Cybersecurity Indices: Review and Classification

Mykola Khudyntsev[1,2], Andrii Davydiuk[3], Oleksiy Lebid[4], Oleksandr Trofymchuck[4], and Artem Zhylin[3]

[1] International Cybersecurity University, 171, 6, Deputats'ka str., Kyiv, 03115, PO Box 10, Kyiv, 04050, Ukraine
[2] G.E. Pukhov Institute for Modelling in Energy Engineering of the National Academy of Sciences of Ukraine, 15, General Naumov str., Kyiv, 03164, Ukraine
[3] State Center of Cyber Defense of the State Service of Special Communication and Information Protection of Ukraine, 83B, Yu. Illienko str., Kyiv, 04119, Ukraine
[4] Institute of Telecommunications and Global Information Space of the National Academy of Sciences of Ukraine, 13, Chokolivs'kyi boulevard, Kyiv, 03186, Ukraine

Abstract

The report is devoted to analyzing and classifying cybersecurity indices developed and implemented by leading global, international, and local organizations as of early 2021. It is proposed to include regular (periodic) information materials, which contain expert, analytical, statistical information on the state of cybersecurity and the level of protection of indexing subjects (rating), as well as on certain indicators regarding the harmful impact of implemented information security and cybersecurity threats, to cybersecurity indices. 65 existing cybersecurity indices and approaches for their formation are described. The definition of the terms necessary for the analysis of indexing (rating) in the field of information security and cybersecurity is offered.

Keywords

Cybersecurity, information security, indices, indexes, ratings

1. Introduction

Research on cybersecurity indicators is an extremely important and urgent task in the field of global security [1–3]. In Ukraine, this task is solved in the framework of building an organizational and technical model of cybersecurity and cyber protection for the national cybersecurity system [4]. The topics of the research are the current world reports, indices, and ratings in the field of information security and cybersecurity. The aim of the study is the describing, review analysis, and classification of cybersecurity indices (ratings) with the proposition of including all different regular (periodic) information materials, expert, analytical and statistical reports, and data. Systematically for mentioned well and little-known indices (rankings, ratings) in the field of information security and cybersecurity we proposed the classification by types and categories, analyzing the main methods of forming these indices to review and analyze the current state of cybersecurity, cybersecurity indices and ratings, approaches to their formation, as well as to determine the main terms required for indexing (rating) in the field of information security and cybersecurity. The paper schematizes information about known cybersecurity indices (ratings), proposes their classification by types and categories and analyzes the main methods of forming these indices (ratings).

2. Cybersecurity Indices: Rankings, Ratings
2.1. Cybersecurity Indices: Definitions, Types, Categories

The subjects of indexing (rating), depending on the type of index (rating) are countries, industries (sectors) of the economy, corporations, and organizations (entities).

The objects of indexing (rating) are the activities of these entities in the fields of information security and cybersecurity, the security status and level of protection of these entities from the relevant security threats, as well as certain indicators of security and safety.

Cybersecurity indices in the sense of high-level indicators (or cybersecurity indexes in the sense of quantitative indicators) will include regular (periodic) information materials that contain expert, analytical, statistical information on the security status and level of protection of indexing entities (ranking), as well as some indicators regarding the harmful effects of the implemented threats to information security and cybersecurity. Typically, cybersecurity indices are compiled to assess the state of information security and cybersecurity, as well as the level of protection from threats.

The list of cybersecurity indices includes some other indices that are indirectly related to cybersecurity, namely:

- Artificial Intelligence Index
- Index of Corporate Attractiveness
- Digital Economy and Society Index
- Index of ICT Development
- Network Readiness Index
- Nuclear Safety Index (in terms of cybersecurity)

Cybersecurity ratings will include cybersecurity indices, which are characterized by lists of indexing (rating) subjects with the definition of the order place of the subject in the list (rating).

Cybersecurity indices are proposed to be divided by:

- types (Global, International, Corporate)
- categories (Reports, Expert, Network, Data sets, Financial (Exchange), Combined)
- access methods or other indicators (platform, questionnaires, libraries, applications, automatic or automated, regulatory, technical, marketing)

Some indices contain features of different types and categories at the same time, so the proposed classification of cybersecurity indices is conditional.

