

INOVAÇÃO DISRUPTIVA NO PODER MARÍTIMO E NA GUERRA NAVAL: UMA REVISÃO SISTEMÁTICA DA LITERATURA

*DISRUPTIVE INNOVATION IN SEA POWER AND NAVAL WARFARE: A
SYSTEMATIC LITERATURE REVIEW*

NIKIFOROS JOANNIS PHILYPPIS JUNIOR

UFRJ

NIVAL NUNES DE ALMEIDA

ADRIANO LAURO

ESCOLA DE GUERRA NAVAL - MARINHA DO BRASIL

Nota de esclarecimento:

O X SINGEP e a 10ª Conferência Internacional do CIK (CYRUS Institute of Knowledge) foram realizados de forma remota, nos dias 26, 27 e 28 de outubro de 2022.



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Objetivo do estudo

O objetivo da pesquisa foi realizar uma revisão sistemática da literatura (RSL) sobre o tema “inovação disruptiva” em Poder Naval e Guerra Naval e fornecer uma visão geral do estado da arte no campo acadêmico em artigos revisados por pares.

Relevância/originalidade

A inovação disruptiva tornou-se um tópico intensamente pesquisado em negócios, gestão e estudos de adoção de tecnologia, mas com muitas lacunas que podem ser atendidas por pesquisas futuras. (Si e Chen 2020) Nos estudos militares, esse tema ainda é superficial.

Metodologia/abordagem

A Revisão Sistemática de Literatura foi desenhada, os artigos analisados e as lacunas nas áreas de pesquisa e sugestões para pesquisas futuras são apresentados. Os dados quantitativos bibliométricos e qualitativos foram organizados em tabelas para fornecer uma visão geral da área.

Principais resultados

Os achados sugerem que a pesquisa em estudos de RH e uma melhor discussão sobre estruturas e modelos de análise podem aprimorar a discussão nas áreas de Poder Marítimo e Guerra Naval, já que a maioria dos artigos são estudos de caso.

Contribuições teóricas/metodológicas

A transformação da tecnologia militar é um campo debatido nas Ciências Militares. Uma de suas principais preocupações é o surgimento de “inovações radicais” e “avanços tecnológicos” que podem anular o poder do Estado, mas em ações tradicionais de P&D e não disruptivas.

Contribuições sociais/para a gestão

O Poder Marítimo e a Guerra Naval são áreas onde inovações disruptivas podem causar uma mudança no curso de um conflito. Como essas tecnologias são relevantes, evitar ser ultrapassado e superado por inimigos em potencial é crucial para a soberania do Estado.

Palavras-chave: Inovação disruptiva, Guerra naval, Poder naval, Poder marítimo, Defesa

DISRUPTIVE INNOVATION IN SEA POWER AND NAVAL WARFARE: A SYSTEMATIC LITERATURE REVIEW

Study purpose

The research goal was to perform a systematic literature review (SLR) on the subject of “disruptive innovation” in Sea Power and Naval Warfare and provide an overview of the state-of-the-art in the academic field.

Relevance / originality

Disruptive innovation has become an intensely researched topic in business, management, and technology adoption studies but with many gaps that can be served by future research (Si and Chen 2020). In Military studies, though, this topic is still superficially addressed.

Methodology / approach

The SLR was designed, retrieved articles were collected and analyzed and gaps in research areas and suggestions for future research are presented. Quantitative bibliometric and qualitative data were organized in tables to provide an overview of study types and gaps.

Main results

Findings suggest that research in HR studies and better discussion on analysis frameworks and models could enhance the discussion on the areas of Sea Power and Naval Warfare, as most articles are organizational case studies and conceptual papers.

Theoretical / methodological contributions

Military technology transformation is a very debated field in Military Sciences. One of its main concerns is the appearance of “radical innovations” and “technological breakthroughs” that may hamper a State’s power but in traditional R&D actions and not disruptive ones.

Social / management contributions

Sea Power and Naval Warfare are areas where disruptive innovations may cause a change in the course of a conflict. As such technologies are relevant, avoiding being outdated and bested by potential enemies is crucial.

Keywords: Disruptive innovation, Naval warfare, Naval power, Sea power, Defense

1. Introduction

Innovation is a widespread word, both ordinarily and in the academic field. Although its common use, it is, often, loosely applied to explain any change of any level in any area ranging from social changes to hard science and technology. (Garcia and Calantone 2002) Notwithstanding, organizational changes due to innovation are more specific and can occur in various ways but having different proposed typologies. (Chandy and Prabhu 2010) Of many types of innovation, disruptive innovation has reached huge popularity in public and private service organizations, academia, and industrial sectors alike. When it comes to disruptive innovation, there is a wide array of publications, but “the theory’s core concepts have been widely misunderstood and its basic tenets frequently misapplied... too many people... use the term loosely to invoke the concept of innovation in support of whatever it is they wish to do” (Christensen et al. 2015). Also, some industries are technology-pushed and more concentrated in formal procedures of scientific research such as it is probable that disruptive innovation is either ignored or misunderstood.

