The 12th IEEE International Conference on Dependable Systems, Services and Technologies, DESSERT'2022
9-11 December, 2022, Athens, Greece

Design Science Research towards ECHO Governance and Management Information System

Jyri Rajamäki
W Unit, Laurea University of Applied Sciences
Espoo, Finland
jyri.rajamaki@laurea.fi

Janne Lahdenperä
W Unit, Laurea University of Applied Sciences
Espoo, Finland
janne.lahdenpera@student.laurea.fi

Velizar Shalamanov
Institute of Information and Communications Technologies – Bulgarian Academy of Sciences
Sofia, Bulgaria
velizar.shalamanov@iict.bas.bg

2022 12th International Conference on Dependable Systems, Services and Technologies (DESSERT) | 979-8-3503-3304-6/22/$31.00 ©2022 IEEE | DOI: 10.1109/DESSERT58054.2022.10018802

***Abstract*—The ECHO (European network of Cybersecurity centers and competence Hub for innovation and Operations) CNO (collaborative network organization) is supposed to start operating in early 2023. The management of the information flows is important for the successful governance of the CNO. For the needs of the future organization, this design science research (DSR) develops a Governance and Management Information System (GMIS), which will be a communication-driven decision-making system with a common space for a document database and tools for communication and teamwork. The paper describes five design cycles and their results: (1) ECHO GMIS high-level functions, (2) process support functions, (3) information-sharing functions, (4) platform planning, and (5) implementation plan. The follow-up studies are presented in three different timeframes: what can be done before the CNO starts operating, what can be done immediately after the CNO starts operating, and a medium-term plan. Finally, the research is evaluated using the DSR framework.**

***Keywords*—Design science research; ECHO governance model; Data governance; Management information system**

I. INTRODUCTION

European network of Cybersecurity centers and competence Hub for innovation and Operations (ECHO) [1] is one of the EU pilot projects launched to prepare the European Cybersecurity Competence Network, others being CONCORDIA [2], SPARTA [3] and CyberSec4Europe [4]. The aim of ECHO is to develop a unified cyber defense ecosystem for the European Union and improve the secure cooperation of its members. This is achieved through multiple different ECHO concepts, such as the governance and management (GM) model for the future ECHO collaborative network organization (CNO) for managing current and future partners, the ECHO Federated Cyber Range for cyber simulation training, and the ECHO Early Warning System for secure sharing of cyber threat information.

The management of the information flows is an important area of successful governance of CNOs and needs an information system to function. The type of suggested governance and management information system (GMIS) [5, pp. 44-48] is the communication-driven decision support system [6] with shared space for documents database and tools for communication and group work.

When designing the GMIS, the main questions are:

How to implement a system of rules, practices and processes aimed at achieving ECHO's strategic goals, decision-making and information coordination, control, analysis and visualization, with the help of this system ECHO CNO will be guided and monitored in such a way that it enables effective, efficient and cyber resilient management that balances the interests of all stakeholders?

How to increase ECHO's business value with the help of IT tools that support processes, functions and intelligence, and balance the risk and value of information, ensuring the compliance with laws and regulations?

The purpose of the study is to focus on the conception, structure, and application of the ECHO GMIS. The simplified research question from the previous broad questions of this design science research (DSR) is: *What kind of information system can be used to support the future CNO's processes and information-sharing needs?* In contrast to behavioral science, DSR aims to provide four general outputs: constructs, models, methods, and instantiations [8]. Fig. 1 shows how the DSR framework is applied in this paper, and how the following DSR checklist questions are mapped to three design research questions [7]: (1) What is the research question (design requirements)? (2) What is the artifact? How is the artifact represented? (3) What design processes (search heuristics) will be used to build the artifact? (4) How are the artifact and the design processes grounded by the knowledge base? What, if any, theories support the artifact design and the design process? (5) What evaluations are performed during the internal design cycles? What design improvements are

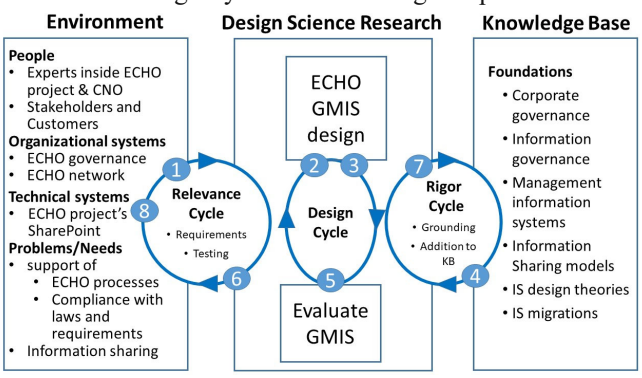

Fig. 1. Design Science Research framework of the study (modified from [7])

identified during each design cycle? (6) How is the artifact introduced into the application environment and how is it field tested? What metrics are used to demonstrate artifact utility and improvement over previous artifacts? (7) What new knowledge is added to the knowledge base and in what form (e.g., peer-reviewed literature, meta-artifacts, new theory, new method)? (8) Has the research question been satisfactorily addressed?