Global cybersecurity indices include cybersecurity indices, which relate to the assessment (indexing, ranking) of countries on the activities of state institutions. Global cybersecurity indices include, for example, the Digital Economy and Society Index (DESI), the Global Cybersecurity Index (GCI), the National Cybersecurity Index (NCSI), the National Cyberpower Index (NCPI). The developers of global cybersecurity indices are usually global and international organizations, such as the European Commission (EC), the International Telecommunication Union (ITU), or well-known research centers, such as the Academy of Electronic Government (EGA), the Robert and Rene Belfer Center for Science and International Relations (BCH).

International cybersecurity indices include cybersecurity indices that relate to sectors of the economy, corporations, and organizations in different jurisdictions. Also, the international cybersecurity indices include an integrated assessment of countries on individual indicators of cybersecurity, relating to industries (sectors) of the economy, corporations, and organizations of certain jurisdictions, including when indexing (ranking) is carried out for a limited number of countries. International cybersecurity indices include, for example, the Cyber Threat Index (CTI), the Cyber Exposure Index (CEI). International cybersecurity indices are usually developed by rating agencies or other expert organizations that specialize in information technology and cybersecurity, such as Imperva Inc. (IMP), Cyber Intelligence House (CIH).

Corporate cybersecurity indices include cybersecurity indices that apply to corporations and organizations. Corporative cybersecurity indices include, for example, the BitSight Security Ratings Platform (BSSR), the Cyber Risk Index (CRI), the Cyber Attacks Timeline Master Indexes (CATMI). Corporate cybersecurity indices are typically generated by manufacturers of technology products and

solutions or information technology expert organizations, such as BitSight Technology Company (BST), Trend Micro Inc. (TMI), HACKMAGEDDON (HMG).

The cybersecurity indices of the reports category include regular (periodic) materials, which, as a rule, do not contain statistical information and ratings of indexing subjects (ratings) and relate to issues of analysis and assessment of threats, risks, events, incidents, negative consequences, and other specialized issues in the areas of information security and cybersecurity, not directly related to the subjects of indexing (rating), evaluation of their activities and security. The cybersecurity indices of this category include, for example, Microsoft Security Intelligence Report (MSIR) from Microsoft (MSF), Command Control Cybersecurity Index (CCCI) from Command Control (Event) - regular professional conference (CCE), Cybersecurity Capacity Maturity Model Review Reports (CMMRR) from Oxford University Global Center for Cybersecurity Capabilities (GCSCC).

Expert cybersecurity indices include cybersecurity indices, which are formed and/or confirmed by surveys and/or conclusions of specially involved or self-involved experts. Expert cybersecurity indices include, for example, global cybersecurity indices, such as the Global Cybersecurity Index (GCI), the National Cybersecurity Index (NCSI), the National Cyberpower Index (NCPI), the Digital Economy and Society Index (DESI), the Network Readiness Index (NRI). It should be noted that some methods of expert evaluation are used to form the most of cybersecurity indices, but at the same time for the most of indices, the methods of examination and formation of groups of experts have significant differences and features.

Cybersecurity indices of the network category include cybersecurity indices, which are formed, as a rule, for individual organizations through a multilevel analysis of control information contained in data packets transmitted in packet data networks. Organizations, which usually specialize exclusively in such activities, take part in the collection, processing, and analysis of management information. Global cybersecurity indices developers include BitSight Technology (BST), SecurityScorecard (SSC), UpGuard Inc. (UGI) with, respectively, BitSight Security Ratings Platform (BSSR), SecurityScorecard Ratings Platform (SSR), UpGuard Ratings (UGR). At a local level (of an individual organization or a particular sector of the economy) in the collection, processing, and analysis of management information are involved (if available) industry centers for monitoring and responding to information security incidents (Security Operation Centers). But, as a rule, the SOCs functionality does not provide for indexing (rating) of entities that use SOC services.

