	Lenzer, [80], Nnakwe et al. [106], Liotta & Painter [82], Amonarriz et al. [7], Bandera et al. [11], Magruk [85],

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Table 4 (*continued*)

Suggested solution	*General description*	*Scholars*
	facilities for new entrepreneurs, and tax breaks for new and striving businesses.	Abereijo [1], Carayannis & Dubina, [25], LaBelle & Goldthau [76], Merceret et al. [93], Saridakis et al. [130], Stam et al. [134]

Table 5
The details of the participating startups.

	Company	*Type of Startup*	*Nature of business*	*Level of VoD*
1	IoT1	Regular	IoT	Passed
2	IoT2	Spinoff	IoT	Struggling
3	IoT3	Spinoff	IoT	Struggling
4	AI1	Regular	AI	Passed
5	AI2	Regular	AI	Passed
6	AI3	Regular	AI	Passed
7	AR/VR1	Regular	AR/VR	Passed
8	AI4	Regular	AI	Passed
9	IoT4	Regular	IoT	Almost passed
10	AR/VR2	Spinoff	AR/VR	Passed
11	IoT5	Regular	IoT	Trapped
12	MD1	Regular	Medical device	Struggling
13	MD2	Spinoff	Medical device	Struggling
14	AI5	Spinoff	AI	Almost passed
15	MD3	Regular	Medical device	Trapped
16	AI6	Regular	AI	Struggling
17	AR/VR3	Spinoff	AR/VR	Struggling
18	AR/VR4	Spinoff	AR/VR	Struggling
19	IoT6	Spinoff	IoT	Struggling
20	AR/VR5	Regular	AR/VR	Struggling
21	CT1	Spinoff	Cleantech	Passed
22	IoT7	Regular	IoT	Passed
23	IoT8	Regular	IoT	Passed
24	CT2	Regular	Cleantech	Passed
25	AI7	Regular	AI	Passed
26	CT3	Regular	Cleantech	Passed
27	IoT9	Regular	IoT	Passed
28	AR/VR56	Spinoff	AR/VR	Passed
29	CT4	Spinoff	Cleantech	Passed
30	AI8	Regular	AI	Struggling

Table 6
List of BSM activities.

Blocks	**Activities**
Team building	Competences / skills
	Agreement
	Attitude/ preparation
Technology development	Intellectual properties and other regulations
	Technology Readiness Level (7 and above)
Ecosystem	Political fitness
	Industrial fitness
	Society fitness
Collaboration	Industrial (supply chain key players)
	Academia
	Agreement
Funding	Grants and government support
	Other external funding -venture capitalists, business angels, and loan
	Sales and internal revenue
Business development	Agreement
	Recruitment of members of board of directors, advisors, and employees.
	Business model development
Technology management	Research & development / innovation
	Product lines
	Intellectual property management
Company building	Organization structure and policies
	Strategic focus
Early marketing	Communications: online marketing, newspapers, radio, and television advertisements

Table 7
BSM blocks' prioritization for pilot cases.

Pilot	*Very important*	*Important*	*Good to do*	*Not yet necessary*
A	Business development, technology development, early marketing	Collaboration, team building, funding	Ecosystem, technology management	Company building
B	Team building, technology development, funding, collaboration	Company building, early marketing	Ecosystem	Technology management

details.

Then, a list of recommendations was proposed by the authors of this article. In one of the pilots, four authors of this article held a series of meeting with the startup team members and providing support for the team. After three months, the four authors asked the team leader of the startup to answer the evaluation questions once again. The answers, at this time, showed that the pilot case had improved, and its situation appeared to be promising. The motivation of the startup was obvious and the university where the startup would spinoff was happy to witness the progress.

Another important thing about BSM is that it is continuous. It was learned from studying the previous models that evaluation was not emphasized. Similarly, it was learned from some (e.g., [93,129,138]) that VoD could occur more than once. The previous studies also pointed that VoD could take several years. Thus, BMS considered all these issues and other salient conditions. BSM suggests that the startup team should evaluate their operation, at least, every 3 months and re-prioritize their blocks.

In addition, BSM has a feature of ***impact***. It was discovered through the piloting cases, as the startups prioritized their key activities and implement them, their length of VoD seemed to be reduced. For instance, when a pilot participant was advised on the team building, technology development, funding and collaboration, after 3 month when one of the authors of this article had a one-on-one meeting with the CEO, it was discovered that the team had improve their level and commitment. This effort reflecting on the pilot's overall VoD graph, as it is shown in the following Figure.

Based on the piloting cases and the lessons from theoretical and empirical findings, it can be assumed that applying BSM on a startup will reduce its VoD time. It is assumed that using BSM recommendations will enable the startups to sail through their VoD conditions. Hence, applying the BSM model will create a bridge across VoD and enable the startups to manage their VoD effectively. The following Figure shows what VoD of a startup might look like after applying BSM.

How BSM can be applied? Detailed notes of BSM piloting activities revealed that there are four 4 steps. The first step is pre-evaluation of a startup. The startup is expected to evaluate itself by defining some questions and answering them. An example of such list of question is provided in the appendix. The list was used for piloting cases (only for technology block of BSM). Notably, pre-evaluation can be done by team members, but it is advised to be conducted by an external individual or organization (preferably, business advisors or investment experts). The next step is analyzing of their answers. Then, prioritizing BSM blocks and activities is the third step. The fourth step is implementation of the prioritized activities. The last step is to conduct a progressive evaluation after 3-4 months. Then, the answers to the evaluation will be analyzed and BSM blocks and activities will be re-prioritized until the startup sails through the VoD trap. The following Figure shows the application steps.

5. Conclusion

It is obvious from the findings that VoD is a problematic situation for startups. It is also well-established that the problem can be managed. However, how the problem could be managed is not yet comprehensively presented in the literature. Thus, this article explored this gap and offered a new model termed BSM. The model appears to be suitable for any technology-based startup. It is iterative and flexible to meet up with needs of any startup. For scholars, the model can be examined to determine its theoretical foundation. And for practitioners, specifically entrepreneurs, potential entrepreneurs, business advisors and coaches, and government agencies, the model can be applied to determine its practical relevance. Therefore, this article contributes to the startup discourse.

Meanwhile, it is important to note that the model cannot be generalized. It is recommended that the model be applied to high technology startups, preferably from the same industry as study participants. Similarly, it is important to note that the research methodology of this article might pose limitations to the model. However, the limitation does not affect quality and usefulness of the model. (Fig. 4, 5, 6, Table 3, 7)

Conflicts of Interest

Dear Editor, We do have not any conflicts of interest. We, the authors, agreed on the article as well as our financier and study participants agreed to publish it. Thank you very much. With regards, Saheed Gbadegeshin

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.sftr.2022.100077.

Appendix. A list of questions for technology development block of BSM

1 Do you have a clear problem that your technology solves for?
2 Does your technology add extra value or reduce cost for your customers?
3 Do you know application areas of your technology/solution? (market segments)
4 Have you done any market research on the application areas?
5 Have you established a network in your application areas?
6 How many products or services you can make from your technology?
7 What is the size of your target market?
8 Do you know the key players in the market
9 Do you know any legal implications of your technology/solution?
10 Do you think that there is an upcoming policy that will affect your technology negatively?
11 Do you know any incoming rules that will affect your new technology positively?
12 Does your technology need infrastructural changes before being market ready?
13 What is readiness level of your technology?
14 Have you patented or submitted patent application for your technology?
15 Do you need an IP to before you can sell your technology?
16 Do you currently have prototype or soultion sample now?
17 Do you know your suppliers?

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