This introduction presents the ECHO environment, in which the GMIS will be designed, and the methodology applied. Section 2 deals with the present knowledge base with regard to (1) corporate and information governance, (2) management information systems, (3) information sharing theories and models, (4) information system (IS) design theories, and (5) IS migrations. Section 3 presents the relevance and design cycles of GMIS. Finally, section 4 answers the DSR checklist questions and concludes the paper.

II. KNOWLEDGE BASE

A. Governance and Management Information Systems

1) Corporate and Information Governance

The governance function of an organization is responsible for determining strategic direction. According to Chartered Governance Institute UK & Ireland [9], "corporate governance is the system of rules, practices and processes by which a company is directed and controlled." They continue that it is a toolkit that enables management and the board to deal more effectively with the challenges of running a company. Corporate governance ensures that businesses have appropriate decision-making processes and controls in place so that the interests of all stakeholders are balanced. Corporate governance also helps us to meet the requirements of laws and regulations such as the Network and Information Security (NIS) Directive and the General Data Protection Regulation (GDPR).

Information governance means the overall strategy for information, looking at it from the perspectives of policies, systems, people, and processes (see Fig. 2). Harnessing its elements will help us to create and maintain appropriate policies and procedures to help meet our data privacy requirements. Information governance balances the risk that information presents with the value that information provides. It covers such issues as information security and protection, compliance, data quality, data governance, electronic discovery, risk management, privacy, data storage and archiving, knowledge management, business operations and management, audit, analytics, IT management, master data management, enterprise architecture, business intelligence, big data, data science, and finance.

Fig. 2. Perspectives of information governance

2) Management Information System

An organization's management functions take the strategic direction and translate it into actions that will bring the organization closer to achieving the strategic goals. A management information system (MIS) is an information system used for decision-making, and the coordination, control, analysis, and visualization of information in an organization. The MIS study field involves people, processes, and technology in an organizational context. In corporations, the goal of the use of MIS is to increase the value and profits of the business through IT tools used to support processes, operations, and intelligence. Information sharing is considered one of the most important ways to increase organizational efficiency and performance [10].

B. Information System Design Theories

The main purpose of any implemented information system is to improve the effectiveness, efficiency and cyber resilience of the organization where it is implemented. Hevner, et al. [11] present seven guidelines for designing information systems with design science. These guidelines are not to be followed too literally, but each of them should be assessed at least somewhat during the design process:

1. Design as an Artifact – The end result of the research should be an IT artifact that addresses a specific organizational problem.
2. Problem Relevance – Information system research must address the problems faced in the environment it is applied to.
3. Design Evaluation – Well-executed evaluation methods must be used to demonstrate the quality of the design artifact.
4. Research Contributions – Clear contributions in the area of the research artifact must be provided.
5. Research Rigor – Both the construction and the evaluation of the designed artifact require the application of rigorous methods.
6. Design as Search Process – The goal of finding an effective solution to a problem is a search process and is inherently iterative.
7. Communication of Research – The results of the research must be presented in a form that is easily understood both by technology-oriented and management-oriented audiences.

When building an information system, it is usually very beneficial to define different roles and responsibilities within the system. One good way to accomplish this is to build a responsibility assignment matrix, also known as RACI matrix [6]. The different roles in a RACI matrix are responsible, accountable, consulted, and informed.

Most critical in information system design is to follow an architectural approach first presented by Zachman [12] with specific aspects developed for the web-based systems presented by Molnár and Tarcsi [13]. We adapt these approaches starting from the operational view through the system view, down to the technical view for the web-based GMIS for ECHO with a focus on information sharing and the need for migration from the ECHO Project Information System to ECHO Collaborative Network Organization GMIS.

C. Information Sharing

Information sharing is a key part of any organization's data management, the lack of effective data sharing can disturb operational capacity and hinder decision-making. The system used for information sharing should be compatible with the whole organization, otherwise, it can lead to unnecessary transcribing and rekeying of the information when it is transferred between systems. Information sharing systems should also be built with ease of access and data search in mind, if the needed information is not readily found, it can lead to frustration and reduced organizational effectiveness. [14]

Information sharing can be both internal and external. Internal communications within an organization can happen, for example, with different mailing lists, where each department (ECHO CNO entity) has its own list. One effective tool for internal information sharing is an organization-wide intranet, where all needed information is readily available when needed. For external information sharing, one widely used method is the organization's web page. Through a www-site, any news or other shared information can be easily accessed by all visitors. It might also be beneficial to build a specific extranet for the organization's various partners so that they can easily communicate without the need for intranet access.