Defense industry is one of those industries that has some specific features beyond standard business models. Relationships with R&D partners and suppliers are strict and tense, with rigorous confidentiality and control of the buyers (States) those industries must comply with rigorous safety and regulation standards and, therefore, limit their scope of investments opening gaps to disruptive processes and players, such as Hamas’ Qassam Rockets. (The Jewish Policy Center 2009) In the case of Naval Warfare, such risks are exponentially increased as a Navy’s sea power is done with huge investments in fleet development, maintenance, and upgrading. As reported, these investments represent great challenges, as reported by some Navies, in R&D integration and Strategic and Operational alignment in shipbuilding, weapons and detection systems development, and personnel training. (BRASIL, 2017; NAVSEA, 2019) Tests with drone terrorism were done in the last years in land and sea attacks and there are pieces of evidence that “cheaper” underwater drones and submarines (such as narcosubs) can be enhanced in a disruptive way to do greater damage to a nation’s fleet and its national security. (Pledger 2021; Boucher 2015; Sparrow and Lucas 2016; Gross 2021)

So, it is relevant to Military research and development to focus on understanding the concept of disruptive innovation and how it can interfere with naval warfare and sea power as a whole. To do that, a systematic literature review for peer-reviewed articles in indexed journals was performed and the collected knowledge was summarized and analyzed. To accomplish this goal, the bellow described research questions are:

RQ1: What is the current state-of-the-art in Disruptive Innovation regarding Sea Power and Naval Warfare in academic peer-reviewed journals?

RQ2: What are the main research fields in Disruptive Innovation regarding Sea Power and Naval Warfare and which gaps are not well-developed?

In section 1, we introduce, contextualize, and demonstrate the importance of this subject, introducing the research goal, the research questions, and methodological approach to research conduction with a summary of the research’s findings. In section 2, a brief literature review of the concept of Disruptive Innovation and its future directions are presented to contextualize the study. Section 3 quickly describes the concept of Sea Power and Naval Warfare to contextualize and give support for scanning and analysis of the retrieved articles. Section 4 describes the methodology of systematic literature review, its application, procedures,

tools used, and search databases where the search was conducted. In section 5, all papers collected are summarized and both their bibliographical data and research information is analyzed so, in section 6, the findings are summarized, and some considerations are briefed.

The results show that disruptive technology in Sea Power and Naval Warfare is a slightly studied subject, as the original concept created by Christensen (1997) is not well-developed in the area of Military & Naval Sciences. The retrieved articles demonstrate that “disruptive innovation” is a terminology used often but rarely comprehended or applied in studies. Some recent propositions exist but are not yet properly evaluated. Also, concepts similar to, but not equal, disruptive innovation may create false confidence in innovation research in Naval Sciences.

2. Disruptive innovation concept, pathways, and possible futures

Disruptive innovation is a concept developed by Clayton Christensen in his 1997 book “The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail”. In his work, based on various case studies of disrupted industries, the author states that innovations can be either created by sustaining technologies or disruptive technologies. While the former is state-of-the-art technology, always being enhanced and improved by incremental procedure and huge capital investments, the latter is an “underperformer” technology that has a low Return on Investment and, thus, is neglected by the main companies of the industry. (Christensen 1997) In short:

Disruption describes a process whereby a company with fewer resources is able to successfully challenge established incumbent businesses. Specifically, as incumbents focus on improving their products and services for their most demanding (and usually most profitable) customers, they exceed the needs of some segments and ignore the needs of others. Entrants that prove disruptive begin by successfully targeting those overlooked segments, gaining a foothold by delivering more-suitable functionality—frequently at a lower price. Incumbents, chasing higher profitability in more-demanding segments, tend not to respond vigorously. Entrants then move upmarket, delivering the performance that incumbents’ mainstream customers require, while preserving the advantages that drove their early success. When mainstream customers start adopting the entrants’ offerings in volume, disruption has occurred. (Christensen et al., 2015, our emphasis)

Seven “insights” are also given by Christensen et al. (2018): 1) market and technology progress have different paths and customers don’t always know what they need; 2) innovation requires resource allocation which is difficult to disruptive technologies; 3) disruptive technologies are developed by unsatisfied developers that need a new market so old customers become irrelevant; 4) different markets require different capabilities and small and flexible disruptors can adapt faster while big companies are frozen in their core capabilities; 5) investment information It does not exist so iterative processes are better than market research, so 6) leaders in disruptive innovations will have advantages as such 7) advantages of supplying innovative customers without being harmed by competition as market leaders see no logic in competing for small market share. Since 1997, this model has been constantly discussed and raises the question of where disruptive innovation research is now.

According to Christensen et al. (2018), disruptive innovation turned from a theoretical descriptive concept, devoid of practical use, to a better prescriptive tool, capable of being used in disruptive innovation foresight. Christensen et al. (2015) pinpoint that disruption is a process and not a stand-alone phenomenon, product or service development, as it builds different business models that are unattractive to both incumbent suppliers and buyers. Also, not all

disruptions succeed in mature companies. Utterback (1994) shows that the dynamics of innovations mostly start with many providers of low-end solutions until the emerging market “adopts” a dominant design that few companies are successful to reconfigure and survive to delve into the new market. Another important consideration by the authors is that established incumbent companies need not dismantle their businesses to get advantages of disruptive innovations.