Cybersecurity indices of the data sets category include cybersecurity indices, which are formed, as a rule, by means of automatic visualization of data (other than the data used in the formation of cybersecurity indices of the network category). If data are directly related to financial (exchange) information, such cybersecurity indices are classified as financial (exchange). The cybersecurity indices of the data sets category include, for example, the Index of Cybersecurity (ICS) of the New York University Tandon School of Engineering (TSE), the Cyber Threat Index (CTI) of Imperva Inc. (IMP), the IBM X-Force Threat Intelligence Index (XFTII) of IBM Inc. (IBM). Cybersecurity indices in the financial (exchange) category include, for example, the VP Cyber Index (BVPCI) of Bessemer Venture Partners (BVP), the Foxberry Tematica Research Cybersecurity & Data Privacy USD PR Index (FXCI) of Foxberry Ltd (FXB), the Indxx Pure Cyber Index (IPCI) from Indxx (IND).

The cybersecurity indices of the combined category include cybersecurity indices (indicators, subindexes, domains) to which several other categories can be assigned simultaneously. The cybersecurity indices of the combined category include the Cyber Risk Index (CRI) of Trend Micro Inc. (TMI) and the Local Cyber Security Index (LCSI) of the International Cybersecurity University (ICU).

2.2. Methodology of Forming Cybersecurity Indices: Ratings

The subject or object of indexing (rating) is determined separately for each cybersecurity index. In a broad sense, by indexing (rating) we mean any method of evaluation.

The objects of indexing (rating) include:
- activity of indexing subjects (entities) in the field of information security and cybersecurity
- state of information security or cybersecurity of indexing subjects (entities)
- the level of protection of indexing subjects (entities) from threats (cyberthreats)

- certain indicators of information security and cybersecurity, as well as protection against relevant threats
- some indicators regarding the harmful effects of implemented threats

Indicators of indexing (rating) are the certain parameters of the subject of indexing (rating), which are used to describe and evaluate the index. Different cybersecurity indexes contain from 1 to 50 indicators that belong to the subject or object of indexing (rating) and can be evaluated separately (as a sub-index) or as part of the main index. The list of indicators of indexing (rating) is determined separately for each index, which is the basis of the methodology of formation of the corresponding index or rating.

Methods of indexing (rating):
- examination - definition and expert assessment of indicators of indexing (rating)
- parameterization - quantitative assessment of indicators of indexing (rating)
- indexing - a method of evaluation, the result of which is a dimensionless numerical indicator (index, score)
- rating - a method of evaluation, the result of which is a natural numerical indicator (number in the rating)

The methodology of index (rating) formation is based on the methods of expert evaluations, index method of mathematical statistics or mathematical rating theory [5]-[9]. The problem of choosing and/or optimizing the methodology for determining and forming indices (ratings) will be considered separately outside the scope of this study.

Methods of index (ratings) formation, as a rule, consist in the use of expert evaluation methods (Delphi method). Determining the weight of individual indicators in the composition of indexes and procedures for calculating index values has significant quantitative differences for different indices (ratings).

The formation of indices (ratings), usually takes place according to the following procedure:
- creation of an expert group, analysis of the subject of research or improvement of the procedure for forming the previous version of the index (rating)
- definition of the objects, subjects, and objectives of indexing (rating)
- data collection
- development or improvement of methods of index (rating) formation
- preparation and publication of the report

3. Global Cybersecurity Indices Data

Table 1
Cybersecurity Indices: Key Indicators

Index Name	Abbr.	Categories	1st Edition	Qual.	Country
Africa Cybersecurity Report	ACR	International (Regional), Reports	2016	4	SAR
Artificial Intelligence Index Report	AIIR	Global, Reports	2021	1	USA
Automate Third-Party Security Rating Platform	A3SRP	Global, Network	2016	∞	USA
Black Kite Cyber Risk Ratings Platform	BKCRRP	Global, Network	2016	∞	USA
BitSight Security	BSSR	Global, Network	2011	∞	USA