Sharing cybersecurity information between different organizations can be very beneficial. It can help to defend against potential attackers, improve response to threats, and mitigate damages. Information sharing can also help to build trust and improve relations between organizations. Information sharing can also have its challenges, legal issues may arise when different countries have different definitions of protecting classified information. Therefore, using the right information-sharing models and frameworks is very important for efficient data sharing between organizations [15].

D. Information System Migration

As time passes, information systems can become outdated and no longer serve their intended purpose. Therefore, an organization's migration to a more evolved and modernized platform that provides all the needed services is often important. An IS migration is a project that should be completed without loss of data or functionalities, and access to the system should be available through the migration process. [16]

Klettke and Thalheim [16] present three different IS migration strategies with their own strengths and weaknesses. The strategy used should be chosen depending on system complexity, modularization of the legacy system, frequency of the data changes, amount of data in the database, and accepted delay time of the system.

1. Big bang – In this strategy, a completely new system is developed at once. The legacy system serves as the operating system through the development process. The migration process may be easy to manage, but the development time is usually long, and the system is not available during the transition.
2. Chicken little – In this strategy, the system is modularized, and all components are migrated separately. The individual development and migration times are short, and system availability is high. Unfortunately, the existence of two parallel systems at the same time may prove problematic when they must interact with each other.
3. Butterfly – Combination of the first two strategies. In this strategy, the focus is on the migration of the database. The legacy system is used only as read-only storage and all changes are done to the new system. This way the risk of possible data loss is mitigated and the new system can be tested with already available data. The downsides of this strategy include long development times and reliance on the design of the old system.

III. Relevance and Design Cycles

Fig. 3 shows the five design cycles applied in this study. It presents the business needs in each design cycle from the contextual environment of the research project. Fig.3 also describes the applicable knowledge base of scientific foundations, experience, and expertise that informs these design cycles.

A. 1st Design Cycle – ECHO GMIS High-level Functions

Fig. 4 places the ECHO GMIS in the future ECHO CNO, whose organizational model consists of three types of units: ECHO Central Hub, National Hubs, and Service Groups. Central Hub is ECHO CNO's overall management (including the governing level of boards/councils) body. National hubs are established on a national level and serve as contact points between the Central Hub and national authorities and organizations. Service groups are formed around the delivery of specific services, such as the ECHO Federated Cyber Range (E-FCR) or the ECHO Early Warning System (E-EWS). The ECHO GMIS is mainly intended for internal use within the organization. The Catalogue (Market Place) is intended for service providers (Service Groups) and their customers, and the web pages serve all stakeholders.

When combining ECHO's business needs with the experiences and expertise that define the state-of-the-art in the application domain of the research (section II.A.), we can define three high-level functions for the ECHO GMIS: (1) support processes, (2) ensure efficient information sharing, and (3) help to meet the requirements of laws and regulations.

1) Support processes

The first high-level function of the ECHO GMIS is to support the ECHO CNO's processes. Fig. 5 presents ECHO CNO's key processes and their relationships. The core processes are strategic planning, partnership development, innovation management, and catalog and customer relations. Other processes to be supported are HR management, financial management, data management including document handling, portfolio management, continuity management, and external relations management.

2) Ensure efficient information sharing

Communication between different partners is a key factor when designing a successful governance model for collaborative networked organizations. The ECHO GMIS aims to solve this by having a communication platform that is community-based and accessible to all different ECHO members and partners. It will include, for example, intranet, extranet, web pages, calendar management, and document repositories.