Understanding the current state-of-the-art in the field, its gaps, and methodological approach analysis is important before starting a literature review. Si & Chen (2020) provide an extensive analysis on the subject claiming that disruptive innovation theory follows one of three perspectives. In the first perspective, research is based on four categorized innovation activities: disruptive business model innovation, disruptive technology innovation, disruptive product innovation, and disruptive strategic innovation. In the second perspective, studies understand the subject as an evolving process and not merely an outcome. Finally, there are disruptive innovation studies based on its effect and the basic characteristics of disruptive innovation. So Si & Chen (2020) summarize disruptive innovation in three aspects: 1) incumbents excessively provide high-cost performance to existing markets; 2) disruptors target marginal buyers that cannot be considered an established market, avoiding existing markets and, because of that, 3) there must be a creation of possibilities so incumbent companies can foster disruptive innovation in existing markets.

As for the research about disruptive innovation in the defense industry, Rao et al. (2019) state that “extra” features of the industry must update Christensen’s model of disruptive innovation. As defense is not a commercial aspect but mission-driven state-sponsored activity, it has different layers of decision-makers (political) and users (military) that create barriers to purchase and invest in developing technologies. Established organizations, to quickly respond to disruptive innovations, must pay attention to some “dimensions” and, when it comes to the Defense industry, such dimensions are even more specific than the disruptive innovation model preconizes. (Rao et al. 2019) So, to clarify the state-of-the-art about disruptive innovation in defense studies, focused on Sea Power and Naval Warfare, a systematic literature review on the subject is performed using the abovementioned terminologies.

3. Sea Power, Naval Warfare and its correlation with innovation

Characterizing Sea Power and Naval Warfare is no easy task. While these concepts have been around us for centuries they are not strictly defined. Till (2008) explains that even Mahan in his seminal book does not explain the concept of “Sea Power” but simply uses it as a given. Till also does not give a straightforward answer but dedicates an entire chapter on the subject. For simplification purposes, the one “synthetized” concept describes

Sea power, means by which a nation extends its military power onto the seas. Measured in terms of a nation’s capacity to use the seas in defiance of rivals and competitors, it consists of such diverse elements as combat craft and weapons, auxiliary craft, commercial shipping, bases, and trained personnel... The capacity for sea power depends upon such factors as population, character of government, soundness of economy, number and quality of harbours and extent of coastline, and the number and location of a nation’s colonies and bases with respect to desired sea traffic. The main purpose of sea power has always been to protect friendly shipping from enemy attack and to destroy or hinder the enemy’s shipping—both commercial and military... Sea power may also be exerted to apply military and economic pressure on an enemy by preventing the import of commodities necessary for prosecution of war. (Editors of Encyclopaedia 2016)

As for Naval Warfare, Warfare at Sea, or Sea Warfare, searches in academic texts also give us more examples than concepts. Vego (2010) gives us a deep and detailed lecture on Warfare at Sea by reporting naval battles in History and separate the “ages” of naval warfare by the technological developments in propulsion, combat weapons, and strategic arrangements. As discussion of concepts and terminologies is not the subject here and for simplification purposes, warfare is defined as:

1: **military operations between enemies**: HOSTILITIES, WAR... also: an **activity** undertaken by a political unit (such as a nation) **to weaken or destroy another**... economic warfare... 2: **struggle** between competing entities: CONFLICT. (Merriam-Webster, [s.d.], our emphasis)

Synthesizing, this search in Sea Power, and Naval Warfare encompass factors both macro and microeconomic forces, such as national and international politics, scientific collaboration networks, access to funding, resources, technology suppliers, personal and alliances, and partnerships that can support agents’ actions to deter or suppress an enemy or competitor, avoiding combat, accomplish missions, and winning combats and wars. Such an understanding of these terms helps us to delve into the systematic literature search.

4. Systematic Literature Review (SLR) Methodology Steps and Procedures

SLR is a method-driven, formally structured, replicable methodology. “Rather than providing a base for the researcher’s own endeavors, it creates a solid starting point for all other members of the academic community interested in a particular topic.” (Okoli and Schabram 2010). According to Okoli & Schabram (2010)

A rigorous stand-alone literature review, according to Fink’s (2005) definition, must be systematic in following a methodological approach, explicit in explaining the procedures by which it was conducted, comprehensive in its scope of including all relevant material, and hence reproducible by others who would follow the same approach in reviewing the topic... comprises studies that can stand on their own, in themselves a complete research pursuit... they can be undertaken to describe available knowledge for professional practice, to identify effective research projects and techniques, to identify experts within a given field, and to identify unpublished sources. (Okoli and Schabram 2010)