Ratings Platform					
BVP Cyber Index	BVPCI	Corporate, Financial (Exchange)	2011	∞	USA
Corporate Attractiveness Index	CAI	International, Expert	2018	1	USA
Cyber Attacks Timeline Master Indexes	CATMI	International, Data sets	2011	10	ITA
Command Control Cybersecurity Index	CCCI	Corporate, Reports	2018	2	DEU
Chubb Cyber Index	CCI	Corporate, Data sets	2009	2w	USA
Cyber Exposure Index	CEI	International, Corporate, Network	2018	9	SGP
Cyber Governance Indices	CGI	Corporate, Data sets	2016	∞	LXB
Cyber Green Index	CGI	Global, Network	2017	∞	USA
Cyber Hygiene Risk Index	CHRI	Corporate (Individuals), Expert	2018	2	USA
Cybersecurity Indices Global Brief Report	CIGBR	Global, Reports	2021	1	UKR
Cyber Maturity Asia Pacific Region	CMAPR	International (Regional), Reports	2014	4	AUS
Cybersecurity Capacity Maturity Model Review Reports	CMMRR	Global, Reports	2015	> 99	GBR
Cyber Norms Index	CNI	International, Data sets	2007	∞	USA
RSA Cybersecurity Poverty Index	CPI	International, Reports	2015	2	USA
Cyber Policy Portal	CPP	Global, Reports	2008 (USA)	∞	CHE
Cyber Readiness Index	CRI	International, Reports	2015	2	USA
Cyber Risk Index	CRI	International, Data sets	2018	3	USA
Cyber Risk Index	CRI	Corporate, Combined	2018	3	USA

Cyber Risk Literacy & Education Index	CRLEI	International, Reports	2020	1	USA
MSCI ACWI IMI Cyber Security Index	CSI	Corporate, Financial (Exchange)	2017	4	USA
Dell Cybersecurity Index	CSI	Corporate, Reports	2020	2	USA
Cyber Security Performance-Index	CSPI	Corporate, Financial (Exchange)	2016	∞	DEU
Cyber Threat Index	CTI	International, Data sets	2001	1m	USA
Digital Economy and Society Index	DESI	International, Expert, Data sets	2014	1y	EU
European Cyber Safe Index	ECSI	International, Data sets	2017	n/a	NLD
Evolve Cyber Security Index Fund	ECSIF	Corporate, Financial (Exchange)	2017	∞	CAN
FICO Cyber Risk Score	FCRS	Corporate, Financial (Exchange)	2001	∞	USA
Foxberry Tematica Research Cybersecurity & Data Privacy USD PR Index	FXCI	Corporate, Financial (Exchange)	2013	6m	GBR
Global Cybersecurity Assurance Report Card	GCARC	International, Reports	2016	2	USA
Global Cybersecurity Index	GCI	Global, Expert	2014	4	UN
Global Cyber Strategies Index	GCSI	International, Reports	n/a (1974 - 1st doc.)	> 99	USA
Global Threat Intelligence Report	GTIR	International, Reports	2017	4	JPN
ISE Cyber Security Index	HXR	Corporate, Financial (Exchange)	2010	∞	USA
International Cyber Benchmarks Index	ICBI	Corporate, Reports	2017	21	GBR

Index of Cybersecurity	ICS	Corporate, Data sets	2011	1m	USA
ICT Development Index (ITU)	IDI	Global, Expert	2010	8	UN
iEdge-FactSet Global Cyber Security Index	IECSI	International, Financial (Exchange)	2017	6m	SNG
Indxx Pure Cyber Index	IPCI	Corporate, Financial (Exchange)	2015	1y	USA
Kaspersky Cybersecurity Index	KCI	International, Expert	2016	n/a	RUS
S&P Kensho Cyber Security Index	KCSI	Corporate, Financial (Exchange)	2013	∞	USA
S&P Kensho Future Security Index	KSECUREP	Corporate, Financial (Exchange)	2013	∞	USA
Local Cyber Security Index	LCSI	Corporate, Combined	2021	1	UKR
Microsoft Security Intelligence Report	MSIR	Global, Reports	2006	6m	USA
National Cyber Power Index	NCPI	International, Expert	2020	1	GBR
National CyberSecurity Index	NCSI	Global, Expert	2018	∞	EST
Nasdaq CTA Cybersecurity Index	NQCYBR	International, Financial (Exchange)	2015	∞	USA
Network Readiness Index	NRI	Global, Expert	2000 (2019)	3	USA
Nuclear Security Index	NSI	Global, Expert	2012	2y	USA
Prime Cyber Defense Index	PCDI	Corporate, Financial (Exchange)	2017	3m	USA
PCS Global Cyber Suite	PCS GCS	Corporate, Expert	~ 2017	n/a	USA
Prevalent Vendor Threat Monitor	PVTM	Global, Network	2019	∞	USAGBR CAN
ReportLinker CyberSecurity Industry Reports	RL CIR	International, Reports	<2016	> 99	FRA
RiskRecon Cybersecurity Ratings	RRCR	Global, Network	2019	∞	USA