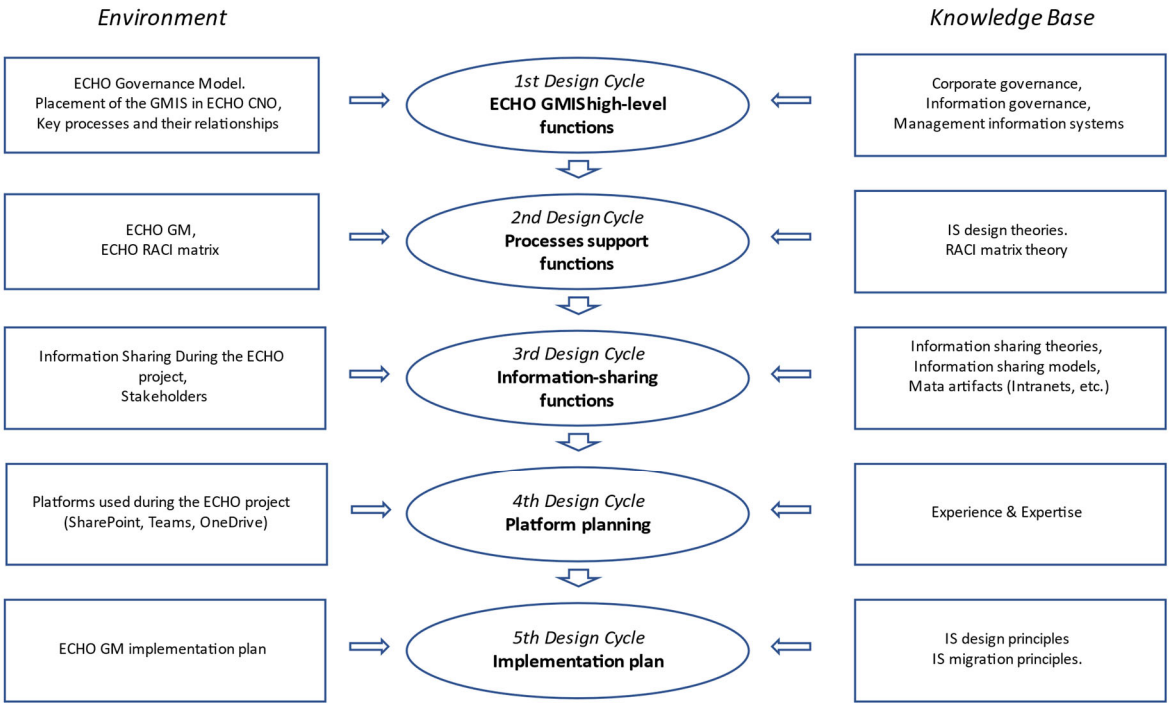

Fig. 3. Design cycles of the study

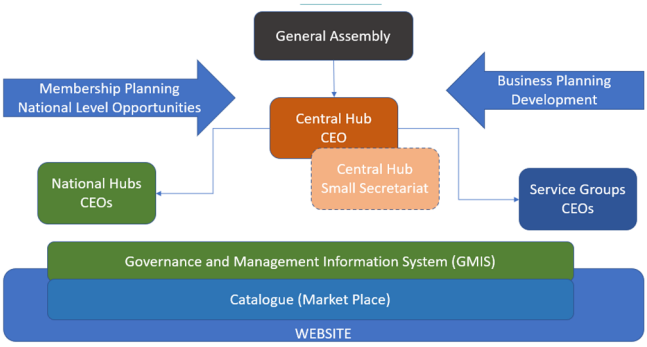

Fig. 4. Placement of the GMIS in the ECHO CNO

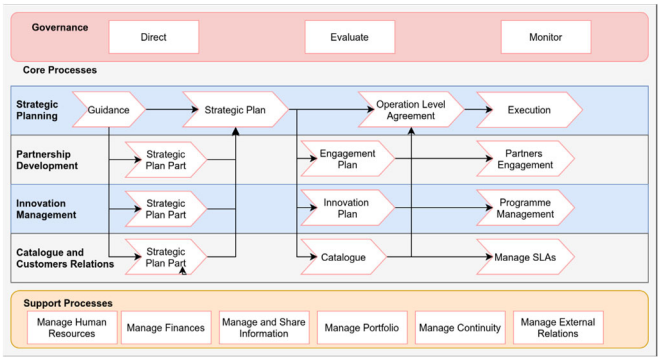

Fig. 5. ECHO CNO's key processes and their relationships

3) *Helping to meet laws and regulations*

The ECHO GMIS should help to meet the requirements of laws and regulations. ECHO services provided by ECHO network members will be offered via an online marketplace which is a digital service that allows individuals or traders to carry out sales or service contracts with traders. This means that the Directive on Security of Network and Information Systems (NIS/NIS 2 Directive) applies.

All personal data is protected under the General Data Protection Regulation (GDPR), which, for example, requires all organizations to have data controllers and processors to demonstrate their compliance with its requirements through certain documentation, including relevant logs, policies, and procedures.

In addition to European legislation, the national legislation of the country/countries where ECHO CNO operates may have its/their own requirements.

B. *2nd Design Cycle - Processes support functions*

According to ECHO D3.3 [5, p. 55], the process support goals of the GMIS are (1) reliable access to documents and information, (2) decision-making process tracking, (3) resource use and planned activities tracking, (4) members' status change agreements and compliance tracking, and (5) maintaining standardized form for output and input data. Next, we will cover some issues in more detail.