Okoli & Schabram (2010) provide the core concepts of a well-defined SLR and Kitchenham et al. (2009) provide solid step-by-step research that serves as a model to this research. With this in mind the following adapted procedure was performed: (1) defining research questions; (2) detailed explanation of search process; (3) defining inclusion and exclusion criteria; (4) doing a quality assessment of the research procedures; (5) perform data collection; (6) analyze articles and (7) summarize bibliographical data and findings. Research questions were defined in the Introduction (topic 1).

a. Search process

In order to search for the subject, the researchers used “*Periódicos Capes*”, a Brazilian search engine supported by the Ministry of Education that searches over many subscribed and open-source services, such as Scopus, JSTOR Archival Journals, Web of Science, Taylor & Francis, among others. A string search for peer-reviewed journal articles (document type) was defined and no date range was determined as Disruptive Innovation is a subject being used since 1987. No specific subject area was previously defined as both Sea Power and Naval Warfare are subjects of multidisciplinary nature. All articles were screened in their titles, keywords, and abstracts and collected in a spreadsheet as the references were collected in Mendeley Desktop software. Repetitions were, then, discarded.

b. Conceptual boundaries

Advanced Boolean search used the key terms “disruptive innovation”, “disruptive technology”, “disruptive technologies”, “disruptive breakthrough”, and “technological breakthrough” as the first term added with “sea power”, “seapower”, “naval power”, and “naval warfare”. The exact combinations and search results are presented in Table 1. A total of 73 non-repeated articles were collected.

Table 1: Articles retreated from search (repetitions excluded)

Search terms and retrieval - only articles + peer-reviewed papers and screening process		
First term	Second term	Articles retrieved (total of 73, without repetition)
"Disruptive Innovation"	"naval warfare"	9
	"sea power"	6
	seapower	3
	"naval power"	4
"Disruptive Technolog(y/ies)"	"naval warfare"	12
	"sea power"	6
	seapower	3
	"naval power"	4
"Disruptive breakthrough"	"naval warfare"	0
	"sea power"	0
	seapower	0
	"naval power"	0
"Technological breakthrough"	"naval warfare"	5
	"sea power"	11
	seapower	2
	"naval power"	8

Source: Authors

c. Inclusion and exclusion criteria

After that, metadata was reviewed, missing information was collected from the journal websites and the information was updated in Mendeley Desktop in a specific directory and, then the author made a preliminary paper selection of all articles to understand in which context “disruptive innovation” was cited and if the term was vaguely used or specifically referred to Christensen’s original concept. Then, detailed paper research was performed to synthesize bibliographical data and analyzing the content, and using the factors of the proposed multilevel framework of Si & Chen (2020) to categorize the type of disruptive innovation all articles encompass.

Inclusion criteria, in the detailed paper selection, considered articles that:

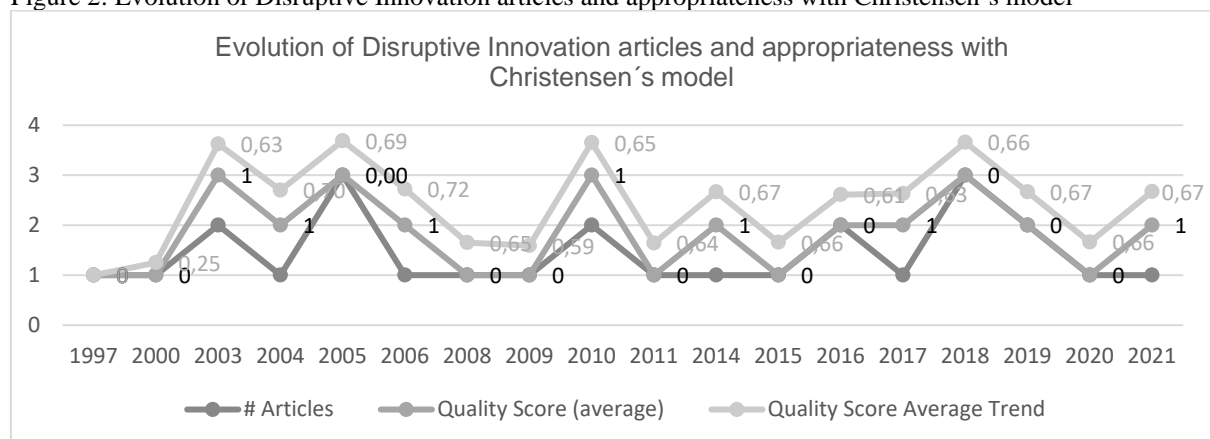
- 1) Directly discussed concepts of disruptive or breakthrough innovations and/or technological enhancements directly aimed at Sea Power definition and/or Naval Warfare;
- 2) Military Innovations that are useful to Sea Power and Naval Warfare, even though they do not cite directly Naval Forces, such as drones and unmanned aerial, surface and underwater vehicles;
- 3) Articles with broader operational scope – Army, Navy, or Air Force – and the specific theoretical concept and
- 4) Ethical discussion articles on warfare and disruptive military technology.