State of Cyber Resilience	SCR	International, Reports	2018	1y	50 countries
Solactive Global Cyber Security Index	SGCSI	Corporate, Financial (Exchange)	2017	∞	DEU
Security Scorecard Ratings Platform	SSR	Global, Network	2017	∞	USA
Travelers Risk Index/ Cyber	TRIC	Corporate, Expert	n/a	1y	USA
UpGuard Ratings Platform	UGR	Global, Network	~2012	∞	USA
Unisys Security Index	USI	International, Expert	2007	n/a	USA
IBM X-Force Threat Intelligence Index	XFTII	International, Data sets	2011	1y	USA

∞ - great number of issues, y - per year, m - per month, w - per week

Table 2

Cybersecurity Indices Publishers (Developers)

Index	Publisher	Index	Publisher
ACR	Africa Immersion Research Centre for Innovation and Training Facilities	FXCI	Foxberry Ltd
AIIR	Stanford Institute for Human-Centered Artificial Intelligence	GCARC	Tenable Network Security
A3SRP	Panorays	GCI	International Telecommunication Union
BKCRRP	Black Kite Inc.	GCSI	Center for Strategic and International Studies
BSSR	BitSight Technology LTD	GTIR	NTT Security LTD
BVPCI	Bessemer Venture Partners	HXR	Nasdaq Group Inc.
CAI	Institute of Electrical and Electronics Engineers	ICBI	Neustar, Inc.
CATMI	HACKMAGEDDON	ICS	Tandon School of Engineering (New York University)
CCCI	Command Control (Event)	IDI	International Telecommunication Union
CCI	Chubb Group Holdings Inc.	IECSI	Singapore Exchange LTD
CEI	Cyber Intelligence House	IPCI	Indxx

CGI	Cyberhedge EUROPE S.a.r.l	KCI	Kaspersky Lab
CGI	CyberGreen Institute	KCSI	S&P Dow Jones Indices LLC
CHRI	Wakefield Research	KSECUREP	S&P Dow Jones Indices LLC
CIGBR LCSI	International Cybersecurity University	MSIR	Microsoft
CMAPR	Australian Strategic Policy Institute	NCPI	Belfer Centre (Harvard University)
CMMRR	Global Cyber Security Capacity Centre (University of Oxford)	NCSI	e-Governance Academy
CNI	Carnegie Endowment for International Peace	NQCYBR	Nasdaq Group Inc.
CPI	EMC Corporation	NRI	World Economic Forum (Portulans Institute)
CPP	United Nations Institute for Disarmament Research	NSI	Nuclear Threat Initiative
CRI	Potomac Institute for Policy Studies	PCDI	ETF Ventures LLC
CRI	NordVPN.com & Tefincom S.A.	PCS GCS	Verisk Analytics, Inc.
CRI	Trend Micro Inc.& Ponemon Institute	PVTM	Prevalent, Inc.
CRLEI	Oliver Wyman Forum	RL CIR	ReportLinker.com
CSI	Morgan Stanley Capital International Inc.	RRCR	RiskRecon Co.
CSI	Dell Secure Works (Counter Threat Unit)	SCR	Accenture
CSPI	Vontobel Holding AG	SGCSI	Soloactive AG
CTI	Imperva Inc.	SSR	SecurityScorecard Co.
DESI	European Commission	TRIC	Travelers Indemnity Co.
ECSI	VPNoverview	UGR	UpGuard Inc.
ECSIF	Evolve ETFs	USI	Unisys Company
FCRS	FICO	XFTII	IBM Inc.