Procedures	General assembly	Board of Directors	NHs and SGs	Membership Committee	Technology and Innovation Committee	Financial Committee	Audit Committee	Risk Management Committee	Chief Executive	Chief Financial Officer	Chief Partnership Officer	Chief Technology Officer	Chief Customer Officer
Strategic Planning Guidance development		A		R	R	R	R	R	R	R	R	R	R
Positioning and NHs and SGs strategic plans preparation		A	R										
Coordination of the Strategic Plan		A	R	C	C	C	C	C	R	R	R	R	R
Approval of the Strategic Plan	R	A											
Business planning of NHs and SGs			R						A				
Business planning for the Central Hub		I							A	R	R	R	R
Coordination of the business plans		A	R	C	C	C	C	C	R	R	R	R	R
Approval of business plans	R	A		C	C	C	C	C	C	C			
Signing Operational Level Agreements		A	R						R	R	R	R	R
Execute Business Plans and Operational Agreements		I	R						A	R	R	R	R
Report KPI on monthly, quarterly and six-moth basis		I	R						A	R	R	R	R
Annual reporting	R	A	R						A	R	R	R	R
Partners engagement	I	A	C	R	C	C	C	R	R		R		
Partners acceptance and certification in membership status		A	C	R	C	C	C	C	R				
Partners monitoring	I	I	R	R					A	C	R	C	C
Service catalogue management	I	I	R	C	C	C	C	C	A	C	C	C	R
Service-level agreement management	I	I	R	C	C	C	C	C	A	C	C	C	R
Portfolio management of investments	I	I	R	C	C	C	C	C	A	C	C	R	C
Programme, project and events management	I	I	R	C	R	C	C	C	A	C	R	C	R
Establishment and change of NHs and SGs	R	A	R	C	C	C	C	C	R	R	R	R	R
Election of BoD and Advisory committees	R		C	C	C	C	C	C	A	R	R	R	R
Appointment of the Executive Management officers	I	A								R			
Escalation procedure for members		A	R	C			R	C		R	R		
Escalation procedures for customers		A	R	C			R	C		R	R		
Development and maintenance of GMIS		A	R	R	R	R	R	R	R	R	R	R	R

Fig. 6. RACI matrix of the central Hub [5]

1) Reliable access to documents and information

The GMIS should provide reliable and well-grained access control to the information and documents. Because a RACI (responsible, accountable, consulted, informed) matrix [17] was applied during the development of the ECHO CNO governance model, it can be used as a good basis for defining the folder structure and access rights of the ECHO GMIS. Fig. 6 is an example of these RACI matrixes.

Penchev and Shalamanova [18] suggest the GMIS will be divided into four main folders: Decision Tracker; Resource Tracker; Final Decisions and Reports; and Archive. Fig. 7 presents one suggestion for the folder structure.

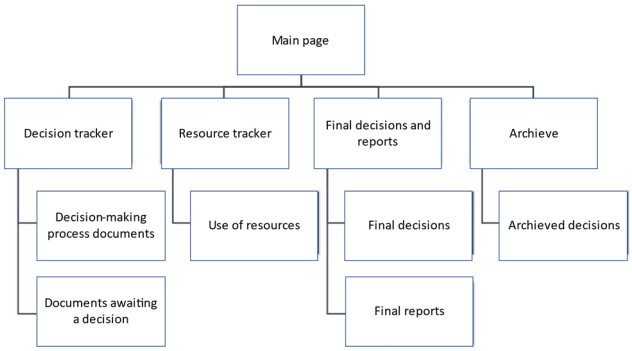

Fig. 7. A possible folder structure for GMIS

2) Decision making-process tracking

The Decision Tracker main folder should contain all data used during the decision-making process and records for intermediate (if there are any) decisions, as well as minutes of meetings in which the decision is made. When a final decision is reached it will be transferred to the Final Decisions and Reports folder, as Fig. 8 shows.

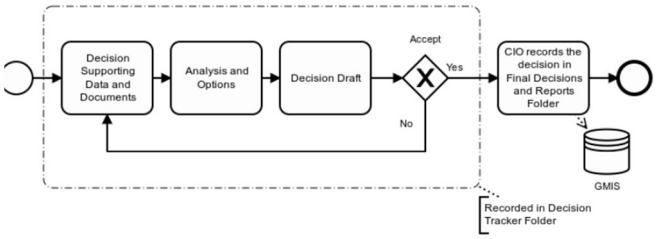

Fig. 8. Decision tracking

3) Resource use and planned activities tracking

According to [18], the Resource Tracker folder will contain forms for tracking resource use, planned activities status reporting, and risk reporting. The responsible organizational bodies for the execution of the planned activities will fill these forms on a regular basis (quarterly, six months, and annually). The full annual reports will be transferred to the Final Decision and Reports folder as Fig.9 shows [5].

C. 3rd Design Cycle - Information-sharing functions

Information sharing during the ECHO project has been implemented through the following channels: (1) The ECHO website shares public deliverables, scientific publications, newsletters, and other information which is intended for general distribution. It also includes a service related to supporting partnership engagement; (2) The SharePoint, Teams, and One Drive for Business internal platform includes project repositories for contractual documents, amendments, review-related documentation, reporting documentation, contact details, templates, working documents of deliverables, final versions of all deliverables, internal working documents, agendas, minutes, etc. Also, the project's teleconference system has also been implemented using this; (3) Zenodo open repository is used for open datasets.