The following criteria were used to exclude articles:

- 5) In the preliminary paper selection, war and combat articles of events before the 20th century were excluded and events after were separated for detailed paper selection procedures as major technological developments are possible disruptive innovation case studies;
- 6) In the detailed paper selection, articles about Disruptive Innovation that are exclusive of other military forces (Homeland Security, Army, and Air Force), unless there are interdisciplinary applications (such as planes in aircraft carriers or troops deployment by sea on land); or articles that cite Christensen’s work lightly as part of a generic literature review;
- 7) In the detailed paper selection, articles that use disruptive innovation generically and vaguely, not directly addressing the original concept and/or 3) articles that describe innovations and breakthroughs as “disruptive” even though they are incremental and/or developments made by incumbent companies are also discarded.

After the screening process, a total of 26 articles were properly selected. A quality assessment of the alignment with Christensen’s theory has been done by a thorough reading of the authors. Results of the bibliographical and content analysis are detailed in the next sections.

Figure 2: Evolution of Disruptive Innovation articles and appropriateness with Christensen’s model



Source: Authors

d. Quality Assessment

All 26 articles were read thoroughly, and a score was assigned according to their appropriateness. If disruptive innovation authorship, concepts, and fundamentals were cited direct or indirectly, even if not used directly, a score of “1” was given. If the article does not directly cite Christensen’s work and its concepts but highlights disruptive innovation in its text or cites other authors, a score of “0.5” was given. If the article cites disruptive innovation concepts but dismisses them, a score of “0” was given. A “score average per year” and “progressive average of the score” throughout the years were calculated to provide a qualitative analysis of Disruptive Innovation’s core concept and application progress over the years. An average score of 1 would be total appropriateness with the theme (Christensen’s theory and model) while a zero would be total inappropriateness. Results are summarized in Figure 2. The number of articles curve has no label while the quality assessment score per year is shown by integer values and the accumulated average score (sum of appropriateness scores divided by the number of articles) are the fractional

numbers. Results show that both article publishing and appropriateness are steady and above 0.6 throughout the years.

5. Bibliographical information and Discussion

a. Journals

Naval War College Review, Security Studies, and Journal of Strategic Studies summed up for 12 out of 26 (46%) of retrieved articles. The other 14 journals have one article each. All journals are focused on International Relations, Military and Navy Sciences, and National Security except five: Global Business Review, International Organization, JOM, Science & Engineering Ethics, and Supply Chain Management. This shows that there is still a concentration of Military Innovation subject in specific channels and media, suggesting the lack of involvement with military research and affairs outside military institutions or affiliated ones. As the exclusion criteria included only peer-reviewed articles, such characteristics could have put aside studies such as technical reports, master's and doctoral thesis, and non-peer-reviewed articles.

a. Article bibliographical data

Table 3 summarizes all articles authors ordered by year and the score of zero, 0.5 or 1, according to the level of appropriateness. Using Peh et al. (2008) description of article types, we categorized each article as an original paper, case study research, or a literature review. Other article types were not identified. Many articles are original papers but use cases as examples and demonstrations of proposed theories and frameworks and have a lean literature review. Case study research also uses concepts and literature review but as secondary goals to the case study. Finally, literature reviews tend to be devoid of original contributions but can list a relevant number of cases in the data collection but not analyzing them. As articles in military affairs have a strong emphasis on History and conceptual discussion, it was decided to "score" articles with a discrete scale ranging from zero to 2 in all three types for each article analyzed. Articles with a score of "2" state that this is the main typology for the article. A score of "1" means that the article uses that type as "secondary" and a zero, means the type of article is not the main focus of the paper.

For example, Bălan (2018) is the only retrieved literature review. The author performed a systematic review on the disruptive impact of future advanced ICTs on maritime transport. It is ranked as a literature review (score 2), but it is also an original paper (score 1), as contributes with studies about the most recent ITs in maritime transport. As the study cases listed in the paper are not meant to be analyzed or used as examples, it scored a zero in "case study". In short, 10 papers counted primarily as original studies, 15 were labeled case study articles, and only one (as described above) as a review.

There is no observable evolution pattern in the articles over the years. Table 3 synthesizes the appropriateness score of each article and its type of score ranging from zero to 2. 14 out of 26 studies (54%) scored "1" as disruptive innovation appeared by the term itself, "disruptive technology(ies) or specific Naval Power studies such as "Revolution in Military Affairs", "breakthrough", "radical innovation", "radical technology" and others. 17 out of 26 (65%) studies do not cite Christensen's model although the concepts are presented by other references and authors. One cites the author in a footnote but does not develop or discuss any of its model factors, raising the score from 65% to 69%.