4. Main Results and Conclusion

The development of high-level indicators to describe the state of information security and cybersecurity of individual organizations, sectors (industries) of the economy, critical (including digital) infrastructures, states, regions, and the world as a whole is gradually becoming the main task of public and global security. A nonlinear increase in the rate of formation of the global hierarchy of safety indicators can be observed. The problem of defining a system of safety indicators, even at a special level, remains unsolved and an extremely urgent task.

For the first time in the frame of a single study 65 existing global, international, and corporate cybersecurity indices and approaches to their formation are described and analyzed. The definition of

the terms necessary for the analysis of indexing (rating) in the field of information security and cybersecurity is offered.

The materials of the report could be used for making a national contribution to the global cybersecurity reports of the world and international organizations in the field of information and communication technologies, telecommunications, and cybersecurity (ITU, FIRST, GFCE).

5. Acknowledgements

6. References

[1] J. Lewis, G. Neuneck, "The Cyber Index International Security Trends and Realities", UNIDIR United Nations Institute for Disarmament Research Geneva, Switzerland, 2013, no.3, URL: https://www.files.ethz.ch/isn/165142/the-cyber-index- international-security-trends-and-realities-en-463.pdf

[2] Global Cybersecurity Index 2018, v.4, ISBN 978-92-61-28201-1, International Telecommunication Union, CH-1211, Geneva, Switzerland, 2019, 90 p., URL: https://www.itu.int/en/ITU-D/Cybersecurity/Pages/global-cybersecurity-index.aspx

[3] S. Gnatyuk and oth.., "Method of Cybersecurity Level Determining for the Critical Information Infrastructure of the State", [COAPSN-2020: International Workshop on Control, Optimisation and Analytical Processing of Social Networks], 2020, URL: http://ceur-ws.org/Vol-2616/paper28.pdf

[4] R. Boyarchuk, M. Khudyntsev, O. Lebid, O. Trofymchuk, "Organizational and Technical Model of National Cybersecurity and Cyber Protection", [CPITS'2021, Workshop on Cybersecurity Providing in Information and Telecommunication Systems CEUR Workshop Proceedings ISSN 1613-0073, January 28, 2021, NURE, Kyiv, Ukraine], URL: http://ceur-ws.org/Vol-2746/frontmatter.pdf

[5] I. Gormley, S. Frühwirth-Schnatter, "Mixtures of Experts` Models", arXiv:1806.08200v1 [stat.ME], 21 June, 2018, Preprint, 38 p., URL: https://www.researchgate.net/profile/ Sylvia_Fruehwirth-Schnatter/publication/325922320_Mixtures_ofdEfelin -Experts-Models.pdf

[6] P. Lutereau and oth., "General Criteria: Group Rating Methodology", Standard&Poor's Financial Services LLC, 2013, 51 p., URL: https://www.maalot.co.il/Publications/MT20180219160103.pdf

[7] L. Davidson, X. Ling, M. Sargis, T. Strauts, "Morningstar Quantitative Rating for funds", 19 March, 2018, 37 p., Morningstar, URL: https://s21.q4cdn.com/198919461/files/doc_downloads/ 2019/11/Morningstar-Quantitative-Rating-for-funds-Methodology-v14.pdf

[8] A. Solodov, Mathematical principles of building rating systems, Economics, Statistics, and Informatics, 2016, №1, p.75-82 (in Russ.), URL: https://cyberleninka.ru/article/n/ matematicheskie- printsipy-postroeniya-reytingovyh-sistem

[9] M. Lyndina, A. Orlov, Mathematical theory of ratings. Nauchnyy zhurnal KubGAU [Scientific Journal of KubSAU], 2015, no. 114, p. 1-26 (in Russ.). URL: http://sj.kubsau.ru/2015/10/pdf/01.pdf