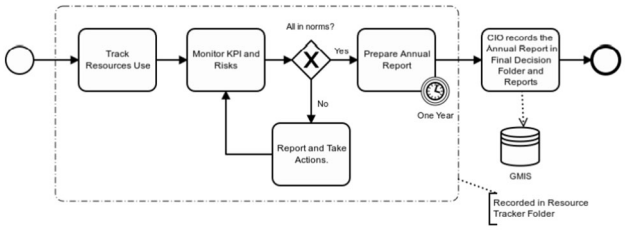

Fig. 9. Resource tracking [5]

The ECHO GMIS should include intranet functions: (1) Central sites: sites can be bundled into a single entity that shares a common top navigation and theme; (2) Official communication, (3) News; (4) Calendar of events; (5) Social intranet; (6) Searches: personal search, which everyone can enhance by completing their own Delve profile, and (7) Electronic desk: Quick links lists, e.g. frequently used tools; Downloads using the Highlighted content web part, e.g. the most recently updated files from the entire intranet or the most popular pages; Possibility of targeting content and links.

Fig. 10 shows the main stakeholders of the ECHO network. Extranet functions are needed for information sharing of non-public information with stakeholders. One such information item might be cyber threat intelligence (CTI) sharing between those who are outsiders of E-EWS.

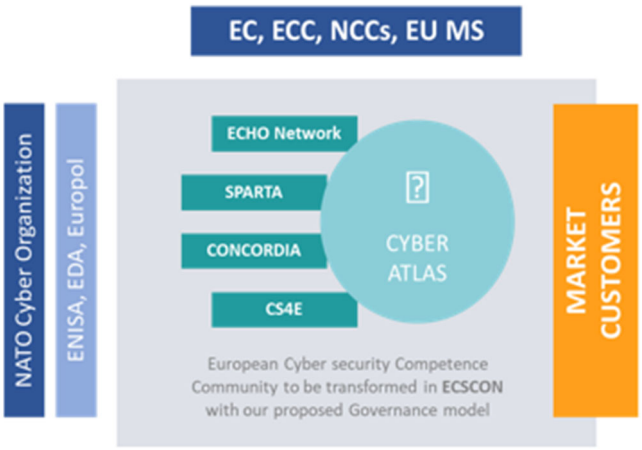

Fig. 10. ECHO CNO's stakeholders (modified from [18])

The ECHO GMIS must enable the organization of webinars and teleconferences.

D. 4th Design Cycle - Platform planning

1) Alternatives for ECHO GMIS Platforms

The ECHO project's information-sharing platform has been implemented via Microsoft SharePoint, so obviously, that is one option. Box File Sharing was selected as the best alternative. Table I presents the comparison of these platforms from the ECHO's point of view. Fig. 11 shows a SWOT analysis of SharePoint.

When choosing between SharePoint Online and On-Premises, there are a few things that point to the online option, as Table I states.

TABLE I. COMPARISON OF POSSIBLE PLATFORMS

COMPARISON OF ALTERNATIVES	
Box	**SharePoint**
• Top-notch security controls backed up by many regulations, Seamless integration also with Cisco • Communication tools integrated by many well-known business partners like Google and Microsoft	• Good baseline security, standards, and usability • Communication tools and capabilities are excellent • Ultimate solution for team collaboration • Used during the ECHO Project!
SharePoint Online	**SharePoint On-Premises**
• is an ideal platform for a small team with no particularly sensitive information to protect. It is also a good option if the organization does not have a full IT staff to support a physical server. • is a good option when the organization has a small budget and requires only a few customizations. • may not be chosen if better control of data and how it's stored is needed, or if the company has a large staff that can both support its specific needs and create custom solutions.	• is best when a business needs a more robust server option. If a company needs to keep sensitive data locked down and already has customizations that are used for its needs, a physical server is the best option. • if a company is already using a physical server and have the budget, staff, and hardware prerequisites in place, then migrating to an online solution might not make the most sense. • it is not worth bothering with on-premises if a company wants people off-site to have access to its servers, doesn't have the right pre-requisites in place, or doesn't have a large enough budget for staff and equipment.

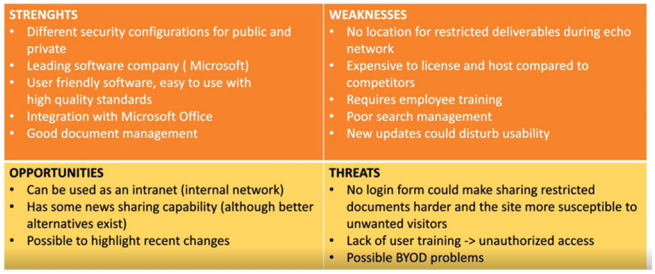

Fig. 11. SWOT analysis of SharePoint

2) ECHO GMIS Management Structure

The management of the ECHO GMIS can be implemented by centralized management which means that the Central Hub manages the system, or by a distributed model meaning shared maintenance responsibility. The most likely model is hybrid management in which some functions are managed centrally (e.g., strategic planning process), and other functions are managed distributedly (e.g., catalogue and customer relations by service groups) with national hubs supporting both the central hub and service groups for the relations with local entities.