Table 2: Journals ordered by number of articles retrieved

Most frequent journals	N. Articles	Cumulative % of Articles
Naval War College Review	6	23%
Security Studies	4	38%
Journal of Strategic Studies	2	46%
Air & Space Power Journal	1	50%
Comparative strategy	1	54%
Defense AU Journal	1	58%
European Security	1	62%
Global Business Review	1	65%
International Journal of Intelligence and CounterIntelligence	1	69%
International Organization	1	73%
JOM - Journal of Materials	1	77%
Nonproliferation Review	1	81%
Science & Engineering Ethics	1	85%
Small Wars & Insurgencies	1	88%
Supply Chain Management: An International Journal	1	92%
The Journal of Defense Modeling and Simulation	1	96%
War in History	1	100%
17 journals	26 articles	100%

Source: Authors

All other studies (31%) discuss the disruptive innovation theory and its tenets in different levels of detail. Smith (2006) uses it to discuss the game simulation industry as a disruptive innovation in defense education. Horowitz (2015) uses it to discuss the case of suicide bombing terrorism as a disruptive warfare innovation. Mukunda (2010) proposes the use of disruptive innovation theory. Gilli & Gilli (2014) contradicts Horowitz (2010) arguing that is a tactical advantage over capital expenditure and not disruptive innovation that makes terrorists adopt suicide bombing.

On a greater scale, Rubel (2017) uses mainly the innovators' dilemma (among other concepts) to explain China's role as disruptive in providing security in Asia, risking the USA's geopolitical position. Rao et al. (2019) advocate the use of disruptive innovation theory and factor analysis adding two others: User and Network evaluation. Finally, Barnea & Meshulach (2021) propose the use of Christensen's model with other concepts to forecast strategic surprise attacks. Most studies cite and describe the relevance and impact of "disruptive technologies" and innovation regarding innovative government-funded research in military technology (IT, communication, weaponry, and other naval assets), at both strategic, tactical, and operational levels. Christensen's Disruptive Innovation is focused more on strategic scanning and industry analysis.

a. Types of articles and analysis

To analyze the articles, both Peh et al. (2008) *Basic structure and types of scientific papers* document and Si & Chen (2020) *Multilevel Analysis Framework* were used. The latter provided a classification of articles used in Table 3. Si & Chen (2020) performed an extensive systematic literature review on Disruptive Innovation and categorized their findings into five constructs and their factors. Each factor takes knowledge from their collected articles. In our research, all Disruptive Innovation concerning Sea Power and Naval Warfare was read twice and categorized in a simple qualitative matrix (Table 4). By counting the existence of one of the factors, we take considerations to answer research questions 1 and 2. Figure 3 shows the

graphic model of the framework. According to the criteria of the article and the discussion in our collected articles, we categorized each article as “case study”, “original paper” or “literature review”. Also, we checked for each influence factor and checked “yes” at the table. Finally, each item was counted, and further considerations were discussed to answer the research questions.

Table 3: Articles ordered by year, quality assessment scores, and article-type scores

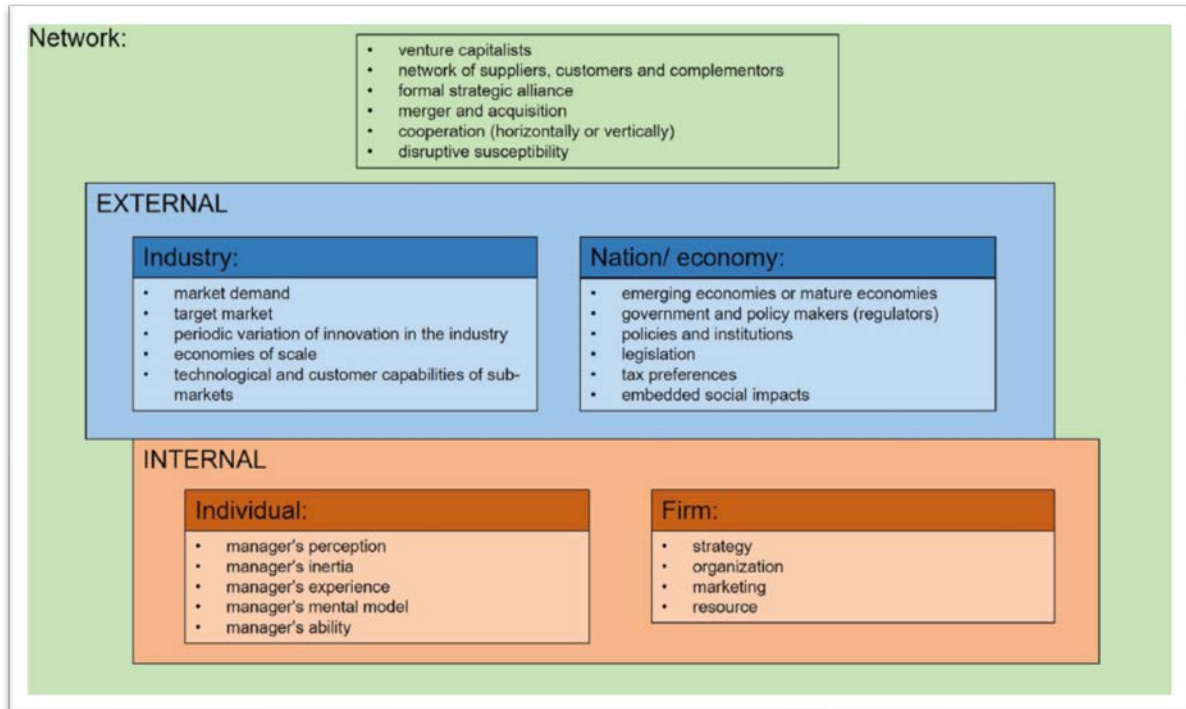
(Author(s), Year)	Quality Score	Original paper	Case study	Review
(Devries 1997)	0	1	2	0
(Wilkie 2000)	0.5	2	1	0
(Dombrowski and Ross 2003)	1	1	2	0
(Wax, Fischer, and Sands 2003)	1	1	2	0
(Goldman 2004)	1	2	0	1
(Bitzinger 2005)	1	1	2	0
(Stulberg 2005)	1	1	2	0
(Wildenberg 2005)	0	1	2	0
(Smith 2006)	1	1	2	0
(Sugden 2008)	0	2	1	0
(Wilkie 2009)	0	2	1	0
(Horowitz 2010)	1	1	2	0
(Mukunda 2010)	1	2	1	0
(Mahnken 2011)	0.5	1	2	0
(Gilli and Gilli 2014)	1	1	2	0
(Boucher 2015)	0.5	2	1	0
(Gilli and Gilli 2016)	0.5	2	1	0
(Sparrow and Lucas 2016)	0	2	1	0
(Rubel 2017)	1	1	2	0
(Bălan 2018)	1	1	0	2
(Csernatoni 2018)	0.5	1	2	0
(Dougherty 2018)	1	1	2	0
(Devore, Stähli, and Franke 2019)	0.5	1	2	0
(Rao et al. 2019)	1	1	2	0
(Yan 2020)	0.5	2	0	1
(Barnea and Meshulach 2021)	1	2	1	0