D. 5th Design Cycle - Implementation plan

1) Mapping Project SharePoint Portal with GMIS

Fig. 12 shows how the ECHO Project material can be transferred to the new SharePoint-based GMIS or other repositories. The material to be transferred can be any digital material, such as a document, image, video, folder, or entire folder structure with documents. Once the material to be transferred is defined, a digital object is formed from it. In this context, it is given a persistent ID and the desired metadata is defined. After this, the transfer to the desired new location is performed (overall migration is key effort to move from ECHO Project to ECHO CNO).

Also, the following aspects should be taken into account: (i) data architecture (TRL and IRL); (ii) data model and design [communication, integration, and interactions]; (iii) data operations and storage; (iv) data security (SecRL); (v) data integration and interoperability (IRL), (vi) document and content management [SharePoint and FAIR REPOSITORY]; (vii) master data and references; (viii) business intelligence and warehouse; (ix) metadata (FAIR implementation and document handling), (x) data quality (accuracy), and (xi) usability.

2) Implementation Steps

Designing a new folder structure for the old SharePoint can be started immediately. In the current SharePoint portal, all users have access to everything. In the future GMIS, this will probably change, and the RACI matrix can be used to define folder access and user rights. CNO partners are not the same as

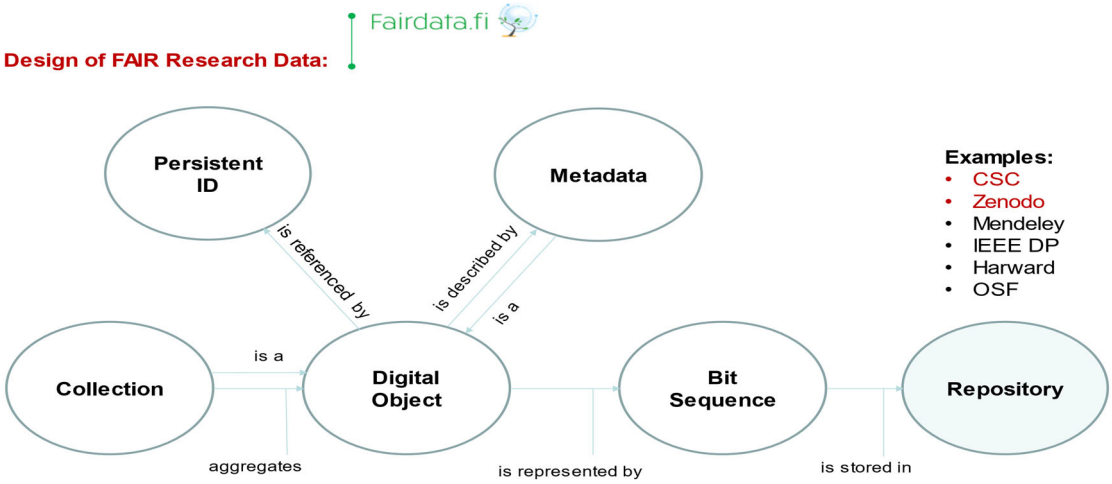

Fig. 12. ECHO project material transfer

ECHO project partners. The project partner must be guaranteed access to the project outputs even after the project ends. On the other hand, some project folders contain confidential information, and not all members of the future CNO can be automatically given access to them.

Creating and implementing a new information system is a big task, and it must be planned carefully. The ECHO project is just coming to an end, and there is no time to build a new system before the CNO starts operating, so the old system has to cope at first. The principle is that the system starts small and grows with the Central Hub. The web presence and GMIS should be outsourced, and in the first phase, the continuation of their maintenance is agreed upon year by year for a maximum of 5 years with the current administrators. Because the CNO partners are not the same as the ECHO project partners, and users can have different levels of access and user rights, extra work is needed during the transition phase.

The GMIS planning project can be initiated once the CNO has established its operations. The size of this information system development project depends on the scale and scope of the CNO's operations.

IV. Discussion

The paper examines the design of a governance and management information (GMIS) system that can be used to support the processes and information-sharing needs of the future CNO. The paper describes five design cycles and their outcomes: (1) ECHO GMIS high-level functions, (2) process support functions, (3) information-sharing functions, (4) platform design, and (5) implementation plan. The implementation plan includes descriptions of future research and follow-up work in three different time frames. Firstly, what can be done before the CNO starts its operations, then what should be done immediately when the CNO's operations start, and finally a medium-term plan is presented.

Hevner and Chatterjee [7] provide a general framework to guide researchers on how to conduct, evaluate, and present design science research. This paper relates to these guidelines, and Table II answers to their design science research checklist questions. The results of this study were presented in the ECHO WP3 Workshop (10-11 Nov. 2022), where confirmations and clarifications were received to complete the study.

TABLE II. Design Science Research Checklist questions and answers

Questions and Answers	This study
What is the research question (design requirements)? • What kind of information system can be used to support the future CNO's processes and information-sharing needs?	Section I
What is the artifact? How is the artifact represented? • Artifact: GMIS • This study presents the needed functions and the implementation plan	Section III
What design processes (search heuristics) will be used to build the artifact? • IS design theories	Section III
How are the artifact and the design processes grounded by the knowledge base? What, if any, theories support the artifact design and the design process? • Corporate governance • Information governance • Management information systems • Information Sharing models	Section II
What evaluations are performed during the internal design cycles? • ECHO WP3 Workshop (10-11 Nov. 2022) *What design improvements are identified during each design cycle?* • Advanced user requirements	Section IV
How is the artifact introduced into the application environment and how is it field tested? What metrics are used to demonstrate artifact utility and improvement over previous artifacts? • The description of the system will be presented in the ECHO Deliverable 3.13.	
What new knowledge is added to the knowledge base and in what form (e.g., peer-reviewed literature, meta-artifacts, new theory, new method)? • This research paper	Sections I-IV
Has the research question been satisfactorily addressed? • Only partly. The R&D&I project is in progress and future research is needed.	Section IV

Acknowledgments

This work was supported by the ECHO project which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no.830943.

References

[1] "ECHO - Home," 2022. [Online]. Available: https://echonetwork.eu/. [Accessed 13 Dec. 2022].

[2] "CONCORDIA - Home," 2022. [Online]. Available: https://www.concordia-h2020.eu/. [Accessed 13 Dec. 2022].

[3] "SPARTA - Home," 2022. [Online]. Available: https://www.sparta.eu/. [Accessed 13 Dec. 2022].

[4] "Cyber Security for Europe - Home," 2022. [Online]. Available: https://cybersec4europe.eu/. [Accessed 13 Dec. 2022].

[5] G. Penchev, et al., "D3.3 GOVERNANCE MODEL DESCRIPTION," 31 Jan. 2021. [Online]. Available: https://echonetwork.eu/wp-content/uploads/2021/03/ECHO_D3.3.Governance-Model-Description.pdf. [Accessed 18 Nov. 2022].

[6] R. F. Smallwood, Information Governance, 2nd Edition, John Wiley & Sons, Inc., 2019.

[7] A. Hevner and S. Chatterjee, Design research in information systems: theory and practice, New York: Springer Science and Business Media, 2010.

[8] T. March and G. Smith, "Design and natural science research on information technology," *Decis. Supp.*, vol. 15, no. 4, pp. 251-266, 1995.

[9] The Chartered Governance Institute UK & Ireland, "What is corporate governance?," The Chartered Governance Institute UK & Ireland, 2022. [Online]. Available: https://www.cgi.org.uk/about-us/policy/what-is-corporate-governance. [Accessed 18 Nov. 2022].

[10] T. Yang and T. Maxwell, "Information-sharing in public organizations: A literature review of interpersonal, intra-organizational and inter-organizational success factors," *Government Information Quarterly*, vol. 28, no. 2, pp. 164-175, 2011.

[11] A. Hevner, S. March, J. Park and S. Ram, "Design science in information systems research," *MIS Quarterly*, vol. 28, no. 1, p. 75–105, 2004.

[12] J. A. Zachman, "A framework for information systems architecture," *IBM Systems Journal*, vol. 26, no. 3, pp. 276-292, 1987.

[13] B. Molnár and Á. Tarcsi, "Design and architectural issues of contemporary web-based information systems," *Mediterr. J. Comput. Netw.*, vol. 9, pp. 20-28, 2013.

[14] K. Gordon, Principles of Data Management - Facilitating Information Sharing. Second Edition, Swindon: BCS Learning & Development Limited, 2013.

[15] J. Rajamäki and V. Katos, "Information Sharing Models for Early Warning Systems of Cybersecurity Intelligence," *Information & Security: An International Journal*, vol. 46, no. 2, pp. 198-214, 2020.

[16] M. Klettke and B. Thalheim, "Evolution and Migration of Information Systems," in Embley, D., Thalheim, B. (eds) Handbook of Conceptual Modeling, Heidelberg, Springer, 2011, p. 381–419.

[17] RACI Chart, "RACI Chart," 2022. [Online]. Available: https://racichart.org/. [Accessed 19 Nov. 2022].

[18] G. Penchev and A. Shalamanova, "A Governance Model for an EU Cyber Security Collaborative Network – ECSCON," *Information & Security: An International Journal*, vol. 46, no. 1, pp. 99-113, 2020.

[19] [D. Oiwer, Decision Support Systems: Concepts and Resources for Managers, Westport, CN: Quorum Books, 2002.