Source: Author

- a. *RQ1: What is the current state-of-the-art in Disruptive Innovation regarding Sea Power and Naval Warfare in academic peer-reviewed journals?*

Table 4 shows that, despite almost 25 years since Christensen’s *Innovator’s Dilemma*, other studies have been discussing the impact of military technology in Naval Warfare and Sea Power much time before. As a multidisciplinary field, Military Technology has both case studies (empirical analysis by inductive approach) and conceptual and theoretical discussions (theoretical debate by deductive approach). This seems reasonable with studies mixed from very diverse areas such as Ethics, Counterintelligence, Engineering, International Relations, and Political Studies. Either by deduction or induction, fields of study may mature concepts, correlate variables, and create more robust theories and frameworks. This is often demonstrated by literature reviews and meta-analysis. In our search and analysis, we did not find any meta-analysis and even the only literature review found is of a generic subject, IT in maritime transport with minor reference to military naval assets (Bălan, 2018) and, thus, cannot be considered a proper literature review in the areas of study.

Figure 3: Multilevel Influence Factors of Disruptive Innovation



Source: Si & Chen (2020)

b. RQ2: What are the main research fields in Disruptive Innovation regarding Sea Power and Naval Warfare and which gaps are not well-developed?

Mapping influence factors, the internal perspective of the firm has more attention in the studies (19 times for 73% presence). This correlates with the number of case studies (11 or 42% of all articles) and thus, is a logical consequence of case study research. The second factor is the network level (17 times for 65% presence). As military technology demands high coordination of research labs, technology developers and suppliers, State funding, and international partnerships for co-joint development, this finding complies with the 14 original studies that mostly discuss topics such as political arrangements, cooperation & partnership, both national and international, ethical issues and so forth. The external national-economic factor and the industry factor come toe-to-toe with 58% and 54%, respectively. Issues as terrorist drones are multifaceted, raising technological and capital concerns, ethical issues, systemic countermeasures to avoid any possible misuse of the technology

The least researched topic is the internal, individual level of analysis with only 31% presence. When discussing incremental or even radical innovations that are State-funded these levels are common but when the subject is Disruptive Innovation, the individual level is crucial not only to foresee possible disruptions but also to avoid that talented personal leave the organization and become the disruptor. The gray-shadowed cells in table 4 are purposely painted to “spot holes” that were not addressed in those studies. Also, we can logically imply that a 31% coverage in all studies in this systematic literature review equals a 69% uncovered potential of research. For example, from 2000 to 2005 only one (Wildenberg 2005) out of seven studies discusses the naval doctrine as a major component in Midway battle, reporting internal individual factors involving Command Officer’s abilities, and perception supported one side as inertia and wrong mental models stuck the other side in a dead-end. Also, between the period

of 2015-2017, all four articles favor industry and firm structure analysis and ignore potential individual interests, complying with disruptive trajectories advocated by Christensen (1997).

Although “disruptive innovation” is used as a terminology on articles, a comparison of what Christensen defines as disruptive (Si and Chen 2020; Christensen et al. 2018b) shows divergences. On the one hand, articles such as Barnea & Meshulach (2021) state the adaptative techniques of terrorist actions as “disruptive” demanding a fast adaptation of IDF while Smith (2006) states the disruptive power of computer games to enhance military simulation posing a threat to current military researchers and suppliers. On the other hand, some articles still define “disruptive” as radical innovation showing a rather misplaced understanding.

Table 4: Articles ordered by year, type, and influence factor analysis

Author (year)	Article type	Si & Chen Multilevel Analysis Framework				
		Internal: Individual	Internal: Firm	External: Industry	External: Nation / Economy	Network level
(Devries 1997)	Original	Not applicable. Historical review pre-20 th century				
(Wilkie 2000)	Original		Yes	Yes		
(Dombrowski and Ross 2003)	Original		Yes		Yes	
(Wax, Fischer, and Sands 2003)	Case		Yes			
(Goldman 2004)	Original				Yes	
(Bitzinger 2005)	Case		Yes	Yes	Yes	Yes
(Stulberg 2005)	Original		Yes	Yes	Yes	Yes
(Wildenberg 2005)	Case	Yes	Yes			
(Smith 2006)	Case	Yes	Yes	Yes		
(Sugden 2008)	Original		Yes			Yes
(Wilkie 2009)	Original		Yes			Yes
(Horowitz 2010)	Case	Yes	Yes		Yes	Yes
(Mukunda 2010)	Original		Yes	Yes	Yes	Yes
(Mahnken 2011)	Case			Yes	Yes	
(Gilli and Gilli 2014)	Case	Yes	Yes		Yes	
(Boucher 2015)	Original		Yes		Yes	Yes
(Gilli and Gilli 2016)	Original		Yes	Yes	Yes	Yes
(Sparrow and Lucas 2016)	Original		Yes		Yes	Yes
(Rubel 2017)	Case		Yes		Yes	Yes
(Bálan 2018)	Review	Yes	Yes	Yes	Yes	Yes
(Csernatoni 2018)	Case			Yes	Yes	Yes
(Dougherty 2018)	Case	Yes	Yes	Yes	Yes	Yes
(Devore, Stähli, and Franke 2019)	Case		Yes	Yes		Yes
(Rao et al. 2019)	Original		Yes	Yes		Yes
(Yan 2020)	Original	Yes		Yes		Yes
(Barnea and Meshulach 2021)	Original	Yes	Yes	Yes		Yes
Research topics by total	11 case studies (42%) 14 original papers (54%) 1 review (6%)	8 (31%)	19 (73%)	14 (54%)	15 (58%)	17 (65%)

Source: Authors

6. Final considerations

With the results from the systematic literature review, we may list the major research fields for Sea Power and Naval Warfare as Military & Naval Sciences, Strategic Studies, Defense Studies, Security, Intelligence and Foresight, War and Simulation. Minor areas comply with Air & Space, Materials, Logistics and Supply Chain, Organizational Theory, and Business with regards to Defense Industry. The main subject areas are widely covered about innovation and even radical innovation but lack disruptive innovation studies. The minor areas are capable of contributing to foster interdisciplinary studies and attract organizational researchers to spread their models and studies in Sea Power and Naval Warfare.

Using Si & Chen's (2020) Multilevel Influence Factors of Disruptive Innovation, we may argue that the main areas of study are internal firm-level studies and network-level studies. Both external-industry aspects and external-national and economic levels are covered but can benefit from further research. Adaptations of other models may be proposed, and some others may be scrutinized by future Systematic Literature Reviews. Many descriptive studies in this research were devoid of quantitative analysis save a few. (Horowitz 2010; Gilli and Gilli 2014; 2016). Another area of study in need of more research is the internal, individual level of decision-makers and managers. In Christensen's theory, the role of entrepreneurs is crucial in developing disruptive innovations and further attention should be given to intrapreneurship. Inside military organizations, the same professional may be an attentive soldier against the disruptive attack of innovative technologies and structural arrangements.

There are some limitations to this study, though. Firstly, the time period was left open as the specific keywords and the origin of Christensen's theory, model of disruptive trajectories, and signals of disruption date back to 1997. So, the results were not too much as expected. But "disruptive innovation" in military affairs is confused with other keywords such as "revolution in military affairs", "revolution in military technologies" and other terms. Even though these do not match with disruptive innovation, a future search on other authors and papers to match similarities among these concepts would broaden the understanding.

As for document types, while peer-reviewed articles guarantee robust research results, it excludes other non-peer-reviewed works. An exploratory search using Google Scholar showed some master and doctoral dissertations on the subject by the Naval War College. Also, reports on suppliers, congress papers, annals, and even online congress videos may broaden the discussion and could be considered for another specific research. The limitation of the English language may discard, even though with less chance, other works in German, French, Finnish, Danish, Japanese and Chinese, for example.

Si & Chen's (2020) framework is an exhaustive model to categorize studies as shown here. Nevertheless, other categorization schemes could improve the observation of other research areas and our contribution in this paper could benefit from other viewpoints. Finally, although our search keywords were proper for the designed study, searches with words like "war" or "military" could retrieve more and, thus, should be considered in future studies.

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